Quality Assurance Project Plan

Wilcox Oil Company

SSID: 06GG RA01

USEPA REGION 6 ERRS CONTRACT

CONTRACT NO. 68HE0422D0001

June 16, 2022

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Title **Page**

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Appendix D Standard Operating Procedures (SOPs)
Appendix E EPA RSLs Used as Project Action Limits for Clean Material
Appendix F Laboratory Quality Manual and SOPs (attached once laboratory is selected)

QAPP Crosswalk			
EPA QA/R-5 Section		**UFP Worksheets**	**Description**
A1	Title and Approval Sheet	1&2	Approval signatures and project identifying information
A2	Table of Contents	TOC	Lists QAPP contents, including appendices, figures and tables
A3	Distribution List	3&5	List of persons receiving QAPP
A4	Project/Task Organization	3&5, 6 ,4,7&8	Project organization chart and responsibilities of personnel
A5	Problem Definition/ Background	1&2, 10,15	Problem to be solved, decision to be made, or outcome to be achieved
A6	Project/Task Description	9, 14&16	Summary of all work to be performed,
A7	Quality Objectives and Criteria	11, 12, 15	QA objectives for measurement data in terms of Precision, Accuracy, Representativeness, Comparability and Completeness
A8	Special Training/ Certification	4,7&8	Special training based on site requirements
A9	Documents and Records	4, 6, 29	Identify all project records / documents that will be produced
B1	Sampling Process Design	11, 14&16,17, 18, 37	Describes data generation or data collection process
B2	Sampling Methods	18, 21	Describes the procedures for collecting samples. If an SOP is not in place, one will be developed
B3	Sample Handling and Custody	19&30, 26& 27	Process for sample documentation, handling, custody, and shipping
B4	Analytical Methods	19&30, 23, 24, 25	Standard methods from EPA SW-846 for routine analysis
B5	Quality Control	12, 15, 20, 28	Describes QC (e.g., spikes, duplicates, blanks) and frequency
B6	Instrument/Equipment Testing, Inspection, and Maintenance	21, 22, 25,19& 30	Describes the maintenance program to ensure the accuracy of measuring systems or instruments
B7	Instrument/Equipment Calibration and Frequency	22, 25	Calibration of both field and laboratory instruments
B8	Inspection/Acceptance of Supplies and Consumables	22	Describes process for supplies acceptance for use in the project
B9	Non-direct Measurements	11, 13, 31 32 &33, 37	Describes secondary data and evaluation process
B10	Data Management	29, 31, 37	Describes data management process/tools
C1	Assessments and Response Actions	31 32 &33	Describes the audit procedures and frequency and correcting deficiencies
C2	Reports to Management	31 32 &33	Type and frequency of QA reports submitted to project and program management
D1	Data Review, Verification, and Validation	34, 35, 36	State the criteria used to review and validate
D2	Verification and Validation Methods	34, 35	Describes how data will be validated and summarized for reporting
D3	Reconciliation with User Requirements	37	Procedures in assessing data precision, accuracy, representativeness, comparability, and completeness. Reconcile data with goals.

LIST OF ACRONYMS

°C	degrees Celsius
ASQ	American Society for Quality
ASTM	American Society of Testing & Materials
CA	Corrective Action
CCC	Calibration Check Compound
CCV	continuing calibration verification
CF	Calibration Factor
CHMM	Certified Hazardous Materials Manager
CLP	Contract Laboratory Program
CO	Contracting Officer
COC	Chain of Custody
COR	Contracting Officer Representative
CRQL	Contract Required Quantitation Limits
CVAA	Cold Vapor Atomic Absorption
DQA	Data Quality Assessment
DQI	Data Quality Indicator
DQO	Data Quality Objective
DOT	Department of Transportation
EDD	electronic data deliverable
EPA	United States Environmental Protection Agency
ER	Environmental Restoration LLC
ERRS	Emergency and Rapid Response Services Contract
ERT	Environmental Response Team
FCA	Field Cost Accountant
FSP	Field Sampling Plan
GC	gas chromatography
GC/MS	gas chromatography / mass spectrometry
GPS	Global Positioning System
HASP	Health and Safety Plan
HDPE	High Density Polyethylene
ICAL	Initial calibration
ICP-AES	inductively coupled plasma atomic emission spectroscopy
ICP-MS	Inductively coupled plasma atomic mass spectroscopy
IDW	investigation-derived waste
ISTD	Instrument Standard
LCS	laboratory control sample
LIMS	Laboratory Information Management System
LOD	limit of detection
LOQ	limit of quantitation
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	Milligram per Liter
MPC	Measurement Performance Criteria
MS/MSD	matrix spike/ matrix spike duplicate
NA	not applicable
NELAP	National Environmental Laboratory Accreditation Program
NFG	National Functional Guidelines
NIOSH	National Institute of Safety & Health
ODEQ	Oklahoma Department of Environmental Quality
OSC	On-Scene Coordinator (EPA)
PAL	Project Action Limit
PCB	Polychlorinated biphenyls
PM	Program Manager
PO	Project Officer (EPA)
POC	Point of Contact
PPE	Personal Protective Equipment
ppm	parts per million
PQM	Program Quality Assurance Manager
PSO	Program Safety Officer
QA	quality assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QMP	Quality Management Plan
RL	reporting limit
RM	Response Manager
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation
SAP	Sampling and Analysis Plan
SSID	Superfund Site Identification Number
SSO	Site Safety Officer
SVOC	Semi-volatile Organic Compounds
SW846	EPA Method SW 846.
T&D	Transportation and Disposal
TAL	Target Analyte List
TAT	Turn-around Time
TBD	to be determined
TCLP	Toxic Characteristic Leaching Procedure
TSA	Technical Systems Audit
UFP	Uniform Federal Policy
VOC	Volatile Organic Compounds

INTRODUCTION

Under the Environmental Protection Agency (EPA) Emergency and Rapid Response Services (ERRS) Contract, Environmental Restoration, LLC (ER) is required to provide cleanup personnel, equipment, and materials. ER will conduct activities as directed by the EPA Contracting Officer Representative (COR) or On-Scene Coordinator (OSC). Data generated by ER will be provided to the EPA COR.

The ER quality program uses a graded approach, using documents prepared by ER, as described in the following table.

Quality Management System		
Plan	**Hierarchy**	**Description**
Quality Management Plan (Region 6 ERRS QMP)	Applicable to all Region 6 ERRS projects	• Describes the general practices of the Region 6 ERRS program • Documents how ER will plan, implement, and assess the effectiveness of its quality assurance/ quality control (QA/QC) operations under the EPA Region 6 contract • Describes the ER quality system structure, including the quality policies and procedures; areas of application; and roles, responsibilities, and authorities
Project Quality Assurance Project Plan (QAPP)	Applicable to specific projects	• Details environmental data quality requirements based on site specific needs including any deviations from the QMP. Uses Optimized UFP-QAPP Worksheets meeting EPA QA/R-5 • Includes site background information, goals, and specific tasks • Includes details on project specific sampling activities and analyses
The site **HASP** provides additional information.		

EPA has directed ER to develop this QAPP and FSP to reflect the specific objectives of data acquired during cleanup strategy construction and supporting work. Work will be completed in accordance with the Wilcox Oil Company SOW, the final Source Control Record of Decision (2018) (Attachment 3), the specifications developed in the Source Control Remedial Design (RD) (Attachment 4), and information gathered during the site visit. Specifically, this QAPP will cover sampling, monitoring, and analyses for characterization of site wastes, field screening during construction to guide activities, sampling of material brought on site to ensure material is appropriate for use, and sampling to confirm cleanup strategy is complete.

This project specific QAPP, provides specific details according to site goals and activities. When prepared in accordance with the Uniform Federal Policy (UFP)-QAPP and addressing each optimized worksheet, this document will address required content of a SAP as described in the National Contingency Plan. A SAP describes the number, type, and location of samples, the type of analyses, and policies, organization, functional activities, and the data quality objectives (DQOs) and measures necessary to achieve adequate data quality.

This project specific QAPP is supported by a project specific HASP and ERRS Task Order (TO) which include quality assurance/ quality control (QA/QC) details and/or procedures pertinent to specific project requirements.

WORKSHEET 1 & 2 | TITLE & APPROVAL PAGE

Document Title:	Project Specific Quality Assurance Project Plan for Wilcox Oil Company
Site Name	Wilcox Oil Company
Site City, County, State	Bristow, OK
SSID	06GG RA01
Task Order (TO)	68HE0622F0025
Job Code	WO6-25
Lead Organization	Unites States Environmental Protection Agency (EPA)
Contract	EPA Region 6 ERRS Contract
Prime Contractor	Environmental Restoration LLC (ER)
Contract Number	68HE0422D0001
QAPP Date	June 16, 2022
QAPP Revision	Final V1
QAPP Type	Project Specific
Guidance used to Prepare QAPP	Uniform Federal Policy for Quality Assurance Project Plans Manual March 2005; Optimized UFP-QAPP Worksheets, March 2012 EPA QA/R-5, EPA Requirements for Quality Assurance Project Plans (March 2001, Reissue May 2006)
Regulatory Program	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) emergency response, time-critical Removals, and rapid remedial actions
Previous Relevant Reports	

Approval for Implementation:

1. **Signature:** _____
   Gary Dupert, ER Response Manager — Date

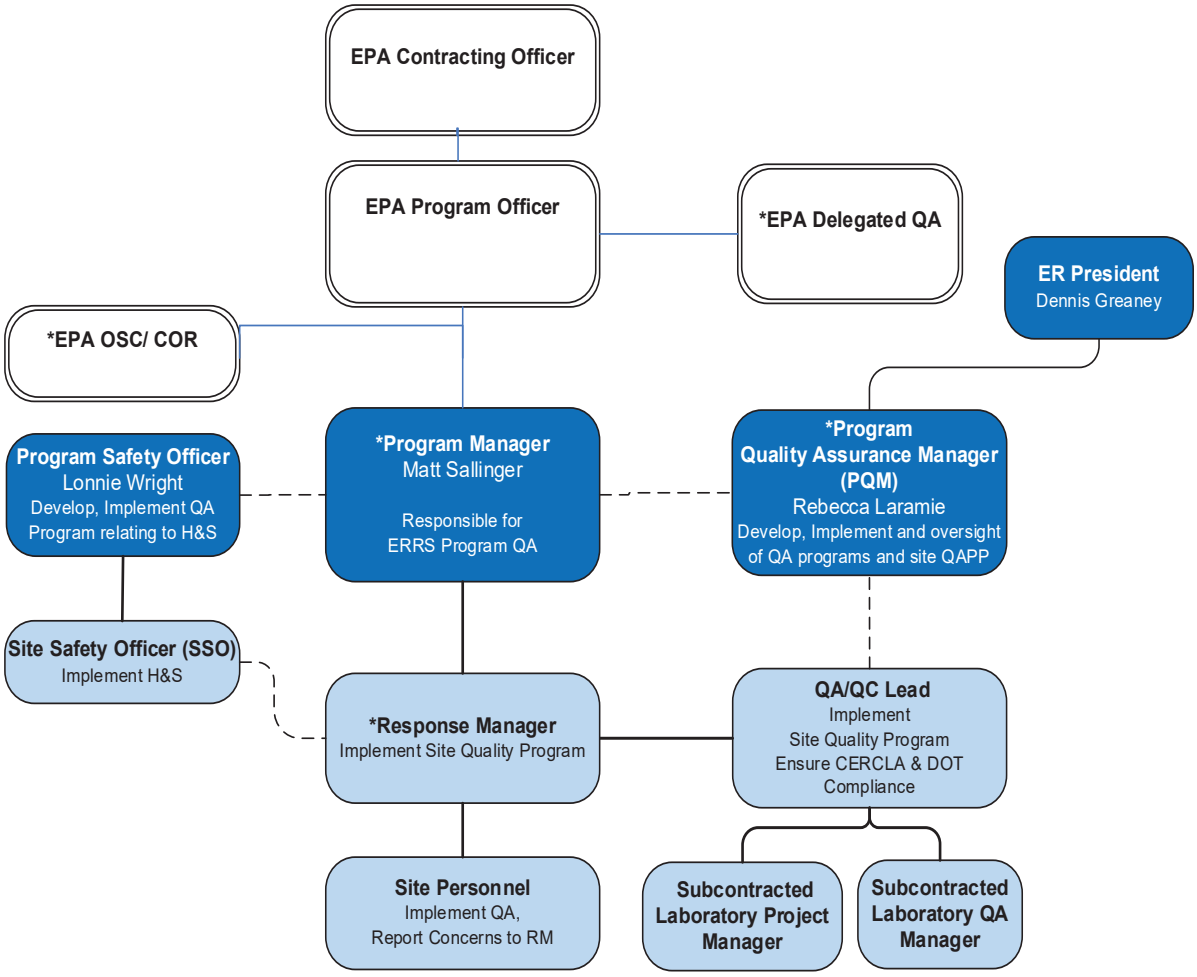
2. **Signature:** Rebecca Laramie — Digitally signed by Rebecca Laramie DN: dc=local, dc=ERLLCSTL, ou=Denver, ou=Users, cn=Rebecca Laramie Date: 2022.06.17 09:04:21 -06'00'
   Rebecca Laramie, ER Program Quality Assurance Manager — Date

3. **Signature:** KATRINA HIGGINS-COLTRAIN — Digitally signed by KATRINA HIGGINS-COLTRAIN Date: 2022.07.09 13:16:10 -05'00'
   Katrina Higgins-Coltrain, RPM (EPA COR) — Date

4. **Signature:** _____
   EPA Quality Officer/ Designee — Date

WORKSHEET 3 & 5 | PROJECT ORGANIZATION AND QAPP DISTRIBUTION

❖ UFP-QAPP Manual Section 2.3 and 2.4



*QAPP Recipient

The most current and approved copy of the QAPP will be located on the ER intranet. Response Manager will be provided an extra copy for the "field copy"

Personnel roles and responsibilities during site activities are listed in **Worksheet 6** and in the Region 6 QMP.

WORKSHEET 4, 7 & 8 | PERSONNEL QUALIFICATIONS AND SIGN-OFF SHEET

- UFP-QAPP Manual Sections 2.3.2 - 2.3.4

Name	Position/ Contact	Education / Experience[1]	Signature[2]
Matthew Salinger	Program Manager m.salinger@erllc.com	B.S. Marine Biology, 31 years ERRS technical experience.	
Rebecca Laramie	Program QA Manager r.laramie@erllc.com	MBA, B.S. Environmental Eng. Minor chemistry. 22 years in environmental industry,12 years high-level quality management experience. PMP	
Lonnie Wright	Program Safety Officer (PSO) l.wright@erllc.com	CSP, CHMM, B.S. Industrial Safety, 30 years' experience in the environmental remediation industry	Not Required
Gary Dupert	Response Manager g.dupert@erllc.com	23 years site management & technical experience, approved ERRS RM	
Aaron Roski	T&D Coordinator Site Safety Officer w.roski@erllc.com	22 years of experience in the environmental field, B.S. Environmental Chemistry, approved T&D and Chemist in Region 6	
Alex Lampe	QA/QC Field (Lead) a.lampe@erllc.com	BS in Industrial and Systems Engineering, 3 years' exp. with ER, XRF training, will work with Aaron Roski for first 20 days in field then turn over tasks	
TBD	Subcontractor Lab(s)	TBD	

[1]Personnel assigned to project positions will meet contract required specifications listed in the QMP, Attachment 1
[2]Personnel with sampling, analytical, or quality related site tasks will sign this table after review prior to work.
See **Worksheet 6** and the Region 6 ERRS QMP for personnel roles and responsibilities during site activities.

Training:

As described in the Region 6 ERRS QMP, a graded approach is used to provide personnel with the appropriate amount of quality training based on their job function and tasks. Specifically, the Program Manger (PM) and project management personnel having responsibilities of developing and implementing project specific quality documents are provided training on how to complete a quality document according to EPA, including the type of data required and where to find the information. This is added to general training on document control, quality and sampling related standard operating procedures (SOPs), general discussion on procedures and processes, and roles and responsibilities necessary to implement the QMP. Response Managers (RMs) and field staff collecting environmental data receive training on sampling strategy, collecting samples, appropriate QC, and sample handling and chain of custody. The following table lists the training and frequency by personnel for this site. See QMP for training certification storage.

Training: Title or Description of Course	Frequency	Personnel Receiving Training
Health and Safety Training/ Field Training/ ER Project Management Training / ICS Training		
See QMP Section 5.0 for list of training for ERRS personnel by job type.		
Specialized Training		
Radiation Safety for XRF Training/ XRF Operation[1]	Once	XRF Operator

[1] field test competency will be determined based on past training and past on-site experience
https://www.thermofisher.com/us/en/home/industrial/spectroscopy-elemental-isotope-analysis/portable-analysis-material-id/xrf-radiation-safety-training.html

WORKSHEET 6 | COMMUNICATION PATHWAYS

❖ UFP-QAPP Manual Section 2.4.2

Communication Drivers	Organization/ Position*	Procedures (Timing, Pathways, Documentation)
Approves contract and project specific QA documents	EPA Delegated QA Authority	Approves documents in accordance with EPA requirement/guidance documents and policy. Approves project specific QAPPs. Provides guidance for site-specific QA.
Regulatory/Project direction	EPA COR	Provides on-site technical direction in accordance with the National Contingency Plan and ERRS contract to ensure overall site objectives are met.
Commit/Assign Resources POC with EPA CO	ER PM	Ensure that trained, qualified personnel and adequate resources are provided to perform the cleanup activity. Maintain lines of communication between EPA CO, COR, and RM.
Manage Project Phases	ER RM	Manage day to day operations of the project. Reports to PM and EPA OSC/COR issues with cost, schedule, etc. Ensure QA project requirements are met. Maintain field documentation/ records. Point of Contact (POC) for COR.
Field Progress Reports		
Corrective Actions (CAs)		
Health and Safety Compliance/ Monitoring/ Reporting/ Training	ER Program Safety Officer (PSO)/ SSO	Prepare or review site HASP and ensure proper implementation. Communicates daily with RM and PM on safety issues/reporting. Directs upgrade/downgrade of PPE. Establish/ ensure work zones are delineated and maintained. Maintain H&S records. Conduct audits.
Health and Safety Concerns	All personnel	Communicate health and safety concerns.
Disposal	T&D Coordinator/ RM	Ensure transporters are compliant with DOT regulations and Resource Conservation and Recovery Act (RCRA) can take CERCLA waste for projects requiring offsite T&D. Communicate status to RM.
QAPP Changes Prior to Field Work, Field & Analytical CAs	ER PQM/ ER RM	The PQM keeps official QAPP, communicates QAPP changes to the RM and EPA COR/CO. Communicates with field team to determine need for field and analytical Corrective Actions (CAs).
QAPP Changes in the Field	RM, QA/QC Lead, T&D Coordinator	Prepare/ implement the project specific QAPP. Communicate QAPP changes and field sampling activities to EPA COR and RM when required. Set up lab. Communicate changes to the lab. The PQM and PM approve major changes to the QAPP.
Data Tracking and Management, Release of Analytical Data	QA/QC Lead, T&D Coordinator	CAs determined on review of data. No analytical data will be released prior to review/validation as described in this document. Releases approved by reviewer and COR.
Lab Data Quality Issues/ CAs	Laboratory Project Manager	Will report project sample issues to the QA/QC lead or T&D Coordinator within 2 business days.
Data Validation	Validator	Validator will report validation issues or missing data to QA/QC Lead within 2 business days.
Verification/ Data Review Issues	QA/QC Lead, T&D Coordinator	Report Data Quality Issues to PM/RM. Ensures CAs.
See Worksheet 4,7, & 8 for name and contact information of personnel filling positions		

WORKSHEET 9 | PROJECT PLANNING SESSION SUMMARY

- UFP-QAPP Manual Section 2.5.1 and Figures 9-12

This worksheet will be completed during the project planning session.

Date of Planning Session: May 17, 2022 **Location: Wilcox Oil Company Site** **Purpose: Site Visit**				
Name	**Title/Role**	**Organization**	**Phone No.**	**E-mail Address**
Todd Downham	Project Manager	ODEQ		
Katrina Higgins-Coltrain	RPM/COR	EPA		
Gary Dupert	RM	ER		
Matthew Salinger	PM	ER		

Notes: Conducted site visit to gain better understanding of site conditions and determine cleanup strategy including resources.

Consensus Decisions Made:

Action Items	**Responsible Party**	**Due Date**

WORKSHEET 10 | CONCEPTUAL SITE MODEL

- UFP-QAPP Manual Section 2.5.2

Background:
Wilcox Oil Company is a 140-150 acre site that operated from the 1920s until 1963 and went through several expansions and mergers in that time. The site includes remnants of former oil refining operations and tank farms and can be divided into five major operational areas: Wilcox Oil Company Process Area, Lorraine Process Area, East Tank Farm, North Tank Farm (NTF), and Loading Dock Area. An active railroad divides the two former process areas and product storage areas. A vacant church property and several residences are presently located within the boundaries of the site. Previous investigations have identified the presence of petroleum contamination at eight former aboveground storage tank locations and one sludge separation pit. The tanks and pits were bottomless and unlined, resulting in residual petroleum byproducts remaining following their demolition and removal from the Site. Oily, tar-like liquid is present at the surface or below a thin layer of soil, which migrates to the surface and spreads out when heated by the summer sun. The liquid and solid forms of the contamination are collectively referred to as tank waste source material, which is not classified as hazardous waste based on previous sampling results. The lead additive area of the Wilcox Oil Company Process Area is in the southwestern portion of the Site, adjacent to Sand Creek. The source material is located near the surface and contains high concentrations of lead. The areas with highest concentrations are devoid of vegetation and the surface appears bright white, in contrast to darker soils and thick vegetation throughout the rest of the site. The Pit 1 lead excavation area is in the central portion of the East Tank Farm area. The source material is located near surface. Laboratory analysis of the samples in this area indicated the presence of actionable levels of lead reported in the subsurface soil at 6-inch (906 mg/kg) and 12-inch (5850 mg/kg) depths. The lead additive area contains characteristically hazardous waste based on Toxicity Characteristic Leaching Procedure (TCLP) testing results, which indicate that lead leaches from the source material above Land Disposal Restriction criteria (40 CFR 268.34). Source material from the lead additive area will be treated through stabilization, which in this case, involves the addition and mixing of a reagent with the lead additive area source material at the site, prior to or immediately after excavation and before final loading and transport. Sources: Additional information and details related to the source areas can be found in the supporting documents: Source Control Record of Decision (2018) and the Final Remedial Design Report for Source Control (2019).
Contaminant(s):
Contaminants of Concern/Concentration Range (if known): Lead and benzo(a)pyrene are selected as the COCs. Lead is present through the lead additive area and exceeds the soil health-based target level. Benzo(a)pyrene is a polycyclic aromatic hydrocarbon (PAH) present in the tank waste and is carcinogenic to humans based on strong and consistent evidence in animals and humans. Benzo(a)pyrene is selected as the representative contaminant for the PAH group because of its low soil health-based target level, it is most detected in the tank waste, and it is co-located with the other PAHs. (ROD 2018)
Source Information:
Facility Type: Historic oil refining and tank farm **Waste Location:** Waste is in the soil. Tanks and refining facilities have been removed during previous actions.
Release Mechanisms:
Primary Release: Initial release was from the tanks and refining facility into the soil

Secondary Migration/ Exposure Medium/ Transport Mechanism: Precipitation may leach contaminants in the soil horizontally or vertically into the groundwater. Soil contaminants may also migrate through surface water runoff.

Site Physical Aspects

Land Use Geography/ Topography: Residential and commercial properties are located adjacent to the site. Due to the size of the site, topography and geography will vary across the site. There are seven residences located on former crude oil storage tank or refinery operations areas. In 2016, two occupied residences located on the East Tank Farm were known to use water from domestic/private wells located onsite; the occupied residence in the North Tank Farm has a private well; however, the residence uses city water. The site is flanked by Route 66 to the west; a residential area and Turner Turnpike to the northwest and north; Sand Creek to the southwest; and residential, agricultural, and wooded areas to the east and south. The topography in the vicinity of the site slopes to the south. The drainage pattern of the property is primarily towards Sand Creek, which borders the western and southwestern boundaries of the property. An intermittent stream (West Tributary), a perennial stream (East Tributary), and several drainage channels transect the property east of the railroad (Wilcox Oil Company Process Area and East Tank Farm), all which flow into Sand Creek. See Figure in Appendix A for site layout, location of nearby community, and nearest waterway.

Data Gaps:

Exact extent of contaminants is unknown. The following table provides estimates of the aerial and depth extent of contamination. Samples will be collected prior to and during field activities to delineate waste and identify/confirm RCRA waste requiring treatment.

Source Location	Aerial Extent (Square Feet)	Average Depth of Excavation (Feet)	Estimated Volume of Removal (Cubic Yard)
NTF 1	2,875	2	213
Tank 11	12,994	5	2,406
Tank 12	43,363	6	9,636
Pit 1 Tank Waste Area	17,316	3	1,924
Pit 1 Lead Area	8,770	1	327
Lorraine Tank	5,167	2	383
Tank 1	12,472	3	1,386
Tank 3	12,191	8	3,612
Tank 10	48,491	3	5,388
Lead Additive Area 2		2	5,711
Total			30, 986 CY

WORKSHEET 11 | PROJECT/DATA QUALITY OBJECTIVES

❖ UFP-QAPP Manual Section 2.6.1

STEP 1: State the Problem

Primary Decision Maker & Planning Team: The primary decision maker is the COR or designee. The planning team will typically consist of the COR, the ER RM, QA/QC Lead and T&D Coordinator. Due to the dynamic nature of the response, planning will be on-going and additional personnel may be included/ separated to specific tasks. Activities will be evaluated at minimum daily. Previous status reports will be used to prioritize new tasks identified.

Problem Statements: The Task Order (TO)/ Scope of Work (SOW) describes problems as they are currently understood, summarize existing information, and identify concerns/uncertainties to be resolved. The three goals for the site are:

RAO-1: Prevent ingestion and dermal contact exposure to human and ecological receptors removal of tank waste to reach a target health-based concentration of 0.11 mg/kg benzo(a)pyrene and the removal of the lead additive area to reach a target health-based concentration of 800 mg/kg lead.

RAO-2: Prevent contaminant migration to soil, sediment, and indoor air removal of tank waste to reach a target health-based concentration of 0.11 mg/kg benzo(a)pyrene and the removal of the lead additive area to reach a target health-based concentration of 800 mg/kg lead.

RAO-3: Removal of source materials to eliminate and prevent further degradation of the surrounding environment because of exposure to or migration from tank waste and the lead additive area.

Initial information is incomplete, due to complexity and time-critical nature of the project. Therefore, the problem definition is an ongoing process until sufficient information is secured to concisely define the problems. ER field activities to meet the goals include stopping migration of contaminants and characterizing, accumulating, segregating, treating, and disposing of source material in a safe manner, to protect people and the environment from contamination, and to minimize removal costs.

Characterization and confirmation samples during excavations, samples to verify treatment of soil, soil sampling of potential backfill, and perimeter air monitoring will be conducted during site activities to provide additional information.

STEPS 2, 3, and 5: Summary of ER Goals, Data Inputs and Decision Rules

Goal	Input	Decision Rule and Data Quality
Removal of source material	Historical data of source material location, XRF data to guide removal, lab results to confirm removal	• Historical data collected by EPA and EPA contractors are used to identify the source material. • ER is tasked with excavating contaminated source material associated with the NTF 1, Tank 11, Tank 12, Pit 1 Tank Waste Area, Pit 1 Lead Area, Lorraine Tank, Tank 1, Tank 3, Tank 10, Lead Additive Area 2 (See Appendix A) • XRF field screening will be used to guide excavation during site activities (primarily lead additive area and pit lead source area) • Confirmation samples will be analyzed by a subcontract laboratory using SW-846 methods to verify excavation is complete (lead < 800 mg/kg; benzo(a)pyrene < 110 ug/kg). Definitive data will be reviewed to ensure that results meet criteria described in this QAPP. A 3-day TAT may be used to expedite confirmation results if deemed more cost efficient for the site. • Surveys will be completed prior to and after excavation to track volumes of material removed
Treatment of source material	Historical data identifying RCRA material	• After stabilization of the lead additive and pit lead source material that fails the TCLP lead standard, TCLP samples and benzo(a)pyrene samples will be analyzed by a subcontract lab to confirm that material does not contain concentrations of metals above RCRA standards

Air monitoring	Visual and air monitoring to ensure protection	• ER will use air monitoring equipment to establish a safety perimeter based on the presence of potential vapors and/or dust to ensure health and safety of onsite workers, the surrounding community, and the environment. Due to the size of site and distance of excavations to other properties the air monitoring will focus on site personnel (H&S) including using a PID for monitoring and potentially collecting personnel samples per the HASP
Stormwater monitoring	Visual inspections and potential lab analysis of samples	• ER will conduct visual inspections of Stormwater BMPs according to ensure drainage control for construction stormwater • Samples may be collected prior to discharge by ER and analyzed by a subcontract lab to ensure OPDES permit and approved SWPPP compliance
Waste Profile: Identify & classify waste stream(s)	Laboratory results	• Lab parameters based on historical data to profile waste stream(s) • Definitive quantitative SW846 results and QC are reviewed to determine potential bias due to matrix or other interferences • Results compared to RCRA to determine verify non-hazardous and meet Treatment, Storage, and Disposal Facility (TSDF) requirements • TSDF will use data for waste profile and appropriate disposal
Restore site	Laboratory results	• Samples will be collected from clean fill material to ensure that material meets site requirements. • Definitive lab results will be compared to EPA RSLs, ASTM standards, and fertility requirements.

See also **Worksheet 15, Worksheets 17, Worksheet 18, and Worksheet 19&30**.

STEP 4: Define Study/Site Boundaries

Source locations (See Figure in Appendix A) will be used as general boundaries for field activities. The site property boundary will be used as the boundary where treatment, air monitoring and stormwater monitoring will be completed. A survey will be completed prior to grubbing or excavating to mark previously identified contaminated material.

STEP 6: Specify Tolerable Limits on Decision Error

All sampling and analytical activities incorporate errors, which are beyond the control of the personnel performing the sampling or analytical activities. These errors can mislead a decision- maker; so, it is important to determine the impact of these errors. Due to the time-critical nature of projects, error tolerance and data uncertainty is typically not quantified. ERRS will use SOPs to minimize sampling error and provide consistency between results.

XRF field test results are considered screening level data with differing levels of error based on the process used to collect and prepare the samples. In-situ XRF readings have the most error due to potential soil moisture and inhomogeneous material. Samples collected in a baggie provides readings with less error because the sample can be mixed, and multiple reading can be collected easily. The most accurate readings are obtained by following the preparation procedure in Method 6200M including drying and sieving but will not be completed unless there is concern about site conditions (very wet soil) or the values received from the XRF using one of the other two methods (in-situ or using baggies). Multiple field tests at the same location will be completed as described in **Worksheet 20** to measure consistency on sampling/ testing procedures. Re-testing will be completed if the test result is unclear or near the RCRA limits (based on the test method). Laboratory tests will be used for correlation and for definitive data. Results will also be used to evaluate the field-testing process.

STEP 7: Optimize the Design
ER will begin cleanup activities by addressing the tasks with the highest priorities identified during site reconnaissance. Multiple locations may be cleaned up at once. This will include removal operations in the lead additive area and the pit area. ER will address several source locations, as possible, concurrently in different phases of removal and restoration. This will allow the removal operations best use of equipment without sacrificing production. Roadway aggregate from areas completed will be removed and used to build roadways to access other source locations. This will reduce the amount of aggregate consumed without affecting overall production. ER will size the equipment used to remove and transport the waste based on the size and location of the source location so that equipment will not be too large or small for that location.

Regulation	Source of Action Levels
RCRA	Characteristic of Hazardous waste 40 CFR 261.21-23 (ignitability, corrosivity, reactivity)
	Toxicity Characteristic Leachate Procedure (TCLP) Limits specified in 40 CFR 261 Subpart C
LDR	40 CFR 268 Subpart C, 268.34. Land Disposal Restriction of Lead Additive Area
ARARs	See Source control ROD for list of ARARs

WORKSHEET 12 | MEASUREMENT PERFORMANCE CRITERIA TABLES

- UFP-QAPP Manual Section 2.6.2

Data Quality Indicators (DQIs) are study objectives generated by the seven-step Data Quality Objectives (DQO) process. DQIs are qualitative and quantitative characteristics used to interpret the degree of acceptability of data. The six principle DQIs are precision, accuracy/bias, representativeness, comparability, completeness, and sensitivity. It should be noted that analytical methods influence acceptable amount of precision and accuracy unless stated in a project specific QAPP. DQI definitions are provided below.

Definitions of Data Quality Indicators and Method Assessment	
Precision	A measure of the reproducibility of measurements under a given set of conditions. Precision will be assessed by analyzing laboratory duplicates (from the same sample container) and will be calculated as relative percent difference (RPD).
	$\%RPD = \frac{(S - D) \times 100}{(S + D)/2}$ S = First sample value (original or MS value); D = Second sample value (duplicate or MSD value)
	Example: LCS/LCSD, laboratory duplicate, MS/MSD, field duplicates, and collocated samples.
Accuracy/ Bias	A measure of the bias that exists in a measurement system. Matrix spike samples performed at the laboratory will be used to assess accuracy, which will be expressed in terms of percent recovery. Worksheet 28
	% Recovery = ([Spiked Sample Conc.] – [Unspiked Sample Conc.])/ [Spike Added} x 100%
	Accuracy = (Measure Value/ True Value) x 100%
	Example QC: initial calibration/continuing calibration verification (ICAL/CCV), matrix spikes, laboratory control samples (LCSs), and trip or equipment blanks Worksheet 28
Representative	Degree to which sampling data accurately and precisely represent selected characteristics. Field replicate samples will be used to assess representativeness, expressed in terms of RPD.
Completeness	Measure of the amount of valid data obtained from the measurement system compared to amount expected under ideal conditions. Completeness is calculated as the valid data percentage of the total tests performed.
	$\text{Completeness (\%)} = \frac{\text{Number of valid data results}}{\text{Number of results expected}} \times 100$
Comparability	Measure that expresses the confidence that one data set can be compared with another. Maximized by using standard procedures for field and laboratory operations (sample collection, analytical method, etc.)
Sensitivity	Ability of an analytical method to detect contaminant of concerns and other target compounds at the level of interest. Analytical methods are selected that can meet project-specific levels of detection for contaminants of concern.
	Examples: Instrument Detection Limit (IDL), Method Detection Limit (MDL), Practical Quantitation Limit (PQL), Reporting Limit (RL), Contract Required Detection Limit (CRDL), and/or Contract Required Quantitation Limit (CRQL)

Non-sampling data will be generated for many of the ER tasks including construction, containment, and restoration activities. Inspections will be used to verify work is completed in accordance with site requirements and to prepare punch lists to ensure completion of outstanding items or activities. Completeness will be used to measure performance. For instance, checklists and daily work reports will be maintained at the discretion of EPA and used to track completeness. The EPA COR will verify that the activity is complete. Because of the limited quality indicators

that can be applied to non-sampling data, data reviews for accuracy (verify no data entry errors) and completeness are typically completed. The following table provides general site measurement performance criteria. The QA/QC Lead and T&D Coordinator will review field test results and analytical data, including QC data, to determine if additional waste profile samples are needed to fill data gaps. The RM, PQM, and Treatment, Storage, and Disposal Facility (TSDF) may assist the T&D coordinator in determining completeness.

Measurement Performance Criteria Table

Analytical Method/ Matrix/ Concentration	Data Quality Indicators (DQIs)	QC Sample and/or Measurement Performance Activity	Measurement Performance Criteria (MPC)	Assesses Error Sampling (S) Analytical (A)
General Chemical Sampling	Completeness	≥ 90%	Data will be evaluated to determine if sufficient data/quality. More samples may be collected to fill data gaps.	S & A
	Comparable	Collaborative Data, Duplicates	Includes a review of other MPC XRF/ duplicates and lab results are comparable	S & A
	Representative	Qualitative	Includes a review of other MPC	S & A
	Sensitivity	MDL/ RL (CRQL) verification	Method Specific (See **Worksheet 15**)	A
	Accuracy/ Bias	Temperature Blank	4°C ± 2°C (Analyses that are temperature sensitive)	S
	Accuracy/ Bias	Trip Blank	Analyte Result < RL (VOCs only)	S
	Precision	Field Duplicate	% RPD < 20 (water) %RPD < 35 (Soil)	S & A
	Precision	XRF baggies (3 measurements)	10% of the mean of the three measurements	S&A
	Accuracy/ Bias	Equipment Blank	Analyte Result < RL (Sampling equipment requiring Decon)	S
Method Specific	See **Worksheet 28** for QC to determine analytical error and respective criteria			A

°C degrees Celsius; MDL Method detection limit; VOC Volatile Organic Compounds
CRQL Contract Required Quantitation Limit; RL Reporting Limit

WORKSHEET 13| SECONDARY DATA USES AND LIMITATIONS

❖UFP-QAPP Manual Section 2.7

Data Type	Data Source (originating organization, report title and date)	Data Uses Relative to Current Project	Factors Affecting Data Reliability and Use Limitations
Safety Data Sheet (SDS)	Manufacturer/supplier or Online SDS site	Defines chemical parameters and Safety risk of materials	Source, age of document. Similar SDS may be compared for similarities
Historical and Current Site Use & Investigations	Historical Records, Previous Investigations, Visual Site Reconnaissance, and Interviews	Supplemental background information on historical site use and current site conditions, and previous investigations	Source/Author of Documents, Age of documents

The secondary data evaluation process uses a tiered approach. Data that is not used for decision making by EPA (antidotal information or guidance of data collection) may not be evaluated or may be reviewed for completeness and obvious errors. Most secondary data obtained by ERRS falls under this category. On the occasion that environmental data collected outside the direction of an EPA program is used to make site decisions, a more thorough evaluation will be completed as described in the QMP, Section 4.3.3 and Attachment 4. If a different contractor is tasked to perform the evaluation, ER will not duplicate the activities. Data collected under the direction of an EPA program is already of known quality and does not require a duplicative evaluation by ER.

WORKSHEET 14 & 16 | PROJECT TASKS & SCHEDULE

- UFP-QAPP Manual Section 2.8.2

General project dates, including mobilization will be provided in the TO and in accordance with contract requirements. It is expected that field activities will be accomplished in 13 weeks. Dates may be modified in the daily work order (DWO) due to site conditions and prioritization of work based on new data. The schedule will be modified as appropriate under the direction of the COR during daily site coordination meetings. The RM is responsible for notifying the COR of schedule delays. Site work is complete when objectives as stated in the TO SOW and/or DWO have been met. The COR and other stakeholders will be involved in the following activities. The COR will guide planning activities and will ultimately review and approve document. Site access agreements will be managed by the EPA COR with the assistance of ER as needed. ER will not conduct activities without proper access.

Site Specific Task	Responsible Personnel	Deliverable
Project Planning Develop work plan/cost estimate/site schedule	RM	Work Plan and Schedule. Draft provided prior to work
Develop Sampling Design/Procedures	RM, PQM, QA/QC Lead, T&D Coordinator, PSO, SSO	Project Specific QAPP
Select Analytical Parameters		
Develop QAPP and EPA R6 Crosswalk	RM, QA/QC Lead, T&D Coordinator, PQM	
Develop Health and Safety Plan (HASP)	RM, PSO, SSO	HASP prior to field activities. New tasks added as identified
Address EPA Comments	Report Writer, RM	Final Reports
Mobilization/Demobilization	RM	NA
Procurement	FCA, RM	Purchasing Documents
Daily Work Orders (DWO)	RM	DWO provided daily
Daily Cost Summary Reports	FCA, RM	EPA Form 1900-55
Over-site	RM	Logbook
Health & Safety	SSO	HASP/ Logbooks/ Daily toolbox
General Operations (excavation/ inspections)	Site Personnel	Logbook/ field forms
Material Tracking (brought to site)	RM	Tracking Spreadsheet
Perimeter Air Monitoring		Not completed unless other personal sampling indicates necessity
ER Sample Collection	QA/QC Lead, T&D Coordinator, Sample Team	Logbook/ Field Form
Field Measurements & Monitoring		
Field XRF		
Laboratory Analytical Activities	QA/QC Lead, T&D Coordinator	Data Package/ Database
Photo Documentation	RM/ Site Personnel	Photolog
Waste Disposal Tracking	QA/QC Lead, T&D Coordinator	Tracking Spreadsheet
Transportation & Disposal	QA/QC Lead, T&D Coordinator	Manifest/ Shipping Documents
Data Verification, Review, Validation	QA/QC Lead, T&D Coordinator, PQM, Validator	Review/ Validation Report

Site Specific Task	Responsible Personnel	Deliverable
Data Usability Assessment/Reporting	RM, QA/QC Lead, T&D Coordinator	Usability Memo
Assessment/Audits	PQM, RM, PSO, SSO	Report

WORKSHEET 15 | PROJECT ACTION LIMITS AND LABORATORY-SPECIFIC DETECTION/QUANTITATION LIMITS

- UFP-QAPP Manual Sections 2.6.2.3 and Figure 15

ER activities, including guiding and confirming completion of excavation and treatment and disposal will be driven by sample results compared to the Project Action Limits (PALs) provided in the following table. Site COCs (lead and benzo(a)pyrene use Residential Regional Screening Levels (RSLs, respectively. Waste profile samples and treatment confirmation will be guided by RCRA standards and TSCA standards (if PCB analysis is required by the TSDF). Clean material such as backfill and topsoil will use EPA RSLs target cancer risk (TR) of 1E-06 and target hazard quotients (THQ) of 0.1.

Analytical Method and Matrix[1]	Analyte	Project Action Limit (PAL)[2]	Example Lab Reporting Limits	Units
Total Lead	Lead	800	See Appendix E	mg/kg
Total Benzo(a) pyrene	Benzo(a) Pyrene	110	See Appendix E	µg/kg
Waste Profile				
TCLP Volatile Organics	1,1-Dichloroethene	700	10	µg/L
	1,2-Dichloroethane	500	10	µg/L
	2-Butanone	200,000	20	µg/L
	Benzene	500	10	µg/L
	Carbon tetrachloride	500	50	µg/L
	Chlorobenzene	100,000	10	µg/L
	Chloroform	6,000	20	µg/L
	Tetrachloroethene	700	10	µg/L
	Trichloroethene	500	10	µg/L
	Vinyl chloride	200	20	µg/L
TCLP Semi-Volatile Organics	1,4-Dichlorobenzene	7,500	10	µg/L
	2,4,5-Trichlorophenol	400,000	50	µg/L
	2,4,6-Trichlorophenol	2,000	50	µg/L
	2,4-Dinitrotoluene	130	50	µg/L
	Hexachloro-1,3-butadiene	500	50	µg/L
	Hexachlorobenzene	130	50	µg/L
	Hexachloroethane	3,000	50	µg/L
	m-Cresol	200,000	50	µg/L
	Nitrobenzene	2,000	50	µg/L
	o-Cresol	200,000	50	µg/L
	p-Cresol	200,000	50	µg/L
	Pentachlorophenol	100,000	50	µg/L
	Pyridine	5,000	25	µg/L
TCLP Metals	Arsenic	5.0	0.010	mg/L
	Barium	100	0.050	mg/L
	Cadmium	1.0	0.0040	mg/L
	Chromium	5.0	0.010	mg/L
	Lead	5.0	0.010	mg/L

Analytical Method and Matrix[1]	Analyte	Project Action Limit (PAL)[2]	Example Lab Reporting Limits	Units
	Selenium	1.0	0.050	mg/L
	Silver	5.0	0.0050	mg/L
TCLP Mercury	Mercury	0.2	0.00010	mg/L
TCLP Pesticides[4]	Gamma-BHC (Lindane)	400	0.031	µg/L
	Chlordane	30	0.21	µg/L
	Endrin	20	0.083	µg/L
	Heptachlor	8	0.052	µg/L
	Heptachlor epoxide	NA	0.052	µg/L
	Methoxychlor	10,000	0.52	µg/L
	Toxaphene	500	1.0	µg/L
TCLP Herbicides[4]	2,4-D	10	50	mg/L
	2,4,5-TP (Silvex)	1.0	5	mg/L
Total PCBs[4]	Aroclor-1016	50,000 (Total PCBs)	0.20	µg/Kg
	Aroclor-1221		0.20	µg/Kg
	Aroclor-1232		0.20	µg/Kg
	Aroclor-1242		0.20	µg/Kg
	Aroclor-1248		0.20	µg/Kg
	Aroclor-1254		0.20	µg/Kg
	Aroclor-1260		0.20	µg/Kg
	Aroclor-1262		0.20	µg/Kg
	Aroclor-1268		0.20	µg/Kg
Flashpoint Analysis	Flashpoint/Ignitability	flashpoint	<140 °F	°F
Cyanide, Reactive (SW7.3.3.2)[3]	Cyanide, Reactive	-	4.0	mg/Kg
Sulfide, Reactive (SW7.3.4.2)[3]	Sulfide, Reactive	-	20	mg/Kg
Paint Filter	Free Liquid Present	Free Liquid	No Free Liquid	NA
Corrosivity	pH ≤ 2, a pH ≥12.5	pH	NA	NA
Clean Material				
See Appendix E for EPA Residential RSLs used as standards for Clean Material (Backfill and Topsoil) compared to 2 Example Houston Laboratories				

[1] Samples will be analyzed for listed parameters. See 19 & 30 for Analytical Method
[2] Waste Profile PALs are based on the regulatory limits for the determination of RCRA hazardous waste, except for Total PCBs which is based on the regulatory limits under TSCA in 40 CFR 761.61
[3] There are currently no test methods for reactivity. ER will work with the TSDF, COR, and lab to determine appropriate analyses Possible methods include SW846 SW 7.3.3.2 or 9013A(total) for CN and 7.3.4.2 or 9030B(total) for sulfide.
[4] Waste samples will be analyzed for TCLP herbicides, TCLP pesticides, and PCBs only if the TSDF requires
See Appendix F for Lab QA Manual

WORKSHEET 17 | SAMPLING DESIGN AND RATIONALE

❖ UFP-QAPP Manual Section 3.1.1

Sampling Rationale
Physical Boundaries: *Describe the physical boundaries for the area under study (include maps).*
Appendix A includes a map of the site. The areas of removal (study areas) include NTF 1, Tank 11, Tank 12, Pit 1, Tank Waste Area, Pit 1 Lead Area, Lorraine Tank, Tank 1, Tank 3, Tank 10, and Lead Additive Area 2. Other areas of the site may be used to provide additional work area for staging equipment and treating waste material that fails RCRA.
Time Period: *Describe the time period being represented by the collected data.*
Field test results will represent a point in time during removal activities and will be used to guide further work. Laboratory analytical results will represent COC concentrations remaining after excavation, concentration of analytes in clean material brought on-site, and final waste streams based on the type of sample collected (see Worksheet 18).
Sampling Areas: *Description/ basis for dividing the site into sampling areas (decision units) to support the decision statements in* ***Worksheet 11****.*
• Each source location will be a decision unit initially. • Based on field results and waste profile results, decision units may be combined based on like material to reduce time and cost handling and treating material.
Number of Samples: *Describe the basis for the number and placement of samples within sampling areas.*
• Samples collected for field tests during removal of contaminated soil will be based on visual observations and historical data on the depth of contamination. • Samples collected for laboratory analysis will be based on the volume of waste and the TSDF sample frequency requirements per waste. • Number of samples for confirmation of cleanup will be based on the size of excavation. • Number of samples for stormwater will be based on the frequency and amount of precipitation during field activities. • See Worksheet 18 for estimated number of samples based on the type of sampling.
Sample Locations: *If sample locations will be determined in the field, the decision process for doing so.*
Sample locations will be selected in the field as described in text following this table and **Worksheet 18**.
Sample Limitations and Design Changes: D*ecision process for changing location/ design*
Due to the dynamic nature of the project, sampling activities will be flexible, and may change as site conditions dictate. It is expected that field activities will be guided by historical information and data, assessment field tests, visual cues (observable contamination), and by using samples to confirm observations and provide additional detail. If modifications become necessary to the proposed sampling design due to inaccessibility or variability, the RM will discuss revisions with the project COR. Sampling changes will be approved by the EPA COR or designee. Deviations from proposed sampling design will be documented in the project logbook, in the project specific QAPP, or on the QAPP modification form in **Appendix B**

Field Activities:

ER is tasked with excavating source material and soil, while completing proper disposal, from the areas listed in the following table.

Source Location	Estimated Aerial Extent (Feet^2)	Average Depth of Excavation (Feet)	Estimated Volume of Removal (Cubic Yard)
NTF 1	2,875	2	213
Tank 11	12,994	5	2,406
Tank 12	43,363	6	9,636

Pit 1 Tank Waste Area	17,316	3	1,924
Pit 1 Lead Area	8,770	1	327
Lorraine Tank	5,167	2	383
Tank 1	12,472	3	1,386
Tank 3	12,191	8	3,612
Tank 10	48,491	3	5,388
Lead Additive Area 2		2	5,711
Total			30, 986 CY

ER is also tasked with treating the lead additive area excavated material, prior to disposal, that is characteristically hazardous waste based on Toxicity Characteristic Leaching Procedure (TCLP) testing results for lead.

During excavation and treatment activities, ER will apply water for dust control to prevent off-site migration of dust. ER will also use air monitoring equipment to establish a safety perimeter based on the presence of potential vapors and/or dust to ensure the health and safety of onsite workers, the surrounding community, and the environment. Each area with removal or treatment will be evaluated prior to activities to determine if perimeter monitoring for particulates should be conducted to ensure that activities are not causing contaminated material to migrate off-site. During specific excavations, monitors may be placed to ensure safety of persons near the site including persons working on-site. A PID will likely be used during site activities and personal samples may be collected for lead.

DataRAMs or similar monitors may be placed at locations upwind and downwind of excavation activities if other monitoring or sampling (H&S) leads to concerns. DataRAMs may also be fitted with a sample cartridge to collect air samples for laboratory analyses. ER will also use a PID monitor near the excavation activities to monitor the safety of workers. In addition to air monitoring, ER will conduct SWPPP inspections to ensure that contaminants are not migrating off-site. SWPPP inspections will be conducted on a regular basis and after major precipitation events. Stormwater samples may be collected and analyzed before stormwater is discharged preventing discharge of untreated stormwater to streams or wetlands.

Additional samples will be collected and analyzed during field activities as described to guide field activities and to verify when activities are completed.

XRF

The field portable XRF will be used to guide excavation activities by identifying lead concentrations at the base and sides of excavation at any given time. The XRF will be calibrated per manufacturer's recommendation. Calibration checks and standards analysis will be completed at minimum each day prior to use. These steps may also be completed after long timeframes of not using the XRF during the day. Soil samples will be analyzed in the field using X-ray fluorescence (XRF) to provide rapid soil analysis for lead. This will allow for near real-time decision-making and decrease down time or multiple mobilizations to the same location caused by lag time in receiving analytical results.

ER will use in-situ XRF readings or samples collected in a zip-top baggie to obtain sample results for the purpose of decision-making about the need for additional excavation or if the area meets the clean-up levels. Generally, in-situ samples may be collected if lead concentrations are much greater than the project action level (800 mg/kg) or if it is important to have much expedited results.

For samples collected in a zip-top baggie, XRF sample locations may consist of grab or composite samples collected to delineate a specific zone. Samples will be collected from the excavated surface with a clean soil sampler. The aliquots shall be thoroughly mixed prior to testing with an XRF. If the soil is too wet, the sample will be dried and sieved through a #10 sieve.

A minimum of 1/20 samples will be measured three times with an XRF. If the three measurements are not within 10% of the mean of the three measurements, the sample will be remixed and measured three times. This cycle will continue until the three measurements are within 10% of their mean. Alternately, a duplicate sample may be collected for every 20 samples and compared to MPC values in worksheet 12; however, high levels of lead may interfere with correct readings using the duplicate method. The ER QA/QC lead and/or RM will be responsible for field corrective action.

Once the decision has been made that no additional excavation is required, verification samples shall be obtained. Verification samples will be collected to confirm that clean-up levels have been achieved. XRF readings at the base of excavation will be compared to the analytical results of these samples and will be used to help determine proper calibration of the XRF instrument. Although, laboratory results will be used to help confirm calibration; the "RCRA Standard" sample or other NIST samples are considered to provide an acceptable measure of value for calibration of the XRF instrument.

Tank Waste Excavation:
After removal of tank waste source material, the excavated area will be surveyed to confirm excavation quantities and sampled to determine contaminant concentrations at the base and sides of excavation. Post-excavation sampling will include grab samples taken from the exposed excavation floor and walls. Excavation floor sample grids of 40 ft by 40 ft will be established, with a 5-point composite taken in each grid. Composite samples include corners and center for each sampling grid. Sidewalls will be sampled every 40 linear feet, with five-point composites taken at the corners and center of the sidewall. If the sidewall material is not homogenous based on field screening methods, an aliquot representing each variation can be collected vertically along the side wall to represent the wall sample. Sample analysis will include benzo(a)pyrene and lead.

The excavated areas will be backfilled with clean fill from an offsite source, compacted, and graded to drain by minimizing low spots and flattening any remaining slopes. The area will be covered with organic topsoil and re-vegetated with native plants and grasses via hydroseeding. ER will be responsible for supplying topsoil for all excavation areas and ensuring 80% vegetation coverage has been achieved. A final survey will be conducted to confirm final backfill quantities.

Lead area Source Material Excavation:
After mixing the stabilizing reagent at the manufacturer's recommended dosage, ER will collect composite samples for TCLP lead analysis at a rate of 1 sample for every 1,000 CY. The time needed for laboratory testing of stabilized material will likely result in multiple, concurrent excavation areas. The effectiveness of the chemical stabilization will be confirmed via sampling directed by the landfill, to include at a minimum, analytical TCLP lead testing. After successful sampling results, the material will be loaded and hauled for disposal at a regulated offsite landfill.

After removal of lead areas source material, the excavated area will be surveyed to confirm excavation quantities and sampled to determine lead concentrations. Post-excavation sampling will be completed by ER and will include grab samples taken of the exposed excavation floor and

walls. Excavation floor sample grids of 40 ft by 40 ft will be established, with a 5-point composite taken in each grid. Composite samples include corners and center for each sampling grid. Sidewalls will be sampled every 40 linear feet, with five-point composites taken at the corners and center of the sidewall. If the sidewall material is not homogenous based on field screening methods, an aliquot representing each variation can be collected vertically along the side wall to represent the wall sample. The maximum targeted depth is 2ft, and the area will be graded to drain; therefore, there may not be ample depth for sidewall samples. Sample analysis will include Benzo(a)pyrene and lead.

The excavated areas will be graded to drain, minimizing low spots and steep slopes, and using runoff controls where necessary. **Because the final site remedy has not been selected, the import of backfill to the lead source area will be used only as a last effort to control drainage. This limitation is to restrict the placement of clean backfill in an area that may be addressed in the final remedy.** Adding clean backfill may result in an increase in the volume of material that will need to be remediated. Any additional backfill in this area will require consultation with EPA and ODEQ.

Offsite Disposal:
Source material characterization data required to meet specific disposal facility requirements will be described by the ER's chosen landfill and completed by ER prior to loading and hauling material offsite. At a minimum it will include sampling and comprehensive analysis of the following categories: TCLP volatile organic compounds, TCLP metals, TCLP semi-volatile organic compounds, total petroleum hydrocarbons, and reactivity, corrosivity, and ignitibility. TCLP herbicide, TCLP pesticide, and total PCBs will also be collected at the direction of the TSDF. Source material shall be direct loaded into trucks for off-site disposal to the greatest extent possible. To accomplish this ER will collect samples using the excavator and/or shovels in the tank waste source material areas prior to bulk excavation.

Fill Material:
Topsoil:
For topsoil already stockpiled, two composite samples shall be collected for every 20,000 cubic yards (one sample for each 10,000 cubic yards). Each composite will be made up of at least 5 aliquots. Undisturbed topsoil is material that has not been stockpiled for removal and will be excavated from its natural location after sampling for stockpiling or immediate placement in a truck for site delivery. For undisturbed topsoil, a 5-point composite will be taken in sampling grids. The grid will be determined in the field to represent approximately 10,0000 cubic yards of loose material including the expended excavation grid. One composite sample will be collected from each grid. Composite samples include the corners and the center for each sampling grid. Samples shall be collected in at least two different intervals depending on the depth of excavation. Analyses must include SVOCs, VOCs, Metals, and TPH. Topsoil should consist of imported friable loam or silty loam with a minimum 10 percent organic matter (by Loss on Ignition Method), no deleterious concentrations of salts, free of subsoil, roots, grass, weeds, large stone, and foreign matter. If organic matter amendment is required based on Loss on Ignition Method testing results, ER will amend topsoil with locally sourced organic compost or similar.

Imported Clean Backfill:

For materials that have already been stockpiled, two composite samples shall be collected for every 20,000 cubic yards. Each composite will be made up of at least 5 aliquots. For backfill that have not been disturbed, a 5-point composite will be taken in 50 ft by 50 ft sampling grids. Composite samples include the corners and the center for each sampling grid. Samples shall be collected in at least two different intervals depending on the depth of excavation. Shallow samples consist of those at 3-24 in and deep samples of 24-48 in. Analyses must include SVOCs, VOCs, Metals, and TPH.

Backfill material should generally consist of clean, ML, CL, or CH material with a liquid limit less than 45 and a plasticity index less than 20, SM or SC. It may consist of a mix of organic and inorganic material but should be free of foreign material larger than 3 inches and appreciable amounts of roots, rock, or debris. Moisture content should be sufficient to obtain compaction: between -5% and +3% of optimum. ER will work with the source supplier to determine the details of the backfill material, including obtaining specifications as detailed above; however, it is not expected that ER will collect geotechnical/ soil properties samples and analyses to determine specification including Atterberg limits, standard proctor details, or other characteristics unless there is concern about a specific source area.

WORKSHEET 18 | SAMPLING LOCATIONS AND METHODS

❖ UFP-QAPP Manual Section 3.1.1 and 3.1.2

Sample Matrix	# Samples [1]	Depth	Composite	Grab	Type 2	Analyte(s) Analytical Method(s)[2] Sampling SOP[3]	Location /Rationale (Comment)
Soil – XRF	TBD	Various	x	x	S	Total Pb	Primarily applicable to lead additive area and pit lead source areas. Guide excavation activities prior to confirmation samples
Soil – Confirmation	75		x		D	Pb and Benzo(a)pyrene	To verify excavation activities are complete and Pb and benzo(a)pyrene concentrations are below the project action levels.
Lead Stabilization	75	NA		x	D	TCLP RCRA metals (at minimum Pb), benzo(a)pyrene based on agreement with TSDF	Confirm non-RCRA material after chemical amendment is added - Lead does not exceed TCLP (5.0 mg/L). One composite test sample shall be collected, at a minimum, for each 1000 cubic yard batch that is to be transported and disposed. Contractor may propose an alternative sampling plan that is acceptable to the landfill.
Waste Profiling	≤10	Various	x		D	TCLP VOC, TCLP SVOC, TCLP metals, TPH, Reactivity Corrosivity Ignitability Paint filter test* TCLP herbicide, TCLP pesticide, and total PCBs may be analyzed at the request of the TSDF	Minimum, 1 composite test sample per 1000 CY batch prior to T&D. Used to characterize waste material for disposal purposes.
Clean Material - Backfill ASTM	3	TBD	x		D	TCL VOC, TCL SVOC, TAL Metals, TPH, Pesticides/ PCBs, and Herbicides	Two samples for every 20,000 CY of material if stockpiled or equivalent area of 20,000 CY loose material if material is still in-situ. To verify material is without contamination and appropriate for use at site
Clean Material - Topsoil		TBD	x		D	TCL VOC, TCL SVOC, TAL metals, TPH, Pesticide, PCBs, and Herbicides, Loss on ignition method (organics)	
Stormwater	≤10	NA		x	D	Total Metals, SVOCs (PAHs), Oil and grease, Ammonia, Chemical Oxygen Demand (COD), pH	Verify that stormwater is free of contaminants prior to release

Sample Matrix	# Samples [1]	Depth	Composite	Grab	Type 2	Analyte(s) Analytical Method(s)[2] Sampling SOP[3]	Location /Rationale (Comment)
Personal H&S	~20	NA		x		Lead and potential other contaminants per HASP	Personnel working on site

[1] Number of samples are estimates especially if based on number of samples per specific volume. Does not include QC samples in **Worksheet 20.**
2 Type: Screening (S), Definitive (D), Collaborative (C) (Screening w/10% Definitive)
[2] See **Worksheet 19&30** for list of analytical methods. See discussion in **Worksheet 21** for SOP site specific summary

WORKSHEET 19 & 30 | SAMPLE CONTAINERS, PRESERVATION, AND HOLD TIMES

- UFP-QAPP Manual Section 3.1.2.2

The chemical laboratory will be selected based on three quotes in writing and documented to demonstrate fair and reasonable pricing per the FAR. The request for quotes will summarize the expected number of samples and analyses required to meet site standards and a request for proof of certifications including NELAP or similar state requirements. It is unlikely that a geotechnical/ soil properties lab will be required; however, it is possible if there is concern about a specific type of material the source supplier has available. The agronomics laboratory will be selected based on location (preferably Texas or Oklahoma) and the ability to conduct loss on ignition analyses.

Laboratory name	Analyses	Address /POC	Certification	Delivery Method
TBD	Chemical	TBD	TBD	TBD
TBD	Geotechnical/ Soil properties	TBD	TBD	TBD
TBD - OSU Soil, Water and Forage Analytical Laboratory	Agronomic - Topsoil Organics	TBD	TBD	TBD

Certification: The laboratory used for chemical analysis will have National Environmental Laboratory Accreditation Program (NELAP) accredited or a CLP laboratory.

The QA/QC Lead, T&D Coordinator, or RM will work closely with the subcontracted laboratory to verify appropriate analyses based on project-specific requirements and disposal facility requirements. Generally standard turn-around time (TAT), 10 business days, will be used for analysis. Confirmation samples may use a 3-day TAT if a quicker TAT is required to meet the project schedule and alleviate extra costs due to waiting on sample results. TAT may be expedited on select waste disposal samples for each matrix to confirm field test results and confirm bulking of soil and potential bulking of containers.

Parameter	Analytical Method (SW-846)	Containers [1]		Preservative		Prep/Analytical Holding Time[2]	
		Liquid	Solid	Liquid	Solid	Liquid	Solid
Lead	See Metals 6010 below						
	XRF	NA	1 Zip-top baggie	NA	NA	NA	180 days
benzo (a) pyrene	See SVOC or PAH SIM 8270 below						
TCL Volatile Organic Compounds (VOC)	8260C	2 40-ml Glass vials, polytetrafluoroethylene (PTFE) septa cap	EnCore/ Methanol 40-ml Glass vials, PTFE septa cap Low Level 40-ml Glass vials, PTFE septa cap & stir bar	Cool 4ºC (.008% $Na_2S_2O_3$ if residual Cl_2 present). No headspace, HCl to pH < 2.	EnCore[3] Cool 4ºC Methanol Method 10ml CH_3OH, Cool 4ºC Low Level Method 1gm $NaHSO_4$ & 5 ml of H_20	14 days	EnCore 48 hours to preserve[2], 14 days to analysis Methanol Method 14 days Low Level Method 14 days
TCL Semi-Volatile Organic Compounds (SVOC)	8270D	2 1-Liter Amber Glass	1 8-oz Clear Wide Mouth Glass	Cool 4ºC, (.008% $Na_2S_2O_3$ if residual Cl_2 present)	Cool 4ºC	7 days to extract, 40 days to analysis	14 days to extract, 40 days to analysis
Chlorinated Herbicides[4]	8151A	2 1-Liter Amber Glass	1 8-oz Clear Wide Mouth Glass	Cool 4ºC	Cool 4ºC	7 days to extract, 40 days to analysis	14 days to extract 40 days to analysis
PCBs / Pesticides[4]	8082A/ 8081B	2 1-Liter Amber Glass	1 8-oz Clear Wide Mouth Glass [4]	Cool 4ºC	Cool 4ºC	7 days to extract, 40 days to analysis	14 days to extract, 40 days to analysis
Polynuclear Aromatic Hydrocarbons (PAH)[5]	8270 SIM 8100/8310	2 1-Liter Amber Glass	1 8-oz Clear Wide Mouth Glass	Cool 4ºC, (.008% $Na_2S_2O_3$ if residual Cl_2 present)	Cool 4ºC	7 days to extract, 40 days to analysis	14 days to extract, 40 days to analysis
TAL Metals (Except Mercury)	6010(Soil) 6020(H_20)	1 1-Liter HDPE	1 8-oz Clear Wide Mouth Glass [5]	Cool 4ºC, HNO_3 to pH < 2	Cool 4ºC	180 days	180 days
Mercury (Hg)	7470(H_2O) / 7471(Soil)	1 250-ml HDPE or Glass	1 8-oz Clear Wide Mouth Glass	Cool 4ºC, HNO_3 to pH < 2	Cool 4ºC	28 days	28 days
TPH (GRO, DRO, ORO)	TX Method 1005	NA	1 4-oz amber glass	NA	Cool 4ºC	NA	14 days
Topsoil Fertility (organics)	Loss on ignition	NA	500 g in glass or plastic	NA	NA	NA	1-month pre drying

Parameter	Analytical Method (SW-846)	Containers [1]		Preservative		Prep/Analytical Holding Time[2]	
		Liquid	Solid	Liquid	Solid	Liquid	Solid
COD	SM 5220D	250 mL Poly	NA	Cool 4°C H_2SO^4	NA	28 Days	NA
Ammonia	SM 4500-NH3G / EPA 350.1	250 mL Poly	NA	Cool 4°C H_2SO^4	NA	28 Days	NA
Waste Profile							
TCLP Volatile Fraction	1311/8260	3 40-ml Glass PTFE lined septa	1 2-oz Glass PTFE lined septa (≥ 25 g)	Cool 4ºC, no headspace	Cool 4ºC, no headspace	14 days to TCLP, 14 days to analysis	14 days to TCLP, 14 days to analysis
TCLP Semi volatile Fraction	1311/8270	3 1-Liter Amber Glass	1 16-oz Clear Wide Mouth Glass (CWMG) (≥ 300 g)	Cool 4ºC	Cool 4ºC	TCLP NA. 7 days to extract, 40 days to analysis	14 days to TCLP, 7 days to extract, 40 days to analysis
PCBs[6]	8082A	See Record Above					
TCLP Pesticides[6]	1311/8081B	2 1-Liter Amber Glass	1 8-oz CWMG (≥ 300 g)	Cool 4ºC	Cool 4ºC	14 days to TCLP, 7 days to extract, 40 days to analysis	14 days to TCLP, 7 days to extract, 40 days to analysis
TCLP Chlorinated Herbicides[6]	1113/8151A	2 1-Liter Amber Glass	1 8-oz CWMG	Cool 4ºC	Cool 4ºC	14 days to TCLP, 7 days to extract, 40 days to analysis	14 days to TCLP, 14 days to extract 40 days to analysis
TCLP RCRA metals (except Hg)	1311/6010	1 1-Liter HDPE	1 8-oz CWMG	Cool 4ºC	Cool 4ºC	TCLP NA. 180 days to analysis	180 days to TCLP, 180 days to analysis
TCLP RCRA metals (Hg)	1311/7470	1 1-Liter HDPE	1 8-oz CWMG	Cool 4ºC	Cool 4ºC	TCLP NA. 28 days to analysis	28 days to TCLP, 28 days to analysis
Ignitibility/Flashpoint	1010A/1020B	1 8-oz CWMG	1 8-oz CWMG	None	None	14 Days	14 Days
Corrosivity/pH	9040C/ 9045	500 mL plastic	1 8-oz CWMG	None	None	ASAP	ASAP
Reactivity (CN/ Sulfide)	Chapter 7 9013A/9030B	125 mL plastic bottle	1 8-oz CWMG	Cool 4ºC	Cool 4ºC	14 days CN, 7 days S	14 days CN, 7 days S
Paint Filter	9095B	16 oz Boston Round	NA	None	NA	None	NA

Parameter	Analytical Method (SW-846)	Containers [1]		Preservative		Prep/Analytical Holding Time[2]	
		Liquid	Solid	Liquid	Solid	Liquid	Solid

[1] ER will work with selected labs to ensure correct number/ type of sample containers/ mass of sample are collected and appropriate analyses are consolidated.
[2] Hold times are a designated length of time samples are considered representative of the area they were taken before sample preparation or analysis must begin
[3] Encore or similar (terracore) [4] May be collected to verify to pesticide/ PCB/ herbicide contamination in source material
[5]May be collected if PAH reporting limits for laboratory is to high using standard SVOC analysis
[6]May be collected for waste profile at the direction of the TSDF

Link to Hazardous Waste Test Methods (SW-846 Methods): https://www.epa.gov/hw-sw846

WORKSHEET 20 | FIELD QUALITY CONTROL SAMPLE SUMMARY

- UFP-QAPP Manual Sections 3.1.1 and 3.1.2.

QC checks of both field sampling and laboratory analysis will be used to assess and document data quality and identify discrepancies in the measurement process that need correction. The quantities and type of QC samples collected will be selected to demonstrate the reliability of the data.

The level of QC provided by the laboratory is based on the analytical method and the laboratory quality system requirements. Laboratories quality control (laboratory control sample (LCS), matrix spike (MS), and surrogate) will be evaluated against the method or laboratory derived criteria. In this case, the lab-generated limits will be reported in the QC section of the analytical report and any exceedances will be noted. Waste profile samples sent to a laboratory do not typically require extensive field QC samples. These sample results will be compared to other like sample results and the field test results for comparability. Results near the regulatory action limit or outside the expected result may require re-sampling or analyses to verify disposal requirements.

If it is determined during data review and verification that quality control limits have been exceeded, those indicators will be evaluated during the data quality assessment process to determine if the data are of the quality necessary to support the project decision. The following is a summary of the types of QC samples that may be collected.

Matrix	Analytical Group	Field Duplicates	Matrix Spikes	Equipment Blanks	Trip Blanks	Other
In-situ Soil (XRF)	Pb XRF	1/ 20 duplicate sample or 3 readings from single baggie	NA	NA	NA	NIST or "RCRA" Standards during calibration checks
Soil – Confirmation	Pb and Benzo(a)pyrene	1/ 20 duplicate samples	1 per 20 as applicable to method	1 per 5% if non-dedicated equipment is used	NA (no VOCs)	Temperature blank:1 per cooler requiring 4°C (unless lab uses sample or cooler temp)
Lead Stabilization	TCLP RCRA metals (Pb), benzo(a)pyrene	0	1 per 20 as applicable to method		NA (no VOCs)	
Waste material soil	TCLP VOC, TCLP SVOC, TCLP metals TPH, Reactivity Corrosivity Ignitability Paint filter test*	0	1 per 20 as applicable to method		NA	NA
Clean Material (Backfill/ Topsoil)	TCL VOC, TCL SVOC, TAL Metals, pest/PCBs, herbicides	1/ 20 duplicate samples	1 per 20 as applicable to method		1 per cooler (VOC analysis)	Temperature blank:1 per cooler requiring 4°C (unless lab uses sample or cooler temp)
Stormwater	Total Metals, SVOCs (PAHs)	1/20 duplicate sample	1 per 20 as applicable to method	NA	NA	NA

WORKSHEET 21 | FIELD SOPS

❖ UFP-QAPP Manual Section 3.1.2

SOP Number/ Reference	Title, Revision, Date, and URL (if available)	Originating Organization	SOP Option Equipment Modification
2001	General Field Sampling Guidelines, 06/2013	ERT	See Discussion Below for summary of SOP procedures including equipment and modifications
2002	Sample Documentation, 01/2016	ERT	
2013	Surface Water Sampling, 07/2016	ERT	
2017	Waste Pile Sampling,07/2016	ERT	
2049	Investigation-Derived Waste Management, 10/2015	ERT	
1720-20	Operation of the Niton xlt792yw Field Portable X-ray Fluorescence Instrument	ERT	
ERHS01	Air Monitoring and Sampling (IH) – See HASP	ER	
ERHS25	X-Ray Radiation Protection Program	ER	
Appendix D contains select ER sampling-related SOPs that may be used during site activities. Link to Environmental Response Team (ERT) SOPs: http://epaosc.org/site/site_profile.aspx?site_id=2107			

Below is a summary of the field sampling procedures to be used during field activities. Field activities will be conducted in strict accordance with the HASP. Sample collection activities for assessment of personal exposure will adhere to applicable National Institute for Occupational Safety and Health (NIOSH) and Occupational Safety and Health Administration (OSHA) method specifications. H&S analytical data will be entered into the ER Industrial Hygiene database, which will be maintained by ER's H&S personnel, who are responsible for Occupational Exposure Limit-related sampling activities. Refer to the project HASP for additional information regarding exposure limits, personal protective equipment (PPE) requirements, and emergency procedures. At minimum, samplers will use clean gloves during the collection of samples.

Soil Sampling Procedure

Surface soil samples will usually be collected from a depth of 0-6 inches (below ground surface) using stainless steel hand augers, bowls, and spoons. This procedure is also used for confirmation samples after excavation of contaminated material. Any debris or vegetation will be removed prior to sample collection. Composite samples for non-volatiles analysis, in accordance with Worksheet 17 sampling rationale for each type of sample, may be collected by combining subsamples in a stainless-steel bucket and thoroughly homogenizing. As presented in Worksheet 26&27, sample points will be identified on a topographic map, using a Surveyor (primary option) or Global Positioning System (GPS), to further assist in defining the extent of remediation. All reusable equipment exposed to the soil samples are constructed of stainless steel and decontaminated before each use (see decontamination procedures below). Samples will be placed in appropriate sample containers. Samples for VOC analysis (for clean fill material) will be collected first using an EnCore sampler (or similar), followed by sampling for non-volatile analysis using a stainless-steel scoop or trowel. Sample descriptions will be logged in the field logbook or form with standard geologic descriptions as appropriate to site data needs. All surface soil sample locations will be photographed and documented during sampling activities.

Grab or composite samples collected for XRF analysis may be collected directly into the sample baggie. The sample will be homogenized by manipulating the outside of the bag to ensure that the material is free of organics and rocks and that clumps of soil are broken up.

Homogenization: Mixing of the sample for non-VOC parameters is necessary to create a representative sample media. It is extremely important that solid samples be mixed as thoroughly as possible to ensure that the sample is as representative as possible of the sample location. Use the "quartering" technique which consists of dividing the sample into quarters and thoroughly mixing each quarter and then mixing the quarters together. This procedure is repeated several times until the sample is homogenous.

Subsurface Soil Sampling Procedure

Prior to performing subsurface activities, public utilities will be located, as necessary. Subsurface soil samples/aliquots may be collected using an excavator to access material at depth. Reusable sampling equipment exposed to the soil samples are constructed of stainless steel and decontaminated before each use (see decontamination procedures below). Homogenization of sample aliquots will follow the procedure described above. Subsurface sample locations will be photographed and documented during sampling activities.

Stormwater Sampling Procedure

Stormwater sampling will be conducted by immersing the sample bottles directly into the sample media. If the stormwater is not deep enough to collect a full sample, an additional sample bottle may be used/ modified at each location to collect sample and before placing in the appropriate containers. Field parameters, which include pH, temperature, and electrical conductivity, may be measured for each sample collected. Data will be recorded on appropriate sample forms or in a site-specific logbook or field form. Sampling will be conducted from the farthest downstream location to the farthest upstream location to minimize the potential for cross contamination. Stormwater sample locations will be photographed and documented during sampling activities.

In-Situ Soil Sampling Procedures

Samples for XRF analysis will be collected by directly placing material in the sample container or placing the XRF analyzer on the material in-situ. Reusable equipment exposed to the soil samples are constructed of stainless steel and decontaminated before each use (see decontamination procedures below). Results and sample descriptions will be logged in the field logbook or form with standard geologic descriptions as appropriate to meet site data needs. Soil sample locations will be photographed and documented during sampling activities, including marking locational data within the excavation on a site sketch.

Equipment Decontamination Procedure

Sampling and monitoring equipment will be mobilized to the site within a sanitary container or stored within a controlled environment to avoid contamination and ensure maintenance of data. Reusable sampling equipment (hand augers, spoons, stainless steel mixing bowls, etc.) will be decontaminated before sampling commences, between each discreet sample location, and prior to leaving the site. The effectiveness of decontamination procedures is documented using equipment rinsate blanks, which are generally collected at a frequency of once per day per matrix per field crew as defined in the SAP. Disposable sampling equipment will be used whenever practical to minimize the need for decontamination.

The decontamination procedure will include the following:

- Wash equipment with Alconox soap and tap water.
- Rinse with tap water.
- When sampling for inorganic contaminants: Rinse with dilute (0.1N) hydrochloric or nitric acid. (Note: Dilute hydrochloric acid is preferred over nitric acid when cleaning stainless steel because nitric acid can oxidize stainless steel.)
- Rinse with distilled water or deionized water.
- When sampling for organic contaminants: Rinse with pesticide-grade, reagent-grade isopropyl alcohol.
- Allow equipment to air dry and wrap in clean plastic.

Decontamination by-products will be handled by combining rinse with appropriate remediation-derived waste for disposal or treatment.

WORKSHEET 22 | FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION

- UFP-QAPP Manual Section 3.1.2.4

Verification of Activities: QA/QC Lead/ T&D Coordinator and RM
Responsible Person (including calibration): ER field personnel; assign office personnel for continued maintenance/ ensure manufactures calibration
SOP Reference: Instrument User's Manual, ERT Quick Start Guides (QSG)/ Equipment Operating Guides (EOGs)

Field Equipment	Calibration Activity	Maintenance	Testing[1]	Frequency	Acceptance Criteria	Corrective Action
MSA Altair 5X PID Multi-gas with PID with electronic data storage (or similar)	Calibrate with Zero Air; span calibrate with multi-gas	Check/ replace battery	Bump Test	Daily before use; if anomaly suspected	Automatic (Pass/ Fail) Reproducibility: LEL <50 % (3 %) LEL 50-100 % (5 %) CH4 <2.5 % (0.15 %) CH4 2.5-5.00 % (0.25 %) O2 0 – 30 % (0.7 %) CO*: ±5 ppm or 10 % of reading H2S*: ±2 ppm H2S or 10 % reading PID* ±10 ppm or 20 % of reading *whichever is greater	Check gas expiration/ check sensor/ follow directions on equip/manual
Niton XRF	Check factory calibration per user manual	Check battery, clean window/replace	Calibration Check + NIST Stnds	Daily before use	Per user manual	Per user manual
DataRAM[1]	Select auto 0/ Initialize	Change Dust Filter	NA	On regular basis, or when visual dust noted on filter	NA	Change Sensor or Factory Service& Calibration
Personal Air Pump with Dry-cal Equipment	Dry calibrate flow rate	Check battery and operational	Within flow rate of test method	Prior to day's activities	Test method dependent	Charge or replace
Sampling Tools	NA	Clean non-dedicated equipment prior to/after use	Inspect for damage or defects	Before use	Repeat decontamination as needed	Replace as needed

[1] Used for Perimeter monitoring if deemed necessary by EPA and based on H&S monitoring/ sampling data results
ERT EOGs & QSGs: https://response.epa.gov/site/site_profile.aspx?site_id=0001

WORKSHEET 23| ANALYTICAL SOPs

- UFP-QAPP Manual Section 3.2.1

SOPs: Quality Manual for chemical analyses lab will be attached once lab is selected
Screening/Definitive: XRF is field screening data. Other methods/ data in the following table are definitive.

Title, Revision Date, and/or Number and URL (if available)	Analytical Group /Matrix	SOP Equip.
Method 1311: Toxicity Characteristic Leaching Procedure (TCLP), July 1992	**TCLP:** Soil, Sediment, Debris, Water	Extraction
Method 8260C: Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), 09/2006	**VOC:** Soil, Sediment, Debris, Water	GC/MS
Method 8270D: Semi volatile Organic Compounds by GC/MS, 02/2007	**SVOC:** Soil, Sediment, Debris, Water	
Method 6010C: Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES), 11/2000	**Metals (no Hg):** Soil, Sediment, Debris	ICP-AES
Method 6020A: Inductively Coupled Plasma-Mass Spectrometry (ICP-MS), 02/2007	**Metals (no Hg):** Water, Air	ICP-MS
Method 7470A: Mercury in Liquid Waste (Manual Cold-Vapor Technique), 09/1994	**Mercury:** Water	Cold Vapor Atomic Absorption
Method 7471B: Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique), 02/2007	**Mercury:** Soil, Sediment, Debris, Air	
Method 8081B: Organochlorine Pesticides by Gas Chromatography (GC), 02/2007	**Pesticides:** Soil, Sediment, Debris, Water	GC
Method 8082A: Polychlorinated Biphenyl (PCBs) by GC, 02/2007	**PCBs:** Soil, Sediment, Debris, Water	
Method 8151A: Chlorinated Herbicides by GC, 12/996	**Herbicides:** Soil, Sediment, Debris, Water	
Method 9010/9012: Total and Amenable Cyanide: Distillation, 11/2004	**Cyanide:** Soil, Sediment, Debris, Water	Distillation/ Titration
Method 2310L: Acidity (as $CaCO_3$)	**Acidity:** Liquids	Titration
Method 9040C/9041: pH Electrometric Measurement, 11/2004	**pH:** Soil, Sediment, Water	Electrode
Method 1110: Corrosivity Toward Steel, Nov. 2004	**Corrosivity:** Liquids	NA
Method 1010/1030: Test Methods for Flashpoint by Pensky-Martens Closed Cup Tester, 11/ 2004	**Flashpoint:** Water	Closed Cup
Method 9095B: Paint Filter Liquids Test, Nov. 2004	**Paint Filter:** Liquids	NA
Method 6200M: Field Portable XRF Spectrometry for the Determination of Elemental Concentrations in Soil/Sediment	Screening	**Metals** Soil

WORKSHEET 24| ANALYTICAL INSTRUMENT CALIBRATION

- UFP-QAPP Manual Section 3.2.2

See Worksheet 22 for field equipment calibration. The responsibility for calibration of laboratory equipment rests with the selected laboratory. Each type of instrumentation and EPA-approved method have specific calibration procedures, based on the analytes of interest and the sample medium. Calibration procedures and frequencies will be in accordance with requirements established by the EPA. NELAP accredited laboratories are required to maintain QA manuals and method specific SOPs documenting calibration requirements, CAs and preventative maintenance frequency. The laboratory QAM is responsible for ensuring that laboratory instrumentation is maintained in accordance with specifications. Laboratory SOPs and/or a Lab Quality Manual will be attached once the lab is selected. The Lab Manager/ analyst is responsible for the following corrective actions.

Instrument/ Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action (CA)
GC/ GC/MD 8081B, 8082A, 8151A	ICAL after instrument set up, then if daily 12-hour calibration verification criteria are not met.	Target compounds: initial r^2 >0.995; and calibration verification % difference <15%	Inspect system, correct problem, re-run calibration / affected samples
GC/MS 8260C, 8270D	ICAL after instrument set up, then if daily 12-hour calibration verification criteria are not met.	Target analytes: initial r^2 >0.99; and % difference <15% (TA) <30% (CCC); ICV within ± 30%	
CVAA 7470A, 7471B	Daily ICAL prior to sample analysis. Perform instrument re-calibration 1/yr min. CCV every 15 samples and end of analysis sequence.	R2 ≥0.995 for linear regression; Analytes within ± 10% expected value	
ICP/ ICP-MS 6010C, 6020A	Calibration & ICV after instrument set up, then daily. CCV 10% or every 2 hours, which is more frequent	Calibration: r^2 >0.995; ICV & CCV: ± 10% of true values	
ICP-AES 6010C	Calibrate & ICV after instrument set up then daily; CCV upper range (UR) w/in 10%. New UR limits determined when significant change in instrument response or every six months. LLCCV stnd 30%.	Linear regression correlation coefficient ≥0.995 ICV & CCV: ± 10% of upper range true values and ± 30% LLCCV true values.	

CCC	Calibration Check Compound	GC	Gas Chromatography	PLM	polarized light microscopy
CCV	continuing calibration verification	GC/MS	Gas Chromatograph/ Mass Spectroscopy	ICP-AES	inductively coupled plasma atomic emission spectroscopy
CF	calibration factor	HPLC	high performance liquid chromatography		
CVAA	Cold Vapor Atomic Absorption	ICAL	initial calibration	TEM	transmission electron microscopy
EDX	Energy Dispersive X-Ray	ICP	Inductively coupled plasma		

NFGs: https://www.epa.gov/clp/superfund-clp-national-functional-guidelines-data-review
SW846 Methods: https://www.epa.gov/hw-sw846

WORKSHEET 25| ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION

- UFP-QAPP Manual Section 3.2.3

Analytical methods and instrument inspection listed here link to analytical methods in **Worksheet 18** and **Worksheet 19&30**

Laboratories conducting sample analyses collected under the contract are NELAP accredited, or similar, and have a preventative maintenance program covering testing, inspection, and maintenance procedures with a schedule for each measurement system and required support activity. Instruments are maintained according to manufacturer's operation requirements. Laboratory SOPs or a Lab Quality Manual may be required from the laboratory to verify their procedures for equipment maintenance, testing, and inspection comply with method requirements and will be attached once the lab is selected. The basic requirements and components of such a program include the following examples. The laboratory analyst is responsible for the following corrective actions.

Instrument	Maintenance	Testing	Inspection	Frequency	Accept. Criteria	Corrective action	SOP
GC & GC/MD	Replace disposables, bake out instrument, condition column	See analytical method & instrument manufacture's recommendations	Check connections, perform leak tests	Daily or as needed	Continuing calibration verification pass criteria	Inspect system; correct problem; re-run calibration & affected samples	8081B 8082A 8151A
GC/MS							8260C 8270D
CVAA	Replace disposables, flush lines, check lamp current & gas flow	Sensitivity check	Instrument performance and sensitivity			Recalibrate	7470A 7471B
ICP-AES	Replace disposable, flush lines, & clean auto sampler	Analytical standards					6010C
ICP & ICP-MS	Replace pump windings & gas tanks, check standard & sample flow	Monitor instrument standard (ISTD) counts for variation		As needed	Monitor ISTD counts for variation	Replace windings, recalibrate & reanalyze	6010C 6020A

AES atomic emission spectroscopy
CVAA Cold Vapor Atomic Absorption
GC Gas Chromatography
MD Multi-detector
MS Mass Spectroscopy
ICP inductively coupled plasma
HSE/NPL Health and Safety Executive/ National Physical Laboratory

WORKSHEET 26 & 27 | SAMPLE HANDLING, CUSTODY AND DISPOSAL

- UFP-QAPP Manual Section 3.3

Sampling Organization: ER
Laboratory: TBD (based on award of laboratory RFQ)
Method of sample delivery (shipper/carrier): TBD based on laboratory location
Number days from reporting to sample disposal: Samples will be held and disposed of per laboratory SOP (usually a minimum of 30 days).

Activity	Organization & Position Responsible	SOP
Sample Labeling	ER Field Sampling Team and QA/QC Lead/ T&D Coordinator	ERT2002
Chain-of-Custody Form Completion	ER Field Sampling Team and QA/QC Lead/ T&D Coordinator	ERT2002
Sample Packaging	ER Field Sampling Team and QA/QC Lead/ T&D Coordinator	Lab guidance
Shipping Coordination	ER QA/QC Lead/ T&D Coordinator	NA
Sample Receipt, Inspection, & Log-in	Subcontract Lab Sample Custodian	Lab SOPs/QAPP
Sample Custody and Storage	Lab Sample Custodian /Lab Analytical Personnel	
Sample Disposal	ER Field Personnel (IDW and field testing) Lab Sample Custodian /Lab Analytical Personnel	

Supplies and Consumables:
Supplies and consumables used in the collection of field samples and field measurements will consist of field measurement equipment, calibration standards, sampling equipment, PPE, sample containers shipping materials and coolers, de-ionized water, and reagents. Supplies will also consist of field supplies for implementing cleanup strategy including geotechnical liners, rock, and aggregate. Supplies and consumables will be received at an ER office, the EPA Warehouse or onsite. When supplies are received, the RM or project QA/QC Lead will sort the supplies according to vendor, check packing slips against purchase orders, applicability to the requirements specified in this plan and site specifications, and inspect the condition of supplies before the supplies are accepted for use on a project. Supplies for personnel protection and H&S monitoring will be inspected by the site SSO for conformity to the project HASP. If the supplies do not meet the acceptance criteria, deficiencies will be noted on the packing slip, purchase order, and site logbook. The item will then be returned to the vendor for replacement or repair. Incomplete or late orders may result in partial payment or disqualification of the vendor for future purchases.

Sample Handling:
Chemical preservatives are used when they do not interfere with the analysis. Sample preservation is intended to retard biological action, retard hydrolysis and chemical compounds and complexes, and reduce volatility of constituents.

Sample containers and preservatives for environmental samples will be provided by the laboratory, unless emergency circumstances preclude this possibility. In this case, ER will only use containers that are certified clean (having a certificate of analysis) and preservatives of known and documented purity. The ER QA/QC Lead will be responsible for ensuring that the proper containers and preservatives are ordered. Pre-qualified laboratories will be required to have procedures in place to certify the cleanliness of sample containers and the purity of their

preservatives. Sample containers and preservatives are assembled prior to mobilization. Preservatives are placed in sample containers if analyte and sampling techniques permit their use.

When samples are collected for off-site analyses, they will be sent to the laboratory within 24 hours of collection, whenever practicable, to ensure that the most reliable and accurate answers will be obtained because of the analyses. Samples are collected according to the appropriate SOP, and sample volume must be sufficient for the analysis. Samples designated for off-site analysis will require samples to be collected in accordance with specified method criteria. Samples collected for multiple analytes may require lesser volume by combining analytes per sample bottle. All samples will be collected and preserved in accordance with specific method requirements. After the sample(s) have been taken, preservative is added immediately, if not added to the sample container prior to sample collection. For composite, sampling, each aliquot should be preserved at the time of collection. When automated samplers are used, preserve after compositing and sample splitting is completed. Sample(s) are to be maintained at 4°C (±2°) during sampling and packaging. Containers, preservatives, and holding times requirements specified by the USEPA SW-846 are presented in Worksheet 19&30.

Field Sample Documentation:
The number and type of samples collected will be recorded on field forms and/or in field logbooks. All hardcopy entries will be made in waterproof permanent ink, and no erasures will be allowed. If an incorrect entry is made, the information will be crossed out with a single strike mark, dated, and initialed. Whenever a sample is collected or a measurement is made, a detailed description of the location shall be recorded. The number of photographs taken and identifiers will also be noted. Equipment used to make measurements will be identified along with the date of calibration.

Samples will be collected following the sampling procedures documented in this plan. The equipment used to collect samples will be noted along with the time of sampling, sample description, volume, and number of containers. Sample points will be located on a topographic map with the aid of a Global Positioning System (GPS) enabled device, if appropriate, after sample collection. This procedure will allow documentation of changes in sample locations as they occur in the field due to unanticipated site conditions.

Sample Identification
Sample Identification will be based on the type of sample collected and the number of samples collected. For instance, stockpiles will use the stockpile ID. Samples collected from the excavation for field testing will at minimum contain the anomaly area and excavation depth and other information deemed necessary during site activities to provide a unique identifier.

Sample Nomenclature

Identifier	Detail	Feature
XXX ETF LPA WPA	Material Source Name East Tank Farm Lorraine Process Area Wilcox Oil Company Process Area	Area
	Named based on size (for grid/ zone samples only)	Grid /Zone[1]
Number	Depth of excavation/ subsurface depth of sample	Depth

Sample Nomenclature

Identifier	Detail	Feature
TP BF SW SO CF WS OA	Topsoil Backfill Storm Water Soil Confirmation Soil Waste Profile Outdoor Air	Matrix
###	Incremental Number[2]	Unique Identifier
_MMDDYY	Date	

The following information shall be recorded using black, waterproof ink in the sample logbook or field form when in-situ measurement or samples for laboratory analysis are collected:

- location of sample/ measurement collection
- date and time of measurement
- samples taken if any
- field observations
- level of personnel protection (if required)
- equipment used to make physical measurements and collect samples

Each sample collected for laboratory analysis will have a completed sample label with the following information:

- Project (EPA TO) Number
- Sample Number
- Sample collection date and time
- Sample medium/matrix and type (grab/composite)
- Preservative
- Analytical method
- Sampler's initials

Custody Procedure:

Sample custody and transfer procedures will be consistent with established regional guidelines. Along with the field logbook/ field forms, the Chain of Custody (COC) form is used to track and document unbroken custody of samples as identified by the unique sample number. Samples sent to the laboratory will be accompanied by a COC form. The COC will include the ER point of contact, sample numbers and locations, requested analytical methods, and the TAT based on project needs. A standard TAT of 10 business days will be used for this project. Confirmation samples may use a 3-day TAT if a quicker TAT is required to meet the project schedule and alleviate extra costs due to waiting on sample results. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area. The original COC form will be kept by the receiving laboratory and will accompany the analytical report and a copy will be placed in the project files.

ER will use Excel spreadsheets and potentially EPA ERT's SCRIBE software to manage the

sample collection, documentation, and submission of all relevant reports. The Excel spreadsheets at minimum will be SCRIBE compatible. An ER COC form is also included as **Appendix C**.

Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis, with a signed COC enclosed. A copy of the COC will be retained by the sampler for reference. Shipping containers will be locked and secured with strapping tape and a minimum of two signed and dated custody seals for shipment to the laboratory. The preferred procedure includes use of a custody seal attached to the front right and back left of the cooler. The custody seals are covered with clear plastic tape. The cooler is strapped shut with strapping tape in at least two locations.

The designated laboratory sample receipt clerk is authorized to accept samples and is charged with the responsibility for proper completion of the required sample receipt documentation. Analysts are assigned to assist the sample receipt clerk in sample log-in procedures. In all cases, the COC and analytical request documents become part of the permanent file relative to the samples collected. Those files are retained indefinitely in the laboratory's facility. A record of the custody change is made by the analyst and checked by the Sample Custodian at the time the sample is taken from the cold storage. Internal custody files are retained indefinitely in laboratory files.

WORKSHEET 28| ANALYTICLA QUALITY CONTROL AND CORRECTIVE ACTION

- UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6

Field and laboratory QC samples and measurements will be used to verify that analytical data meet project specific MPC, which are based on PQOs/DQOs. Field QC samples and measurements and laboratory QC samples will be used to assess how they influence data quality. See Worksheet 12 and 20 for descriptions of QC samples, DQIs, and MPC. The following table documents typical method specific and/or NFG specific acceptance limits and CAs.

Responsible Person for CA: Laboratory Analyst/ Supervisor
Project-Specific MPC: Laboratory generated limits for laboratory control sample (LCS), MS/MSD, and surrogates will be provided once lab is selected and will be used for verification as described in Worksheets 34 through 36.

Method/Matrix Concentration	Lab QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	DQI
SW846 1311 TCLP Soil/ Waste Low, Medium, High	Method Blank	1 per ≤ 20 samples	Method dependent	Stop analysis until requirements met	Accuracy
	Matrix Spike	1/ waste type	Method dependent	Check calculations and instruments, reanalyze affected samples	Accuracy
	Extraction Time Limits	All samples	VOC; N/A SVOC; 7 days Hg; N/A Metals; N/A	Make sure samples are extracted within appropriate time constraints	Accuracy
SW846 8260B VOCs Aqueous Soil Waste Low Medium High	Method Blank	1 every 12 hours	No analyte > RL	Stop analysis until requirements met	Accuracy
	Matrix Spike	1 per ≤ 20 samples	Analyte specific	Flag outliers in conjunction with other QC criteria.	Accuracy
	Matrix Spike Dup.	1 per ≤ 20 samples	Analyte specific		Precision
	Internal Standards**	All Samples	Sample ISTD area must be -50% to +100% From CCV, + 30 sec retention time shift	Check calcs/ instrument, reanalyze affected samples; up to 3 DMCs per sample allowed to exceed limit; qualify as necessary	Accuracy
	Lab Control Sample	1 per ≤ 20 samples	70-130 %R %RPD < 20	Reanalyze if possible; Flag outliers	Accuracy Precision
	Field Duplicate	1 per ≤ 20 samples	%RPD < 20	Flag outliers	Accuracy
	DMC (Surrogate) Compounds	All Samples	Analyte specific	Check calcs/ instrument reanalyze affected samples; up to 3 DMCs per sample allowed to exceed limit. Qualify per NFG	Accuracy
SW846 8270D SVOCs Aqueous	Method Blank	1 per ≤ 20 samples	< RL; except Bis(2-ethylhexyl)phthalate < 5x RL	Stop analysis until requirements met	Accuracy
	Matrix Spike	1 per ≤ 20 samples	Analyte specific		Accuracy

Method/Matrix Concentration	Lab QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	DQI
Soil Waste Low-Low (SIM) Low Medium High	Matrix Spike Dup.	1 per ≤ 20 samples	Analyte specific	No action is taken on MS/MSD data alone. Qualify data in conjunction with other QC criteria	Precision
	Internal Standards	All Samples	Area count 50-200% 12 hr stnd ± 30 sec retention time shift	Check calculations and instruments, reanalyze affected samples	Accuracy
	Lab Control Sample	1 per ≤ 20 samples	Same as Matrix Spike MPC Same as Matrix Spike Duplicate MPC	Flag outliers	Accuracy Precision
	DMC (Surrogate) Compounds[1]	All Samples	Analyte specific	Check calculations and instruments, reanalyze affected samples	Accuracy
SW846 8081B Pesticides Soil Waste Water Low Medium High	Method Blank	1 per ≤ 20 samples	< RL	Stop analysis until requirements met	Accuracy
	Matrix Spike	1 per ≤ 20 samples	Analyte specific	No action taken on MS/MSD data alone. Qualify data in conjunction with other QC criteria	Accuracy
	Matrix Spike Dup.	1 per ≤ 20 samples	Analyte specific		Precision
	Surrogate Compounds	All samples	All surrogates: 30-150 %R	Check calcs and instrument, reanalyze affected samples; qualify as necessary	Accuracy
	Lab Control Sample	1 every 12 hours (1 per batch)	Analyte specific	Flag outliers	Accuracy
SW846 8082A PCBs Aqueous Soil Waste Low Medium High	Method Blank	1 per ≤ 20 samples	< RL	Stop analysis until requirements met	Accuracy
	Matrix Spike	1 per ≤ 20 samples	Analyte specific	No action is taken on MS/MSD data alone. Qualify data in conjunction with other QC criteria	Accuracy
	Matrix Spike Dup.	1 per ≤ 20 samples	Analyte specific		Precision
	Surrogate Compound	All samples	30-150 %R	Check calcs and instrument, reanalyze affected samples; qualify as necessary	Accuracy
	Lab Control Sample	All samples	Analyte specific		Accuracy
SW846 8151A Herbicides Aqueous Soil Waste	Method Blank	1 per ≤ 20 samples	< RL	Stop analysis until requirements met	Accuracy
	Matrix Spike	1 per ≤ 20 samples	70-130 %R	No action is taken on MS/MSD data alone. Qualify data in conjunction with other QC criteria	Accuracy
	Matrix Spike Dup.	1 per ≤ 20 samples	70-130 %R		Precision
	Surrogate Compounds	All samples	2,4-dichlorophenylacetic acid: 70-130 %R		Accuracy

Method/Matrix Concentration	Lab QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	DQI
Low Medium High	Lab Control Sample	1 per ≤ 20 samples	70-130 %R	Check calculations and instruments, reanalyze affected samples; qualify as necessary	Accuracy
SW846 6010C /7471 Metals/ Mercury Aqueous Soil Waste Low Medium High	Preparation Blank	1 per ≤ 20 samples	No constituent > RL	Suspend analysis until source rectified; re-digest & reanalyze affected samples; use professional judgment to qualify	Accuracy
	Instr. Calibration	Per Method	90-100%	Suspend analysis	Accuracy
	Matrix Spike	1 per ≤ 20 samples	<30% R; < 75 %R; or >125 %R	Qualify as necessary	Accuracy
	Duplicate	1 per ≤ 20 samples	< 20 %RPD**		Precision
	Post-Digestion Spike	After failed MS/MSD %R	80-120 %R		Accuracy
	ICP Serial Dilution	1 per ≤ 20 samples	< ± 10 %D 1:5 Dilution		Accuracy
	Interference Check Sample	Beginning, during, and after analysis	Within ± 2 times RL or ± 20% of true value, whichever is greater except Al, Fe, Ca, K, Mg, Na	Check calculations and instruments, reanalyze affected samples	Accuracy
	Laboratory Control Sample	1 per ≤ 20 samples (Every 12 hours)	70-130 %R; Except Ag & Sb: 40-170 %R	Suspend analysis until source rectified; re-digest/ reanalyze affected samples, Qualify as necessary	Accuracy
	Internal Standard (ICP-MS)	All samples	Yttrium & Scandium 60-125 %RI	Qualify as necessary	Accuracy

RSD relative standard deviation
CRQL Contract Required Quantitation Limit
DMC deuterated monitoring compound
HEM Hexane Extractable Material
ISTD instrument standard
MS/MSD Matrix Spike/Matrix Spike Duplicate
NFG National Functional Guidelines
RL Reporting Limit
RPD relative percent difference
SGT Silica Gel Treated

EPA NFG: http://www2.epa.gov/clp/contract-laboratory-program-national-functional-guidelines-data-review (RL = CRQL for CLP laboratory)
Link to SW-846 Methods: https://www.epa.gov/hw-sw846S

WORKSHEET 29 | PROJECT DOCUMENTS AND RECORDS

- UFP-QAPP Manual Section 3.5.1

Controlled documents include policies, SOPs, manuals, work instructions/plans, and other documents that describe how tasks are performed and controlled. Technical and quality records generated and retained are objective evidence of actions taken or observations made while implementing field activities and the quality management system. These include photographs, Daily Work Reports, Field Logbook or Data Collection Sheets, Chain-of-Custody (COC) Forms, Corrective Action Reports, Correspondence, Field Sample Results/Measurements, Tailgate Safety Meeting Items, Waste Profile Sheets, and Waste Manifest(s). Audits, assessments, and management system reviews (MSRs) are also controlled by ER. ER complies with the following sections description during the development, collection, maintenance, distribution, and storage of documented information.

The following records will be generated and verified by ER personnel and stored electronically on the ER intranet and in the on-site project file during site activities, as described in the Region 6 QMP. The following table provides additional locations where files will be maintained and stored. The RM is responsible for ensuring the collection, assembly, and inventory of documents for their project.

Record	Generation	Verification	Location
Sample Collection and Field Records			
Photographs	RM/ Field Personnel	RM	Project electronic file system. Photo log with key photos sent to RPM
Daily Work Orders/Reports	RM/ Foremen	RM	
Field Logbook or Data Collection Sheets	Foremen/ QA/QC Lead	RM, QA/QC Lead, T&D Coordinator	Project hard copy file system
Correspondence	Field Personnel	PM, RM	Email system
Areas of excavation, sample locations	Field Personnel	Field personnel	Logbook
Survey data GPS Coordinates	QA/QC Lead	RM	Project electronic file system
EPA 1900-55 Forms	FCA	RM	Project electronic file system
COC Forms/ Custody Seals	Project QA/QC Lead/ Field sampling team	RM, QA/QC Lead/ T&D Coordinator	Project hard copy file system
Air Bills/ Receipt of samples form			
Deviations			
Field Sample Results/Measurements	Project QA/QC Lead	RM	Scribe and Project electronic file system
Laboratory Data Package/ Validation	Subcontractor Lab	QA/QC Lead T&D Coordinator	
Tailgate Safety Meeting Items	RM/Field Personnel	H&S, RM	Project hard copy file system
Sign-In/ Sign-Out Sheet			
Equipment checklist	Operator	RM	Project hard copy file system

Waste Profile Sheets/ Waste Manifest(s)	RM	QA/QC Lead, T&D Coordinator	Project hard copy file system
Final CERCLA Off-Site Disposal Report			
*Project specific personnel will be assigned to generation/verification based on site complexity and type of data. Verification personnel will be qualified to review data and will be different from persons generating data.			
Project assessment, laboratory records (generated and internally assessed by the lab) are detailed in Worksheet 29			

Data Management

At the project level, quality management records are created and reviewed by the project team and approved/authenticated by the RM and/or QA/QC Lead prior to release for use. The PQM may periodically review documents and records outside the project-level review. The RM is also responsible for ensuring site documents and records and associated transmittal log are maintained on-site, as appropriate. Hardcopy and original documents are retained at a dry secure location at the office designated for working or retention. These documents are transferred to the STL office file retention area as soon as feasibly possible.

ER encourages the use of electronic format documents to reduce the use of paper products. In general, records and documents, including contracts, SOPs, and project plans are maintained electronically on ER's secure SharePoint website or network system based on the type of document or record. Quality documents and records submitted to EPA are typically submitted in electronic form via email, with the email retained as submission verification. Hard copies of project plans, other reference documents for site activities, and records created during site activities will be maintained on-site for easy access to personnel. ER also understands that paper versions are necessary in some situations like when electronic devices are unavailable during field activities. Hardcopy records created on-site will be scanned at the earliest convenience. The electronic file system and paper file system are mirrored so records are easily accessible using either method and completeness can be verified. This system also allows flexibility if internet access is limited on-site.

During work, obsolete and/or draft deliverables will be retained in accordance with the records schedule for the particular type of document. Once the retention time has expired, the documents will be deleted/destroyed unless ER opts to retain an outdated version as record of specific project details or recommendations that have been superseded. Controlled ERRS quality documents are retained for this purpose. If obsolete, superseded, or draft deliverables are retained, they will be marked and moved to an "Archive" folder.

Data collected on site will be recorded on the field forms, Instrument Calibration Logs, and field logbooks. These data records will become a part of the project file.

As discussed previously, Excel spreadsheets will be used, at minimum to manage analytical data. The Excel spreadsheet will be consistent with ERT Scribe software. The EPA ERT SCRIBE software may be used for data management purposes including key field test results, survey data, and laboratory analytical results. Commercially available spreadsheet and database software may also be used for tracking material brough on-site and material sent for disposal. Laboratory Data Deliverables will be received as electronic data deliverables (EDDs) and a Data Report (PDF). The EDD ensures that the data can be formatted quickly with minimal chance of typographic errors. The QA/QC Lead/ T&D Coordinator will maintain the Scribe processing of ER data. Scribe Data Manager may be used to automatically verify valid values and completeness of data. A level 2

package consists of a narrative, the sample results sheets (Form Is), and additional summary forms for the laboratory QC samples performed. The QA/QC Lead, T&D Coordinator assists the response manager in selecting the appropriate level of data package. Typically, a Form 2 report (waste disposal purpose where limited QA is required) or will be provided. The minimum requirement for the laboratory is the delivery of a SEDD Stage 2a deliverable. Worksheet 36 provides detail of which laboratory data will require Level 2 versus Level 4 data packages.

Sampling data will be reviewed by the ER QA/QC Lead or T&D Coordinator. Unacceptable results will immediately warrant CA procedures. Data are released for decision-making purposes only after approval of the QA/QC Lead/ T&D Coordinator. Upon approval by the QA/QC Lead/ T&D Coordinator and following a QA/QC review, analytical results will be submitted to the ER RM. The results will include a tabulation of the analytical data and an explanation of field conditions or laboratory QA/QC problems and their effects on data quality. Results of performance audits and system audits will also be included, as appropriate. Proposed CA will be recommended if QA problems are identified during review of data quality or results of performance or system audits.

Due to the iterative nature of investigation and remediation activities, data will be presented to the EPA in the interim in the form of tables, figures, laboratory analytical reports, and a brief letter report presenting conclusions, updating the COR, and proposing additional work, if necessary. Following project completions, ER will submit a report summarizing activities as requested by EPA and may include a summary of activities, final disposal summary, and tabulated results of all field and analytical data.

Report Review Process

Peer reviews are conducted during the preparation of a report on select areas and on select topics to evaluate performance, improve quality, and resolve professional differences of opinions. Peer reviews may be performed on program documents, implementation procedures, research studies, technical reports, and special assignments. In general, each review is unique, has individual objectives, and requires the use of individual methodologies and technical skills. Due to the unique nature of these reviews, the PM evaluates the qualifications of potential reviewers to ensure only properly qualified peer reviewers are selected. Each peer review will be formally documented and signed by the reviewers.

WORKSHEET 31, 32 & 33 | ASSESSMENTS AND CORRECTIVE ACTION

❖ UFP-QAPP Manual Sections 4.1.1 and 4.1.2

Internal Assessment Type	Responsible Person for Review & CAs	Evaluation	Frequency/ Audit Date	Deliverable/ Due Date[1]
Daily Safety Tailgate/ review of work	RM/SSO	• Review Job Hazard Analysis (JHA) for tasks scheduled for that day • Discuss previous issues	Daily during field activities	Tailgate Safety Form and JHA Form - immediately
Daily QC	RM	• Review current and previous DWO • Verify QC issues resolved	Daily during field activities	Punch list form - immediately
Field Sampling/ COC Review	QA/QC or T&D Coordinator	• Review sampling activities and completion based on this document • Review COC for accuracy/ completeness	Daily if sampling	Email to RM of sampling status within 1 day
Lab Data Review	QA/QC or T&D Coordinator	• Lab Data Review • Data package received • TAT achieved • Proper COC • Correct analytical method • Hold times not exceeded • Lab QC sample results within limits	Within day of data package received (per data package)	Findings Memo/ within 2 days of data package receipt Summary Report if required by TO
Data Validation	QA/QC	• Review results of data validation to determine usability of data	2 days of validation received	Report to RM
Field Instrument Documentation Assessment (TSA)	RM	• Internal Calibration complete & accurate • Standards are not expired • Duplicates are accurate • QC checks performed and within limits • Documentation complete • Calculations & entries are complete • COC maintained	Complete review each day of use as instrument is calibrated/ operated	Checklist - Daily

[1]Reports will be prepared by ER. Distribution will include the ER RM, PM and PQM, QA/QC Lead/ T&D Coordinator, and the EPA CO, COR, and Delegated QA Approving Officer, as applicable.

Additional audits, as discussed in the Region 6 QMP, may be completed based on site performance. Factors determining the scope and frequency for audits include complexity of the TO, project duration, degree of specified QC, criteria to achieve DQOs, subcontractor participation, criticality of data collection and frequency/potential of nonconformance. These audits will be used to verify that measurement systems are operating properly, assess whether data quality is adequately documented, confirm the adequacy of data collection systems, and evaluate management effectiveness to meet QA guidelines.

QA Management Reports Table				
Type of Report	**Frequency**	**Projected Delivery Date**	**Person(s) Responsible for Report**	**Report Recipients**
DWO, reports quality issues	Daily	Daily	RM	EPA COR
Monthly Report includes quality assessments and issues reporting	Monthly	TBD	RM	EPA Contract Officer
Monthly summary of QA/QC activities/ audit findings	As applicable	TBD	PQM	PM and RMs

WORKSHEET 36 | DATA VALIDATION PROCEDURES

- UFP-QAPP Manual Section 5.2.2

Data validation, in accordance with National Functional Guidelines (NFGs), is not expected for field data ER generates on this project. Laboratory data generated for this site will be validated in accordance with the NFGs as stated in the following table. For data without NFG validation, such as waste profile samples, the QA/QC Lead/ T&D Coordinator will, at minimum, review laboratory data packages as describe in **Worksheet 35** and **Worksheet 37**. The review may include evaluating data according to some NFG parameters.

Analytical Group/ Method	Typical Data Deliverable Requirement	Analytical Specifications	MPC	% Data Packages to be Validated	% Raw Data Reviewed	% Results to be Recalculated	Validation Procedure	Validation Code[1]	Electronic Validation Program/ Version
Confirmation Laboratory Analytical	Level IV	Soil – Pb and benzo(a) pyrene	Worksheet 11, 12, 19 & 30, 28	10%	TBD	TBD	NFG	TBD – Stage 4	TBD
Lead Stabilization	Level IV	Soil- TCLP and benzo(a) pyrene		10%	TBD	TBD	NFG	TBD- Stage 4	TBD
Waste Profiling	Level II	Soil	Lab QC/ RCRA stnd.	0%	0%	0%	NA	NV	NA
Clean material	Level II min	Soil – TCL VOC, SVOC, TAL Metals	Worksheet 11, 12, 19 & 30, 28	TBD	TBD	TBD	TBD	TBD	SBD
Stormwater	Level II min	Water	Lab QC/ NPDES	0%	0%	0%	NA	NV	NA

[1] Potential Validation Codes:
Stage_2A_Validation_Electronic S2AVEStage_2A_Validation_Manual S2AVM
Stage_2A_Validation_Electronic_and_Manual S2AVEMStage_2B_Validation_Electronic S2BVE
Stage_2B_Validation_Manual S2BVMStage_2B_Validation_Electronic_and_ Manual S2BVEM
Stage_3_Validation_Electronic S3VE
Stage_3_Validation_Manual S3VM
Stage_3_Validation_Electronic_and_Manual S3VEM
Stage_4_Validation_Electronic S4VE
Stage_4_Validation_Manual S4VM
Stage_4_Validation_Electronic_and_ Manual S4VEM
Not_Validated NV

For data that will be validated, specifically field data generated by ER, the validator will receive the data packages electronically. Additionally, the validator will be required to submit final validation reports via pdf format and must provide an annotated laboratory analytical result EDD with applicable data validation qualifiers and/or result value modifications. It is expected that a combination of manual and electronic validation will be completed, as approved by EPA prior to data validation. The validation code and process used by the validator will be used based on the validator selected and the EPA requirements for this project in accordance with EPA *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (January 2009). For instance, stage 4 validation may be electronic, manual, or a combination.

WORKSHEET 34| DATA VERIFICATION AND VALIDATION INPUTS

- UFP-QAPP Manual Section 5.2.1 and Table 9

The following information are typically used to complete verification and validation.

	Description	Verification (completeness)	Validation (conformance to specs)
	Planning Documents/Records		
1	Approved QAPP	X	
2	Field SOPs	X	
3	Laboratory SOPs	X	
4	Laboratory QA Manual	X	
5	Laboratory Certifications	X	
	Field Records		
6	Field Logbooks	X	X
7	Equipment Calibration Records	X	X
8	COC Forms	X	X
9	Sampling Diagrams	X	X
10	Change Orders/Deviations	X	X
11	Field Audit Reports	X	X
12	Field Corrective Action (CA) Reports	X	X
	Analytical Data Package		
13	Cover Sheet (laboratory identifying information)	X	X
14	Case Narrative	X	X
15	Sample Receipt Records	X	X
16	Limit of detection (LOD)/ Limit of Quantitation (LOQ) meet requirements	X	X
17	Definition of Laboratory Qualifiers	X	X
18	Results Reporting Forms	X	X
19	QC Sample Results	X	X
20	Electronic Data Deliverable	X	X

WORKSHEET 35 | DATA VERIFICATION PROCEDURES

- UFP-QAPP Manual Section 5.2.2

Records Reviewed	Required Documents	Process Description	Responsible Person
Approved QAPP	Project specific QAPP, QMP, Contract	Verify completeness, correctness, and contractual compliance of project QA/QC and data set against the methods, SOPs, and contract requirements.	PQM
Field SOPs		Ensure that field sampling SOPs were followed.	QA/QC Lead, T&D Coordinator, RM
Analytical SOPs	Project specific QAPP, SOPs	Ensure that laboratory analytical SOPs were followed.	Lab PM
Laboratory Certifications	Project specific QAPP	Ensure lab(s) has current State, NELAP, or other certifications as required by project.	QA/QC Lead, T&D Coordinator, RM
Field Logbook/ Forms Records	Project specific QAPP, QMP, Contract	Verify records are present and complete for each day of field activities. Verify samples (including field QC) were collected; documentation for sample locations/time, monitoring, or deviations are present. Use logbook checklist for completeness.	QA/QC Lead, T&D Coordinator, RM
Equipment Calibration		Ensure field analytical and lab SOPs for equipment calibration were followed.	QA/QC Lead, T&D Coordinator, RM, Lab PM
COC Forms		Verify completeness of COC records. Examine consistency with field logbook. Check for appropriate methods, preservation, TAT, sample volume (including QC samples [MS/MSD]). Verify required signatures/dates are present. Check for transcription errors.	QA/QC Lead, T&D Coordinator' RM' Lab PM
Reports & correspondence		Verify relevant reports are present and complete for each day of field activities. Verify correspondence are documented and were reported in accordance with requirements.	PQM, QA/QC Lead, T&D Coordinator, RM
Field test results		Verify data is complete. Check if physical characteristics are consistent with test results. Check if results are consistent with results from other like materials. Check if test results are consistent with analytical data for disposal	QA/QC Lead, T&D Coordinator, RM
Laboratory Deliverable		Verify lab deliverable contains records specified in the QAPP. Check sample receipt records to ensure sample condition and missing/broken sample containers were noted/ reported. Compare data package & COCs to verify all collected samples have results. Ensure narrative has QC exceptions described. Check for evidence that notifications were provided to project personnel as specified in the QAPP. Verify necessary signatures and dates are present.	QA/QC Lead, T&D Coordinator, RM
Audit Reports, CA Reports		Verify that planned audits were conducted. Examine audit reports. For deficiencies noted, verify that CA was implemented according to plan.	PQM, QA/QC Lead, T&D Coordinator, RM, Lab PM
Analytical Data (Lab)	Data Package	Data produced by the laboratory will undergo review at the lab to verify completeness and ensure the appropriate analyses, calculations, and QC were completed and required forms and data are included for each data package based on data package type.	Lab Project Manager

Level II data packages will be required for waste disposal/ profiling analytical results and does not require a full (Stage 4 data validation) unless directed by the COR. Data will be reviewed by the QA/QC Lead or T&D Coordinator or PQM for Stage 1 and Stage 2A items including laboratory specific QC requirements as documented in the project specific QAPP.

In addition to data validation specified in the above table, if the data review raises questions about the quality of the data, project validation may be completed by a person qualified based on the level of validation selected. The guidelines to be used for data validation will be the latest revision of EPA's NFG for data Validation of Organics and Inorganics in conjunction with the project specific QAPP, appropriate ER SOPs, and the laboratory's SOPs. If it is determined during data review and data verification that quality control limits have been exceeded, those indicators will be further evaluated during the data quality assessment process to determine if the data are of the quality necessary to support the project decision. Validation guidelines and communication between stakeholders will determine the usability of the data. Data limitations will be detailed in a memo or in the final site report. If the data user has questions about the data validator's report, the data user may go back to the data validator and request further explanation or information. A focused validation that provides more detail may be required to determine usability.

WORKSHEET 37 | DATA USABILITY ASSESSMENT

❖ UFP-QAPP Manual Section 5.2.3 and Table 12

Personnel responsible for participating in the data usability assessment will include the ER Project QA/QC Lead/ T&D Coordinator and may include RM, PQM, and other internal or external subject matter experts as needed.

In general, deficiencies found during a QC data review, verification or data review/validation that could potentially affect the site decision process will be reported to the COR. For instance, waste disposal data review will verify that the results detection limits are less than the appropriate disposal level. If detection limits are greater than the appropriate regulatory level, the COR will be immediately notified to determine if additional actions are necessary.

The following items will be reviewed to assure that the data usability assessment evaluates whether underlying assumptions used during systematic planning are supported, sources of uncertainty have been accounted for and are acceptable, data are representative of the population of interest, and the results can be used as intended, with the acceptable level of confidence:

- Review the project's objectives and sampling design
- A QA/QC review of field generated data and observations
- Individual data verification/ validation reports as directed by EPA
- Review of the procedures used by the validator (if completed) to qualify data for reasons related to dilution, reanalysis, and duplicate analysis of samples
- Evaluation of QC samples such as field blanks, trip blanks, field duplicates, and matrix spike laboratory control samples to assess the quality of the field activities and laboratory procedures
- Assessment of the quality of data measured and generated in terms of accuracy, precision, and representativeness (compare planned and actual DQI criteria)
- Evaluate actual Laboratory Reporting limits to required standards or site limits.
- Compare sampling and analysis activities to project specific DQIs and site objectives/goals
- Deviations from project specific QAPP
- Summary of the usability of the data and conclusions based on the assessment of data conducted.

See Worksheet 12 for DQI calculations and a general description of the reconciliation of data.

REFERENCE LIST

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U.S Environmental Protection Agency Environmental Response Team (EPA ERT). Standard Operating Procedures. Various Dates. http://epaosc.org/site/site_profile.aspx?site_id=2107

APPENDIX A

SITE FIGURE

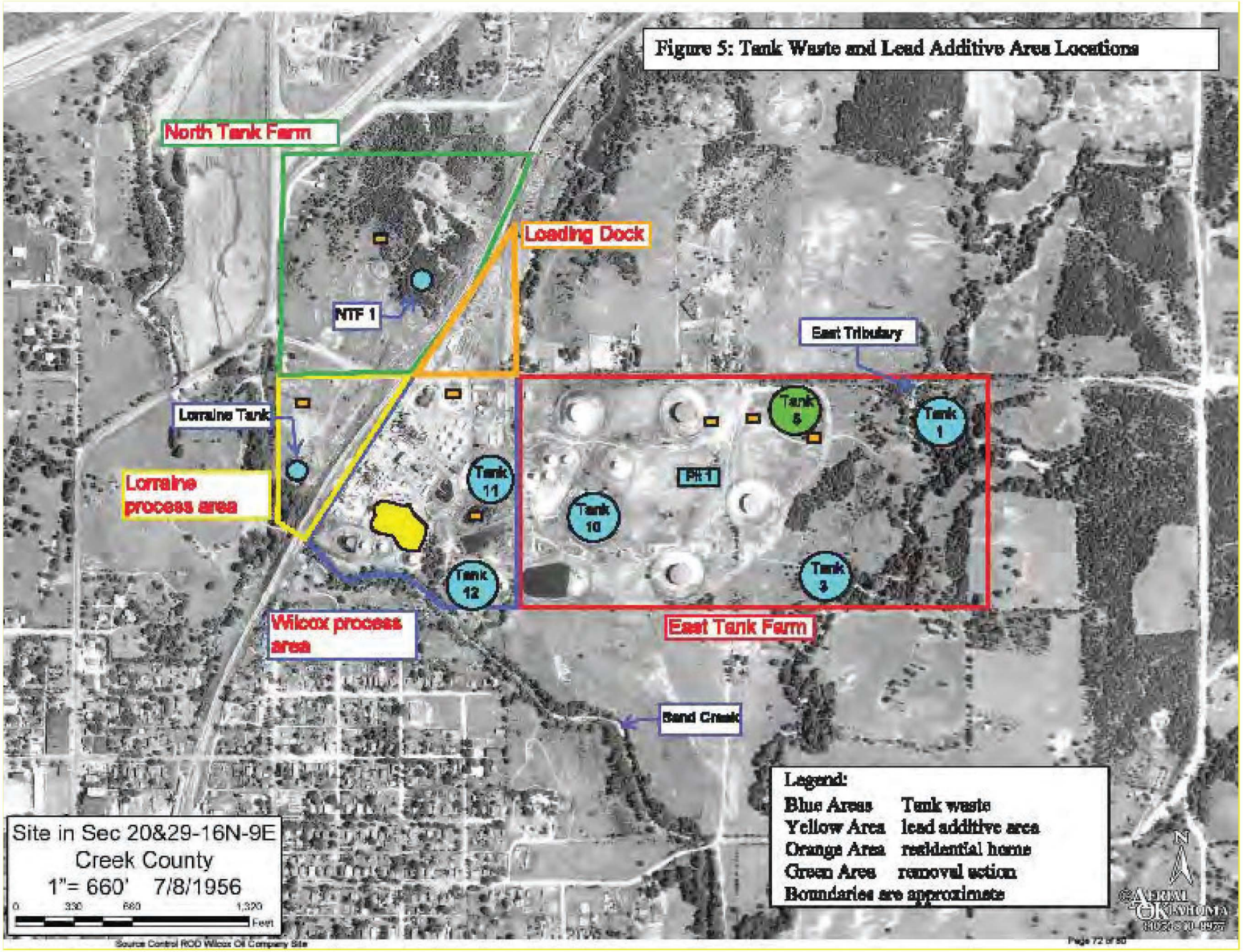
Figure 5: Tank Waste and Lead Additive Area Locations
North Tank Farm
Loading Dock
NTF 1
East Tributary
Lorraine Tank
Lorraine process area
Tank 11
Tank 12
Tank 10
Tank 5
Tank 1
Tank 3
PK 1
Wilcox process area
East Tank Farm
Sand Creek
Site in Sec 20&29-16N-9E
Creek County
1"= 660' 7/8/1956
0 330 660 1,320
Feet
Legend:
Blue Areas Tank waste
Yellow Area lead additive area
Orange Area residential home
Green Area removal action
Boundaries are approximate
N
Source Control ROD Wilcox Oil Company Site
Page 72 of 80

APPENDIX B

QAPP Changes

Version	Date Modified	Brief Description
Draft V 1	12/4/20	Submitted QAPP to EPA for comments and approval
Draft V 2	6/6/22 (Submitted 6/14/22)	Final draft plan includes EPA changes from 2021 and modifications based on the new TO and a conversation with the RPM. Submitted to EPA for comments and approval.
Final V 1	6/16/22	Final plan, V 1, submitted to EPA for signature – RPM advised removing sidewall samples from due to shall excavations, 2-ft, and identified a need for clarify sampling frequency based on contractor and landfill requirements and best management practices.

APPENDIX C

Wilcox Oil Company Sampler Guidance, Field Forms and Checklists

Wilcox Oil Company Sampler Guidance
ER Chain of Custody
XRF Calibration Form

Field Guidance:

Source Location	Estimated Aerial Extent (Feet^2)	Average Depth of Excavation (Feet)	Estimated Volume of Removal (Cubic Yard)
NTF 1	2,875	2	213
Tank 11	12,994	5	2,406
Tank 12	43,363	6	9,636
Pit 1 Tank Waste Area	17,316	3	1,924
Pit 1 Lead Area	8,770	1	327
Lorraine Tank	5,167	2	383
Tank 1	12,472	3	1,386
Tank 3	12,191	8	3,612
Tank 10	48,491	3	5,388
Lead Additive Area 2		2	5,711
Total			30, 986 CY

ER is tasked with excavation of material as specified in the table above. ER is also tasked with treating the lead additive area excavated material, prior to disposal, that is characteristically hazardous waste based on Toxicity Characteristic Leaching Procedure (TCLP) testing results for lead.

During excavation and treatment activities, ER will apply water for dust control to prevent off-site migration of dust. ER will also use air monitoring equipment to establish a safety perimeter based on the presence of potential vapors and/or dust to ensure the health and safety of onsite workers, the surrounding community, and the environment. Each area with removal or treatment will be evaluated prior to activities to determine if perimeter monitoring for particulates should be conducted to ensure that activities are not causing contaminated material to migrate off-site. During specific excavations, monitors may be placed to ensure safety of persons near the site including persons working on-site. A PID will likely be used during site activities and personal samples may be collected for lead.

DataRAMs or similar monitors may be placed at locations upwind and downwind of excavation activities if other monitoring or sampling (H&S) leads to concerns. DataRAMs may also be fitted with a sample cartridge to collect air samples for laboratory analyses. ER will also use a PID monitor near the excavation activities to monitor the safety of workers. In addition to air monitoring, ER will conduct SWPPP inspections to ensure that contaminants are not migrating off-site. SWPPP inspections will be conducted on a regular basis and after major precipitation events. Stormwater samples may be collected and analyzed before stormwater is discharged preventing discharge of untreated stormwater to streams or wetlands. Additional samples will be collected and analyzed during field activities as described to guide field activities and to verify when activities are completed.

XRF

The field portable XRF will be used to guide excavation activities by identifying lead concentrations at the base and sides of excavation at any given time. The XRF will be calibrated per manufacturer's recommendation. Calibration checks and standards analysis will be completed at minimum each day prior to use. These steps may also be completed after long timeframes of not using the XRF during the day. Soil samples will be analyzed in the field using X-ray fluorescence (XRF) to provide rapid soil analysis for lead. This will allow for near real-time decision-making and decrease down time or multiple mobilizations to the same location caused by lag time in receiving analytical results.

ER will use in-situ XRF readings or samples collected in a zip-top baggie to obtain sample results for the purpose of decision-making about the need for additional excavation or if the area meets the clean-up levels. Generally, in-situ samples may be collected if lead concentrations are much greater than the project action level (800 mg/kg) or if it is important to have much expedited results. For samples collected in a zip-top

baggie, XRF sample locations may consist of grab or composite samples collected to delineate a specific zone. Samples will be collected from the excavated surface with a clean soil sampler. The aliquots shall be thoroughly mixed prior to testing with an XRF. If the soil is too wet, the sample will be dried and sieved through a #10 sieve.

A minimum of 1/20 samples will be measured three times with an XRF. If the three measurements are not within 10% of the mean of the three measurements, the sample will be remixed and measured three times. This cycle will continue until the three measurements are within 10% of their mean. Alternately, a duplicate sample may be collected for every 20 samples and compared to MPC values in worksheet 12; however, high levels of lead may interfere with correct readings using the duplicate method. The ER QA/QC lead and/or RM will be responsible for field corrective action.

Once the decision has been made that no additional excavation is required, verification samples shall be obtained. Verification samples will be collected to confirm that clean-up levels have been achieved. XRF readings at the base of excavation will be compared to the analytical results of these samples and will be used to help determine proper calibration of the XRF instrument. Although, laboratory results will be used to help confirm calibration; the "RCRA Standard" sample or other NIST samples are considered to provide an acceptable measure of value for calibration of the XRF instrument.

Tank Waste Excavation:
After removal of tank waste source material, the excavated area will be surveyed to confirm excavation quantities and sampled to determine contaminant concentrations at the base and sides of excavation. Post-excavation sampling will include grab samples taken from the exposed excavation floor and walls. Excavation floor sample grids of 40 ft by 40 ft will be established, with a 5-point composite taken in each grid. Composite samples include corners and center for each sampling grid. Sidewalls will be sampled every 40 linear feet, with five-point composites taken at the corners and center of the sidewall. If the sidewall material is not homogenous based on field screening methods, an aliquot representing each variation can be collected vertically along the side wall to represent the wall sample. Sample analysis will include benzo(a)pyrene and lead.

The excavated areas will be backfilled with clean fill from an offsite source, compacted, and graded to drain by minimizing low spots and flattening any remaining slopes. The area will be covered with organic topsoil and re-vegetated with native plants and grasses via hydroseeding. ER will be responsible for supplying topsoil for all excavation areas and ensuring 80% vegetation coverage has been achieved. A final survey will be conducted to confirm final backfill quantities.

Lead area Source Material Excavation:
After mixing the stabilizing reagent at the manufacturer's recommended dosage, ER will collect composite samples for TCLP lead analysis at a rate of 1 sample for every 1,000 CY. The time needed for laboratory testing of stabilized material will likely result in multiple, concurrent excavation areas. The effectiveness of the chemical stabilization will be confirmed via sampling directed by the landfill, to include at a minimum, analytical TCLP lead testing. After successful sampling results, the material will be loaded and hauled for disposal at a regulated offsite landfill.

After removal of lead areas source material, the excavated area will be surveyed to confirm excavation quantities and sampled to determine lead concentrations. Post-excavation sampling will be completed by ER and will include grab samples taken of the exposed excavation floor and walls. Excavation floor sample grids of 40 ft by 40 ft will be established, with a 5-point composite taken in each grid. Composite samples include corners and center for each sampling grid. Sidewalls will be sampled every 40 linear feet, with five-point composites taken at the corners and center of the sidewall. If the sidewall material is not homogenous based on field screening methods, an aliquot representing each variation can be collected vertically along the side wall to represent the wall sample. Considering the area will be graded to drain and the maximum

target depth is 2 ft, there may not be sufficient depth to allow for sidewall samples. Sample analysis will include Benzo(a)pyrene and lead.

The excavated areas will be graded to drain, minimizing low spots and steep slopes, and using runoff controls where necessary. **Because the final site remedy has not been selected, the import of backfill to the lead source area will be used only as a last effort to control drainage. This limitation is to restrict the placement of clean backfill in an area that may be addressed in the final remedy.** Adding clean backfill may result in an increase in the volume of material that will need to be remediated. Any additional backfill in this area will require consultation with EPA and ODEQ.

Offsite Disposal:
Source material characterization data required to meet specific disposal facility requirements will be described by the ER's chosen landfill and completed by ER prior to loading and hauling material offsite. At a minimum it will include sampling and comprehensive analysis of the following categories: TCLP volatile organic compounds, TCLP metals, TCLP semi-volatile organic compounds, total petroleum hydrocarbons, and reactivity, corrosivity, and ignitibility. TCLP herbicide, TCLP pesticide, and total PCBs will also be collected at the direction of the TSDF. Source material shall be direct loaded into trucks for off-site disposal to the greatest extent possible. To accomplish this ER will collect samples using the excavator and/or shovels in the tank waste source material areas prior to bulk excavation.

Fill Material:
Topsoil:
For topsoil already stockpiled, two composite samples shall be collected for every 20,000 cubic yards (one sample for each 10,000 cubic yards). Each composite will be made up of at least 5 aliquots. Undisturbed topsoil is material that has not been stockpiled for removal and will be excavated from its natural location after sampling for stockpiling or immediate placement in a truck for site delivery. For undisturbed topsoil, a 5-point composite will be taken in sampling grids. The grid will be determined in the field to represent approximately 10,0000 cubic yards of loose material including the expended excavation grid. One composite sample will be collected from each grid. Composite samples include the corners and the center for each sampling grid. Samples shall be collected in at least two different intervals depending on the depth of excavation. Analyses must include SVOCs, VOCs, Metals, and TPH. Topsoil should consist of imported friable loam or silty loam with a minimum 10 percent organic matter (by Loss on Ignition Method), no deleterious concentrations of salts, free of subsoil, roots, grass, weeds, large stone, and foreign matter. If organic matter amendment is required based on Loss on Ignition Method testing results, ER will amend topsoil with locally sourced organic compost or similar.

Imported Clean Backfill:
For materials that have already been stockpiled, two composite samples shall be collected for every 20,000 cubic yards. Each composite will be made up of at least 5 aliquots. For backfill that have not been disturbed, a 5-point composite will be taken in 50 ft by 50 ft sampling grids. Composite samples include the corners and the center for each sampling grid. Samples shall be collected in at least two different intervals depending on the depth of excavation. Shallow samples consist of those at 3-24 in and deep samples of 24-48 in. Analyses must include SVOCs, VOCs, Metals, and TPH.

Backfill material should generally consist of clean, ML, CL, or CH material with a liquid limit less than 45 and a plasticity index less than 20, SM or SC. It may consist of a mix of organic and inorganic material but should be free of foreign material larger than 3 inches and appreciable amounts of roots, rock, or debris. Moisture content should be sufficient to obtain compaction: between -5% and +3% of optimum. ER will work with the source supplier to determine the details of the backfill material, including obtaining specifications as detailed above; however, it is not expected that ER will collect geotechnical/ soil properties

samples and analyses to determine specification including Atterberg limits, standard proctor details, or other characteristics unless there is concern about a specific source area.

Sample Matrix	# Samples[1]	Depth	Compos	Grab	Type 2	Analyte(s) Analytical Method(s)[2] Sampling SOP[3]	Location /Rationale (Comment)
Soil – XRF	TBD	Various	x	x	S	Total Pb	Primarily applicable to lead additive area and pit lead source areas. Guide excavation activities prior to confirmation samples
Soil – Confirmation	75		x		D	Pb and Benzo(a)pyrene	To verify excavation activities are complete and Pb and benzo(a)pyrene concentrations are below the project action levels.
Lead Stabilization	75	NA		x	D	TCLP RCRA metals (at minimum Pb), benzo(a)pyrene based on agreement with TSDF	Confirm non-RCRA material after chemical amendment is added - Lead does not exceed TCLP (5.0 mg/L). Minimum, 1 composite test sample per 1000 CY batch prior to T&D
Waste Profiling	≤10	Various	x		D	TCLP VOC, TCLP SVOC, TCLP metals, TPH, Reactivity Corrosivity Ignitability Paint filter test* TCLP herbicide, TCLP pesticide, and total PCBs may be analyzed at the request of the TSDF	Minimum, 1 composite test sample per 1000 CY batch prior to T&D. Used to characterize waste material for disposal purposes.
Clean Material -Backfill ASTM	3	TBD	x		D	TCL VOC, TCL SVOC, TAL Metals, TPH, Pesticides/ PCBs, and Herbicides	Two samples for every 20,000 CY of material if stockpiled or equivalent area of 20,000 CY loose material if material is still in-situ. To verify material is without contamination and appropriate for use at site
Clean Material -Topsoil		TBD	x		D	TCL VOC, TCL SVOC, TAL metals, TPH, Pesticide, PCBs, and Herbicides, Loss on ignition method (organics)	
Stormwater	≤10	NA		x	D	Total Metals, SVOCs (PAHs), Oil and grease, Ammonia, Chemical Oxygen Demand (COD), pH	Verify that stormwater is free of contaminants prior to release
Personal H&S	~20	NA		x		Lead and potential other contaminants per HASP	Personnel working on site

[1] Number of samples are estimates especially if based on number of samples per specific volume. Does not include QC samples in **Worksheet 20.**
2 Type: Screening (S), Definitive (D), Collaborative (C) (Screening w/10% Definitive)
[2] See **Worksheet 19&30** for list of analytical methods. See discussion in **Worksheet 21** for SOP site specific summary

Matrix	Analytical Group	Field Duplicates	Matrix Spikes	Equipment Blanks	Trip Blanks	Other
In-situ Soil (XRF)	Pb XRF	1/ 20 duplicate sample or 3 readings from single baggie	NA	NA	NA	NIST or "RCRA" Standards during calibration checks
Soil – Confirmation	Pb and Benzo(a)pyrene	1/ 20 duplicate samples	1 per 20 as applicable to method	1 per 5% if non-dedicated	NA (no VOCs)	Temperature blank:1 per cooler requiring 4°C (unless lab uses

Lead Stabilization	TCLP RCRA metals (Pb), benzo(a)pyrene	0	1 per 20 as applicable to method	equipment is used	NA (no VOCs)	sample or cooler temp)
Waste material soil	TCLP VOC, TCLP SVOC, TCLP metals TPH, Reactivity Corrosivity Ignitability Paint filter test*	0	1 per 20 as applicable to method		NA	NA
Clean Material (Backfill/ Topsoil)	TCL VOC, TCL SVOC, TAL Metals, pest/PCBs, herbicides	1/ 20 duplicate samples	1 per 20 as applicable to method		1 per cooler (VOC analysis)	Temperature blank:1 per cooler requiring 4°C (unless lab uses sample or cooler temp)
Stormwater	Total Metals, SVOCs (PAHs)	1/20 duplicate sample	1 per 20 as applicable to method	NA	NA	NA

Sampling Techniques:

Below is a summary of the field sampling procedures to be used during field activities. Field activities will be conducted in strict accordance with the HASP. Sample collection activities for assessment of personal exposure will adhere to applicable National Institute for Occupational Safety and Health (NIOSH) and Occupational Safety and Health Administration (OSHA) method specifications. H&S analytical data will be entered into the ER Industrial Hygiene database, which will be maintained by ER's H&S personnel, who are responsible for Occupational Exposure Limit-related sampling activities. Refer to the project HASP for additional information regarding exposure limits, personal protective equipment (PPE) requirements, and emergency procedures. At minimum, samplers will use clean gloves during the collection of samples.

Soil Sampling Procedure

Surface soil samples will usually be collected from a depth of 0-6 inches (below ground surface) using stainless steel hand augers, bowls, and spoons. This procedure is also used for confirmation samples after excavation of contaminated material. Any debris or vegetation will be removed prior to sample collection. Composite samples for non-volatiles analysis, in accordance with Worksheet 17 sampling rationale for each type of sample, may be collected by combining subsamples in a stainless-steel bucket and thoroughly homogenizing. As presented in Worksheet 26&27, sample points will be identified on a topographic map, using a Surveyor (primary option) or Global Positioning System (GPS), to further assist in defining the extent of remediation. All reusable equipment exposed to the soil samples are constructed of stainless steel and decontaminated before each use (see decontamination procedures below). Samples will be placed in appropriate sample containers. Samples for VOC analysis (for clean fill material) will be collected first using an EnCore sampler (or similar), followed by sampling for non-volatile analysis using a stainless-steel scoop or trowel. Sample descriptions will be logged in the field logbook or form with standard geologic descriptions as appropriate to site data needs. All surface soil sample locations will be photographed and documented during sampling activities.

Grab or composite samples collected for XRF analysis may be collected directly into the sample baggie. The sample will be homogenized by manipulating the outside of the bag to ensure that the material is free of organics and rocks and that clumps of soil are broken up.

Homogenization: Mixing of the sample for non-VOC parameters is necessary to create a representative sample media. It is extremely important that solid samples be mixed as thoroughly as possible to ensure that the sample is as representative as possible of the sample location. Use the "quartering" technique which

consists of dividing the sample into quarters and thoroughly mixing each quarter and then mixing the quarters together. This procedure is repeated several times until the sample is homogenous.

Subsurface Soil Sampling Procedure

Prior to performing subsurface activities, public utilities will be located, as necessary. Subsurface soil samples/aliquots may be collected using an excavator to access material at depth. Reusable sampling equipment exposed to the soil samples are constructed of stainless steel and decontaminated before each use (see decontamination procedures below). Homogenization of sample aliquots will follow the procedure described above. Subsurface sample locations will be photographed and documented during sampling activities.

Stormwater Sampling Procedure

Stormwater sampling will be conducted by immersing the sample bottles directly into the sample media. If the stormwater is not deep enough to collect a full sample, an additional sample bottle may be used/ modified at each location to collect sample and before placing in the appropriate containers. Field parameters, which include pH, temperature, and electrical conductivity, may be measured for each sample collected. Data will be recorded on appropriate sample forms or in a site-specific logbook or field form. Sampling will be conducted from the farthest downstream location to the farthest upstream location to minimize the potential for cross contamination. Stormwater sample locations will be photographed and documented during sampling activities.

In-Situ Soil Sampling Procedures

Samples for XRF analysis will be collected by directly placing material in the sample container or placing the XRF analyzer on the material in-situ. Reusable equipment exposed to the soil samples are constructed of stainless steel and decontaminated before each use (see decontamination procedures below). Results and sample descriptions will be logged in the field logbook or form with standard geologic descriptions as appropriate to meet site data needs. Soil sample locations will be photographed and documented during sampling activities, including marking locational data within the excavation on a site sketch.

Equipment Decontamination Procedure

Sampling and monitoring equipment will be mobilized to the site within a sanitary container or stored within a controlled environment to avoid contamination and ensure maintenance of data. Reusable sampling equipment (hand augers, spoons, stainless steel mixing bowls, etc.) will be decontaminated before sampling commences, between each discreet sample location, and prior to leaving the site. The effectiveness of decontamination procedures is documented using equipment rinsate blanks, which are generally collected at a frequency of once per day per matrix per field crew as defined in the SAP. Disposable sampling equipment will be used whenever practical to minimize the need for decontamination.

The decontamination procedure will include the following:

- Wash equipment with Alconox soap and tap water.
- Rinse with tap water.
- When sampling for inorganic contaminants: Rinse with dilute (0.1N) hydrochloric or nitric acid. (Note: Dilute hydrochloric acid is preferred over nitric acid when cleaning stainless steel because nitric acid can oxidize stainless steel.)
- Rinse with distilled water or deionized water.
- When sampling for organic contaminants: Rinse with pesticide-grade, reagent-grade isopropyl alcohol.
- Allow equipment to air dry and wrap in clean plastic.

Decontamination by-products will be handled by combining rinse with appropriate remediation-derived waste for disposal or treatment.

CHAIN OF CUSTODY

COC No. ER_____

Page ____ of ____

Headquarters:
1666 Fabick Drive
Fenton, MO 60326
Tel: 636-227-7477
Fax: 636-227-6447

ER Office/ Send Results To:
Contact:
Address:
City: State: Zip:
Email/phone:
☐ Mail ☐ Fax ☐ Verbal ☐ E-mail

Lab Info:
Lab:
Address:
City: State: Zip:
Contact:
Email/phone:

Project Name:
City/State:
Project Number:
Project Manager:
Phone:
Email:

Deliverable:
Check all that apply
☐Results Only PDF
☐Level II
☐Level III
☐Level IV
☐EDD
☐CLP-like
☐Add:

Billing Information (if different):
Contact:
Address:
City: State: Zip:
PO #: Email:

Sampler(s) Name/Sign/Phone:

Turn Around Time:
☐5 Business days ☐24 Hours ☐Other:
☐10 Business days ☐48 Hours
Date needed:
*Notify Lab if Rush is required (if < 10 days)

Matrix *
S Solid/Soil
P Product
W Waste
GW Groundwater
SW Surface Water
DW Drinking Water
WW Waste water
WP Wipe

Air Matrix:
C Charcoal
SG Silica Gel
F Membrane Filter
Cy Cyclone
B Badge
I Impinger

User Defined:

ER Sample ID	Date	Time	Matrix*	Volume (L)	Comment	# of Pres. Bottles: None	HCl	HNO3			Total # Containers	Grab (G)/Composite (C)								Lab Use

Comments/Special Instructions:

Airbill No:

Relinquished by (signature):	Date/Time	Received by(signature):	Date/Time
Relinquished by (signature):	Date/Time	Received by(signature):	Date/Time
Relinquished by (signature):	Date/Time	Received by lab(signature):	Date/Time

DAILY CALIBRATION LOG

Date: _____

XRF Niton XL3T 300

Serial Number: _____

Technician: _____

Project: _____

Energy Calibration Check:

	Time	Reading
Power Up:		
Power Down:		

Note: Power Down Energy Calibration must be within 20% of Power Up Calibration. If variance exceeds 20% Contact Thermo Niton for product support. Energy Calibration must be within 20% of Initial product calibration of 174.0

Field Calibration Check: (60 seconds)

	NIST 2780 (5000 ppm)	+/-	RCRA (500 ppm)	+/-
Reading 1				
Reading 2				
Reading 3				
Average				

Note: Field Calibration check of Niton Standards must be within 20% of the known Standard Concentrations. The average +/- error must be less than 20% of the reading value.

Name: _____
Print

_____
Sign

APPENDIX D

Standard Operating Procedures

ERHS01	Air Monitoring and Sampling (IH)
ERHS25	X-Ray Radiation Protection Program

ERT SOPs https://response.epa.gov/site/site_profile.aspx?site_id=2107

Links to Manufacturer Operating Procedures for Equipment used during field activities:

MSA AltAir 5X Multi-gas with PID	http://s7d9.scene7.com/is/content/minesafetyappliances/ALTAIR%205X%20PID%20Operating%20Manual%20-%20GB
DataRAM (possible)	https://semspub.epa.gov/work/05/912459.pdf
XRF	https://www.manualslib.com/manual/1405327/Thermo-Scientific-Niton-Xl3t-500.html?page=7#manual
ERT EOG Link	https://response.epa.gov/site/doc_list.aspx?site_id=0001s

1.0 PURPOSE

This program describes minimum requirements for an air monitoring and sampling program to identify and evaluate worker exposures to hazardous substances at ER field jobsites. Use of this procedure complies with federal and state OSHA regulations in 29 CFR 1910 and 1926.

2.0 CONTAMINANT SELECTION

The selection of specific airborne contaminants for monitoring and sampling is based on the chemical substances and concentrations present in each work operation. This information is obtained from historical site records and pre-startup job site evaluations.

A task-specific hazard analysis is performed for the proposed scope of work. This hazard analysis is included in the site-specific safety and health plan.

3.0 SITE CHARACTERIZATION

3.1 Preliminary Evaluation

A preliminary evaluation of each jobsite's characteristics will be performed by the project supervisor and the site safety representative prior to on-site work. This information will be used in task-specific hazard analyses and to aid in the selection of appropriate personal protection. The preliminary evaluation will focus on hazardous substances and health hazards present or anticipated at the site.

The following additional information, to the extent available, will also be obtained prior to on-site work:

- Location and approximate size of the site;
- Description of the proposed work activities;
- Duration of the work activities;
- Site topography;
- Site accessibility by air and roads;
- Potential pathways for hazardous substance dispersion; and
- Present status and capabilities of local emergency response organizations, including hospitals, ambulance, fire, police and spill response.

3.2 Detailed Evaluation

During initial site entry, a more detailed evaluation of site-specific characteristics will be performed by the site safety and health officer to further aid in the selection of personal protective equipment and engineering controls for the tasks to be performed.

Based on the preliminary evaluation, air monitoring will be conducted to identify any Immediately Dangerous to Life and Health (IDLH) or other potentially dangerous conditions such as; the presence of flammable atmospheres, oxygen-deficient environments, toxic levels of airborne contaminants, and radioactive materials. The monitoring will be performed with direct-reading instruments such as; combustible gas, oxygen, or hydrogen sulfide meters, colorimetric detector tubes, photo ionization detectors, flame ionization detectors, or ionizing radiation detectors.

This monitoring will be repeated when contaminants change, work begins on a different portion of the site, a different type of operation is initiated (i.e., drum opening instead of well drilling), or when employees begin handling leaking drums or containers, or working in areas with obvious free liquid contamination (i.e., spills, ponds).

3.3 Quality Control

Primary or secondary standards will be used to perform field calibration checks on air monitoring equipment in accordance with the manufacturers' instructions. Instruments that fail these field calibration checks will replaced immediately and returned for repair to ER's Field Services group or to the manufacturer.

4.0 PERSONAL SAMPLING

4.1 Sample Selection

After hazardous substance operations begin, personal air sampling will be performed on employees who have the highest potential for exposures to those hazardous substances most likely to be present above established exposure limits. Since work crew size varies significantly, a representative sampling approach will be used, by job title and by work shift. This will require that at least one air sample be collected for each job task selected for monitoring.

4.2 Sampling and Analytical Methods

NIOSH Sampling and Analytical Methods will be used for personal air sampling. Samples to be analyzed will be sent to a laboratory accredited by the American Industrial Hygiene Association (AIHA) for analysis of the specified contaminants.

4.3 Pump Calibration

Personal sampling pumps will be calibrated before and after sampling using a primary standard airflow calibration or a rotameter calibrated to a primary standard. A filter cassette or sorbent tube assembly of the same type used to collect air samples will be attached to the pump during calibration. This will compensate for air flow resistance due to the sampling media. Sampling media used for pump calibration will be discarded and fresh media will be used for actual air samples and blanks. Pumps that fail to maintain calibrated flow rates within 10 percent of the original flow setting will be replaced and returned for repair to ER's Field Services group or to the manufacturer.

4.4 Quality Control

Personal exposure samples will be submitted to AIHA-certified laboratories for analysis. These labs participate in proficiency analytical testing and performance audits by AIHA in order to receive and maintain such certification.

At least one field blank will be submitted to the analytical lab with each shipment of air samples. Blanks will be of the same media as that used to collect air samples. Blanks will be labeled with their own unique sample numbers.

A chain-of-custody form will be completed for each day of sampling. These forms will show the unique sample numbers, including sample numbers for appropriate field blanks. Chains-of-custody will also show the sample collection date, shipping date, project number and location, names of persons collecting and processing the samples, and dates that each individual was in possession of the samples.

Air sampling calibrations, collection data, and results will be recorded on the attached forms. Copies of these forms, the chain-of-custody, and the lab analytical results will be placed in the project-specific files and in the affected ER, employees' occupational medical files, to document exposure histories.

5.0 EXPOSURE CONTROL MEASURES

The results of air monitoring and sampling will be compared with OSHA Permissible Exposure Limits (PELs), ACGIH Threshold Limit Values (TLVs), and NIOSH Recommended Exposure Limits (RELs). If these results are outside acceptable limits, job tasks will be reexamined to identify and control the source of exposure. Control methods may include engineering and administrative measures, or changes in personal protective equipment and respirators.

6.0 PERSONNEL NOTIFICATION AND RECORDKEEPING

ER employees will receive written notice of the results of their personal air sampling. Notices will be sent out within 5 days after the results are received. Copies of these notification letters will be included in the associate's occupational medical file.

7.0 QUALIFICATION OF MONITORING PERSONNEL

Air monitoring and sampling will be performed by employees trained on the required monitoring and sampling instruments. This training must include use, limitations, calibration and maintenance of air monitoring and sampling instruments; as well as quality control, storage, and shipping procedures for air samples. Equivalent training and work experience may also be accepted as qualification for air monitoring and sampling personnel. This training and experience must be evaluated and approved by the safety and health staff before the individual is assigned to perform air monitoring or sampling.

1. Purpose

The purpose of this Radiation Protection Program (RPP) is to keep radiation exposures to workers using a portable, X-Ray Tube based Thermo NITON Analyzer XL3t at Environmental Restoration to levels that are as low as reasonably achievable (ALARA), and

Ensure that use of the NITON Analyzers is in compliance with all applicable State and Federal regulations.

2. Scope

This RPP applies to any use of NITON Analyzers at Environmental Restoration, *LLC.*

3. Responsibilities

Luke Wisniewski shall be designated as the individual in charge of the RPP. Luke Wisniewski will be responsible for maintaining and implementing the RPP which will minimize the risks associated with using portable X-Ray producing machines and which will ensure compliance with the regulations of the Nebraska.

The specific actions to be performed by the individual in charge are as follows:

- Receive Radiation Safety Training at a one day course provided by Thermo NITON Analyzers or by a qualified expert. This will be documented by a certificate of completion which is to be kept on file with other RPP documents
- Maintain a list of authorized users and ensure that only authorized users operate the Analyzers.
- *Notify staff of additions to or subtractions from the authorized user list.*
- Schedule and/or conduct training for employees prior to authorizing their use of the NITON Analyzer without direct supervision. Maintain records of training including a copy or a summary of the training material. Training shall include Radiation Safety, Operational, and Emergency Procedures.
- *If personal exposure monitoring (dosimetry) is part of the RPP, then the Individual in charge will be responsible for maintaining dosimetry records.*
- Ensure that all users are following appropriate operating procedures while using Analyzers.
- Maintain manufacturer provided instruction manuals, and operations and maintenance records.
- Ensure proper disposal of unneeded Analyzers.
- Ensure that labels on Analyzers are intact and legible. Notify NITON for assistance with labeling that is damaged or illegible.
- *Review, as needed, the RPP content, implementation, and effectiveness.*

Authorized Workers are responsible for using only approved safe techniques and procedures in operations involving the Analyzer. The specific actions to be performed are as follows:

- Follow proper operating procedures as described in training and ensure other individuals also adhere to these requirements.
- Ensure that the label on the Analyzer is in tact and legible.
- *Ensure proper use of dosimetry, if dosimetry is issued.*
- Be familiar with emergency procedures and know how to recognize and terminate unsafe operations.

4. Safe Operating Procedures

A copy of the Users Manual or Operating and Emergency Procedures shall be made available to all workers using the NITON Analyzer. A copy will be kept with the Analyzer and another copy shall be kept on file with other RPP records.

Only authorized personnel with training on state regulations, operating and emergency procedures shall be allowed to operate the NITON Analyzer. All authorized personnel are responsible for complying with the requirements of this RPP and will report any and all incidents involving the NITON Analyzer to the individual in charge.

The operator is responsible for ensuring that no part of a person's body is at or near the measurement point, and no closer than one foot during a measurement (trigger finger excluded).
The operator must be aware that the NITON Analyzer is emitting radiation when lights are flashing.
The operator must be aware that radiation in the primary beam could eventually cause physical harm if the device is used improperly and must be able to recognize the symptoms which would begin with skin reddening in the exposed area and at higher doses would appear as a burn or localized tissue damage.
Prior to each use:

- The operator will inspect and maintain the Kapton window and all labels on the NITON Analyzer
- *The operator will fill out the utilization log (if required)*

Environmental Restoration will maintain a log documenting use of the Analyzer that contains, at a minimum, the unit serial number, date/time removed, date/time returned, and responsible individual. At the front of this log will also be a list of authorized users. Refer to Appendix A for example.

5. Emergency Procedures

In any case where one suspects that the x-ray tube remains on when the measurement is terminated:

- Disconnect the battery pack immediately to turn off the x-ray tube, and
- Call Thermo Electron Corporation's Service Department in the United States, toll free, at (800) 875-1578.

Suspect accidental exposure to primary beam
Notify the Individual in Charge and RSO at 314 280-8328
Individual in charge will asses impact and call NITON RSO for assistance if necessary
Severe Physical Damage
There is no radioactive material so a fire or severe damage poses no radiation hazard.

6. Radiation Safety Training

The Individual in charge will be responsible for receiving Radiation Safety Training from Thermo NITON Analyzer LLC 1 day training, or a qualified expert. It will then be this individual's responsibility to train the rest of the workers, whether the workers are trained by the individual in charge, Thermo NITON Analyzer LLC, or by a qualified expert. This training will be documented by a sign-off sheet that includes the topics covered in the radiation safety training which is to be kept with all the RPP documents.

7. Personnel Monitoring

Personal exposure levels may, as determined by the responsible individual or as required by state regulations, be monitored utilizing dosimetry providers accredited by the National Voluntary Laboratory Accreditation Program (NVLAP). Badges are not transferable. The following are a few examples of NVLAP accredited labs:

- *Environmental Restoration will use AEIL, 9251 Kirby Drive, Houston, TX 77054*
- *Dosimeters shall only be worn by the individuals they are issued to and shall only be worn during occupational hours.*
- *Never wear the badge during non-occupational exposures such as during medical x-rays or any medical procedures involving radiation.*
- *Dosimeters should be protected from extremes of heat, moisture, and pressure.*
- *Dosimeters shall be stored in a protected area to prevent loss, damage, and other sources of radiation.*

8. Posting and Labeling

There is a relatively low radiation hazard associated with the Analyzer, and because the authorized user will be with the Analyzer at all times it is operational, posting radiation area signs will not be necessary. A copy of the Nebraska Notice to Employees will be kept in the Analyzer case as well as on file with other RPP documents and will be available for review at any time.
The label on the Analyzer will be checked periodically by the Individual in charge as well as the workers using the Analyzer. The label will be checked for integrity and legibility. If the label becomes faded, worn, damaged, or defaced, the Analyzer will be promptly returned to Thermo NITON Analyzers LLC for relabeling.

9. Record Keeping

The individual in charge will be responsible for all the records associated with the RPP. These records will be kept in an identified location and will be made available for review by any worker or state official upon request. The following is a list of records that will be kept at minimum:

- Personnel training records
- Manufacturer provided instruction manuals and service & maintenance records
- Authorized Users
- State Analytical X-Ray Regulations and Notice to Radiation Workers
- *Analyzer usage log*
- *Personnel Dosimetry Records, if dosimetry is required*

10. Quality Assurance / Annual Review

At the minimum, items on the following list will be done annually:

- *Radiation Safety Review for all workers*
- *Operational & Emergency Procedures Review for all workers*
- *Audit of the RPP content, implementation, and effectiveness*

11. References:

- DOE G 441.1-5 “Radiation-Generating Devices Guide”
- Thermo NITON Analyzers Sample Radiation Safety Program
- NBS Handbook 111, Revised 1977
- Radiation Safety Topics “Writing a Radiation Protection Program For the Industrial X-Ray Program For a Facility with Cabinet Radiographic or Analytical X-Ray Machines”
- Table 11.4.9 “Good Work Practice for X-Ray Diffraction and X-Ray Fluorescence Units” The Health Physics and Radiological Health Handbook

Appendix A

Utilization Log

Serial #	Date	Time Out	Time Returned	Reason	Responsible Individual

MSA
The Safety Company

Operating Manual

ALTAIR® 5X PID

Multigas Detector

Order No.: *10165710/00*

MSA*safety*.com

1000 Cranberry Woods Drive
Cranberry Township, PA 16066
USA
Phone 1-800-MSA-2222
Fax 1-800-967-0398
For your local MSA contacts please go to our website ***www.MSAsafety.com***

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MSA
The Safety Company

EC Declaration of Conformity

MANUFACTURED BY:	Mine Safety Appliances Company, LLC 1000 Cranberry Woods Drive, Cranberry Township, PA 16066 USA
The manufacturer or his authorized representative established in the community	MSA Europe GmbH, Schlüsselstr.12, CH - 8645 Rapperswil-Jona

declares that the product

ALTAIR 5X PID/IR

based on the EC-Type Examination Certificate : FTZU 15 ATEX 0038X

complies with the ATEX directive 94/9/EC, Annex III.

Quality Assurance Notification complying with Annex IV of the ATEX Directive 94/9/EC has been issued by Ineris , Notified Body number: 0080.

Standards.

EN 60079-0:2012, EN 60079-1:2014, EN 60079-11 :2012

EN 60079-18:2009, EN 50303:2000

The product is in conformance with the directive 2004 / 108/ EC, (EMC):

EN 50270:2006 Type 2, EN 61000 - 6 - 3:2011

The product is in conformance with the Directive 1999/5/EC (R&TTE):

EN 301 489-1, V1.9.2 , EN 301 489-3 V1.4.1., EN 301 489-17 V2.2.1

The product is in conformance with the directive 93/68/EG (LVD):

EN 61010-1:2010.

The product is in conformance with the directive 2006/66/EC.

Paul Craig
Marketing Director
MSA Europe GmbH

Rapperswil-Jona,
August 2015

US

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1 Safety Regulations

1.1 Correct Use

The ALTAIR® 5X PID Multigas Detector, hereafter also referred to as device, is for use by trained and qualified personnel. The device is designed to be used when performing a hazard assessment to:

- Assess potential worker exposure to combustible and toxic gases and vapors as well as low level of oxygen.
- Determine the appropriate gas and vapor monitoring needed for a workplace.

The ALTAIR 5X PID Multigas Detector can be equipped to detect:

- Combustible gases and certain combustible vapors.
- Volatile organic compounds (VOC).
- Oxygen-deficient or oxygen-rich atmospheres.
- Specific toxic gases for which a sensor is installed.
- While the device can detect up to 30 % oxygen in ambient air, it is approved for use only up to 21 % oxygen.

WARNING

- Perform a blocked flow test before each day's use.
- It is recommended that a Bump Test is performed before each day's use; adjust if necessary.
- Perform a Bump Test more frequently if exposed to silicone, silicates, lead-containing compounds, hydrogen sulfide, or high contaminant levels.
- Recheck calibration if unit is subjected to physical shock.
- Use only to detect gases/vapors for which a sensor is installed.
- Do not use to detect combustible dusts or mists.
- For accurate catalytic combustible readings, make sure adequate oxygen is present (>10 % O_2).
- Never block pump inlet, except to perform a sampling system safety test.
- Have a trained and qualified person interpret device readings.
- Risk of Explosion: Do not remove battery pack or recharge Li Ion battery in a hazardous location.
- Do not alter or modify device.
- Use only MSA-approved sampling lines.
- Do not use silicone tubing or sampling lines.
- Wait sufficient time for the reading; response times vary based on gas and length of sampling line.
- Properly identify the VOC gas being measured before using VOC response factors or setting alarm values (exposures, STEL, TWA)
- Recognize that the VOC display readings are in increments of 0.1ppm from 0-999 ppm, then 1 ppm increments from 1000-2000 ppm with a Response Factor of one.
- Ensure installed PID lamp corresponds to the PID lamp setting on the display shown at startup.

Incorrect use can cause death or serious personal injury.

It is imperative that this operating manual be read and observed when using the product. In particular, the safety instructions, as well as the information for the use and operation of the product, must be carefully read and observed. Furthermore, the national regulations applicable in the user's country must be taken into account for safe use.

Alternative use, or use outside this specification will be considered as non-compliance. This also applies especially to unauthorized alterations to the product and to commissioning work that has not been carried out by MSA or authorized persons.

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1.2 Liability Information

MSA accepts no liability in cases where the product has been used inappropriately or not as intended. The selection and use of this product must be under the direction of a qualified safety professional who has carefully evaluated the specific hazards of the jobsite where it will be used and who is completely familiar with the product and its limitations. The selection and use of this product and its incorporation into the safety scheme of the jobsite is the exclusive responsibility of the employer.

Product liability claims, warranties also as guarantees made by MSA with respect to the product are voided, if it is not used, serviced or maintained in accordance with the instructions in this manual.

1.3 Safety and Precautionary Measures

WARNING

Carefully review the following safety limitations and precautions before placing this device in service. Incorrect use can cause death or serious personal injury.

- Check function (see chapter 4.8) each day before use. MSA recommends carrying out a routine inspection prior to each day's use.
- It is recommended that a Bump Test is performed before each day's use (see chapter 4.9) to verify proper device operation. The device must pass the bump test. If it fails the test, perform a calibration (see chapter 4.10) before using the device.
- The ALTAIR 5X PID Detector is designed to detect gases and vapors in air only.
- Bluetooth Operation is dependent upon signal availability of the wireless service(s) necessary to maintain the communication link. Loss of wireless signal will prevent communication of alarms and other information to linked devices. Take appropriate precautions in the event a loss of wireless signal occurs.

WARNING

It is very important to have an understanding of PID basics when changing PID settings. Failure to properly identify the VOC gas being measured and/or failures to select the correct Response Factor alarm values (exposure, STEL, TWA) that match the desired Response Factor and/or the correct lamp will result in erroneous readings or erroneous alarm limits that could cause death or serious personal injury.

Perform a Bump Test more frequently if the device is subjected to physical shock or high levels of contaminants. Also, check calibration more frequently if the tested atmosphere contains the following materials, which may desensitize the combustible gas sensor and/or VOC sensor (PID) and reduce its readings:

- Organic silicones
- Silicates
- Lead-containing compounds
- Sulfur compound exposures over 200 ppm or exposures over 50 ppm for one minute
- High concentration of VOC gas may affect CO sensor performance

- The minimum concentration of a combustible gas in air that can ignite is defined as the Lower Explosive Limit (LEL). A combustible gas reading of **XXX** indicates the atmosphere is above 100 % LEL, and an explosion hazard exists. Move away from hazardous area immediately.
- Do not use the device to test for combustible or toxic gases in the following atmospheres as this may result in erroneous readings:
  - Oxygen-deficient or oxygen-rich atmospheres
  - Reducing atmospheres
  - Furnace stacks
  - Inert environments
  - Atmospheres containing combustible airborne mists/dusts.

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- Do not use the ALTAIR 5X PID Multigas Detector to test for combustible gases in atmospheres containing vapors from liquids with a high flash point (above 38 °C, 100 °F) as this may result in erroneously low readings.
- Allow sufficient time for device to display accurate reading. Response times vary based on the type of sensor being utilized (→ chapter 6.2). Allow a minimum of 1 second per foot (3 seconds per meter) of sample line to allow the sample to be drawn through the sensors.
- Sampling lines made from 0.062 inch (1.57 mm) inner diameter tubing provide fast transport times to the device; however, they must be limited to 50 feet (15 m) in length.
- Sampling of reactive toxic gases (Cl_2, ClO_2, NH_3) must only be done with the reactive gas sample line and probe kits listed in chapter 9.
- All device readings and information must be interpreted by someone trained and qualified in interpreting device readings in relation to the specific environment, industrial practice and exposure limitations.

Observe Proper Battery Maintenance

Use only battery chargers made available by MSA for use with this device; other chargers may damage the battery pack and the device. Dispose of in accordance with local health and safety regulations.

Be Aware of Environmental Conditions

A number of environmental factors may affect the sensor readings, including changes in pressure, humidity and temperature. Pressure and humidity changes also affect the amount of oxygen actually present in the atmosphere.

Be Aware of the Procedures for Handling Electrostatically Sensitive Electronics

The device contains electrostatically sensitive components. Do not open or repair the device without using appropriate electrostatic discharge (ESD) protection. The warranty does not cover damage caused by electrostatic discharges.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

This device complies with part 15 of the FCC Rules. Operation is subject to the following conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including any interference that may cause undesired operation.

WARNING

This is a class A product in accordance with CISPR 22. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.

This Class A digital apparatus complies with Canadian ICES-003.

Be Aware of the Warranty Regulations

The warranties made by Mine Safety Appliances Company with respect to the product are voided if the product is not used and maintained in accordance with the instructions in this manual. Please protect yourself and others by following them. We encourage our customers to write or call regarding this equipment prior to use or for any additional information relative to use or service.

Be Aware of the Product Regulations

Follow all relevant national regulations applicable in the country of use.

1.4 Warranty

ITEM	WARRANTY PERIOD
Chassis and electronics	Three years
XCell COMB, O_2, H_2S, CO, SO_2, NO_2, and MSA IR sensors	Three years
XCell Cl_2, NH_3 sensors	Two years
Series 20 ClO_2, HCN, NO, NO_2, PH_3 sensors	One year
PID sensor	One year

This warranty does not cover filters, fuses, etc. As the battery pack ages, there will be a reduction in usable device run time. Certain other accessories not specifically listed here may have different warranty periods. This warranty is valid only if the product is maintained and used in accordance with Seller's instructions and/or recommendations.

The Seller shall be released from all obligations under this warranty in the event repairs or modifications are made by persons other than its own or authorized service personnel or if the warranty claim results from physical abuse or misuse of the product. No agent, employee or representative of the Seller has any authority to bind the Seller to any affirmation, representation or warranty concerning this product. Seller makes no warranty concerning components or accessories not manufactured by the Seller, but will pass on to the Purchaser all warranties of manufacturers of such components.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, AND IS STRICTLY LIMITED TO THE TERMS HEREOF. SELLER SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

Exclusive Remedy

It is expressly agreed that Purchaser's sole and exclusive remedy for breach of the above warranty, for any tortious conduct of Seller, or for any other cause of action, shall be the replacement at Seller's option, of any equipment or parts thereof, which after examination by Seller is proven to be defective.

Replacement equipment and/or parts will be provided at no cost to Purchaser, F.O.B. Seller's Plant. Failure of Seller to successfully replace any nonconforming equipment or parts shall not cause the remedy established hereby to fail of its essential purpose.

Exclusion of Consequential Damage

Purchaser specifically understands and agrees that under no circumstances will seller be liable to purchaser for economic, special, incidental or consequential damages or losses of any kind whatsoever, including but not limited to, loss of anticipated profits and any other loss caused by reason of nonoperation of the goods. This exclusion is applicable to claims for breach of warranty, tortious conduct or any other cause of action against seller.

2 PID Theory and Definitions

To support the safe and effective operation of the ALTAIR 5X PID, MSA believes operators should have a working knowledge of how the device functions, not just how to make it work. The information presented in this section supplements the hands-on operational instruction provided in the rest of the manual for the PID.

PID Theory

A photoionization detector (PID) uses an ultraviolet lamp to ionize the compound of interest. A current is produced in proportion to the concentration of the VOC present, and the concentration of the compound is shown on the device display.

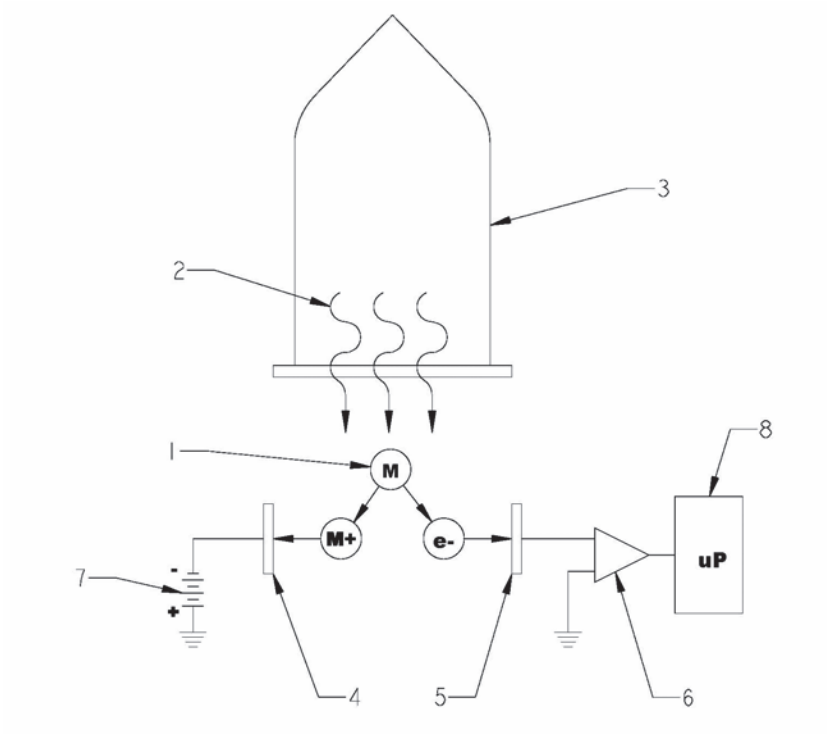

Fig. 1 Typical photoionization sensor design

1	*Molecules of Interest*	*5*	*Electrodes*
2	*High energy Vacuum Ultra Violet (VUV) radiation*	*6*	*Amplifier*
3	*UV lamp*	*7*	*DC Source*
4	*Electrodes*	*8*	*Microprocessor*

Zero Gas

Zero gas is a reference gas used during calibration to zero the device. When a zero gas with no hydrocarbon content is introduced to the device, the detector will still respond with a small signal. This signal is a result of secondary background processes. During calibration, zero gas is applied to quantify the background ionization current.

When only measuring concentration changes relative to a reference ambient environment, fresh air can be used as the zero gas. When background hydrocarbon vapors are present, MSA recommends using zero gas air.

US

Span Gas

Span gas is a reference gas used during calibration to determine the slope (response per unit concentration) of the calibrated response curve.

For the 0-2000 ppm PID sensor the allowable calibration gas is 100 ppm isobutylene.

See Chapter 4.10 for calibration instructions.

Response Factors

When a compound is ionized by photoionization, the ionized molecules are collected and converted to a current. This response is a characteristic property of the specific compound which is influenced by its molecular structure. The slope of the response curve (defined in picoamperes per ppm) is different for different chemicals. To properly report the concentration for a given sample gas, the ALTAIR 5X PID uses response factors. See Chapter 10, for instructions on using the pre-programmed list of response factors.

WARNING

It is very important to have an understanding of PID basics when changing PID settings. Failure to properly identify the VOC gas being measured and/or failures to select the correct Response Factor alarm values (exposure, STEL, TWA) that match the desired Response Factor and/or the correct lamp will result in erroneous readings or erroneous alarm limits that could cause death or serious personal injury.

The response factor is defined as the ratio of the detector response for isobutylene to the detector response for the sample gas. Response factors for a wide range of substances have been determined experimentally. These response factors are programmed into the device. Note that the calibrated response curve, and all programmed response factors are relative to isobutylene. Isobutylene has a response factor of one.

The response factor is a multiplier that compensates for the difference between the response of the sample gas and the response of isobutylene at 100ppm. Whenever the device detects the presence of a VOC, it uses the response factor for the user-assigned target gas to convert the signal to the correct, concentration. This is done by multiplying the equivalent isobutylene response by the response factor for the set sample gas. The isobutylene response curve is calculated at every calibration.

If the response factor is known, a device calibrated with isobutylene can be used to calculate the actual concentration of a target gas.

For example:

An operator is using a device that has been calibrated on isobutylene. The sample gas is set to isobutylene. While using this device to sample for hexane, the display reads 100 ppm. Since the response factor for hexane is 4.5, the actual concentration of hexane is:

Actual hexane concentration = 4.5 x 100 ppm = 450 ppm.

Calculating a Response Factor

To determine a response factor for a target chemical, perform the following simple procedure:

(1) Calibrate the ALTAIR 5X PID using isobutylene as the span gas.

(2) On the device, set the sample gas name to isobutylene.

(3) Apply a known concentration of the target chemical to the device and note the concentration reported in the display.

The response factor for the target chemical relative to isobutylene:

$$RF\ target\ gas = \frac{\text{Actual known concentration}}{\text{Concentration reported by device}}$$

For example:

A device is calibrated on isobutylene, and has isobutylene defined as the sample gas. When sampling 106 ppm of benzene in air, the device reports a concentration of 200 ppm. In this example, the response factor for benzene relative to isobutylene would be:

$$RF\ benzene = \frac{\text{106 ppm known concentration benzene}}{\text{200 ppm reported}} = 0.53$$

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When surveying, if benzene is selected as the sample gas in the Response Factor page, 0.53 will be used by the device as a response factor. The device will use this response factor to automatically correct the displayed concentration into PPM benzene.

A target gas with a response factor between zero and one implies that the device has a higher detector response for that gas when compared to isobutylene. If the response factor is greater than one, the device has a lower detector response for this gas when compared to isobutylene.

WARNING

It is very important to select the correct lamp setting during PID setup since PID response factors for a target chemical relative to isobutylene are different depending on what energy PID lamp is installed. See Chapter 4.5 for setup instructions. Failure to follow this warning can result in inaccurate readings that could lead to serious injury or death.

3 Description

3.1 Overview

Fig. 2 Device view

1	*LEDs* *2 red "Alarm", 1 green "Safe" and 1 yellow "Fault"*	8	*IRDA communication port*
2	*Horn*	9	*Pump inlet*
3	*Display*	10	*Filter*
4	*▲ Button*	11	*RFID tag*
5	*⏻ Button*	12	*Charging port*
6	*▼ Button*	13	*Charge Status LED*
7	*Bluetooth Status LED*		

The device monitors gases in ambient air and in the workplace.
The ALTAIR 5X PID is available with a maximum of five sensors, which can display readings for six separate gases (one Two-Tox Sensor provides both CO and H_2S or CO and NO_2 sensing capabilities in a single package).
The ALTAIR 5X PID Multigas Detector is only available with a color display.
The alarm levels for the individual gases are factory-set and can be changed through the Instrument Setup Menu. These changes can also be made through MSA Link Software. Ensure that the latest version of the MSA Link software has been downloaded from MSA's website **www.msasafety.com**.
It is recommended that after making changes using MSA Link software, the device should be turned OFF and ON.
While the device can detect up to 30 % oxygen in ambient air, it is approved for use only up to 21 % oxygen.

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3.2 Device Hardware Interfaces

Device operation is dialog driven from the display with the aid of the three function buttons (→ Fig. 2). The device has three buttons for user operation. Each button can function as a "soft key", as defined on the display directly above the button.

Button Definitions

Button	Description
⏻	The ⏻ button is used to turn the device ON or OFF and to confirm user action selections.
▼	The ▼ button is used to page down through data screens or to decrease the values in setup mode. This button is also used to initiate a Bump Test for the installed sensors, directly from the MEASURING page. If the user is granted access to the MotionAlert setting feature, this button can be used to activate the InstantAlert™ alarm. See chapter 4.5 for the means to allow/disallow user access.
▲	The ▲ button is used to reset Peak, STEL, TWA and alarms (where possible) or perform calibration in measuring mode. It is also used as page up or to increase the values in setup mode.

When the ▲ button and the ▼ button are pressed simultaneously while in normal measure mode, the Setup mode can be entered after the password is confirmed.

LED Definitions

LED	Description
RED (Alarm)	The red alarm LEDs are visual indications of an alarm condition or any type of error in the device.
GREEN (Safe)	The Safe LED flashes once every 15 seconds to notify the user that the device is ON and operating under the conditions defined below: - The green SAFE LED is enabled - Combustible reading is 0 % LEL or 0 % Vol - Oxygen (O_2) reading is 20.8 % - All other sensor readings are 0 ppm - No gas alarms are present (low or high) - Device is not in Low Battery warning or alarm - STEL and TWA readings are 0 ppm This option can be turned OFF through the MSA Link software.
YELLOW (Fault)	The Fault LED activates if any of several fault conditions are detected during device operation. This includes: - A device memory error - A sensor determined to be missing or inoperative - A pump fault These faults are also indicated by activation of device alarm LEDs, horn, and vibrating alarm.
BLUE (Bluetooth Status)	The blue LED is a visual indication of the Bluetooth connection status. - Off = Bluetooth board OFF or Undiscoverable - Fast Flash = Discoverable Mode - Slow Flash = Connected

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3.3 Alarms

The device is equipped with multiple alarms for increased user safety:

Icon	Alarm	
	Vibrating Alarm	The device vibrates when any alarm condition is active. This can be turned OFF through the SETUP- ALARM OPTIONS menu (→ chapter 4.5).
	Horn	The device is equipped with an audible alarm. The horn can be turned OFF through the SETUP- ALARM OPTIONS menu (→ chapter 4.5).
	InstantAlert™ Alarm	The InstantAlert exclusive feature allows the user to manually activate an audible alarm to alert those nearby to potentially dangerous situations. Holding the ▼ button for approximately 5 seconds while in Normal Measure Mode activates the InstantAlert alarm. Access to this feature may be restricted by user settings. See chapter 4.5 for means to allow/disallow user access.
	MotionAlert™ Alarm	If MotionAlert is turned ON (→ chapter 4.5), the device activates a "Man Down" alarm if motion is not detected within 30 seconds. The Alarm LEDs flash, and the horn activates with an increasing audible frequency. MotionAlert is always turned OFF when the device is turned OFF. Access to this feature may be restricted by user settings. See chapter 4.5 for means to allow/disallow user access.
	Stealth Mode	Stealth Mode disables the visual, audible and vibrating alarms. MSA recommends that this feature be left in its default "OFF" state. Stealth mode can be turned ON through the SETUP - INSTRUMENT OPTIONS menu (→ chapter 4.5). On the display, all three alarm icons are shown as OFF.
	Sensor Life Alarm	The device evaluates the condition of the sensors during Calibration. As the end of a sensor's life approaches, a warning is provided. While the sensor is still fully functional, the warning gives the user time to plan for a replacement sensor to minimize downtime. The Sensor Life indicator ♥ displays during ongoing operations as a reminder of a sensor's pending end of life. When a sensor's end-of-life is reached, sensor calibration will not be successful, and the user is then alerted by a Sensor Life Alarm. A flashing Sensor Life indicator ♥ displays during ongoing operations until the sensor is replaced and/or successfully calibrated. On the display, each displayed gas will have its own Sensor Life indicator. If a sensor is in end-of-life warning, its indicator will be an orange ♥. If a sensor has reached end-of-life, it is in alarm and its Sensor Life indicator will be a continuous blinking red ♥. See chapter 4.10 for additional details on Sensor Life determination and indication.
	Backlight	The backlight automatically activates when any front panel button is pressed and remains ON for the duration of user-selected timeout. This duration can be changed using the SETUP - INSTRUMENT SETUP (→ chapter 4.5) or through MSA Link software.
	Operating Beep	This operating beep activates every 30 seconds by momentarily beeping the horn and flashing the alarm LEDs under the following conditions: - Operating beep is enabled - Device is on normal Measure Gases page - Device is not in battery warning - Device is not in gas alarm. The Operating Beep can be disabled using the SETUP - INSTRUMENT OPTIONS (→ chapter 4.5) or through MSA Link software.

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3.4 On-Screen Indicators

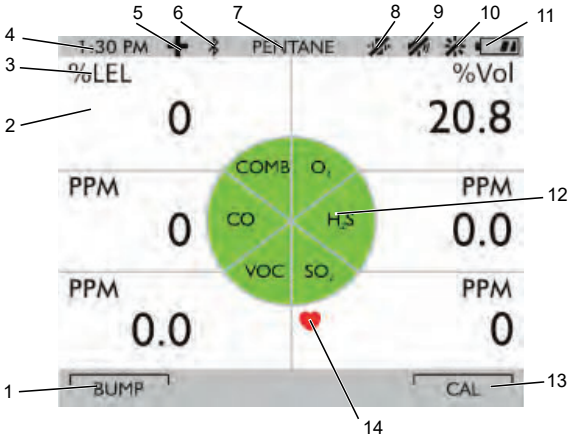

Fig. 3 Color display

1		"Soft Key" ▼ Indicator	8		Vibration alarm OFF
2		Gas reading	9		Horn OFF or successful Bump Test/ Calibration Indicator
3		Gas Concentration Units	10		LED OFF
4		Current Time	11		Battery charge level
5	✚	Motion Alert symbol ON	12		Gas Type
6		Wireless USB or Bluetooth ON	13		"Soft Key" ▲ Indicator
7		Combustible Gas Type/ VOC Gas Type alternates (the display switches between each type every few seconds)	14	♥	Sensor Life Indicator

Battery Charge Level Indicator

The battery condition icon continuously displays in the upper right-hand corner of the display. A bar represents the charging level of the battery.

The nominal run-time of the device (COMB, O_2, CO, H_2S, and PID sensor) at room temperature is 13 hours. Actual run-time will vary depending on ambient temperature, battery and alarm conditions.

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Low Battery Warning

WARNING

If battery warning alarm activates while using the device, leave the area immediately as the end of battery life is approaching. Failure to follow this warning can result in serious personal injury or death.

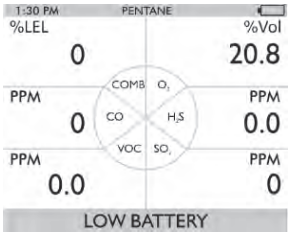

Fig. 4 Battery Warning

The duration of remaining device operation during a Low Battery Warning depends on ambient temperatures, battery condition alarm status. Nominal battery life is 30-60 minutes after the Battery Warning activates.

When the device goes into battery warning the:

- battery life indicator continuously blinks
- alarm sounds and alarm LEDs flash every 30 seconds
- Safe LED no longer flashes
- device continues to operate until it is turned OFF or battery shutdown occurs.

Battery Shut Down

WARNING

If battery alarm displays, stop using the device as it no longer has enough power to indicate potential hazards, and persons relying on this product for their safety could sustain serious personal injury or death.

The device goes into battery shutdown mode 60 seconds before final shutdown (when the batteries can no longer operate the device):

- "`BATTERY ALARM`" flashes on the display
- Alarm sounds
- Alarm LEDs flash
- Fault LED is on
- No other pages can be viewed; after approximately one minute, the device automatically turns OFF.

Fig. 5 Battery Shut Down

When battery shutdown condition occurs (shown in Fig. 5):

(1) Leave the area immediately.

(2) Recharge or replace the battery pack.

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Battery Charging

WARNING

Risk of explosion: Do not recharge device in hazardous area.

NOTICE

Use of any charger, other than the charger supplied with the device, may damage or improperly charge the batteries.

For users in Australia/ New Zealand: The charge cradle is a Class A product. In a domestic environment, this product may cause radio interference, in which case, the user may be required to take adequate measures.

The charger is capable of charging a completely depleted pack in less than six hours in normal, room-temperature environments.

Allow very hot or cold devices to stabilize for one hour at room temperature before attempting to charge.

- Minimum and maximum ambient temperature to charge the device is 10 °C (50 °F) and 35 °C (95 °F), respectively.
- For best results, charge the device at room temperature 23 °C (73 °F).

To Charge the Device

- Firmly insert the charger connector into the charge port on the back of the device.
- An LED in the battery pack is used to indicate on the charge status.
  Red = charging, Green = charged, yellow = fault
- If a problem is detected during charging (LED turns yellow):
  Disconnect the charger momentarily to reset the charge cycle.
- The battery pack may be charged separately from the device.
- During periods of non-use, the charger may remain connected to the device/battery pack.

The charger must be disconnected for the device to operate.

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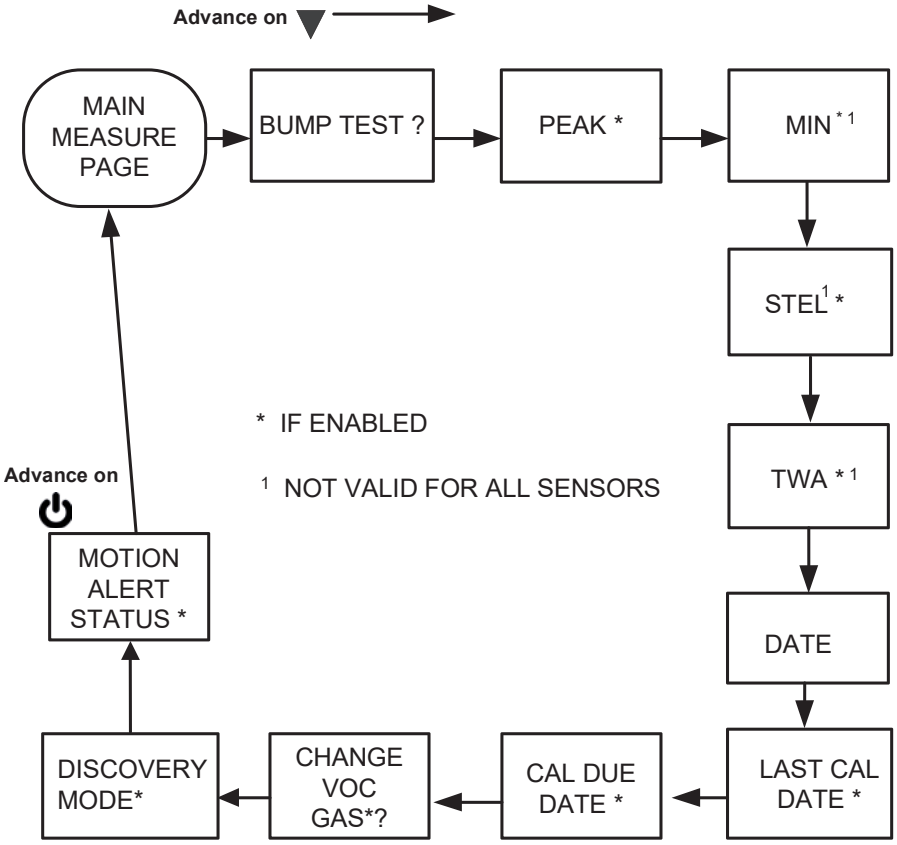
3.5 Viewing Additional Pages

The Main Screen appears at device turn-ON.
Additional displays can be viewed by pressing the ▼ button to move to the screen as indicated by the "soft key".
The sequence of pages are as follows and are described below:



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Bump Test (BUMP page)

This page allows the user to perform an automated Bump Test on the device. To perform the test, the (YES) button is pressed. See chapter 4.9 for details on performing the Bump Test.

If the ▼ button is pressed, the Bump Test is not performed, and the display shows the next page in the sequence (PEAK).

If the ▲ button is pressed, the Bump Test is not performed, and the display reverts back to the normal MEASURE page.

Peak Readings (PEAK page)

This page shows the highest levels of gas recorded by the device since turn-ON or since peak readings were reset.

To reset the peak readings:

(1) Access the PEAK page.

(2) Press the ▲ button.

This page can be de-activated through MSA Link software.

Minimum Readings (MIN page)

This page shows the lowest level of oxygen recorded by the device since turn-ON or since the MIN reading was reset. It is only shown if an oxygen sensor is installed and enabled.

To reset the MIN reading:

(1) Access the MIN page.

(2) Press the ▲ button.

Short Term Exposure Limits (STEL page)

WARNING

If the STEL alarm activates, leave the contaminated area immediately; the ambient gas concentration has reached the preset STEL alarm level. Failure to follow this warning will cause over-exposure to toxic gases and persons relying on this product for their safety could sustain serious personal injury or death.

This page shows the average exposure over a 15-minute period.

When the amount of gas detected by device is greater than the STEL limit:

- Alarm sounds, alarm lights flash.
- Alarm LEDs flash
- "`STEL ALARM`" message flashes.

To reset the STEL:

(1) Access the STEL page.

(2) Press the ▲ button.

The STEL alarm is calculated over a 15-minute exposure.

STEL calculation examples:

Assume the device has been running for at least 15 minutes:

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15 minute exposure of 35 ppm:

$$\frac{(15 \text{ minutes} \times 35 \text{ ppm})}{15 \text{ minutes}} = 35 \text{ ppm}$$

10 minute exposure of 35 ppm and 5 minutes exposure of 15 ppm:

$$\frac{(10 \text{ minutes} \times 35 \text{ ppm}) + (5 \text{ minutes} \times 5 \text{ ppm})}{15 \text{ minutes}} = 25 \text{ ppm}$$

This page can be de-activated through MSA Link software.

Time Weighted Average (TWA page)

WARNING

If the TWA alarm activates, leave the contaminated area immediately; the ambient gas concentration has reached the preset TWA alarm level. Failure to follow this warning will cause over-exposure to toxic gases and persons relying on this product for their safety could sustain serious personal injury or death.

This page shows the average exposure over 8 hours since the device was turned ON or since the TWA reading was reset. When the amount of gas detected is greater than the eight-hour TWA limit:

- Alarm sounds
- Alarm LEDs flash
- "`TWA ALARM`" message flashes.

To reset the TWA Readings:

(1) Access the TWA page.

(2) Press the ▲ button.

The TWA alarm is calculated over an eight-hour exposure.

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TWA calculation examples:
1 hour exposure of 50 ppm:

$$\frac{(1\text{ hour} \times 50\text{ ppm}) + (7\text{ hours} \times 0\text{ ppm})}{8\text{ hours}} = 6.25\text{ ppm}$$

4 hour exposure of 50 ppm and 4 hour exposure of 100 ppm:

$$\frac{(4\text{ hours} \times 50\text{ ppm}) + (4\text{ hours} \times 100\text{ ppm})}{8\text{ hours}} = 75\text{ ppm}$$

12 hour exposure of 100 ppm:

$$\frac{(12\text{ hours} \times 100\text{ ppm})}{8\text{ hours}} = 150\text{ ppm}$$

This page can be de-activated through MSA Link software.

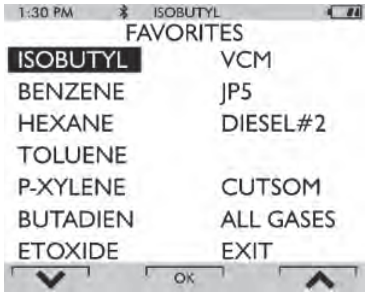
Date Display
Current date appears on the display in the format: **MM-DD-YY**.

Last cal page
Displays the device last successful calibration date in the format: **MM-DD-YY**. This page can be de-activated through MSA Link software or the SETUP - CAL OPTIONS page.

Cal due page
Displays the days until the device's next calibration is due (user selectable). This page can be de-activated through MSA Link software or the SETUP - CAL OPTIONS page.

Discoverable Mode page
Allows the user to put the device into Bluetooth discoverable mode in order to pair with another device. This page can be deactivated through the SETUP - INSTRUMENT OPTIONS page.

Change VOC Gas? Page
This page is selectable if the "Menu Enable" feature is ON as described in section 4.5. This page contains the 10 Favorite PID gases, the All Gases list and the Custom Gas list. An example of this screen is shown below:



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Motion Alert Activation Page

When the MotionAlert feature is active, the **+** symbol appears. The device enters pre-alarm when no motion is detected for 20 seconds. This condition can be cleared by moving the device. MotionAlert is turned OFF each time the device is powered OFF. After 30 seconds of no motion, the full MotionAlert alarm is triggered. This alarm can only be cleared by pressing the ▲ button. This page displays if it was selected in Setup Mode. To activate or deactivate the MotionAlert feature, press the ▲ button while the MOTIONALERT ACTIVATION page is displayed.

3.6 Sensor Missing Alarm

Enabled PID and XCell sensors are continuously monitored for proper function. If, during operation, the PID or an XCell sensor is detected as failed or disconnected, this alarm message appears.

- "SENSOR MISSING" flashes on the display.
- The problematic sensor is indicated.
- The alarm sounds and the Fault and Alarm LEDs flash.
- The alarm can be silenced by pressing the ▲ button; no other pages can be viewed.

WARNING

When this alarm occurs, the device is inoperative for measuring gases. The user must exit the hazardous area, the device must be powered down, and the sensor situation must be corrected.

3.7 Monitoring Toxic Gases

The device can monitor the concentration of a variety of toxic gases in ambient air. Which toxic gases are monitored depends on the installed sensors.

The device displays the gas concentration in parts per million (ppm), µmol/mol or mg/m^3 on the Measuring page. Gas units are selected in the SETUP - INSTRUMENT OPTIONS page.

WARNING

If an alarm is triggered while using the device, leave the area immediately.
Remaining in the area under such circumstances can cause serious personal injury or death.

The device has four gas alarms:

- HIGH Alarm
- LOW Alarm
- STEL Alarm
- TWA Alarm

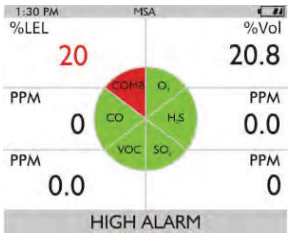

Fig. 6 Alarm Conditions (here High Alarm)

The carbon monoxide channel in the device is equipped with an internal filter. The purpose of this filter is to protect the CO sensor from acid gases (H2S, SO2, etc.) and from the hydrocarbons that the device is intended to measure, including the calibration gas, isobutylene. In normal use, an interferent signal for calibration or bump checking the device should not be observed on the CO channel. However, exposure to large amounts of certain hydrocarbons (either long exposure times or high concentrations) can overwhelm the filter and appear as signals on the CO channel.

In normal operation, after the hydrocarbon exposure is ended, the filter is designed to outgas absorbed hydrocarbons at a rate that will not cause a signal on the CO channel. However, if the unit is exposed to high temperature (>40°C), this desorption rate increases and spurious signals may be observed on the CO channel due to gassing of previously absorbed hydrocarbons. Typically the CO sensor will

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recover within 24 hours but extremely high exposures can extend this time. After the recovery period if the CO sensor can no longer be calibrated or shows an elevated reading that cannot be brought to zero with a zero calibration, the CO sensor should be replaced.

If the gas concentration reaches or exceeds the alarm set point or the STEL or TWA limits, the:

- alarm message displays and flashes in combination with the corresponding gas concentration
- backlight turns on
- alarm sounds (if active)
- alarm LEDs flash (if active)
- vibrating alarm triggers (if active)

3.8 Monitoring Oxygen Concentration

The device monitors the oxygen concentration in ambient air. The alarm set points can be configured to activate on two different conditions:

- Enriched - oxygen concentration > 20.8 vol % or
- Deficient - oxygen concentration < 19.5 vol %.

WARNING

If an alarm is triggered while using the device, leave the area immediately.
Remaining in the area under such circumstances can cause serious personal injury or death.

When the alarm set point is reached for either of the above conditions:

- the alarm message displays and flashes in combination with the corresponding gas concentration
- backlight turns on
- alarm sounds (if active)
- alarm LEDs flash (if active)
- vibrating alarm triggers (if active)

The LOW alarm (oxygen deficient) is latching and will not automatically reset when the O_2 concentration rises above the LOW set point. To reset the alarm press the ▲ button. If the alarm is latching, the ▲ button silences the alarm for five seconds. Alarms can be made latching or unlatching via MSA Link software.

False oxygen alarms can occur due to changes in barometric pressure (altitude), humidity or extreme changes in ambient temperature.

It is recommended that an oxygen calibration be performed at the temperature and pressure of use. Be sure that the device is in known fresh air before performing a calibration.

3.9 Monitoring Combustible Gases

The device can be equipped with a catalytic combustible sensor that detects a variety of combustible gases up to 100 % LEL and displays the reading as either % LEL or % CH_4.

WARNING

If an alarm is triggered while using the device, leave the area immediately.
Remaining in the area under such circumstances can cause serious personal injury or death.

The catalytic combustible sensor has two alarm setpoints:

- HIGH Alarm
- LOW Alarm

If the gas concentration reaches or exceeds the alarm set point, the device:

- alarm message displays and flashes in combination with the corresponding gas concentration:
- backlight turns on
- alarm sounds (if active)
- alarm LEDs flash (if active)

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Gas Exposure of 100 % LEL

When gas reading exceeds 100 % of the lower explosive limit (LEL), the device enters a Lock Alarm state and displays “**XXX**” in place of the actual reading.

WARNING

A catalytic combustible gas reading of "**XXX**" indicates the atmosphere could be above 100 % LEL and an explosion hazard exists. Move away from contaminated area immediately.

The user can clear the LockAlarm state only by turning the device OFF, and then ON again in a fresh air environment. When catalytic combustible gas reading digits appear, the device is available for measuring gases once again.

Check your national standard values for 100 % LEL.

3.10 Monitoring VOC Gases

The device is equipped with a PID sensor that detects a variety of VOC gases. The device displays the gas concentration in parts per million (ppm), µmol/mol or mg/m3 on the Measuring page.

WARNING

If an alarm is triggered while using the device, leave the area immediately.
Remaining in the area under such circumstances can cause serious personal injury or death.

The device has four gas alarms:
- HIGH Alarm
- LOW Alarm
- STEL Alarm
- TWA Alarm

If the gas concentration reaches or exceeds the alarm set point or the STEL or TWA limits, the:
- alarm message displays and flashes in combination with the corresponding gas concentration
- backlight turns on
- alarm sounds (if active)
- alarm LEDs flash (if active)
- vibrating alarm triggers (if active)

To reset the alarm press the ▲ button.
False VOC alarms can occur due to changes in barometric pressure (altitude), humidity or extreme changes in ambient temperature.
It is recommended that a VOC calibration be performed at the temperature, humidity and pressure of use.
Be sure that the device is in known fresh air before performing a calibration. For optimal lamp strike, the PID lamp should be started within the normal temperature range.

When the device is calibrated in an dry, air conditioned environment and taken to a high temperature and high humidity outdoor environment, a VOC Low or High alarm may be triggered by this sudden change. It is recommended that the PID sensors be cleaned prior to this transition to avoid this situation, or to acclimate the sensor to the outdoor conditions in a known safe area.

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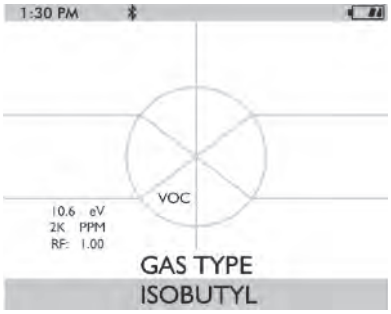
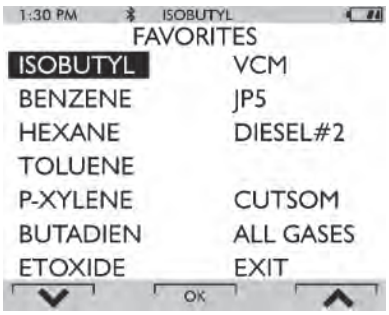
3.11 Displaying Current Response Factor

The current Response Factor (RF) is displayed at device startup along with the PID lamp potential in eV value, sensor range and VOC gas type.



During operations, the RF can be displayed through several menus. If the Menu Enable option is On, use the ▼ button on the Main Measuring page to scroll through the menu options and select YES on "Change VOC Gas?". Selecting any gas on this page will display the 8 character gas name, the Response Factor, the Maximum Value of the VOC gas and the current High and Low Alarm values.



The Maximum Value is calculated by multiplying the sensor range by the RF. For example, the Max Value for Hexane is 2000 *4.5 = 9000 ppm. The maximum value cannot exceed 9999 ppm .

> It is the responsibility of the user to change the VOC Low and High Alarms as appropriate for the applied RF. The selection of the alarm limits must be under the direction of a qualified safety professional who has carefully evaluated the specific hazards of the jobsite where it will be used and who is completely familiar with the product and its limitations.

A complete list of the 8 character gas name and Response Factors for all VOC gases is contained in chapter 10.

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4 Operation

Device operation is dialog driven from the display with the aid of the three function buttons (→ chapter 3.2).

For more information, see the flow charts in chapter 11.

4.1 Environmental Factors

A number of environmental factors may affect the gas sensor readings, including changes in pressure, humidity and temperature. Pressure and humidity changes affect the amount of oxygen actually present in the atmosphere.

Pressure Changes

If pressure changes rapidly (e.g., stepping through airlock), the oxygen sensor reading may temporarily shift and possibly cause the device to go into alarm. While the percentage of oxygen may remain at or near 20.8 Vol %, the total amount of oxygen present in the atmosphere available for respiration may become a hazard if the overall pressure is reduced by a significant degree.

Humidity Changes

If humidity changes by any significant degree (e.g., going from a dry, air conditioned environment to outdoor, moisture laden air), oxygen readings can be reduced by up to 0.5 %, due to water vapor in the air displacing oxygen.

The oxygen sensor has a special filter to reduce the effects of humidity changes on oxygen readings. This effect will not be noticed immediately, but slowly impacts oxygen readings over several hours.

Temperature Changes

The sensors have built-in temperature compensation. However, if temperature shifts dramatically, the sensor reading could shift.

Combined Humidity and Temperature Changes

When the device is calibrated in an dry, air conditioned environment and taken to a high temperature and high humidity outdoor environment, a VOC Low or High alarm may be triggered by this sudden change. It is recommended that the PID sensors be cleaned prior to this transition to avoid this situation, or to acclimate the sensor to the outdoor conditions in a known safe area.

4.2 Turning ON and Fresh Air Setup

Device operation is dialog driven from the display with the aid of the three function buttons (→ chapter 3.2).
For more information, see the flow charts in chapter 11.

Turn the device ON with the ⏻ button.
The device performs a self test:
During the self test, the device checks alarm LEDs, audible alarm, vibrating alarm and installed sensors.
The device displays:

- Startup logo
- Software version, device serial number, company name, department and user names
- IC / FCC ID Identifier
- Sampling system safety test

During the turn-ON sequence, if a sensor was changed since the previous device operation, the current listing of the installed sensors displays and user interaction is required.

  ▷ The user must accept the new configuration by pressing the ▲ button.

  ▷ If the current sensor configuration is not accepted, the device alarms and is not usable.

- FCC Identification page
- Combustible gas type, and installed sensor indication
- VOC gas type, lamp value, detectable range and Response Factor
- Alarm setpoints Low Alarm
- Alarm setpoints High Alarm
- Alarm setpoints STEL Alarm (if enabled)
- Alarm setpoints TWA Alarm (if enabled)
- Settings for calibration cylinder
- Current date
- Last calibration date (if enabled)
- CAL due date. If the calibration due date is enabled, the message "**CAL DUE; X DAYS**" appears on the device display.
  - X = the number of days until a calibration is due, user selectable for 1 to 180 days.

  If the number of days until calibration is due reaches 0, an alert occurs and "**CAL DUE, NOW**" displays.
  - Press the ▲ button to clear the alert
- Sensor warm-up period
- Fresh Air Setup option (if enabled).

The Main Measure Page will appear.
The presence of a ♥ indicator on the display means a sensor is approaching or has reached its end-of-life. See chapter 3.3 for details on the Sensor Life Alarm situation.
Refer to flowchart in chapter 11.1.

Sampling System Safety Test

Upon startup, an alarm (visual, audible and vibrating) is triggered and the customer is prompted to block the pumps/sampling system of the device within 30 seconds.
When the device detects a pump flow block, it will display a PASS message. The startup sequence will resume.
If the device does not detect a pump flow block, it will display an error message.
The device will shut OFF after the customer acknowledges this message by pressing the ▲ button.
Check your sampling system if this occurs and contact MSA as needed.
Users can check the operation of the sampling system any time during operation by blocking the sampling system to generate a pump alarm.

US

WARNING

Do not use the pump, sample line, or probe unless the pump alarm activates when the flow is blocked. Lack of an alarm is an indication that a sample may not be drawn to the sensors, which could cause inaccurate readings.

Failure to follow the above can result in serious personal injury or death.

Never let the end of the sampling line touch or go under any liquid surface. If liquid is drawn into the device, readings will be inaccurate and device could be damaged. We recommend the use of an MSA sample probe containing a special membrane filter, permeable to gas but impermeable to water, to prevent such an occurrence.

Fresh Air Setup (FAS) at device Turn-ON

The **F**resh **A**ir **S**etup (FAS) is for automatic ZERO adjustment of the device.

The FAS has limits. If a hazardous level of gas is present, the device ignores the FAS command and the device alarm activates.

The ability to perform an FAS at device turn-ON can be disabled by using MSA Link software.

WARNING

Do not perform the Fresh Air Setup unless you are certain you are in fresh, uncontaminated air; otherwise, inaccurate readings can occur which can falsely indicate that a hazardous atmosphere is safe. If you have any doubts as to the quality of the surrounding air, do not use the Fresh Air Setup feature. Do not use the Fresh Air Setup as a substitute for daily calibration checks. The calibration check is required to verify span accuracy. Failure to follow this warning can result in serious personal injury or death.

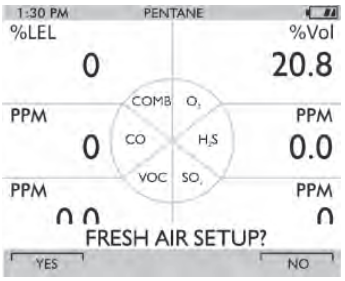


Fig. 7 Fresh Air Setup

US

The device displays a blinking "FRESH AIR SETUP?", prompting the user to perform a Fresh Air Setup:

(1) Press the ▲ button to bypass the Fresh Air Setup.
  ▷ The Fresh Air Setup is skipped and the device goes to the Measuring page (Main page).

(2) Press the ▼ button to perform the Fresh Air Setup.
  ▷ The device starts the FAS sequence and the FAS screen displays.
  ▷ A progress bar shows the user how much of the FAS has been completed.
  ▷ At the end of the FAS, the device displays either "FRESH AIR SETUP PASS" or "FRESH AIR SETUP FAIL".

If the FAS fails, perform a zero calibration (→ chapter 4.10).

4.3 Special Consideration for Oxygen Sensor

Under the following situations, the oxygen sensor display reading may be suppressed for up to 30 minutes at device turn-ON as a sensor 'cook down' is performed.

This could occur if:

- the oxygen sensor was just installed
- the battery pack was allowed to be deep-discharged
- the battery pack was removed from the device.

During this time, the oxygen sensor numeric position on the display indicates "PLEASE WAIT". While this message displays, the device cannot respond to a:

- Fresh Air Setup
- Calibration
- Bump Test procedure.

When the numeric oxygen reading appears, the FAS, calibration, or Bump Test procedures may be performed.

US

4.4 Measurement Mode (Normal Operation)

The following options pages can be executed from the Measurement screen:

BUMP page		This page allows user to perform a Bump Test on installed sensors
Peak Page*		This page shows the peak readings for all sensors.
Min Page		This page shows the minimum readings for the oxygen sensor.
STEL Page*		This page shows the calculated STEL readings of the device.
TWA Page*		This page shows the calculated TWA readings of the device.
Date Page	12	This page shows actual date settings of the device.
Last Cal Date		This page shows the date of the last calibration.
Cal Due*		This page shows the set date for the next calibration.
Change VOC Gas?		This page allows the VOC gas type to be changed
Discoverable Mode		This page allows the user to put the device into Bluetooth discoverable mode in order to pair with another device.
Motion Alert		This page allows the Motion Alert Feature to be activated or deactivated.
Wireless USB		This page allows the Wireless USB communication to be activated or deactivated.

* The display of these pages can be de-activated through MSA Link software

For further information see chapter 12.

US

4.5 Device Setup

The device has provisions to access and modify the following parameters through direct button interface:

- Calibration Options
- Alarm Options
- Instrument Options

These menus can be accessed only from the measure page by pressing and holding the ▼ and ▲ buttons simultaneously until you are prompted for a password.

The operation is as follows:

(1) Turn the device ON and wait until the measure page appears.

(2) Simultaneously press and hold the ▼ and ▲ buttons for approximately five seconds.

▷ The default password is "672".

PASSWORD

000

(3) Enter the first digit by pressing the ▼ or ▲ button and confirm with the ⏻ button.

▷ The cursor jumps to the second digit.

(4) Enter the second as well as the third digits.

▷ Incorrect password: device returns to the Main Page.

▷ Correct password: user can enter the Setup mode.

The password can be changed with a PC through the MSA Link software.If the password is forgotten, it can be reset by using MSA Link software. Contact MSA Customer Service for assistance. The following Options are available by pressing the ▼ and ▲ buttons:

- Calibration Options - see chapter 4.5
- Alarm Options - see chapter 4.5
- Instrument Options - see chapter 4.5

US

Calibration Setup

CALIBRATION OPTIONS

The Calibration Options menu has provisions to:

- modify the calibration cylinder settings (`CYLINDER SETUP`)
- enable/disable calibration due and to set the number of days (`CAL DUE OPTIONS`)
- enable/disable the option to show the last cal date at turn on and (`LAST CAL DATE`)
  When enabled, the date of the last device calibration displays during the turn-ON process.
- enable/disable the option for password protected calibration (`CAL PASSWORD`)
  When enabled, the device setup password must be entered prior to calibration.

Press:

- the ▼ button go to next page
  the ▲ button to go previous page
  the ⏻ button to enter setup.

Setting Calibration Cylinder

This option has a dialog similar to the span calibration dialog.
The display shows all active sensors.

(1) Press the ⏻ button to enter setup.
  ▷ The screen for the first calibration cylinder displays.

(2) Press
  ▷ the ▼ or ▲ button to change the value.
  ▷ the ⏻ button to confirm the setup.

With this confirmation the device automatically moves to the next cylinder setting.

(3) Repeat the sequence for changing the required settings for all necessary gas values.

After the last setting is performed, the device returns to the Calibration Options menu.

The only allowed calibration gas for the 0-2000 ppm PID sensor is 100 ppm isobutylene balanced in air. Higher concentrations can cause false readings of the CO sensor.

US

Setting Cal Due Options

(1) Press the ⏻ button to enter setup.
(2) Press the ▼ or ▲ button to enable/disable this option.
(3) Press the ⏻ button to confirm.
(4) After confirmation the device prompts the user to enter the number of days for the reminder.
(5) Change number of days by pressing the ▼ or ▲ button.
(6) Press the ⏻ button to go to the next menu.

Setting Last Cal Date

(1) Press the ⏻ button to enable/disable this option.
(2) Press the ▼ button to go to the next page.
(3) Press the ▲ button to go to the previous page.

Setting Calibration Password

(1) Press the ⏻ button to enable/disable this option.
(2) Press the ▼ button to go to the next page.
(3) Press the ▲ button to go to the previous page.

Back To Main Menu

(1) Press the ⏻ button to go to Device Setup Menu
▷ The Cal Options screen displays
(2) Press the ▼ button to go to the next (Alarm options) or the ▲ button to exit the Setup menu.

Alarm Setup

ALARM OPTIONS

The Alarm Options Menu allows the user to:

- enable/disable the vibrating alarm
- enable/disable the audible alarm (horn)
- enable/disable the Alarm LEDs
- enable/disable the MOTIONALERT SELECTION page.
  If disabled, the user cannot change the device MotionAlert setting.
- set Sensor Alarms.

Press

- the ▼ button go to next page
  the ▲ button to go previous page
  the ⏻ button to enter setup.

Setting Vibrating Alarm

Press the ⏻ button to enable/disable this option.

Setting Horn Alarm

Press ⏻ button to enable/disable this option.

Setting LED Alarm

Press ⏻ button to enable/disable this option.

US

Setting MotionAlert Access

Setting this parameter allows access to the MOTIONALERT page from the MEASURE page.
If access is denied here:

- the user cannot access the MOTIONALERT page to enable or disable that feature
- the InstantAlert feature (chapter 3.3) cannot be activated.

(1) To grant or deny user access to the MOTIONALERT page, use the button to change the indicated selection.
User access is:
▷ permitted when the setting indicates ON.
▷ denied when the setting indicates OFF.

(2) The selection is confirmed by pressing either the ▼ or ▲ button.

Setting Sensor Alarms

This page allows modifying the preset alarm values of:

- LOW Alarm
- HIGH Alarm
- STEL Alarm
- TWA Alarm.

Factory set alarm levels are shown in chapter 6.1.

(1) Press the ⏻ button to enter Sensor Alarm setup.
▷ LOW Alarm Setup screen displays.

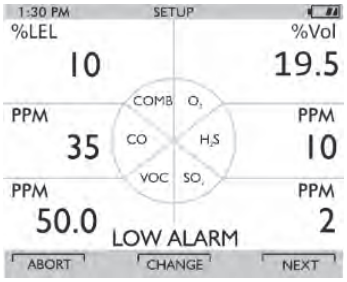


Fig. 8 Sensor Alarm Setup

(2) Press
the ▼ button to abort the operation or
the ▲ button to go to next alarm setup or
the ⏻ button to change the alarm setpoints.
▷ Alarm Value for the first Sensor displays.

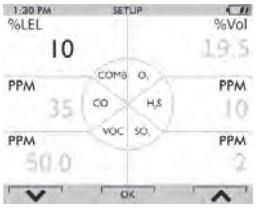


Fig. 9 Sensor Alarm Setup

US

(3) Set values for Sensor Alarm by pressing the ▼ or ▲ button.
(4) Press the ⏻ button to confirm set value.
(5) Repeat setting for all other sensors.
(6) Press the ▲ button to return to the Alarm Options menu.
(7) Repeat setting for all other alarm types.

Instrument Options

SETTINGS

The Instrument Options menu allows modification of different device options:
- Sensor Setup (enable/disable the channel)
- Language Setup
- Time Date Setup
- Datalog Intervals
- Stealth Mode
- Operating Beep
- Backlight Options
- VOC Gas Setup
- Bluetooth

Press
- the ▼ button go to next page
  the ▲ button to go previous page
  the ⏻ button to enter setup.

Setting Sensor Options

(1) Press the ⏻ button to enter setup.
▷ Following screen displays:

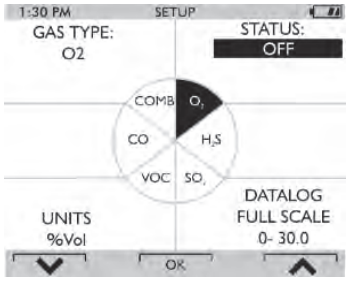


Fig. 10 Sensor Options Setup

(2) Press the ▼ button to select sensor, press the ⏻ button to make changes.
▷ The sensor information is displayed and the sensor can be enabled or disabled.

Other operations such as changing the combustible gas type (Methane, Butane, Propane etc.) and units (ppm to mg/m3) are only possible using the MSA Link software.

(3) Change status by pressing the ▼ or ▲ button.

US

(4) Press the ⏻ button to confirm and advance to next screen (next sensor).
(5) Perform the sequence for all other sensors.
▷ After setting up the last sensor the device goes to the next Setup Page.

Language Setup
This option is for setting the language of the device.
(1) Press the ⏻ button to enter setup.
(2) Change language by pressing the ▼ or ▲ button.
(3) Confirm with the ⏻ button.
▷ The device goes to the next Setup Page.

Time and Date Setup
This option is for setting the device time and date. The device first prompts to set the time and then it prompts for the date.

The time can be set up for either regular AM/PM or military time (through MSA Link software). AM/PM time is the default setting.

(1) Press the ⏻ button to enter setup.
(2) Change hours by pressing the ▼ or ▲ button.
(3) Confirm with the ⏻ button.
(4) Change minutes by pressing the ▼ or ▲ button.
(5) Confirm with the ⏻ button.
▷ The device goes to the Set Date Page.
(6) Change month, date and year by pressing the ▼ or ▲ button and confirming with the ⏻ button.
▷ The device goes to the next Setup Page.
(7) Confirm with the ⏻ button.
▷ The device goes to the next Setup Page.

Setting Datalog Intervals
This option is for setting the intervals at which all the readings will be logged.
(1) Press the ⏻ button to enter setup.
(2) Change interval by pressing the ▼ or ▲ button.
(3) Confirm with the ⏻ button.
▷ The device goes to the next Setup Page.

Setting Stealth Mode
Stealth mode disables the visual, audible and vibrating alarms.
(1) Press the ⏻ button to change mode (ON/OFF).
(2) Press the ▼ button to go to the next page or the ▲ button to return to previous page.

Setting Operating Beep
(1) Press the ⏻ button to change mode (ON/OFF).
(2) Press the ▼ button to go to the next page or the ▲ button to return to previous page.

Setting Backlight
(1) Press the ⏻ button to enter setup.
▷ Change option by pressing the ▼ or ▲ button.
(2) Press the ⏻ button to enter.
(3) Change timeout by pressing the ▼ or ▲ button.
(4) Press ⏻ button to confirm timeout.

PID Setup

WARNING

It is very important to have an understanding of PID basics when changing PID settings. Failure to properly identify the VOC gas being measured and/or failures to select the correct Response Factor alarm values (exposure, STEL, TWA) that match the desired Response Factor and/or the correct lamp will result in erroneous readings or erroneous alarm limits that could cause death or serious personal injury.

The PID sensor should be configured prior to initial operation.

- Enter the correct password enter the 'Instrument Setup' menu and press the ▼ button until VOC Gas Setup is highlighted, then select OK.

There are five configuration pages available:

Configuration page	
Menu Enable	Menu Enable On allows the VOC gas to be changed without entering the password. When Menu Enable On is active, the "Change VOC Gas?" option is available from the Main Measuring Page as described in section 3.4. The default setting is ON.
Maintain VOC Gas	Maintain VOC Gas ON retains the currently selected VOC gas when the device is powered down and restarted. If this option is set to OFF the device will always power up with isobutylene selected as the VOC gas type. This option should be set to ON if the same VOC gas is to be monitored on every use. The default setting is ON.
Favorites Setup	This set of pages allows the default Favorites list to be changed with VOC gases suitable for the user's particular environment. The ten default Favorites will be displayed on initial use. The first screen in the Favorites Setup page will ask which Favorite is to be replaced. (1) Select the gas to be replaced by using the ▼ or ▲ button to highlight then select OK. ▷ The next screen will display the current 10 Favorites, and options for Custom Gas and All Gases. (2) Highlight the gas to add to the Favorites and select OK. ▷ A Confirmation Screen will be displayed showing the gas to be replaced and the gas to be added to Favorites. ▷ Selecting YES will return to the Favorites list showing the new gas, selecting NO will return to the Favorites list showing the previous Favorites and selecting ABORT will return to the menu page.

US

Configuration page	
VOC Gas Selection	This menu displays all of the gases available for detection by this PID sensor type. The gases are listed by an 8 character abbreviation. The full gas names are listed in chapter 10 of this manual. The first 10 gases listed are the Favorites gases followed by options for the All Gas List and the Custom List. Gas names starting with the letters A-Z are listed alphabetically. Each page contains 14 gas names. ■ Select the gas of interest by using the ▼ or ▲ button to highlight then select OK. ▷ Holding down the ▼ or ▲ button for more than 2 seconds will scroll a full page at a time. Selecting OK will display a confirmation page that contains the following information: - 8 character short name - Response Factor (RF) for the selected gas - Maximum Value of that gas (Full scale sensor value x RF). The Maximum Value is calculated by multiplying the sensor range by the RF. For example, the Max Value for Hexane is 2000 *4.5 = 9000ppm. The maximum value cannot exceed 9999ppm due to display resolution limitations. - High Alarm - this reflects the current High Alarm value. Change if necessary for the chosen Response Factor - Low Alarm - this reflects the current High Alarm value. Change if necessary for the chosen Response Factor
Custom Gas Setup	The Custom Gas Setup allows a unique 8 character gas name and associated Response Factor to be entered for up to 10 Custom gases. (1) Select which Custom Gas (1 - 10) to enter or replace. ▷ Confirm with OK. (2) On the next screen, enter the 8 character gas name using the ▼ or ▲ buttons to select letters and numbers. ▷ Select OK when the appropriate alpha-numeric characters are reached. (3) After the 8th character is entered, enter the Response Factor (0.1- 40.0). ▷ Once the RF is complete, a final confirmation page will display. (4) Select OK to apply the Custom Gas as the current gas or select NO and abort to the menu page.

WARNING

Failure to properly identify the VOC gas being measured and/or failures to select the correct alarm values (exposure, STEL, TWA) that match the desired Response Factor and/or the correct lamp will result in erroneous readings that could cause death or serious personal injury.

Enabling Bluetooth

The device is configured with a Bluetooth capable communications feature.

(1) Press the ⏻ button to enable or disable the Bluetooth communications device (ON/OFF).

(2) Press the ▼ button to to return to the Main Menu or the ▲ button to return to previous page.

Back To Main Menu

There are three options at this point:

the ▼ button	Sensor Options menu
the ▲ button	Previous Setup page in the Instrument Options menu
the ⏻ button	Instrument Options menu

US

4.6 Bluetooth Operation

Bluetooth must be enabled for any Bluetooth functions to operate. See chapter 4.5. Compatible Bluetooth host with appropriate software is required for proper operation.

Bluetooth security

The Bluetooth connection is encrypted and secured with a unique six digit pin that must be double confirmed on both device and Bluetooth host at the time of pairing.

Discovery Mode

This device mode is used to enable a Bluetooth host to pair with the device for the first time or if a different Bluetooth host was connected with the device previously.

Note that the device will automatically enter discovery mode for five minutes at device turn on if Bluetooth has been enabled. Discovery mode will also be entered for 5 minutes following a disconnection.

To manually enter discovery mode:

(1) Page down through the menu pages in Measurement Mode using the ▼ button until the Discovery Mode page is displayed.

(2) Press the ⏻ button to enter discovery mode.

▷ The blue led will blink rapidly indicating that the device is in Discovery Mode.

Connecting the device to a Bluetooth host for the first time

(1) Ensure that the device is on and in Discovery Mode

(2) On the Bluetooth host, locate the Bluetooth device list. Select "A5X-xxxxxxxx" from the list.

▷ Both the device and Bluetooth host will display a unique six digit security code to ensure that the correct devices are being paired.

(3) After confirming that the six digit codes match, confirm the pairing request on the device by pressing the ▼ button.

(4) Confirm on the Bluetooth host as well.

Connecting the device to a Bluetooth host

If this was the last device connected to the Bluetooth host, the Bluetooth host can connect to the device whether or not the device is in discovery mode as long as Bluetooth is enabled. The six digit code confirmation will not be displayed.

The device will only recall the last Bluetooth host it was paired with. If connecting to another Bluetooth host, the device must be placed into discovery mode to be detected.

Bump pairing the device to a Bluetooth host

This device has an integrated RFID chip to facilitate a faster Bluetooth pairing process with a Bluetooth host that supports a RFID or NFC reader with appropriate software. Simply align the RFID or NFC reader of the Bluetooth host directly over the MSA logo on the front of the device.The device and Bluetooth host should become paired and connected.

Disconnecting the device from a Bluetooth host

The device does not have a disconnect feature as this would be initiated by the Bluetooth host. Use the Bluetooth host functions to purposefully disconnect the device from the Bluetooth host.

Device configuration over Bluetooth connection

The device has the ability to receive updates to device settings over the Bluetooth connection. The user must successfully pair the device and Bluetooth host confirming that the six digit security code matches both on the device and the Bluetooth host. After a configuration change has been initiated, the user must confirm the request on the device by pressing the ▲ button.

Evacuation alert over Bluetooth connection

The device has the ability to receive an evacuate message over the Bluetooth connection. The user must successfully pair the device and Bluetooth host confirming that the six digit security code matches both on the device and the Bluetooth host. Once connected, an evacuate message sent to the device will send the device into alarm while displaying EVACUATE on the display. Press the ▲ button to silence the Evacuation alert and confirm the alert was received. Press the ▲ button a second time to reset the Evacuation alert once in a safe area.

4.7 MSA Link Operation

Connecting device to PC

(1) Switch ON the device and align the Datalink Communication port on the device to the IR interface of the PC.

(2) Start the MSA Link software on the PC and start the connection by clicking the connect icon.

4.8 Function Tests on the Device

Alarm Test

■ Turn ON the device.

The user should verify that:

- alarm LEDs flash
- horn sounds briefly
- vibrating alarm triggers briefly.

4.9 Bump Test

WARNING

Perform a Bump Test before each day's use to verify proper device operation. Failure to perform this test can result in serious personal injury or death.

Bump test frequency is often stipulated by national or corporate regulations; however, bump testing before each day's use is generally the accepted best safety practice and is therefore MSA's recommendation.

This test quickly confirms that the gas sensors are functioning. Perform a full calibration periodically to ensure accuracy and immediately if the device fails the Bump Test. The Bump Test can be performed using the procedure below or automatically using the GALAXY GX2 Test Stand.

CSA requires (per 22.2 NO. 152) that combustible sensor sensitivity be tested before each day's use on a known concentration of methane equivalent to 25 to 50 % of full scale concentration. ACCURACY MUST BE WITHIN 0 to +20 % OF ACTUAL. Correct accuracy by performing the calibration procedure described in chapter 4.10.

NOTE: The GALAXY GX2 cannot test the Chlorine Dioxide sensor. For this sensor, use this Bump Test procedure and/or manually calibrate as described in chapter 4.10.

Equipment

See accessory chapter for ordering information for these components.

- Calibration Check Gas Cylinder(s)

  See chapter 6.3 for calibration gas target values and appropriate MSA calibration gas cylinders.
- Demand Flow Regulator(s)
- Tubing appropriate for the gases to be tested
- Kits containing tubing and regulators suitable for reactive and non-reactive gases are available from MSA.

US

Performing a Bump Test

When bumping a PID sensor, use 100ppm isobutylene balanced in air.

(1) While the device is turned ON in a clean, fresh air environment, verify that readings indicate no gas is present.

(2) From the normal measure screen press the ▼ button to display "`BUMP TEST?`".

(3) Verify the gas concentrations displayed match the Calibration Check Gas Cylinder. If they do not, adjust the values through the Calibration Setup menu.

▷ Depending on the sensors installed, there could be one to five separate Bump Tests performed, each with a different cylinder, regulator, and tubing used.

(4) Attach the demand regulator (supplied in the calibration kit) to the cylinder providing the indicated gases.

(5) Connect tubing (supplied in the calibration kit) to the regulator.

(6) Attach the other end of tubing to the device pump inlet.

(7) Press the ⏻ button to start the bump test:

▷ the progress bar advances

▷ the sensors respond to the gas.

The message BUMP TEST PASS indicates a successful Bump Test of the sensors.

If any sensor fails the Bump Test:

- the message BUMP TEST FAIL appears
- the failed sensor is indicated.

If there are more sensors to be Bump Tested, the next sensor displays and the process repeats from Step 4.

If there are no more sensors to be Bump Tested, the tubing can be removed from the device pump inlet.

After the Bump Test

After all installed sensors pass the Bump Test, the √ symbol displays on the MEASURE page. This √ symbol appears on the display in the upper feature bar

If any sensor was not bump tested, or fails the Bump Test, the √ symbol does not display.

The color display:

- temporarily shows the √ symbol at each gas reading for successfully bump tested sensors
- √ symbol is then replaced by the present gas reading.

The √ symbol shows for 24 hours after the Bump Test.

If a sensor fails the Bump Test, calibrate the device as described in chapter 4.10.

US

4.10 Calibration

The ALTAIR 5X PID can be calibrated either manually using this procedure or automatically using the GALAXY GX2 test stand. Refer to chapter 11.5.

The use of the demand regulators listed in chapter 9 is recommended. If a new sensor has been installed, the battery pack has been depleted or a new battery pack has been installed allow sensors to stabilize for 30 minutes before calibration is performed.

WARNING

Special conditions with toxic gases!

If the device is to be checked or calibrated for reactive gases, prerequisites are required; otherwise, incorrect calibration would result in incorrect device operation.

Reactive toxic gases (e.g., chlorine, ammonia, chlorine dioxide) have the property of diffusing into the rubber and plastic tubes so that the volume of test gas available in the device would no longer be sufficient to correctly perform device calibration.

When calibrating the device with toxic gases, certain prerequisites are required, otherwise incorrect calibration could result:

- A special pressure regulator
- Shortest possible connection tubes between the pressure regulator and the device
- Connection tubes made from a material that does not absorb the test gases (e.g., PTFE).

NOTE: If using normal tubes and pressure regulators, expose them to the required test gas for an extended time period. Keep these materials dedicated for use with that test gas only; do not use them for other gases.

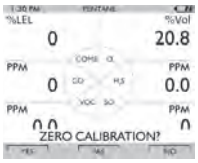
For example, for chlorine, allow the entire contents of a test gas cylinder to flow through the pressure regulator and tubes before using to calibrate the device. Mark these materials for use with chlorine only.

US

Zero Calibration

(1) Press the ▲ button for five seconds in Normal Measurement page.

▷ ZERO screen displays.



To skip the ZERO procedure and move directly to the span calibration procedure, push the ▲ button. If no button is pushed for 30 seconds, the device prompts user to perform a SPAN calibration before device returns to the Normal Measurement page.

To perform ONLY a Fresh Air Setup at this time, press the ⏻ button. The device then performs a Fresh Air Setup as described in chapter 4.2. When the Fresh Air Setup is complete, the device returns to the normal Measure screen.

(2) Press the ▼ button to confirm the ZERO screen, i. e. to execute zero calibration.

▷ The message "SENSOR REFRESH" displays, followed by the message "ZERO CALIBRATION".

▷ The "REFRESH" message does not appear if a catalytic combustible sensor is not installed.

▷ ZERO calibration starts.

▷ A progress bar shows the user how much of the calibration has been completed.

During the first moments of a ZERO calibration, the combustible sensor reading may be replaced by a moving display of “PLEASE WAIT”. This is normal.

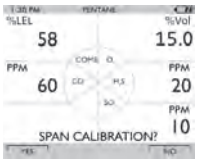
▷ After the ZERO calibration is completed the device displays either

“ZERO CALIBRATION PASS”

or

“ZERO CALIBRATION FAIL”.

▷ Only if the device passes the zero calibration the SPAN screen displays.



US

Span Calibration

To skip the Span calibration procedure, push the ▲ button.

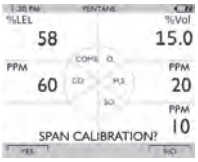
> If the SPAN calibration of the combustible sensor is skipped after a successful ZERO calibration, the combustible sensor reading may be replaced with a moving display of “PLEASE WAIT” for a few moments. This is normal, and the device is fully operational once a combustible gas reading reappears.

If no button is pushed for 30 seconds, span calibration is skipped.
Because of the different possible combinations of gases that are possible, skipping a Span calibration could advance the user to the Span calibration of another installed sensor, or back to Measuring mode.

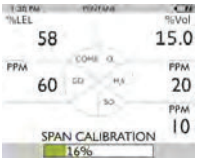
> When calibrating a PID sensor, use 100 ppm isobutylene balanced in air. Isobutylene calibration gas greater than 100 ppm is not allowed due to long term affect on the CO sensor.

(1) Connect one end of tubing to the cylinder regulator (supplied in the calibration kit).

(2) Connect the other end of the tubing to the pump inlet.



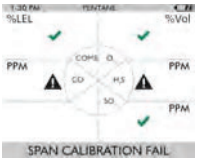
(3) Press the ▼ button to calibrate (span) the device.
- ▷ “SPAN CALIBRATION“ flashes
- ▷ SPAN calibration starts.
- ▷ A progress bar shows the user how much of the calibration has already been completed.



- ▷ After the SPAN calibration is completed, the device displays either

“`SPAN CALIBRATION PASS`”
or
“`SPAN CALIBRATION FAIL`”

- ▷ The device returns to Measuring mode.



US

If a sensor is nearing its end-of-life, the "PASS" display is followed by the Sensor Life indicator ♥ display.

- While the sensor is still fully functional, this warning gives the user time to plan for a replacement sensor to minimize downtime.
- The ♥ indicator blinks as the device returns to Measure mode.
- After 15 seconds, the blinking stops, but the ♥ indicator continues to display during ongoing operations as a reminder of a sensor's pending end-of-life.

If a span calibration fails:

- The Sensor Life Indicator ♥ blinks to show a sensor has reached its end-of-life and should be replaced.
- The device remains in the Sensor Life alarm condition until the ▲ button is pressed.
- After the alarm is cleared, the device enters Measure mode and the Sensor Life indicator ♥ blinks during ongoing operations until the sensor is replaced and/or successfully calibrated.

Span calibration can fail for reasons other than a sensor at the end of its life. If a span calibration failure occurs, verify items such as:

- sufficient gas remaining in the calibration cylinder
- gas expiration date
- integrity of calibration tubing/fittings, etc.

■ Reattempt the span calibration before replacing the sensor.

Finishing Successful Calibration

(1) Remove the calibration tube from pump inlet.

The calibration procedure adjusts the span value for any sensor that passes the calibration test. Sensors that fail calibration are left unchanged.

On the color display, each successfully calibrated sensor temporarily shows a √ symbol at its gas reading.

These √ symbols remain visible for a few moments and are then replaced by the present gas reading.

Since residual gas may be present, the device may briefly go into an exposure alarm after the calibration sequence is completed.

■ Press the ▲ button to reset the alarm as necessary.

Following a PID sensor calibration, VOC gas readings may be slightly elevated (< 5 ppm) for several minutes. This is normal behavior as the isobutylene is purged from the device.

A √ symbol displays on the MEASURE page.This √ symbol appears on the:

- color display in the upper feature bar

The √ symbol displays for 24 hours after the calibration and then turns off.

If the horn alarm is turned OFF, the calibration √ symbol does not appear on the color display.

US

Calibration with an Automated Test System

The device can be calibrated using the GALAXY GX2 Automated Test System - contact MSA for a list of compatible gases and concentrations.

Similar to the successful (manual) calibration described in chapter 4.10, a √ symbol displays on the MEASURE page after successful GALAXY GX2 calibration.

This √ symbol appears on the display in the upper feature bar.

The √ symbol displays for 24 hours after the calibration and then turns off.

If the horn alarm is turned OFF, the calibration √ symbol does not appear on the color display.

4.11 Time of Day Testing

This feature permits the device to be automatically calibrated on a user-defined interval. The most common use of this feature allows the user to configure the ALTAIR 5X PID and the GALAXY GX2 System to automatically calibrate a device prior to the start of work-shift. See the GALAXY GX2 Operating Manual ("Automated Testing Features" section) for a complete description of how to configure the GALAXY GX2 for this mode.

On ALTAIR 5X PID devices, the following settings must be configured using either MSA Link or the GALAXY GX2 → Instrument Setup page:

- For automated calibration testing, Calibration Due must be enabled and a non-zero Calibration Interval must be entered for automatic calibration testing
- For automated bump testing, Bump Due must be enabled and a non-zero Bump Interval must be entered for automatic bump testing

Carefully follow all GALAXY GX2 set-up directions as described in the GALAXY GX2 Operating Manual for proper setup.

4.12 Device Shutdown

For device shutdown press and hold the ⏻ button.

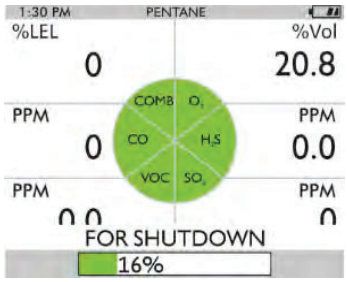


Fig. 11 Shutdown

The device displays a blinking "`HOLD BUTTON FOR SHUTDOWN`" and a progress bar shows the user how much longer to hold the button to complete the shutdown.

US

5 Maintenance

If irregularities occur during operation, use the displayed error codes and messages to determine appropriate next steps.

WARNING

Repair or alteration of the device beyond the procedures described in this manual or by anyone other than a person authorized by MSA, could cause the unit to fail to perform properly. Use only genuine MSA replacement parts when performing any maintenance procedures described in this manual. Substitution or incorrect installation of components can seriously impair performance of the unit, alter intrinsic safety characteristics or void agency approvals. Failure to follow this warning can result in serious personal injury or death.

Refer to EN 60079-29-2 (Guide for the selection, installation, use and maintenance of apparatus for the detection and measurement of combustible gases or oxygen) and EN 45544-4 (Guide for the selection, installation, use and maintenance of electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapors).

5.1 Troubleshooting

Error State	Details	Recommended Action
Alternating display		
ADC ERROR	Analogue measurement error	Contact MSA
MEM ERROR	Memory error	Contact MSA
PROG ERROR	Program error	Contact MSA
RAM ERROR	RAM error	Contact MSA
BT ERROR	Bluetooth error	Contact MSA
LOW BATTERY (flashing)	Battery Warning repeats every 30 seconds	Remove from service as soon as possible and recharge or replace battery
BATTERY ALARM	Battery is completely discharged	Device is no longer sensing gas; Remove from service and recharge or replace battery.
Device does not turn ON	Battery fully discharged	Remove from service as soon as possible and recharge or replace battery pack.
SENSOR MISSING	Sensor damaged or missing	Replace sensor
NO SENSORS	No sensors are enabled	Device must have at least one sensor enabled at all times
	Sensor warning	Sensor is near the end of its life
(flashing)	Sensor alarm	Sensor has reached the end of its life and cannot be calibrated. Replace sensor and recalibrate.
PUMP ERROR	Pump malfunction or flow path blockage	Check flowpath for blockage. If error persists, remove from service.
INVALID CONFIGURA-TION	Sensor(s) installed in incorrect location.	Install sensors as shown in Figure 13.

US

5.2 Verifying Pump Operation

Users can check operation of the sampling system any time during operation by blocking the sampling system to generate a pump alarm.

When the pump inlet, sample line or probe is blocked, the pump alarm must activate.

Once gas readings are displayed, plug the free end of the sampling line or probe.

- The pump motor shuts down and an alarm sounds.
- PUMP ERROR will flash on the display.

■ Press the ▲ button to reset the alarm and restart the pump.

If the alarm does not activate:

- Check the sample line and probe for leaks.
- Once leak is fixed, recheck pump alarm by blocking the flow.

■ Press the ▲ button to reset the alarm and restart the pump.

WARNING

Do not use the device, sample line, or probe unless the pump alarm activates when the flow is blocked. Lack of an alarm is an indication that a sample may not be drawn to the sensors, which could cause inaccurate readings. If a sample line or probe is installed and the pump alarm does not activate, remove the line or probe and repeat the test. This will provide information on where the blockage is located.

Failure to follow the above can result in serious personal injury or death.

Never let the end of the sampling line touch or go under any liquid surface. If liquid is drawn into the device, readings will be inaccurate and device could be damaged. We recommend the use of an MSA sample probe containing a special membrane filter, permeable to gas but impermeable to water, to prevent such an occurrence.

During operation, a pump alarm may occur when the:

- Flow system is blocked
- Pump is inoperative
- Sample lines are attached or removed.

To Clear Pump Alarm

(1) Correct any flow blockage.

(2) Press the ▲ button.

▷ The Pump will now restart.

US

5.3 Replacing the Battery

WARNING

Never replace the battery in a hazardous area. This could result in an explosion.

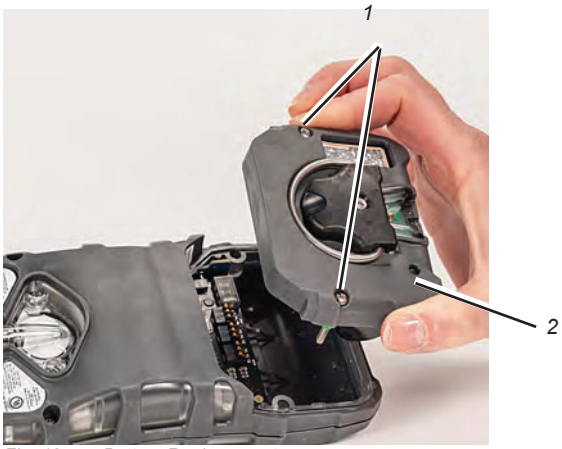


Fig. 12 Battery Replacement

1	*Captive screw*	*2*	*Battery pack*

(1) Unscrew the two captive screws on the rear of the device.

(2) Pull the battery pack out of the device by gripping the sides and lifting it up and away from the device.

(3) When replacing the battery, be sure to accurately align screws and battery with housing.

(4) Screws should be tightened and torqued to 5.5 in lb.

5.4 Maintenance Procedure - Replacing or Adding a Sensor

Any factory-installed Series 20 sensor may be removed or replaced with a like type. Any XCell sensor may be removed or replaced according to the positions allowed in table below Figure 13.

WARNING

The PID sensor may be replaced with an authorized MSA PID replacement sensor. If the PID sensor range is different than the previously installed sensor, the new configuration MUST be selected in the Instrument Options → Sensor Setup screen. Otherwise wrong readings could occur and persons relying on this product for their safety could sustain serious personal injury or death.

WARNING

Remove and reinstall sensors carefully, ensuring that the components are not damaged; otherwise device intrinsic safety may be adversely affected, wrong readings could occur, and persons relying on this product for their safety could sustain serious personal injury or death.

NOTICE

Before handling the PC board, ensure you are properly grounded; otherwise, static charges from your body could damage the electronics. Such damage is not covered by the warranty. Grounding straps and kits are available from electronics suppliers.

US

While device case is open, do not touch any internal components with metallic/conductive objects or tools.
Damage to the device can occur.

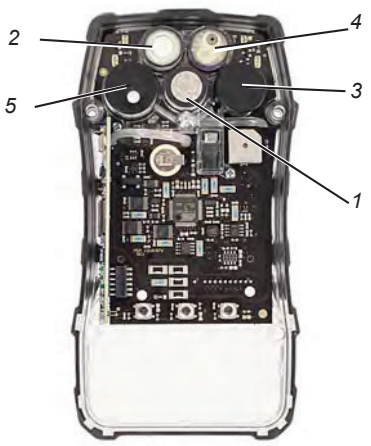


Fig. 13 Possible positions for sensor replacement

1	*Combustible sensor*	*4*	*See table below or a sensor plug*
2	*O_2 sensor*	*5*	*PID sensor*
3	*See table below*		

SENSOR	OPERATIONAL ONLY IN POSITION
XCell combustible sensor	1
XCell O_2 sensor	2
XCell SO_2, Cl_2, NH_3, H_2S, H_2S-LC sensor	4
XCell Two-Tox, SO_2, Cl_2, NH_3, CO-HC	3
Series 20 sensor	3
PID sensor	5

(1) Verify that the device is turned OFF.
(2) Remove the battery pack.
(3) Remove the two remaining case screws, and remove the case front.
(4) Gently remove the sensor to be replaced.
(5) Carefully align the new sensor contact pins with the sockets on the printed circuit board.
(6) Press the new sensor into place.

US

(7) Note the position restrictions in the table above.
- ▷ Adapter (part no. 10110183) is required for XCell usage in position 3.
- ▷ If a sensor is removed and will not be replaced, be sure to install a sensor plug in its place in order to maintain correct device function.
- ▷ The plug for XCell positions is P/N 10105650.
- ▷ The Series 20 plug is P/N 10088192.

(8) Visually inspect the green gasket, assuring that it is seated properly in the front housing.

(9) Attach front case and tighten two case screws using 5.5 in-lbs of torque.

(10) Attach the battery pack and tighten the two battery pack screws using 5.5 in-lbs of torque.

If a change in XCell Sensor configuration is detected during the device turn-ON process:

- The "ACCEPT?" prompt appears on the display
- The ▼ button accepts the sensor configuration
- The ▲ button rejects the sensor configuration; the device is not operational.

When an XCell sensor is replaced, the device automatically enables the sensor after the change has been accepted. If a Series 20 or PID sensor is replaced, it must be manually enabled (→ chapter 4.5, SETTING SENSOR OPTIONS).

If the oxygen sensor was replaced, see chapter 4.2 regarding the oxygen reading display.

(11) Allow sensors to stabilize at least 30 minutes before calibration.

(12) Calibrate device before use.

WARNING

Calibration is required after a sensor is installed; otherwise, the device will not perform as expected and persons relying on this product for their safety could sustain serious personal injury or death.

US

5.5 Replacing the Pump Filter

(1) Turn OFF the device.

(2) Unscrew the two captive screws from the clear filter cover on the back of the device to access the filter.

(3) Carefully lift out the O-ring and the filter disk(s).

(4) Use both the paper-like filter and the fibrous dust filter (the thicker disk) as supplied in the Maintenance Kit if the device is NOT configured to use a reactive toxic gas sensor (does not have a Cl_2, ClO_2, or NH_3 sensor).

Use ONLY the paper filter supplied in the Reactive Gas Maintenance Kit if the device IS configured to use a reactive toxic gas sensor (Cl_2, ClO_2, or NH_3).

(5) Place the new paper-like filter into the recess in the back of the device. If it is to be used, place the fibrous dust filter into the clear filter cover.

WARNING

Use of the fibrous dust filter or the incorrect paper filter for the measurement of reactive gases could cause erroneous readings.

(6) Replace the O-ring in the recess.

(7) Re-install the clear filter cover on the back of the device.

5.6 Cleaning the Device Exterior

Clean the exterior of the device regularly using only a damp cloth. Do not use cleaning agents as many contain silicones which will damage the combustible sensor.

5.7 Storage

When not in use, store the device in a safe, dry place between 18 °C (65 °F) and 30 °C (86 °F). After storage, always recheck device calibration before use. If not to be used in 30 days, remove battery pack or connect it to a charger.

5.8 Shipment

Pack the device in its original shipping container with suitable padding. If the original container is unavailable, an equivalent container may be substituted.

5.9 PID Sensor Cleaning and Maintenance Procedure

WARNING

All maintenance procedures must be performed on a clean surface using clean tools. Avoid touching the lamp's window as well as the metalized portion of the Cell Assembly with bare fingers. Fingerprints left on these parts may adversely affect the sensors operation. Latex gloves are recommended, but if they are not used, hands must be clean and free of oils, lotions, etc. It is acceptable to hold the lamp by its glass body or by the edges of the window.

Remove and reinstall sensors carefully, ensuring that the components are not damaged; otherwise device intrinsic safety may be adversely affected, wrong readings could occur, and persons relying on this product for their safety could sustain serious personal injury or death.

NOTICE

While device case is open, do not touch any internal components with metallic/conductive objects or tools. Damage to the device can occur.

US

Cleaning Procedure
Recommended Supplies

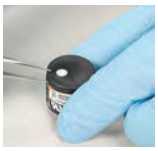
MSA PID Sensor Cleaning Kit P/N:10165248
- Methanol
- Cotton Tipped Applicator
- Teflon Filter
- Cotton Filter
- Tweezers

Latex Gloves (Optional)

Prior to Cleaning

(1) Verify that the device is turned OFF.
(2) Remove the battery pack.
(3) Remove the two remaining case screws and the case front.
(4) Gently remove the PID sensor.

Sensor Disassembly



(1) Remove the Filter Cap by applying slight upward pressure with the tip of the tweezers to the seam dividing the housing body and cap.
▷ This will be just below the hole in the cap. It should pop off and can be set aside.

(2) With tweezers, remove both the Teflon Filter and Cotton Filter and set aside.

(3) With tweezers, remove the Spacer and set aside.

(4) With tweezers, carefully loosen the Cell Assembly by prying under the cell's edge near the three connector pins. Once loose, cell can be lifted out and set aside.

(5) With tweezers, grasp the lamp by placing the tips in the sensor housing notch and gently prying up on the lamp perimeter.
▷ Lift out and be careful not to scratch the lamp lens or chip the edges.

US

Cleaning

(1) Hold the lamp by the cylindrical glass body.

(2) Soak a cotton tipped applicator in methanol from MSA PID Sensor Cleaning Kit (P/N 10165248).

(3) Rub the soaked swab on the surface of the Lamp lens in a circular motion for 60 seconds.

(4) Repeat process with a dry cotton tipped applicator.
(5) Allow the lamp to dry for 30 minutes before proceeding with reassembly.

Cleanliness of the PID sensor is essential for optimum performance in high humidity and temperature environments.

Reassembly

(1) Place the lamp back in the sensor, making sure that the two metallized pads are aligned with the corresponding excitation springs inside the sensor cavity.

(2) Using a dry cotton tipped applicator, press the lamp down firmly to seat in the housing.
▷ Be careful not to scratch the lamp lens.

(3) With tweezers, reinstall the Cell Assembly. Align the three pins with the corresponding sockets on the sensor and press this edge with a dry cotton tipped applicator to seat the Cell Assembly. Make sure the Cell Assembly is flush with the Lamp lens.

(4) Place the Spacer back in the sensor housing, surrounding the Cell Assembly.

(5) Place both of the filters on top of the Cell Assembly. Make sure the Cotton Filter is installed first, followed by the Teflon Filter.
▷ The shiny side of the Teflon Filter should be on top.

US

(6) Align the Filter Cap key with the notch in the housing:
- ▷ Starting at the side opposite the notch, press down the Filter Cap until it snaps onto the housing.
- ▷ If the key is incorrectly aligned, there will be a noticeable bulge on the side of the cap.

Device Re-assembly

(1) Ensure all sensors are fully seated in the circuit board.
(2) Visually inspect the green gasket, assuring that it is seated properly in the front housing.
(3) Attach front case and tighten two case screws using 5.5 in-lbs of torque.
(4) Attach the battery pack and tighten the two battery pack screws using 5.5 in-lbs of torque.
(5) Turn on the device and verify all sensors are showing on the measuring page.
(6) **Calibrate the device and ensure that all sensors show successful calibration.**

Maintenance Procedure

Recommended Supplies

MSA PID Sensor Maintenance Kit P/N:10165247
- Cell Assembly
- Teflon Filter
- Cotton Filter
- Filter Cap
- Spacer
- Tweezers

MSA 10.6eV Lamp P/N: 10165272

Background Information

The sensor's rugged, durable design provides for trouble-free operation over the course of its lifetime. However, in certain conditions, maintenance may be required. This is customer required maintenance and is not covered under warranty.

Parts that may need cleaning or replacing over time include the UV Lamp, Cell Assembly, Teflon Filter, Cotton Filter, Cap, and Spacer. See *Recommended Supplies* section above.

Over time when the sensor is exposed to harsh chemicals or in a polluted environment, lamp window contamination can occur. This will degrade the sensor's performance. The contamination will block some of the UV light and decrease the sensors gain.

If several bump or calibration tests fail on the PID sensor, this is an indication that the lamp could be contaminated. Follow the Cleaning Procedure above.

US

PID Error States

PID Error States	Details	Recommended Action
Device Display		
`PID LAMP ERROR`	This error indicates that there is an error with the UV lamp in the PID sensor. Possible causes include: - lamp not installed - lamp not installed correctly - damaged lamp - non-functioning lamp. This test is functional at temperatures ≤ 30 °C	Complete a calibration. If the device fails calibration, the device should be shut down and cleaning procedure should be followed paying careful attention to the orientation of the lamp. If user is not in a location where the maintenance procedure can be followed, the PID sensor can be disabled through the security menu. This will allow other functioning sensors to continue working with the PID disabled. **NOTE**: The error may occur when installing a new PID sensor into the device. This is expected and the error will be cleared when the device is calibrated.
`PID SENSOR ERROR`	This is a fatal and non-recoverable error indicating a failure in the sensor.	Device should be shut down and sent to an authorized MSA repair center.
Calibration		
Fail	At the completion of the calibration sequence a Fail message is displayed. On Galaxy GX2, user can press the Calibration Details button to determine which sensor failed.	If PID sensor failed calibration, device should be reviewed and then calibration should be re-run. If PID calibration fails a second time, device should be shut down and the cleaning procedure should be followed.

When `PID LAMP ERROR` is displayed, it is required to carry out the following sensor maintenance procedure.

(1) Thoroughly review the PID sensor assembly and verify all components are present and installed correctly.

(2) If assembly is correct then follow the lamp cleaning procedure.

▷ For lamp cleaning instructions, refer to *Cleaning Procedure* section above.

(3) If the lamp is cleaned and a PID error still exists, replace the lamp.

(4) If the lamp is replaced and a PID error still exists, replace the cell assembly.

If error still exists, device should be sent to an authorized MSA repair center.

US

6 Technical Specifications

Weight	0.45 kg (1 lb.) - device with battery and clip
Dimensions (cm)	Length: 6.7 inches (169.9mm) Width: 3.5 inches (89.7mm) Height: 2.0 inches (51.4mm)
Alarms	LEDs, audible alarm, vibrating alarm
Volume of audible alarm	95 dBa at 30cm with fully charged battery, average
Display	Color
Battery types	Rechargeable Li ION battery
Charging time	≤ 6 hours The maximum safe area charging voltage Um = 6.7 Volts DC
Normal Temperature range	-10 °C to 40 °C (14 °F to 104 °F)
Extended Temperature range	-20 °C to 50 °C (-4 °F to 122 °F)
Humidity range	15 - 90 % relative humidity, non-condensing, 5 - 95 % RH intermittent
Atmospheric pressure range	80 kPa to 120 kPa (11.6 to 17.4 PSIA)
Ingress protection	IP 65
Measuring methods	Combustible gases - Catalytic sensor Oxygen and Toxic gases - Electrochemical sensor Volatile Organic Compounds - PID sensor
Warranty	See chapter 1.4

Measuring Range			
ClO_2	0-1.00 ppm	**NH_3**	0-100 ppm
Cl_2	0-10 ppm	**NO**	0-200 ppm
CO	0-2000 ppm	**NO_2 (S20)**	0-20.0 ppm
CO - HC	0-10,000 ppm	**NO_2 (XCell)**	0-50.0 ppm
Combustible	0-100 % LEL 0-5.00 % CH_4	**O_2**	0-30 % Vol.
H_2S	0-200 ppm	**PH_3**	0-5.00 ppm
H_2S - LC	0-100 ppm	**PID**	0-2000 ppm
HCN	0-30 ppm	**SO_2**	0-20.0 ppm

6.1 Factory-set Alarm Thresholds and Setpoints

Check the device or calibration certificate for exact alarm levels as they vary depending on national or corporate regulations.

US

Sensor	LOW alarm	HIGH alarm	SETPOINT min	SETPOINT max	STEL	TWA
CL_2	0.5 ppm	1.0 ppm	0.3 ppm	7.5 ppm	1.0 ppm	0.5 ppm
ClO_2	0.1 ppm	0.3 ppm	0.1 ppm	0.9 ppm	0.3 ppm	0.1 ppm
CO	25 ppm	100 ppm	10 ppm	1700 ppm	100 ppm	25 ppm
CO-HC	25 ppm	100 ppm	10 ppm	8500 ppm	100 ppm	25 ppm
COMB	10 % LEL	20 % LEL	5 % LEL	60 % LEL	--[1]	--[1]
H_2S	10 ppm	15 ppm	5 ppm	175 ppm	15 ppm	10 ppm
H_2S-LC	5 ppm	10 ppm	1 ppm	70 ppm	10 ppm	1 ppm
HCN	4.5 ppm	10.0 ppm	2.0 ppm	20.0 ppm	10 ppm	4.5 ppm
HCN	4.5 ppm	10.0 ppm	2.0 ppm	20.0 ppm	10.0 ppm	4.5 ppm
NH_3	25 ppm	50 ppm	10 ppm	75 ppm	35 ppm	25 ppm
NO	25 ppm	75 ppm	15 ppm	100 ppm	25 ppm	25 ppm
NO_2 (S 20)	2.0 ppm	5.0 ppm	1.0 ppm	17.5 ppm	5.0 ppm	2.0 ppm
NO_2 (XCell)	2.5 ppm	5.0 ppm	1.0 ppm	47.5 ppm	5.0 ppm	2.5 ppm
O_2	19.5 %	23.0 %	5.0 %	24.0 %	--[1]	--[1]
PH_3	0.3 ppm	1.0 ppm	0.3 ppm	3.75 ppm	1.0 ppm	0.3 ppm
SO_2	2.0 ppm	5.0 ppm	2.0 ppm	17.5 ppm	5.0 ppm	2.0 ppm
PID	50 ppm	100 ppm	2 ppm	1500 ppm	25 ppm	10 ppm

[1]STEL and TWA not applicable for combustible and oxygen gases.
In environments with >100 % LEL combustible gas present, devices with a catalytic combustible LEL sensor will be in a latching over-range alarm.

US

6.2 Performance Specifications

Sensor	Range	Resolution	Reproducibility	Response time
Combustible Gas	0 to 100 % LEL or 0 to 5 % CH_4	1 % LEL or 0.05 Vol % CH_4	Normal temp. range: <50 % LEL: 3 % LEL 50-100 % LEL: 5 % LEL <2.5 % CH_4: 0.15 % CH_4 2.5-5.00 % CH_4: 0.25 % CH_4 Extended temp. range: <50 % LEL: 5 % LEL 50-100% LEL: 8% LEL <2.5 % CH_4: 0.25 % CH_4 2.5-5.00 % CH_4: 0.40 % CH_4	t(90)< 15 sec (Pentane) (normal temp.) t(90)< 10 sec (Methane) (normal temp.)
Oxygen	0 – 30% O_2	0.1% O_2	0.7 % O_2 for 0 – 30 % O_2	t(90)< 10 sec (normal temp.)
Carbon Monoxide	0-2000 ppm CO	1 ppm CO	normal temperature range: ±5 ppm CO or 10 % of reading, whichever is greater	t(90)< 15 sec (normal temp.)
			extended temperature range: ±10 ppm CO or 20 % of reading, whichever is greater	
Hydrogen Sulfide	0-200 ppm H_2S	1 ppm H_2S, for 3 to 200 ppm H_2S	normal temperature range: ±2 ppm H_2S or 10 % of reading, whichever is greater	t(90)< 15 sec (normal temp.)
			extended temperature range: ±20 ppm H_2S or 20 % of reading, whichever is greater	

US

Additional Toxic Sensors

Sensor	Range (ppm)	Resolution (ppm)	Reproducibility		Nominal response
			Normal temperature range:	Extended temp. range:	
Cl_2 Clorine	0 - 10	0.05	±0.2 ppm or 10 % of reading, whichever is greater	±0.5 ppm or 20 % of reading, whichever is greater	t(90)< 30 s
ClO_2 Clorine dioxide	0 - 1	0.01	±0.1 ppm or 10 % of reading, whichever is greater	±0.2 ppm or 20 % of reading, whichever is greater	t(90)< 2 min
CO-HC Carbon Monoxide	0 - 10000	5	±5 ppm or 10 % of reading, whichever is greater	±10 ppm or 20 % of reading, whichever is greater	t(90)< 15 s
H_2S-LC Hydrogen Sulfide	0 - 100	0.1	±0.2 ppm or 10 % of reading, whichever is greater	±0.5 ppm or 20 % of reading, whichever is greater	t(90)< 15 s
HCN Hydrogen cyanide	0 - 30	0.5	±1 ppm or 10 % of reading, whichever is greater	±2 ppm or 20 % of reading, whichever is greater	t(90)< 30 s
NH_3 Ammonia	0 - 100	1	±2 ppm or 10 % of reading, whichever is greater	±5 ppm or 20 % of reading, whichever is greater	t(90)< 40 s
NO_2 Nitrogen dioxide (S 20)	0 - 20	0.1	±2 ppm or 10 % of reading, whichever is greater	±3 ppm or 20 % of reading, whichever is greater	t(90)< 40 s
NO_2 Nitrogen dioxide (XCell)	0 - 50	0.1	±1 ppm or 10 % of reading, whichever is greater	±2 ppm or 20 % of reading, whichever is greater	t(90)< 15 s
NO Nitric oxide	0 - 200	1	±5 ppm or 10 % of reading, whichever is greater	±10 ppm or 20 % of reading, whichever is greater	t(90)< 40 s
PH_3 Phosphine	0 - 5	0.05	±0.2 ppm or 10 % of reading, whichever is greater	±0.25 ppm or 20 % of reading, whichever is greater	t(90)< 30 s
SO_2 Sulfur dioxide	0 - 20	0.1	±2 ppm or 10 % of reading, whichever is greater	±3 ppm or 20 % of reading, whichever is greater	t(90)< 20 s
PID	0-2000	0.1 (0-999ppm) 1 (1000-2000ppm)	±5 ppm or 10 % of reading, whichever is greater	±10 ppm or 20 % of reading, whichever is greater	t(90)< 10 s

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6.3 Calibration Specifications

Sensor	Zero Gas	Zero Cal Value**	Span Cal Gas	Span Cal	
				Value	Time (min)
COMB Pentane	Fresh Air	0	1.45 % Vol Methane	58 % LEL	1
COMB Methane (0 - 5 % Vol)	Fresh Air	0	2.5 % Vol Methane	2,5 %	1
COMB Methane (4.4 % Vol)	Fresh Air	0	1.45 % Vol Methane	33 % LEL	1
COMB Propane (2.1 % Vol)	Fresh Air	0	1.45 % Vol Methane	46 % LEL	1
COMB Propane (1.7 % Vol)	Fresh Air	0	1.45 % Vol Methane	37 % LEL	1
COMB Butane (1.4 % Vol)	Fresh Air	0	1.45 % Vol Methane	46 % LEL	1
COMB Methane (5 % Vol)	Fresh Air	0	1.45 % Vol Methane	29 % LEL	1
COMB Hydrogen (4,0 % Vol)	Fresh Air	0	1.45 % Vol Methane	33 % LEL	1
O_2	Fresh Air	20.8 %	15 % O_2	15 %	1
CO	Fresh Air	0	60 ppm CO	60 ppm	1
H_2S	Fresh Air	0	20 ppm H_2S	20 ppm	1
SO_2	Fresh Air	0	10 ppm SO_2	10 ppm	1
Cl_2	Fresh Air	0	10 ppm Cl_2	10 ppm	2
NO	Fresh Air	0	50 ppm NO	50 ppm	4
NO_2	Fresh Air	0	10 ppm NO_2	10 ppm	2
NH_3	Fresh Air	0	25 ppm NH_3	25 ppm	2
PH_3	Fresh Air	0	0.5 ppm PH_3	0.5 ppm	1
HCN	Fresh Air	0	10 ppm HCN	10 ppm	4
*ClO_2	Fresh Air	0	2 ppm Cl_2	0.8 ppm	6
PID	Fresh Air	0	100 ppm isobutylene	100 ppm	1

Span values can be changed if using different gas cylinders than those listed. Changes can be made using MSA Link software and through calibration cylinder setup.

*For most accurate results, calibration with ClO_2 is recommended.

**Zero cal time is one minute if a catalytic combustible sensor is installed - 30 seconds if not.

LEL values, if not listed here, are according to EN 60079-20-1. Local regulations may differ.

6.4 Combustible Gas Cross Reference Factors for General-Purpose Calibration Using Calibration Cylinder (Part no. 10053022)

See the applicable addendum on the Product CD.

US

7 Certification

See device label for the certification that applies to your specific device.

USA and Canada

USA	
USA / NRTL (Intrinsic Safety, Non-Mining)	UL913 for Class I, Div. 1, Groups A, B, C and D -20 °C to +50 °C, T4
Canada	
Canada / CSA (Intrinsic Safety, Combustible Performance, Non-Mining)	CSA C22.2 No. 157 for Class I, Div. 1, Groups A, B, C and D CSA C22.2 No. 152 M1984 Combustible Performance Tamb = -20 °C to +50 °C, T4 for Intrinsic Safety Tamb = -20 °C to +50 °C, for Combustible Performance

7.1 Marking, Certificates and Approvals According to the Directive 94/9/EC (ATEX)

Manufacturer: Mine Safety Appliances Company, LLC
1000 Cranberry Woods Drive,
Cranberry Township,
PA 16066 USA

Product: **ALTAIR 5X PID/IR**

EC-Type Examination Certificate: FTZU 15 ATEX 0038X

Standards: EN 60079-0:2012, EN 60079-1:2014, EN 60079-11:2012
EN 60079-18:2009, EN 50303:2000

Marking:

I M1 Ex ia I Ma
I M1 Ex db ia I Ma - when MSH2ia sensor is installed

II 2G Ex db ia mb IIC T4 Gb
II 1G Ex ia IIC T4 Ga - when MSH2ia and XCell Ex sensor is not installed

-20 °C ≤ Ta ≤ +50 °C

Li-Ion Um 6,7 V DC
IP 65

Special Conditions:
The model ALTAIR 5X PID/IR shall be charged by Manufacturer's chargers only (0 - 45 °C) and opened in a non-hazardous area.
When using the ALTAIR 5X PID/IR in a hazardous area, the device should be be worn or carried on the body. Do not store the device in a hazardous location. This prevents the possibility of the device building up an electrostatic charge.
The antenna used for activation of the internal RFID tag with the RF radiation power shall not exceed 6 W for Group I and 2 W for Group IIC.
Capacitance:

D-Ring: 24pF
Charge contact pins: 17pF

US

Quality Assurance Notification:	0080
Year of Manufacture:	see Label
Serial Nr.:	see Label

7.2 Marking, Certificates and Approvals According to IECEx

Manufacturer:	Mine Safety Appliances Company, LLC 1000 Cranberry Woods Drive, Cranberry Township, PA 16066 USA
Product:	**ALTAIR 5X PID/IR**
IECEx-Type Examination Certificate:	IECEx FTZU 15.0009X
Type of protection:	IEC 60079-0:2011, IEC 60079-1:2014, IEC 60079-11:2011 IEC 60079-18:2009
Performance	none
Marking:	Ex ia I Ma Ex ia IIC T4 Ga , when combustible XCell sensor is not installed Ex d ia mb IIC T4 Gb -20 °C ≤ Ta ≤ +50 °C
Li-Ion	Um ≤ 6,7 V DC IP65

Special Conditions:
The model ALTAIR 5X PID/IR shall be charged by Manufacturer's chargers only (0 - 45 °C) and opened in a non-hazardous area.
When using the ALTAIR 5X PID/IR in a hazardous area, the device should be be worn or carried on the body. Do not store the device in a hazardous location. This prevents the possibility of the device building up an electrostatic charge.
The antenna used for activation of the internal RFID tag with the RF radiation power shall not exceed 6 W for Group I and 2 W for Group IIC.
Capacitance:

D-Ring:	24pF
Charge contact pins:	17pF

Quality Assurance Notification:	0080
Year of Manufacture:	see Label
Serial Nr.:	see Label

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8 XCell Sensor Patents

SENSOR	PART NO.	PATENT STATUS
Combustible	10106722	US8826721
Oxygen	10106729	US8790501
Carbon Monoxide / Hydrogen Sulfide	10106725	US8790501, US8702935
Ammonia	10106726	US8790501, US8623189
Chlorine	10106728	US8790501, US8623189
Sulphur Dioxide	10106727	US8790501, US8623189

9 Ordering Information

9.1 US

Gas Cylinder Parts List

		MSA P/N		
Gases	**Gases Mix**	**ECONO-CAL (34 L)**	**RP (58 L)**	**Recommended CAL Gas for:**
1	100ppm isobutylene	10048279	494450	0-2000 ppm PID
1	10 ppm NO2 in Air	711068	808977	NO2 sensor
1	10 ppm SO2 in Air	711070	808978	SO2 sensor
1	25 ppm NH3 in N2	711078	814866	NH3 sensor
1	10 ppm Cl2 in N2	711066	806740	Cl2 sensor
1	2 ppm Cl2 in N2	711082	10028080	ClO2 sensor
1	10 ppm HCN in N2	711072	809351	HCN sensor
1	0.5 ppm PH3 in N2	711088	710533	PH3 sensor
3	1.45 % CH4, 15.0 % O2, 20 ppm H2S	10048790	10048788	
3	2.50 % CH4, 15.0 % O2, 20 ppm H2S	10048888	10048889	
3	1.45 % CH4, 15.0 % O2, 60 ppm CO	10048789	478191(100L)	
3	2.50 % CH4, 15.0 % O2, 60 ppm CO	10049056	813718 (100L)	
4	1.45 % CH4, 15.0 % O2, 60 ppm CO, 10 ppm NO2	10058036	10058034	
4	1.45 % CH4, 15.0 % O2, 60 ppm CO, 20 ppm H2S	10048280	10045035	
4	2.50 % CH4, 15.0 % O2, 60 ppm CO, 20 ppm H2S	10048981	10048890	
4	2.50 % CH4, 15.0 % O2, 60 ppm CO, 10 ppm NO2	10058172	10058172	
5	1.45 % CH4, 15.0 % O2, 60 ppm CO, 20 ppm H2S, 10 ppm SO2	10098855	10117738	SO2 sensor

9.2 Outside US

Description	Part No.
Gas	
Cylinder 34L, 60 ppm CO	10073231
Cylinder 34L, 40 ppm H_2S	10011727
Cylinder 34L, 25 ppm NH_3	10079807
Cylinder 34L, 10 ppm Cl_2	10011939
Cylinder 34L, 10 ppm SO_2	10079806
Cylinder 34L, 10 ppm NO_2	10029521
Cylinder 34L, 0.5 ppm PH_3	10029522
Cylinder 34L, 2 ppm Cl_2 (To calibrate ClO_2 sensor)	711082
Cylinder 34L, 10 ppm HCN	711072
Cylinder 34L, 100 ppm Isobutylene	10169196
Calibration Cylinder 58L (1.45 % CH_4, 15.0 % O_2, 60 ppm CO, 20 ppm H_2S)	10053022
Calibration Cylinder 58L (1.45 % CH_4, 15.0 % O_2, 60 ppm CO, 20 ppm H_2S)	10045035
Cylinder 34L, 50 ppm NO	10126429
Cylinder 58L (0,4 % Propane, 15 % O2, 60 ppm CO, 20 ppm H2S)	10086549
Cylinder 34L (1.45 % CH4, 15 % O2, 60 ppm CO, 20 ppm H2,S, 10 ppm SO2,)	10122425
Cylinder 58L (1.45 % CH4, 15 % O2, 60 ppm CO, 20 ppm H2,S, 10 ppm SO2,)	10122426

9.3 Accessories

Description	Part No.
Universal Demand Regulator kit	10034391
MSA Link USB dongle	10082834
MSA Link Datalogging Software	10088099
Shoulder Strap	474555
Retractable Line with Belt Clip	10050976
Holster, leather	10099648
Sampling Probe, flexible 30 cm, conductive	10103191
Sampling Line, 1,5 m, conductive	10103188
Sampling Line, 3 m, conductive	10103189
Sampling Line, 5 m, conductive	10103190
Sampling Line, 20 m, conductive	10159430
Sampling Line, 30 m, conductive	10159431
Sampling System w/floating probe, 5 m, PU conductive	10082307
Probe, 1 ft. straight PEEK	10042621
Probe, 3 ft. straight PEEK	10042622
Polyurethane Sample Line, 10 ft.	10040665

Description	Part No.
Polyurethane Sample Line, 25 ft.	10040664
Polyurethane Sample Line, 3 ft. Coiled	10040667
(Cl2, ClO2, NH3) 5 ft.PU Coiled Sample line & probe, kit	10105210
(Cl2, ClO2, NH3) 5 ft. PU Sample line & probe, kit	10105251
(Cl2, ClO2, NH3) 10 ft. Teflon Sample line & probe, kit	10105839
Replacement Filters for probe, 10 pack	801582
Charger only (North America)	10087913
Charger only (Global version)	10092936
Charging Cradle with Barrier- (North America)	10093055
Charging Cradle - (North America)	10093054
Charging Cradle (Europe)	10093057
Charging Cradle (Australia)	10093056
Vehicle Charger Cradle	10099397
Cradle Only - (no charger)	10093053
ALTAIR 5/5X Multi-Unit Charger, 4 Unit (North American)	10127427
ALTAIR 5/5X Multi-Unit Charger, 4 Unit (Europe)	10127428
ALTAIR 5/5X Multi-Unit Charger, 4 Unit (UK)	10127429
ALTAIR 5/5X Multi-Unit Charger, 4 Unit (Australia)	10127430
ALTAIR 5/5X Multi-Unit Charger, 4 Unit No Power Cord	10128704
Carrying Case	10152079

Please note that not all accessories are available in every local market. Check availability with the local MSA representative .

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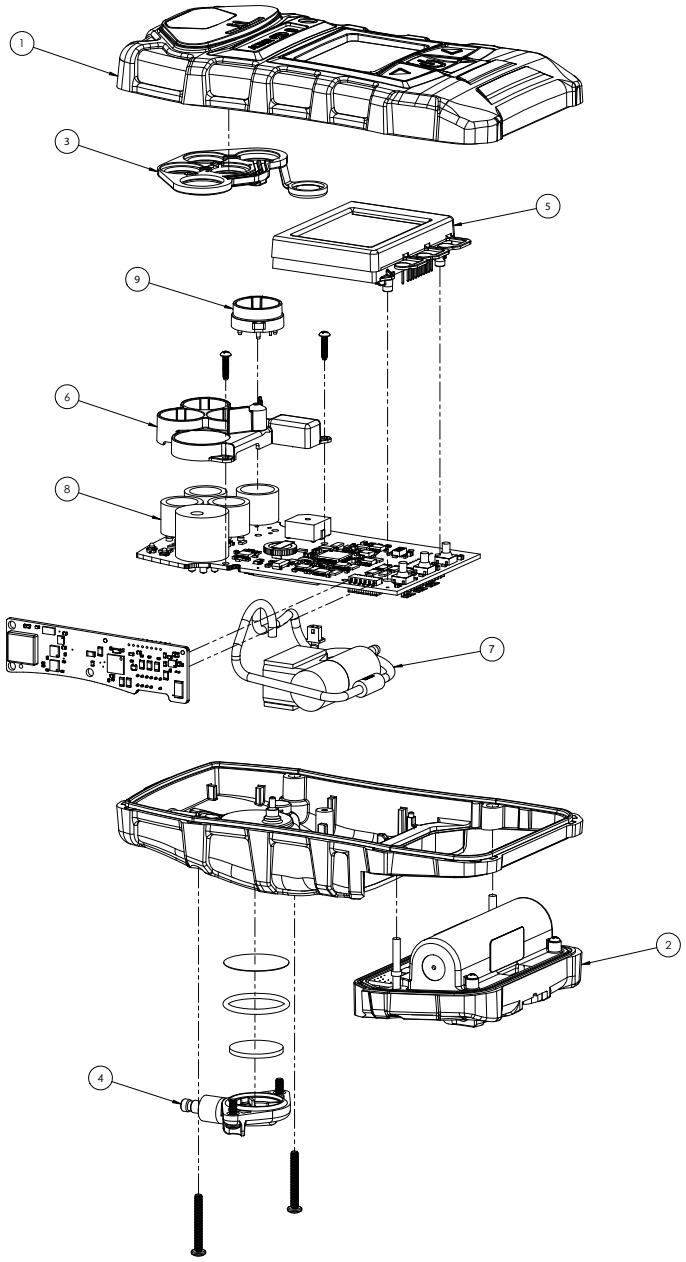
Replacement Parts



No.	Description	Part No.
1	Case Assembly, Front w/ Bluetooth, ALTAIR 5X PID	10165249
2	Battery Pack, Rechargeable, North America, ALTAIR 5X IR	10114839
	Battery Pack, Rechargeable, EU/Aus, ALTAIR 5X IR	10114851
3	Kit, PID Sensor, Maintenance (Cell Assembly, Cap, Spacer, Filters, Tweezers)	10165247
	Kit, PID Sensor, Cleaning (Filters, Tweezers, Methanol & Cotton Applicators)	10165248
	Kit, Instrument Maintenance, ALTAIR 5X PID (Filters, O-ring, Screws, Gasket)	10165285
	Kit, Instrument Maintenance, Reactive (Cl2, ClO2, NH3), ALTAIR 5X PID (Filters, O-ring, Screws, Gasket)	10165284
4	Filter Cover Assembly, ALTAIR 5X PID	10165275
5	Color Display Assembly, ALTAIR 5X	10148366-SP
6	Sensor Bracket and Vibe Motor Assembly, ALTAIR 5X PID	10165273
7	Pump Assembly, ALTAIR 5X PID	10165274
8	Sensor, HCN (Series 20)	10106375
	XCell Sensor, Cl_2	10106728
	Sensor, ClO_2 (Series 20)	10080222
	XCell Sensor, SO_2	10106727
	Sensor, NO_2 (Series 20)	10080224
	XCell Sensor, NH_3	10106726
	Sensor, PH_3 (Series 20)	10116638
	XCell Sensor, COMB	10106722
	XCell Sensor, O_2	10106729
	XCell Sensor, CO	10106724
	XCell Sensor, H2S	10106723
	XCell Sensor, CO-H_2S, Two-Tox	10106725
	XCell Sensor, CO/ NO_2	10121217
	XCell Sensor, CO-HC	10121216
	XCell Sensor, H_2S-LC/CO	10121213
	XCell Sensor, CO-H_2 Res/H_2S	10121214
	Sensor, NO (Series 20)	10114750
	XCell Sensor plug	10105650
	20 mm sensor plug	10088192
	Sensor, PID, 0-2000ppm	10165271
	Lamp, PID Sensor, 10.6eV	10165272
9	X Cell Adapter Socket	10110183

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10 PID Response Factor Table

WARNING

VOC Response factors apply in the 0-500 ppm range. The values in this table were obtained using dry bottled gases at room temperature. The response factors may change at higher concentrations, different temperature and humidity conditions, or with cleanliness of lamp. For increased accuracy at different ambient conditions or concentrations, determine a custom response factor and enter it via the Custom Gas page; see Chapter XX, Custom Gas Setup. These response factors are specific to the energy of the lamp designated in the table. They are not valid for devices using PID lamps at any other energy. Using these response factors with a lamp at any other energy may critically compromise the device's ability to detect volatile organic compounds which can result in serious personal injury or death.

WARNING

Use of Altair5X PID for detection of extremely toxic gases:

The system resolution limit of the Altair5X PID in normal mode (with a new, clean lamp) is approximately 0.1 ppm isobutylene equivalent. Users must be aware of exposure limit guidelines, such as TLV, for the target compound. Do not use the Altair5X PID Detector if the exposure limit for the target compound is below 0.1 ppm. Failure to follow this warning can cause over-exposure, which can result in serious personal injury or death.

For any compound, its exposure limit guideline can be recalculated in terms of equivalent ppm isobutylene by dividing the exposure limit guideline by the appropriate response factor. Example: For butyl acetate (CAS 123-86-4), the recommended threshold limit value (as TWA) is 150 ppm. Its response factor (10.6 eV lamp) is 2.4. The TLV for butyl acetate, in terms of equivalent ppm isobutylene is: 150 ppm ÷ 2.4 = 62.5 ppm isobutylene equivalent.

WARNING

The ALTAIR 5X PID Detector has a reproducibility of ±2 ppm(± 2000 ppb) or 10%, whichever is greater (see table in chapter 6.2).The user must account for this potential variation between the displayed value and the actual concentration when setting alarms and interpreting readings. Failure to comply with this warning can cause over-exposure and result in serious personal injury or death.

Gases with very high response Factors (RF):

The Altair5X PID is a very versatile solution for monitoring many different gases and vapors. In addition to the pre-programmed list provided in the Altair5X PID device, users can determine response factors for many other compounds (see Section X). The maximum response factor value that will be accepted by the Altair5X PID device is 39.99.

WARNING

Use the correct lamp when determining the response factor. Failure to apply the appropriate response factors can result in inaccurate readings, and serious injury or death can occur.

Contact MSA Customer Service at 1-800-MSA-2222 with any question regarding the above information.

COMPOUND NAME	Display Name	Synonym(s)	CAS Number[1]	Chemical Formula	Ioniza-tion Potential	RF 10.6eV lamp
acetaldehyde	ETHANAL		75-07-0	C2H4O	10.23	10.8
acetone	ACETONE	2-Propanone	67-64-1	C3H6O	9.71	1.2
acetophenone	ACETPHEN		98-86-2	C8H8O	9.28	0.59

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COMPOUND NAME	Display Name	Synonym(s)	CAS Number[1]	Chemical Formula	Ioniza-tion Potential	RF 10.6eV lamp
acrolein	ACROLEIN		107-02-8	C3H4O	10.1	3.9
allyl alcohol	PROPENOL		107-18-6	C3H6O	9.67	2.5
ammonia	AMMONIA		7664-41-7	NH3	10.16	9.4
amyl acetate	AMYLACET	mix of n-Pentyl acetate & 2-Methylbutyl acetate	628-63-7	C7H14O2		3.5
arsine	ARSINE	Arsenic trihydride	7784-42-1	AsH3	9.89	2.6
benzene	BENZENE		71-43-2	C6H6	9.25	0.53
bromoform	BRFORM	Tribromomethane	75-25-2	CHBr3	10.48	2.3
bromomethane	MEBR	Methyl bromide	74-83-9	CH3Br	10.54	1.8
butadiene	BUTADIEN	1,3-Butadiene, Vinyl ethylene	106-99-0	C4H6	9.07	0.69
butanol, 1-	BUTANOL	Butyl alcohol, n-Butanol	71-36-3	C4H10O	9.99	3.4
butoxyethanol, 2-	BTOXETOH	Butyl Cellosolve, Ethylene glycol monobutyl ether	111-76-2	C6H14O2	<10	1.3
butyl acetate	BTYLACET		123-86-4	C6H12O2	10	2.4
butyl alcohol, tert-	TBUOH	tert-Butanol, t-Butyl alcohol, t-butanol	75-65-0	C4H10O	9.9	3.4
butyl mercaptan, tert-	TBUMRCAP	1-Butanethiol	109-79-5	C4H10S	9.14	0.55
butylamine, tert-	TBUAMINE	Butylamine, t-	75-64-9	C4H11N	8.5	0.71
carbon disulfide	CS2		75-15-0	CS2	10.07	1.2
chlorobenzene	CLBNZ	Monochloroben-zene	108-90-7	C6H5Cl	9.06	0.4
cumene	CUMENE	Isopropylbenzene	98-82-8	C9H12	8.73	0.54
cyclohexane	CYCHEXAN		110-82-7	C6H12	9.86	1.5
cyclohexanone	CYCHEXON		108-94-1	C6H10O	9.14	0.82
decane	DECANE		124-18-5	C10H22	9.65	1.6
Diacetone alcohol	PYRATON	4-Methyl-4-hydroxy-2-pentanone	123-42-2	C6H12O2	9.50	0.55
dibromoethane, 1,2-	EDB	EDB, Ethylene dibromide, Ethylene bromide	106-93-4	C2H4Br2	10.37	11.7
dichlorobenzene, 1,2-	O-DCLBNZ	dichlorobenzene, o-	95-50-1	C6H4Cl2	9.08	0.5

COMPOUND NAME	Display Name	Synonym(s)	CAS Number[1]	Chemical Formula	Ioniza-tion Potential	RF 10.6eV lamp
Dichloroethene, trans-1,2-	DCETHENE	t-1,2-DCE, trans-Dichloroethylene	156-60-5	C2H2Cl2	9.65	0.45
diesel fuel #1	DIESEL		68334-30-5	m.w. 226		0.9
diesel fuel #2	DIESEL		68334-30-5	m.w. 216		0.75
diethylamine	DEA		109-89-7	C4H11N	8.01	1
dimethoxymethane	METHYLAL	Methlylal	109-87-5	C3H8O2	10	11.3
dimethyl disulfide	DMDS	DMDS	624-92-0	C2H6S2	7.4	0.3
dimethylacetamide, n,n-	DMA	DMA	127-19-5	C4H9NO	8.81	0.73
dimethylformamide, n,n-	DMF	DMF	68-12-2	C3H7NO	9.13	0.8
dioxane, 1,4-	DIOXANE		123-91-1	C4H8O2	9.19	1.4
epichlorhydrin	EPCLHYD	ECH Chloromethy-loxirane, 1-chloro2,3-epoxy-propane	106-89-8	C2H5ClO	10.2	7.6
ethanol	ETHANOL	Ethyl alcohol	64-17-5	C2H6O	10.47	10
ethyl acetate	ETACET	Acetic ether; Ethyl acetic ester; Ethyl ethanoate	141-78-6	C4H8O2	10.01	4.2
ethyl acetoacetate	EAA		141-97-9	C6H10O3		0.9
ethyl acrylate	ETHYLACR		140-88-5		<10.3	2.3
ethyl ether	ETETHER	Diethyl ether	60-29-7	C4H10O	9.51	1.2
ethyl mercaptan	ETMERCAP	Ethanethiol	75-08-1	C2H6S	9.31	0.6
ethylbenzene	ETBNZE		100-41-4	C8H10	8.77	0.51
ethylene	ETHYLENE	ethene	74-85-1	C2H4	10.51	10.1
ethylene glycol	ETGLYCOL	1,2-Ethanediol	107-21-1	C2H6O2	10.16	15.7
ethylene oxide	ETOXIDE	Oxirane, Epox-yethane	75-21-8	C2H4O	10.57	19.5
gasoline (summary hydrocarbons)	GASOLINE		8006-61-9	m.w. 72		1.1
heptane	HEPTANE		142-82-5	C7H16	9.92	2.5
hexane, n-	HEXANE		110-54-3	C6H14	10.13	4.5
hydrazine	HYDRAZINE		302-01-2	H4N2	8.1	2.6
hydrogen sulfide	H2S		7783-06-04	H2S	10.45	3.2
isoamyl acetate	IAMYACET	Isopentyl acetate	123-92-2	C7H14O2	<10	1.8
isobutanol	IBUTANOL	2-Methyl-1-propanol	78-83-1	C4H10O	10.02	4.7

COMPOUND NAME	Display Name	Synonym(s)	CAS Number[1]	Chemical Formula	Ioniza-tion Potential	RF 10.6eV lamp
isobutene	ISOBUTYL	Isobutylene, Methyl butene	115-11-7	C4H8	9.22	1
isobutyl acetate	IBUACET	2-methylpropyl acetate, β-methylpropyl ethanoate	110-19-0	C6H12O2	9.97	2.6
isooctane	IOCTANE	2,2,4-Trimethyl-pentane	540-84-1	C8H18	9.86	1.3
isopentane	ISOPENT	2-Methylbutane	78-78-4	C5H12	10.32	8
isophorone	IPHORNE		78-59-1	C9H14O	9.07	0.74
isoprene	ISOPRENE	2-Methyl-1,3-buta-diene	78-79-5	C5H8	8.86	0.6
isopropanol	IPA	Isopropyl alcohol, 2-propanol, IPA	67-63-0	C3H8O	10.12	5.6
isopropyl acetate	ISOPRACE		108-21-4		9.99	2.6
isopropyl ether	IPROETHR	Diisopropyl ether	108-20-3	C6H14O	9.2	0.8
isopropylamine	2PRAMINE		75-31-0	C3H9N	8.6	0.9
Jet A fuel	JETA(A1)	F-34, Kerosene type aviation fuel	8008-20-6	m.w. 145		0.4
JP-5 fuel	JP5	Jet 5, F-4 4, Kero-sene type aviation fuel	8008-20-6	m.w. 167		0.48
JP-8 fuel	JP8	F-34, Kerosene type aviation fuel	8008-20-6	m.w. 165		0.48
mesityl oxide	MSTYLOXD		141-79-7	C6H10O	9.1	0.47
methoxyethanol, 2-	MEOXETOH	Methyl cellosolve, Ethylene glycol monomethyl ether	109-86-4	C3H8O2	10.1	2.5
methyl acetate	MEACET		79-20-9	C3H6O2	10.27	7
methyl acetoacetate	MEACACET		105-45-3	C5H8O3	9.82	1.1
methyl acrylate	MEACRYLT	Methyl 2-propenoate, Acrylic acid methyl ester	96-33-3	C4H6O2	9.9	3.4
methyl benzoate	MEBNZOTE		93-58-3	C8H8O2	9.32	0.93
methyl ethyl ketone	MEK	MEK, 2-Butanone	78-93-3	C4H8O	9.51	0.9
methyl isobutyl ketone	MIBK	MIBK, 4-Methyl-2-pentanone	108-10-1	C6H12O	9.3	1.1
methyl mercaptan	METHMERC	Methanethiol	74-93-1	CH4 S	9.44	0.6
methyl methacrylate	MEMEACRY		80-62-6	C5H8O2	9.7	1.5

COMPOUND NAME	Display Name	Synonym(s)	CAS Number[1]	Chemical Formula	Ioniza-tion Potential	RF 10.6eV lamp
methyl tert-butyl ether	MTBE	MTBE, tert-Butyl methyl ether	1634-04-4	C5H12O	9.24	0.86
methylamine	MEAMINE	Aminomethane	74-89-5	CH5N	8.97	1.2
methylbenzyl alcohol, 4-	MEBNZOL		589-18-4	C8H10O		0.8
naphthalene	NAPHTH	Mothballs	91-20-3	C10H8	8.13	0.37
nitric oxide	NO		10102-43-9	NO	9.26	7.2
nitrogen dioxide	NO2		10102-44-0	NO2	9.59	10
nonane, n-	NONANE		111-84-2	C9H20	9.71	1.6
octane	OCTANE		111-65-9	C8H18	9.82	2.2
pentane, n-	PENTANE		109-66-0	C5H12	10.35	9.7
pentanone, 2-	PENT2ONE	MPK, 2-Pentanone, Methyl propyl ketone	107-87-9	C5H10O	9.38	0.78
phenol	PHENOL	Hydroxybenzene	108-95-2	C6H6O	8.51	1
phosphine	PHOSPHIN		7803-51-2	PH3	9.87	2.8
picoline, 2-	2PICOLIN		109-06-8	C6H7N	9.23	0.57
picoline, 3-	3PICOLIN	3-Methylpyridine	108-99-6	C6H7N	9.04	0.9
pinene, alpha	PINENEA		80-56-8		8.07	0.4
pinene, beta	PINENEB		127-91-3			0.4
propanol, 1-	PROPANOL		71-23-8	C3H8O	10.22	5.7
propionaldehyde	PROPANAL	Propanal	123-38-6	C3H6O	9.96	14.8
propyl acetate, n-	PRACETAT		109-60-4		9.98	3.1
propylene	PROPENE	Propene	115-07-1	C3H6	9.73	1.3
Propylene glycol methyl ether	MEOXPROP	PGME, 1-methoxy-2-propanol	107-98-2	C4H10O2	9.54	1.4
propylene oxide	PROPLYOX	Methyloxirane	75-56-9	C3H6O	10.22	6.5
pyridine	PYRIDINE		110-86-1	C5H5N	9.25	0.79
quinoline	QUNOLINE		91-22-5		8.63	0.72
styrene	STYRENE		100-42-5	C8H8	8.47	0.4
tetrachloroethylene	PERC	PCE, Perchlo-roethylene, Tetra-chloroethylene, Perchloroethene	127-18-4	C2Cl4	9.32	0.56
tetrahydrofuran	THF	THF	109-99-9	C4H8O	9.41	1.6
thiophene	THIOLE		110-02-1		8.86	0.47
toluene	TOLUENE	Methylbenzene	108-88-3	C7H8	8.82	0.53

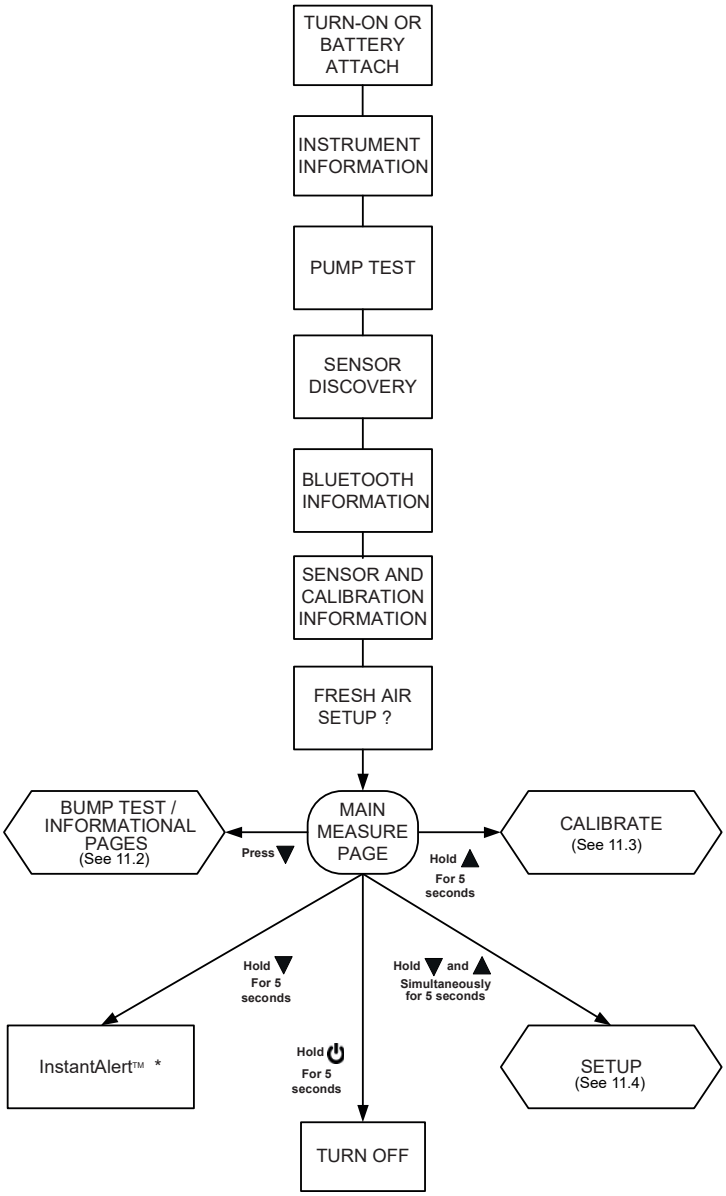
COMPOUND NAME	Display Name	Synonym(s)	CAS Number[1]	Chemical Formula	Ioniza-tion Potential	RF 10.6eV lamp
trichloroethylene	TCE		79-01-6		9.47	0.5
trimethylamine	TEN	TEN	121-44-8	C6H15N	7.53	0.83
trimethylbenzene, 1,2,3-	123MEBNZ		526-73-8	C9H12	8.42	0.49
trimethylbenzene, 1,2,4-	124MEBNZ		95-63-6	C9H12	8.27	0.43
trimethylbenzene, 1,3,5-	135MEBNZ		108-67-8	C9H12	8.4	0.34
turpentine - crude sulfite	TURPS-CS	Pinenes (85%) + other diisoprenes	8006-64-2	C10H16		1
turpentine - pure gum	TURPS-PG	Pinenes (85%) + other diisoprenes	8006-64-2	C10H16		0.45
vinyl acetate	VNYLACET		108-05-4	C4H6O2	9.19	1.3
vinyl bromide	VBRM	Bromoethylene	593-60-2	C2H3Br	9.8	0.4
vinyl chloride	VCM	Chloroethylene, VCM	75-01-4	C2H3Cl	9.99	1.8
vinylcyclohexane	VYLCYHEX	VCH	695-12-5	C8H14	9.51	0.54
vinylidene chloride	VDC	1,1-DCE, dichlo-roethene, 1,1-	75-35-4	C2H2Cl2	9.81	0.8
xylene, m-	M-XYLENE	1,3-Dimethylben-zene	108-38-3	C8H10	8.56	0.53
xylene, o-	O-XYLENE	1,2-Dimethylben-zene	95-47-6	C8H10	8.56	0.54
xylene, p-	P-XYLENE	1,4-Dimethylben-zene	106-42-3	C8H10	8.44	0.5

[1] The CAS Number is a unique numerical identifier created and assigned to a chemical substance by the American Chemical Society. All Rights Reserved.

US

11 Flow Charts

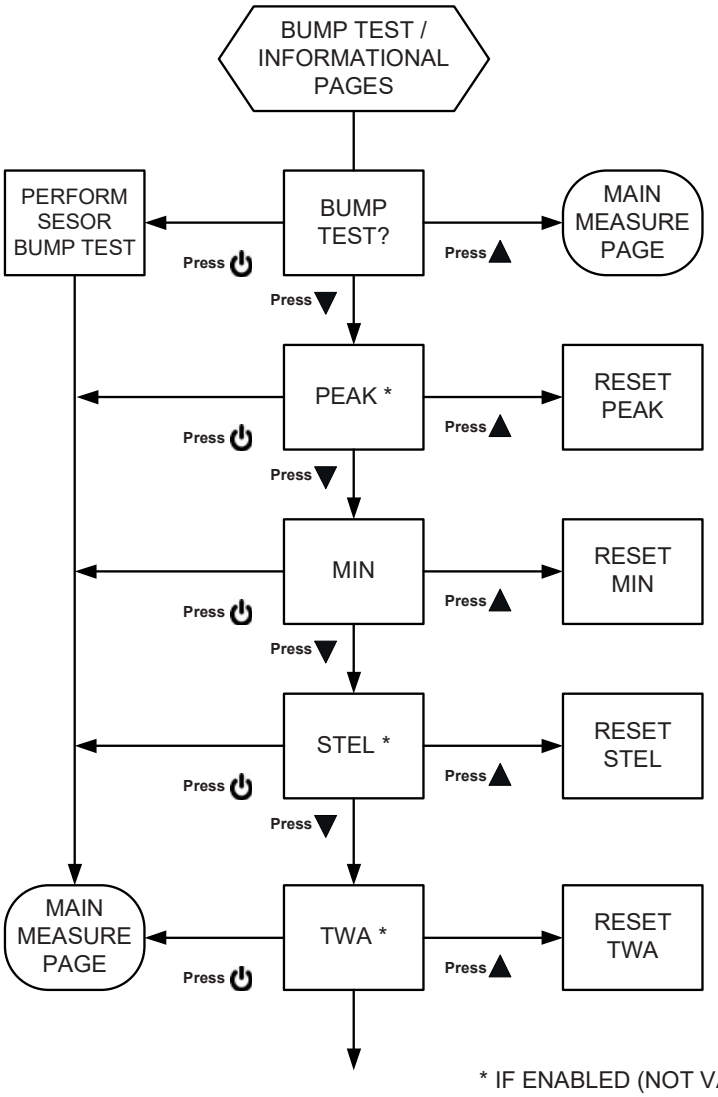
11.1 Basic Operation



* IF ENABLED

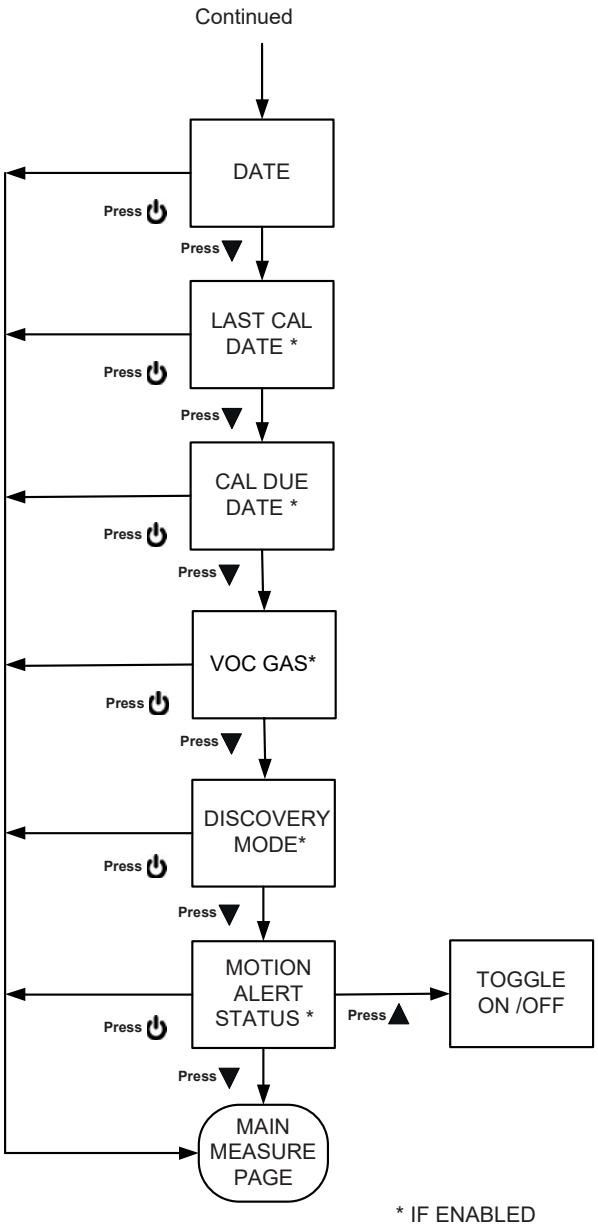
US

11.2 Bump Test/ Informational Pages



* IF ENABLED (NOT VALID FOR ALL SENSORS)

US

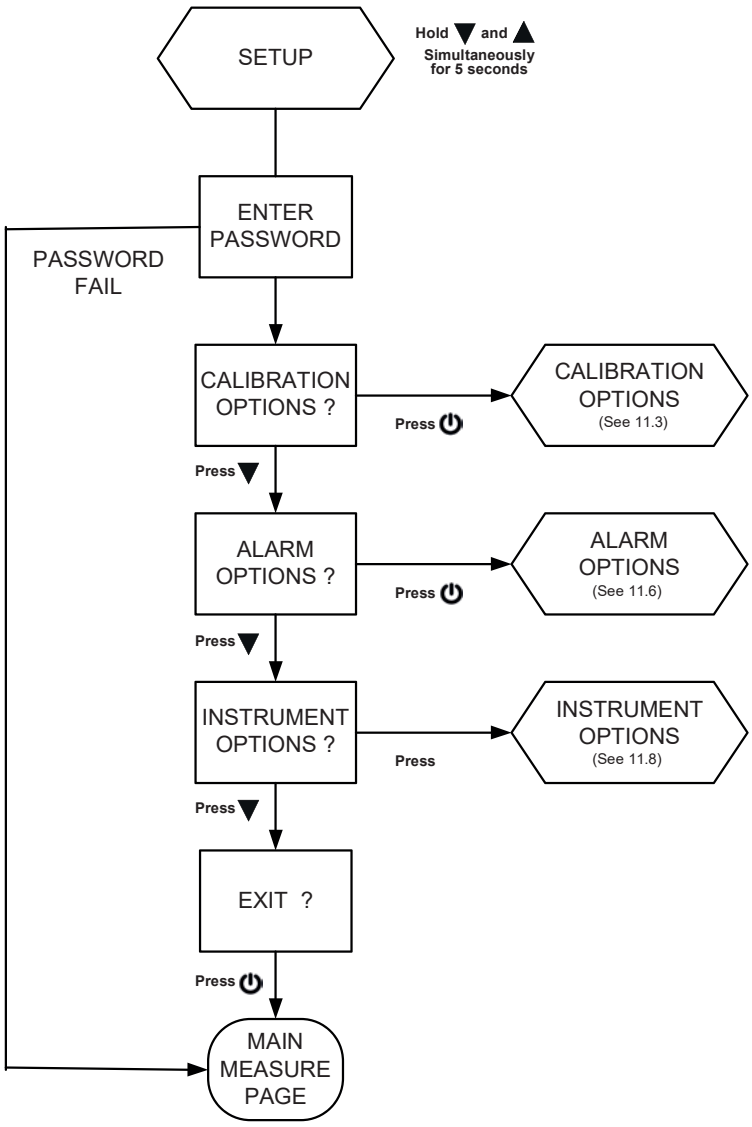


* IF ENABLED

** IF WIRELESS IS INSTALLED

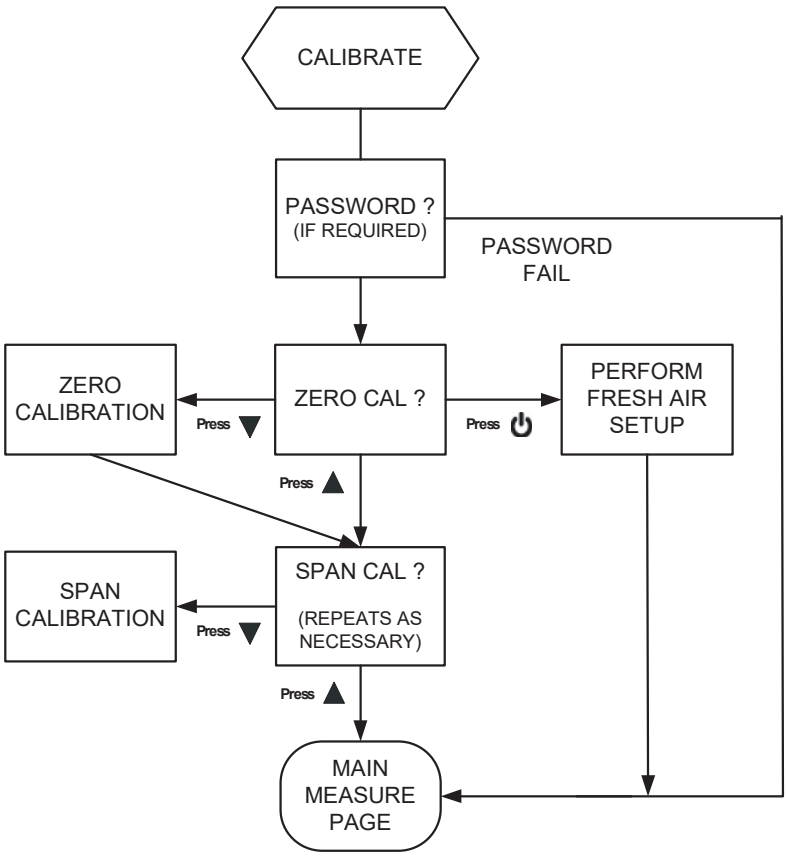
US

11.3 Setup


SETUP
Hold ▼ and ▲
Simultaneously
for 5 seconds
ENTER
PASSWORD
PASSWORD
FAIL
CALIBRATION
OPTIONS ?
Press
CALIBRATION
OPTIONS
(See 11.3)
Press ▼
ALARM
OPTIONS ?
Press
ALARM
OPTIONS
(See 11.6)
Press ▼
INSTRUMENT
OPTIONS ?
Press
INSTRUMENT
OPTIONS
(See 11.8)
Press ▼
EXIT ?
Press
MAIN
MEASURE
PAGE

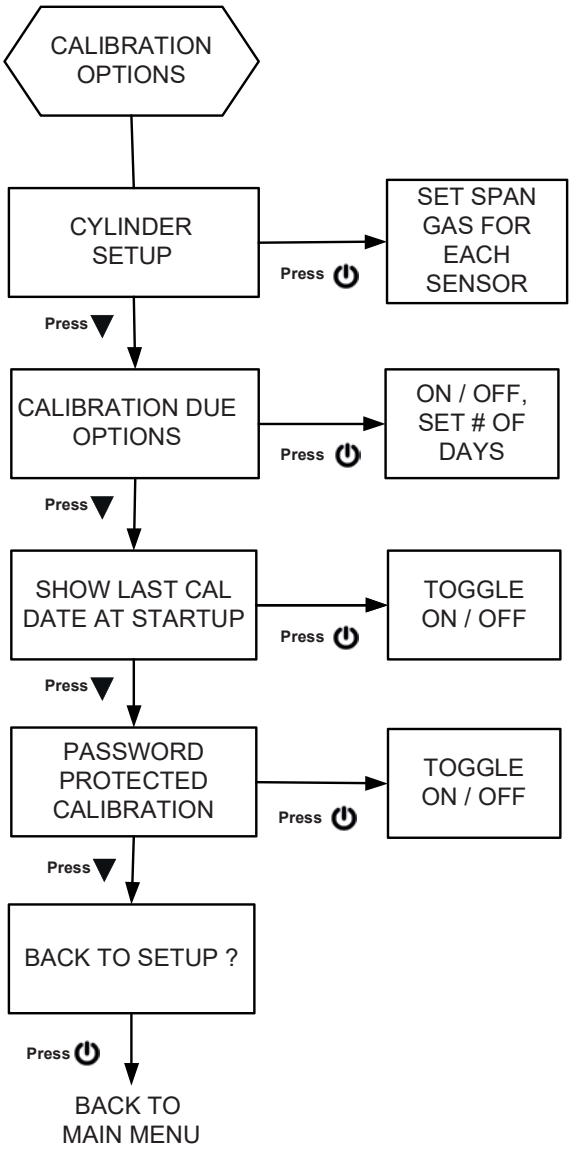
US

11.4 Calibrations



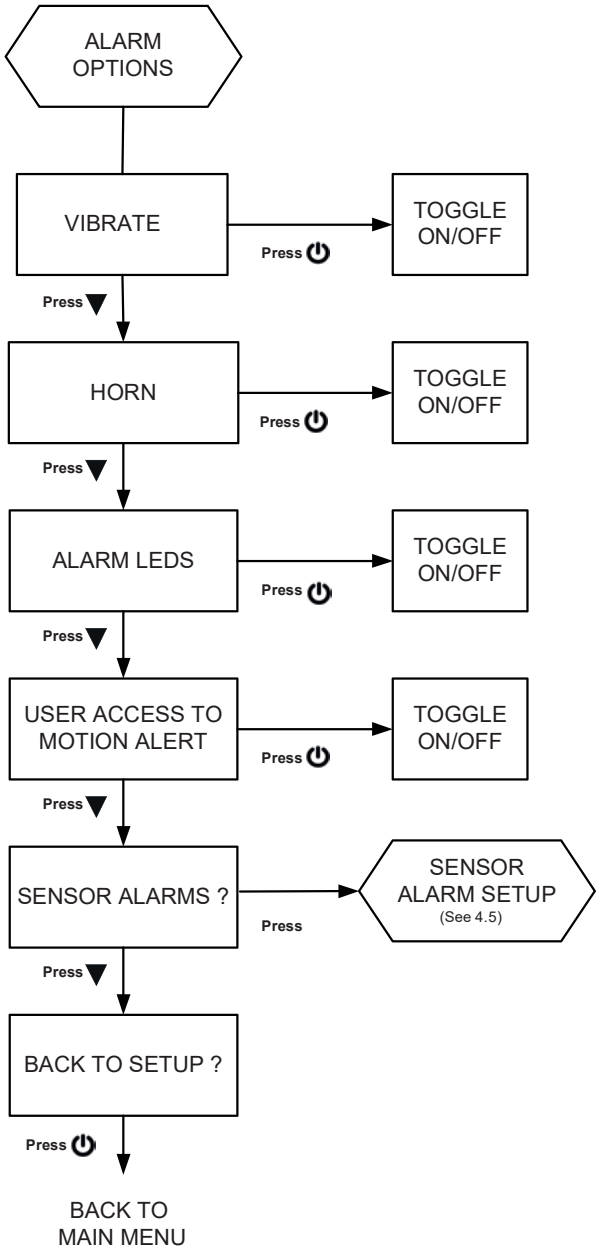
US

11.5 Calibration Options



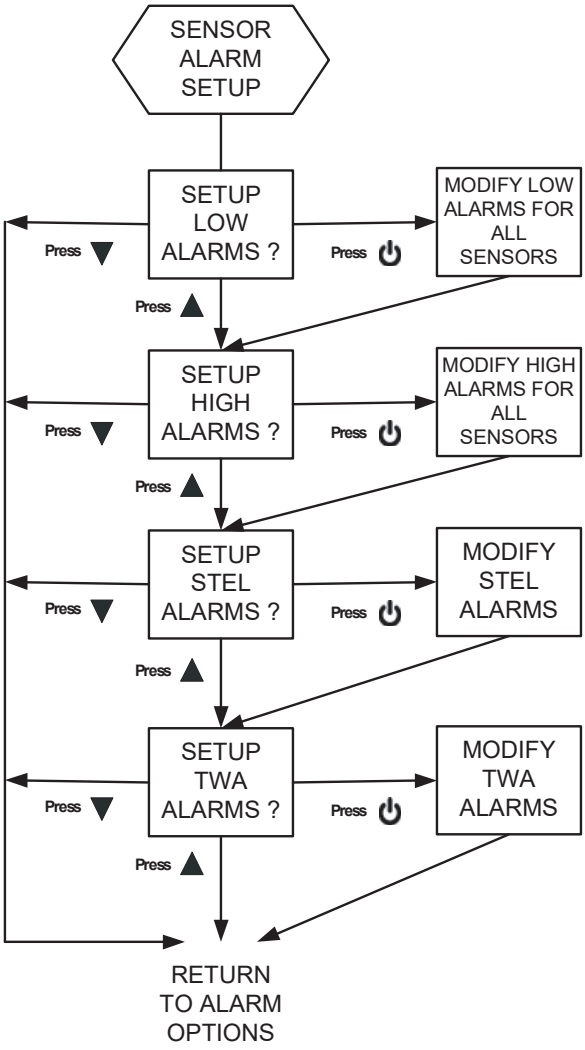
US

11.6 Alarm Options



US

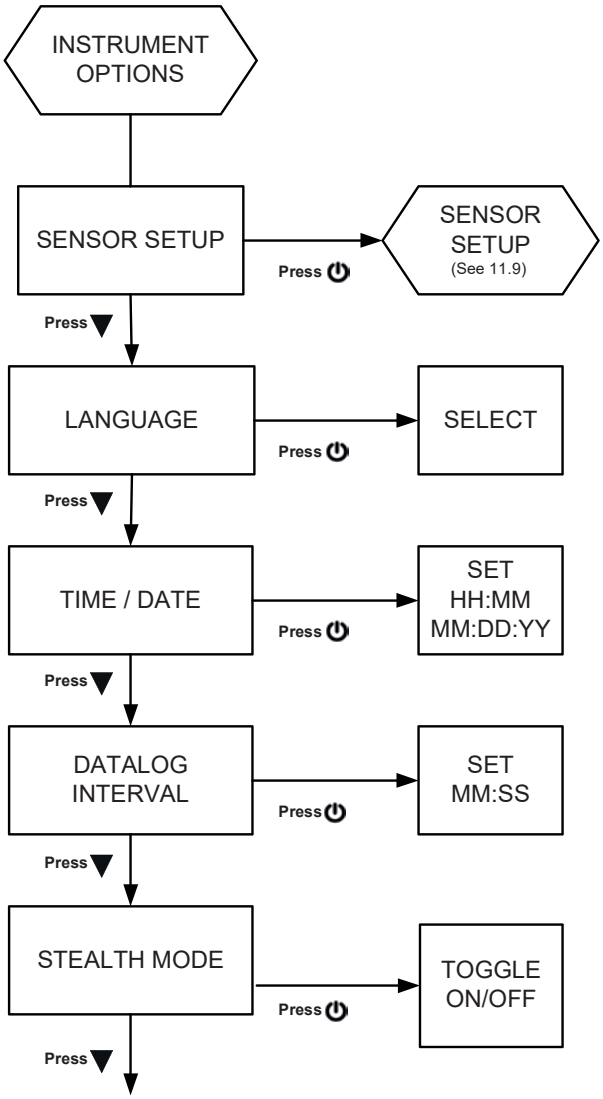
11.7 Sensor Alarm Setup



NOTE: STEL AND TWA ARE NOT VALID FOR ALL SENSORS

US

11.8 Instrument Options



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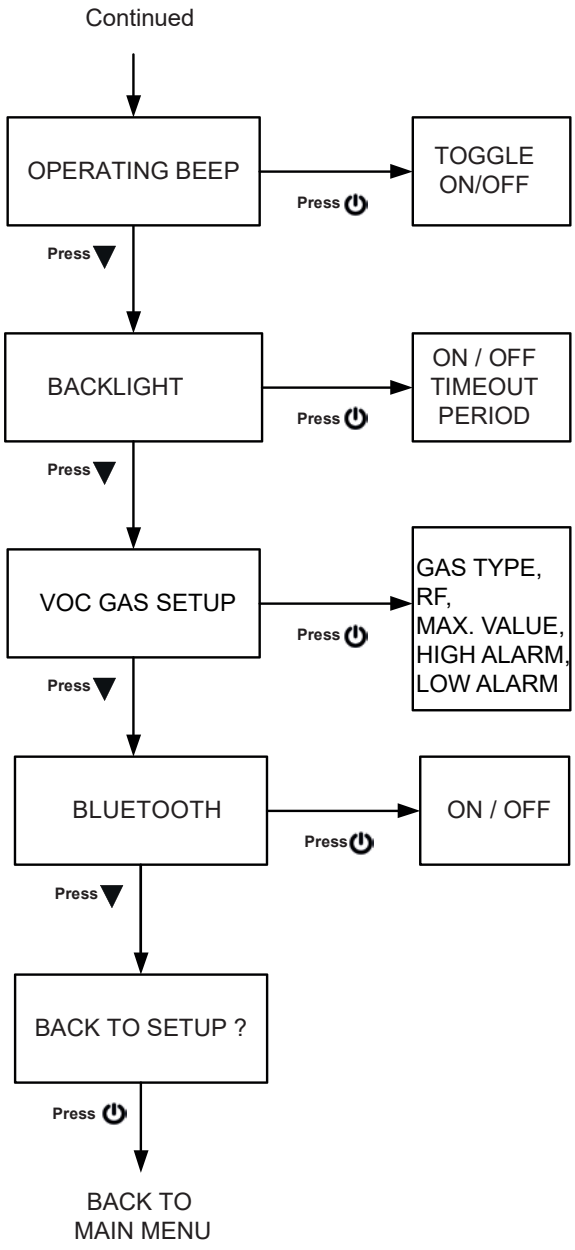
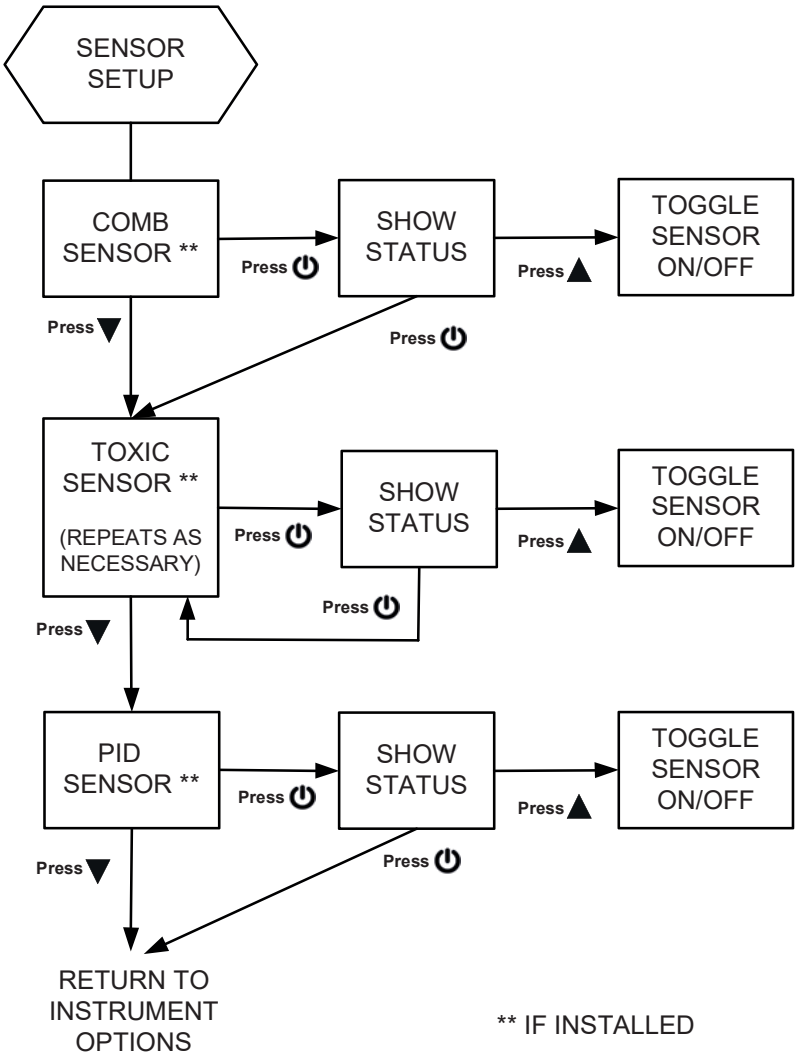

Continued
OPERATING BEEP
Press
TOGGLE ON/OFF
Press
BACKLIGHT
Press
ON / OFF TIMEOUT PERIOD
Press
VOC GAS SETUP
Press
GAS TYPE, RF, MAX. VALUE, HIGH ALARM, LOW ALARM
Press
BLUETOOTH
Press
ON / OFF
Press
BACK TO SETUP ?
Press
BACK TO MAIN MENU

US

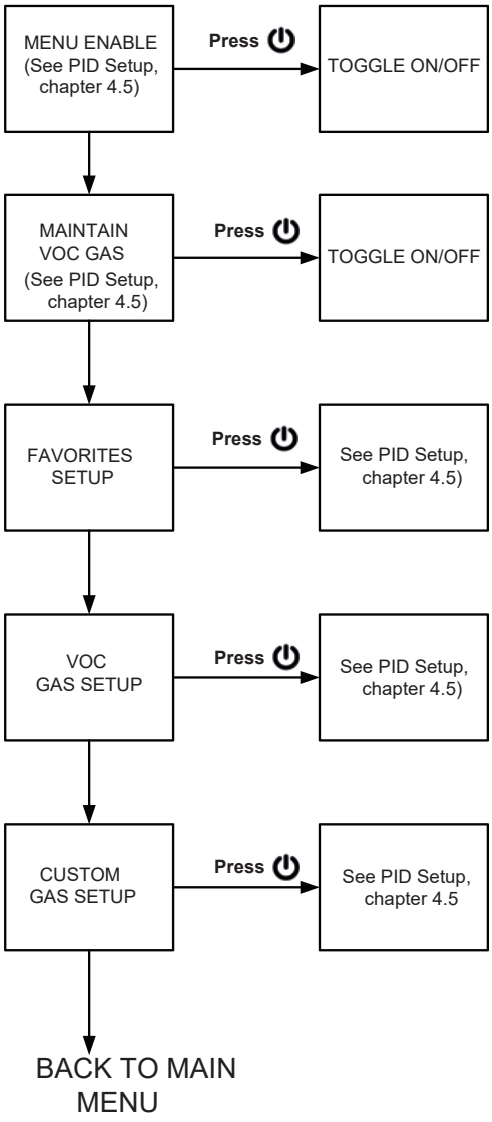
11.9 Sensor Setup



** IF INSTALLED

US

11.10 VOC Gas Setup



US

12 Changeable Feature Summary

Feature	Initial Setting	Setup Path to Change this Setting	Change with MSA link?	Change via Blue-tooth?
Setup Password	672	-	Yes	No
Vibrating Alarm	ON	ALARM OPTIONS	Yes	Yes
Horn Alarm	ON	ALARM OPTIONS	Yes	Yes
LED Alarm	ON	ALARM OPTIONS	Yes	Yes
Safe LED (green)	ON	-	Yes	No
Operating Beep (alarm LEDs & horn)	OFF	INSTRUMENT OPTIONS	Yes	No
Stealth	OFF	INSTRUMENT OPTIONS	No	No
MotionAlert - Access	Allowed	ALARM OPTIONS	No	Yes
MotionAlert	OFF	Use ▼ button from MEASURE page	No	Yes
Sensor Alarm Levels		ALARM OPTIONS / SENSOR ALARM SETUP	Yes	Yes
Enable / Disable High & Low Alarms	Enabled	-	Yes	Yes
Turn Sensors ON / OFF	ON	INSTRUMENT OPTIONS / SENSOR SETUP	Yes	No
Show Peak	ON	-	Yes	No
Show STEL, TWA	ON	-	Yes	No
Cal Cylinder Setup		CAL OPTIONS	Yes	Yes
Show Last Cal Date	ON	CAL OPTIONS	No	No
Show Cal Due	ON	CAL OPTIONS	Yes	No
Cal Password Required	OFF	CAL OPTIONS	No	No
Backlight	Enabled	-	No	Yes
Backlight Duration	10 s	INSTRUMENT OPTIONS	Yes	Yes
Display Contrast	Factory-set	INSTRUMENT OPTIONS	No	No
Language	User-set	INSTRUMENT OPTIONS	No	Yes
Date, Time	User-set	INSTRUMENT OPTIONS	Yes	Yes
Datalog Interval	3 min	INSTRUMENT OPTIONS	Yes	No
Custom Logo Screen	Factory-set	Certified service center	Yes	No
Device S/N	Factory-set	-	No	No
Company Name	Blank	-	Yes	Yes
Dept./User Name	Blank	-	Yes	Yes
VOC RF ON/OFF	ON	INSTRUMENT OPTIONS	Yes	No
Bump Due ON/OFF	OFF	-	Yes	Yes
Bump Interval	1	-	Yes	Yes
Cal Due Interval	30	INSTRUMENT OPTIONS	Yes	Yes

The Safety Company

For local MSA contacts, please visit us at ***MSAsafety.com***

Because every life has a ***purpose...***

MODEL DR-4000

DataRAM 4

INSTRUCTION MANUAL
P/N 100334-00

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WARRANTY

Seller warrants that the Products will operate substantially in conformance with Seller's published specifications, when subjected to normal, proper and intended usage by properly trained personnel, for 13 months from date of installation or 12 months from date of shipment, whichever is less (the "Warranty Period"). Seller agrees during the Warranty Period, provided it is promptly notified in writing upon the discovery of any defect and further provided that all costs of returning the defective Products to Seller are pre-paid by Buyer, to repair or replace, at Seller's option, defective Products so as to cause the same to operate in substantial conformance with said specifications. Replacement parts may be new or refurbished, at the election of Seller. All replaced parts shall become the property of Seller. Shipment to Buyer of repaired or replacement Products shall be made in accordance with the provisions of Section 5 above. Lamps, fuses, bulbs and other expendable items are expressly excluded from the warranty under this Section 8. Seller's sole liability with respect to equipment, materials, parts or software furnished to Seller by third party suppliers shall be limited to the assignment by Seller to Buyer of any such third party supplier's warranty, to the extent the same is assignable. In no event shall Seller have any obligation to make repairs, replacements or corrections required, in whole or in part, as the result of (i) normal wear and tear, (ii) accident, disaster or event of force majeure, (iii) misuse, fault or negligence of or by Buyer, (iv) use of the Products in a manner for which they were not designed, (v) causes external to the Products such as, but not limited to, power failure or electrical power surges, (vi) improper storage of the Products or (vii) use of the Products in combination with equipment or software not supplied by Seller. If Seller determines that Products for which Buyer has requested warranty services are not covered by the warranty hereunder, Buyer shall pay or reimburse Seller for all costs of investigating and responding to such request at Seller's then prevailing time and materials rates. If Seller provides repair services or replacement parts that are not covered by the warranty provided in this Section 8, Buyer shall pay Seller therefore at Seller's then prevailing time and materials rates. ANY INSTALLATION, MAINTENANCE, REPAIR, SERVICE, RELOCATION OR ALTERATION TO OR OF, OR OTHER TAMPERING WITH, THE PRODUCTS PERFORMED BY ANY PERSON OR ENTITY OTHER THAN SELLER WITHOUT SELLER'S PRIOR WRITTEN APPROVAL, OR ANY USE OF REPLACEMENT PARTS NOT SUPPLIED BY SELLER, SHALL IMMEDIATELY VOID AND CANCEL ALL WARRANTIES WITH RESPECT TO THE AFFECTED PRODUCTS.

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1.0 GENERAL DESCRIPTION

The MIE DataRAM 4 (for Data-logging Real-time Aerosol Monitor 4), model DR-4000 is a technologically advanced instrument (**embodies U.S. Patent No. 6,055,052**) designed to measure the concentration of airborne particulate matter (liquid or solid), as well as mean particle size, air temperature and humidity, providing direct and continuous readout as well as electronic recording of the information.

The DataRAM 4 is the result of many years of field experience acquired with thousands of units of its well known predecessors, the MIE model RAM-1 and its successor, the DataRAM, and embodies many technological advances made possible by the latest electronic hardware and software.

The DataRAM 4 is a high sensitivity, two-wavelength nephelometric (i.e. photometric) monitor whose light scattering sensing configuration has been optimized for the measurement of the fine particle fraction of airborne dust, smoke, fumes and mists in ambient, atmospheric, industrial, research, and indoor environments.

The DataRAM 4 is a compact, rugged and totally self-contained instrument designed for portable, as well as unattended fixed-point operation. It is powered by its internal rechargeable battery, or by an AC power supply/charger (included as standard accessory).

In addition, the instrument automatically checks its own optical background during the zeroing sequence and indicates any significant deviations requiring maintenance.

The DataRAM 4 covers a wide measurement range: from 0.0001 mg/m^3 (0.1 µg/m^3) to 400 mg/m^3, a 4 million-fold span, corresponding to very clean air up to extremely high particle levels.

In addition to the auto-ranging real-time concentration readout, the DataRAM 4 offers the user a wide range of information by scrolling its four-line LCD screen. This information includes: median particle diameter, scattering coefficient, Ångström coefficient, visual range, run start time and date, time averaged concentration, elapsed run time, maximum with time of occurrence, air temperature and relative humidity, etc. Operating parameters and diagnostic information screens can also be displayed.

Furthermore, the DataRAM 4 features complete, large capacity internal data logging capabilities with data retrieval on screen or through an externally connected computer. The stored information (up to 50,000 data points) includes individual point averages, particle size, temperature and humidity with time information as well as overall average and maximum concentration, and tag numbers.

Selectable alarm levels with built-in audible signal as well as switched and signal outputs, RS-232 and RS-485 communications ports, and a programmable analog (voltage and current) concentration output are all part of this versatile instrument.

A custom software package is provided with the DataRAM 4 for communications to and from a PC.

2.0 SPECIFICATIONS

Concentration measurement range (auto-ranging)[1]:
0.0001 to 400 mg/m^3

Precision/repeatability (2-sigma)[2,3]:
± 1% of reading or ± 0.001 mg/m^3, whichever is greater (1-second averaging)
± 0.3% of reading or ± 0.0003 mg/m^3, whichever is greater (10-second averaging)

Accuracy[1]:
± 2% of reading ± precision

Resolution:
0.1% of reading or 0.0001 mg/m^3, whichever is greater

Scattering coefficient range:
10^{-7} to 0.4 m^{-1} (resolution: 3 significant digits, max.)

Visual range:
0.01 to 337 km (@ λ = 550 nm) (resolution: 3 significant digits, max.)

Ångström coefficient measurement range:
0.0 to 4.0

Particle sizing range (log-normal, σ_g = 2.0, m = 1.50):
0.04 to 4.0 μm

Temperature measurement range:
-15 to 60 C° (accuracy: 0.5 C°)

Relative humidity measurement range:
0 to 100% (accuracy: 2%, non-condensing, @ 25 C°)

Sampling flow rate range[4]:
1.0 to 3.0 liters/minute (accuracy[2]: 0.05 liters/minute; adjustability: 0.1 liters/minute)

Measurement/display integration time range[4]:
1 to 60 seconds (selectable in 1-second steps)

Measurement/display update frequency:
1/second

HEPA filter cartridge replacement frequency (typical):
< I per 5 years (@ < 1 mg/m^3)

Alarm level adjustment range[4]:
Selectable over entire measurement range for any of the selected measurement units (concentration, scattering coefficient or visual range)

Data logging averaging periods[4]:
1 second to 24 hours (selectable in 1-second increments)

Data logging memory capacity:
50,000 data points in up to 99 tags (data groups)

Programmable zeroing periods[4]:
1 to 168 hours (selectable in 1-hour increments; if enabled, logging period must be > 10 minutes)

Elapsed time readout range:
1 second to 100,000 hours (over 11 years), in seconds, minutes and hours

Digital communications:
RS232/RS485: full duplex, 9600 baud, software controlled, device filtered

Computer requirements:
IBM-compatible PC, 486 or higher (Pentium I or higher, preferred); Windows™95 or higher; 8 MB memory or more

Analog outputs:
0 to 5 V and 4 to 20 mA, with selectable full scale ranges between 0.1 and 400 mg/m^3

Power:
- Internal battery: rechargeable sealed lead-acid, 7.2 Ah, 6 V, 20-hour run time between charges (typical)
- AC line: universal voltage charger/power supply (included), 100 – 250 V, 50 – 60 HZ (CE marked)
- Optional solar power system, model DR-SOL

Alarm outputs:
- Alarm switch: 0 to +30 VDC (off, open), 2.5 A (on, closed)
- Alarm signal: 0 V (off), 5 V (on) (1 mA maximum load current)

- Audio alarm (back panel): > 60 dB @ 1 m

Operating environment:
-10 to 50 C° (14º to 122º F), 10 to 95% RH, noncondensing

Storage environment:
-20 to 70 C° (-4º to 158º F)

Dimensions (maximum external, including handle and inlet fitting):
166 mm (6.54 in) H x 226 mm (8.90 in) W x 327 mm (12.87 in) D

Weight:
5.5 kg (12 lbs)

[1] Referred to gravimetric reference calibration (NIST traceable) with SAE Fine test dust (mmd = 2 to 3 μm, σ_g = 2.5, as aerosolized)
[2] At 25 °C
[3] For single wavelength concentration sensing
[4] User selectable

3.0 USER GUIDELINES

3.1 Handling Instructions

The DataRAM 4 is a sophisticated optical/electronic instrument and should be handled accordingly. Although the DataRAM 4 is very rugged, it should not be subjected to excessive shock, vibration, temperature or humidity. As a practical guideline, the DataRAM 4 should be handled with the same care as a portable CD player. ***The DataRAM 4 must be protected from all forms of precipitation***.

If the DataRAM 4 has been exposed to low temperatures (e.g. in the trunk of a car during winter) for more than a few minutes, care should be taken to allow the instrument to return to near room temperature before operating it indoors. This is advisable because water vapor may condense on the interior surfaces of the DataRAM 4 causing temporary malfunction or erroneous readings. Once the instrument warms up to near room temperature, such condensation will have evaporated. If the DataRAM 4 becomes wet (e.g. due to exposure to water sprays, rain, etc.), allow the unit to dry thoroughly before operating it.

Whenever the DataRAM 4 is shipped care should be taken in placing it in its carrying case and repackaging it with the original cardboard box with the factory provided padding.

3.2 Safety Instructions

- ***Read and understand all instructions in this manual.***
- ***Do not attempt to disassemble the instrument. If maintenance is required, return unit to the factory for qualified service.***
- ***The DataRAM 4 should be operated only from the type of power sources described in this manual.***
- ***Shut off DataRAM 4 and any external devices (e.g. PC) before connecting or disconnecting them.***
- ***Shut off DataRAM 4 before plugging in or disconnecting the AC power supply.***
- ***Never operate the DataRAM 4 without one of its internal filters in place.***
- ***If the internal battery of the DataRAM 4 has been allowed to discharge completely, recharge the battery for at least 30 minutes before operating the DataRAM 4.***
- ***During battery charging the DataRAM 4 should not rest on its front (i.e., bottom up).***
- ***To change position (angle) of the carrying/support handle, the large buttons on both sides of the handle must be pushed in at the same time to release handle lock. Do not attempt to rotate handle without releasing its lock.***

3.3 Orientation During Operation

The DataRAM 4 can be operated and/or charged in any of three orientations or attitudes:

- Horizontally (front panel vertical), resting on its 4 bottom rubber pads.
- Tilted with front panel up, resting on 2 rear rubber pads and locked down handle.
- Vertical (front panel horizontal, upwards) resting on 4 rear rubber pads.

3.4 Air Sampling Guidelines

Caution: The DataRAM 4 is not designed to sample highly corrosive aerosols or solvent fumes

3.4.1 Area Monitoring

For typical area monitoring applications, the DataRAM 4 should be placed and operated centrally within the area to be monitored, away from localized air currents due to fans, blowers, ventilation intakes/exhausts, etc. This is to ensure representative sampling within the area to be assessed.

3.4.2 Ambient Air Monitoring

For ambient (extramural) sampling/monitoring the following procedures and precautions should be applied:

- The sampling inlet should be away and above any obstructions whose wake may affect sampling representativeness. Typically, the inlet should be about 1 m (or more) above ground or any major surface (e.g., roof).
- Under typical horizontally directed and variable wind conditions, the use of the MIE Omnidirectional Inlet, model DR-OSI, is required, otherwise particles with equivalent (inertial) diameters larger than about 1 μm may not be sampled representatively.
- At ambient relative humidity above 65% to 70% airborne particles are likely to grow by accretion of water. If only the solid portion of the particulates is to be measured, the use of the MIE Temperature Conditioning Heater, model DR-TCH should be considered, especially when monitoring under fog or water mist conditions. On the other hand, the user should be aware that such heating of the sample stream might result in the evaporation of some volatile and semi-volatile particles of interest.
- The DataRAM 4 is not weatherproof. To operate the DataRAM 4 outdoors, provisions must be made to protect it from environmental extremes such temperatures beyond its specified range, and from any form of precipitation. A small shelter or roof may be required, with a modicum of heating during the winter.

3.4.3 Extractive Sampling

Two general types of extractive sampling occur: a) from a chamber/vessel/room, and b) from a duct or stack. In the first case the air to be monitored is generally nearly stagnant or gently stirred (by means of a fan or blower). The second case almost invariably involves a directed flowing stream at typical speeds of 3 to 30 m/s (600 to 6,000 ft/min).

To sample either from an enclosure (assuming the DataRAM 4 is to be located externally to that enclosure), or a duct/stack, a length of tubing can be used to which the following guidelines should be applied:

- Minimize tubing length, especially horizontally running lengths.
- Minimize the number bends and angle of change in direction.
- Minimize tubing inner diameter thus maximizing transport velocity (a practical lower limit of about 2 mm, or 0.08 in. ID is indicated for reasons of excessive pressure drop).
- If possible, changes in inner diameter (at unions, couplings, etc.) should be incremental in the direction of flow, i.e., the inner diameter should only increase in the direction of flow.
- Use non-electrostatic tubing. Best is electrically grounded metal or conductive plastic (black) tubing, Tygon™ is acceptable, and Teflon™ is not to be used.

For tubing lengths of up to 2 m (6 ft.), 6 mm ID (1/4 in. ID) plastic tubing with wall thickness of 1/16 in. is a practical size which can be stretched over the DataRAM 4 inlet stem.

For enclosure monitoring, the sampling inlet should be at some distance from the inner wall of the enclosure in order to ensure sampling representativeness. Typically, a minimum of 20 or 30 cm (1 ft.) is advisable. If a particle precollector is required (e.g., a cyclone) it should be used as the inlet to the tubing, within the enclosure to be monitored. If there is any pressure difference between the interior of the enclosure and the location of the DataRAM 4, its exhaust port (on rear panel) must be connected by tubing to the enclosure, i.e., the air stream extracted from the enclosure must be returned to it after passing through the DataRAM 4.

For duct/stack monitoring, a probe should be used whose inlet faces the direction of the airflow. If particles in the stream are larger than about 1 μm, sampling should be under isokinetic conditions, i.e., the velocity of the air entering the sampling inlet should equal the air velocity in the duct/stack at that point. This can be achieved using the MIE Isokinetic Sampling Kit model RAM-ISN which, in combination with the DataRAM 4 covers the range of about 3 to 30 m/s (600 to 6000 ft./min). As in the case of enclosure monitoring, it is advisable to return the DataRAM 4 exhaust air stream to the duct/stack in order to ensure proper internal flow conditions within the instrument.

3.5 Environmental Constraints and Certifications

The DataRAM is designed to be reasonably dust and splash resistant, however, it is not weatherproof. To operate the unit outdoors provisions should be made to protect it from environmental extremes outside its specified range, and ***from any exposure to precipitation.***

The DataRAM 4 is certified for compliance with the electromagnetic radiation limits for a Class A digital device, pursuant to part 15 of the FCC Rules. The unit also complies and is marked with the CE (European Community) approval for both immunity to electromagnetic radiation and absence of excessive emission interference.

4.0 ACCESSORIES

4.1 Standard Accessories

The DataRAM 4 is provided to the user with the following standard accessories:

- Soft-shell carrying case (MIE model RAM-2-184-1))
- Digital communications cable (MIE model DR-DOC)
- Communications software disk (MIE model DR4-COM)
- Universal AC power supply/charger (MIE model RAM-2-183-1)
- Standard filter cartridge (installed)(MIE model MSA-95302)
- Analytical Filter Holder (MIE model RAM-2-182-1)
- Instruction manual

4.2 Optional Accessories

The following optional accessories are available from MIE for use with the DataRAM 4:

- Omnidirectional Sampling Inlet (MIE model DR-OSI)
- Temperature Conditioning Heater (MIE model DR-TCH)
- In-line Impactor Head (10 and 2.5 μm) (MIE model DR-PM10/2.5)
- Impaction Nozzle for 1 μm (MIE model DR-PM1N)
- Ambient Sampling Inlet Set (consists of DR-OSI, DR-TCH and DR-PM10/2.5)
- Isokinetic Sampling Set (MIE model RAM-ISN)
- Sampling Dilution Unit (MIE model DR-SDU)
- Respirable Cyclone Precollector (MIE model DR-RCP10)
- Solar Power Supply (MIE model DR-SOL)
- External DC cable assembly (MIE model DR-DCS)
- Analog signal output cable (MIE model DR-ANC

5.0 INSTRUMENT LAYOUT

The user should become familiar with the location and function of all externally accessible controls, connectors and other features of the DataRAM 4. Refer to Figures 1 through 3.

All user related functions are externally accessible. Qualified MIE personnel should perform all repair and maintenance. Please contact the factory if any problem should arise. Do not attempt to disassemble the DataRAM 4, except as described in Section 12.0 (Maintenance), otherwise voiding of instrument warranty will result.

5.1 Front Panel

Refer to Figure 1 for location of controls and display.

The front panel contains the 10 touch switches (keys) and the LCD screen required for the operation of the DataRAM 4.

The touch switches provide tactile ("popping") feedback when properly actuated.

The ON/OFF key serves only to turn on the unit (while it is in the off state), and to turn it off (when it is operating). In the latter case, the DataRAM 4 switches automatically to its internal purge mode for about one minute, and then shuts itself off.

The EXIT and ENTER keys serve to execute specific commands that may be indicated on the screen, and the NEXT key generally serves to scroll the displayed information, e.g. to review the operating parameters that have been programmed, diagnostic values, etc.

The four-line, 20-character per line LCD indicates either measured values of concentration (instantaneous and time averaged on the same screen), elapsed run time, maximum and STEL (short term excursion limit) values, operating and logging parameters, diagnostics, command prompting or other messages.

The LCD screen is backlighted whenever the DataRAM 4 is powered by its AC charger/power supply. When operating from the internal battery, the screen backlighting is disabled in order to save battery charge.

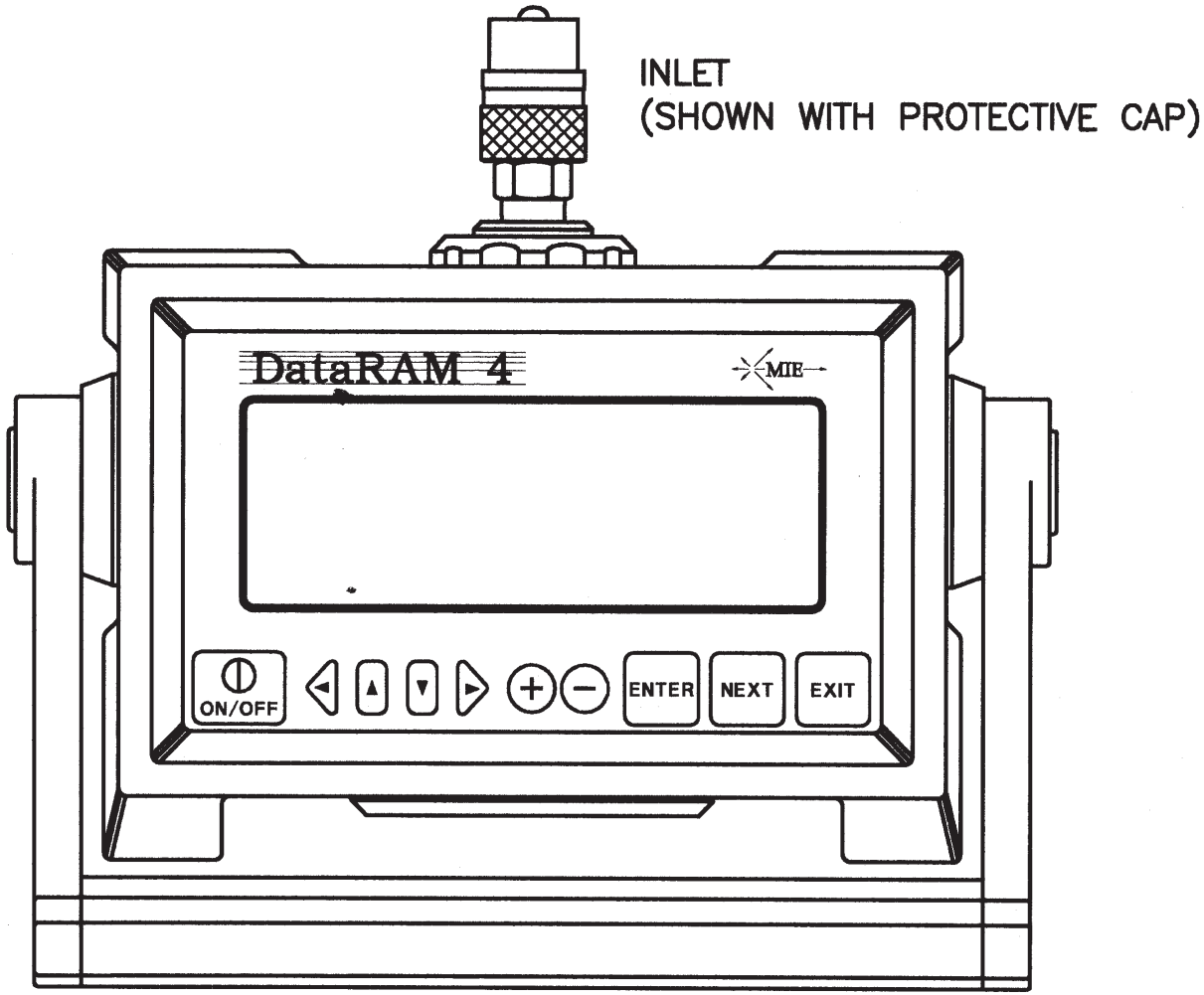


FIGURE 1. FRONT–PANEL VIEW OF DataRAM

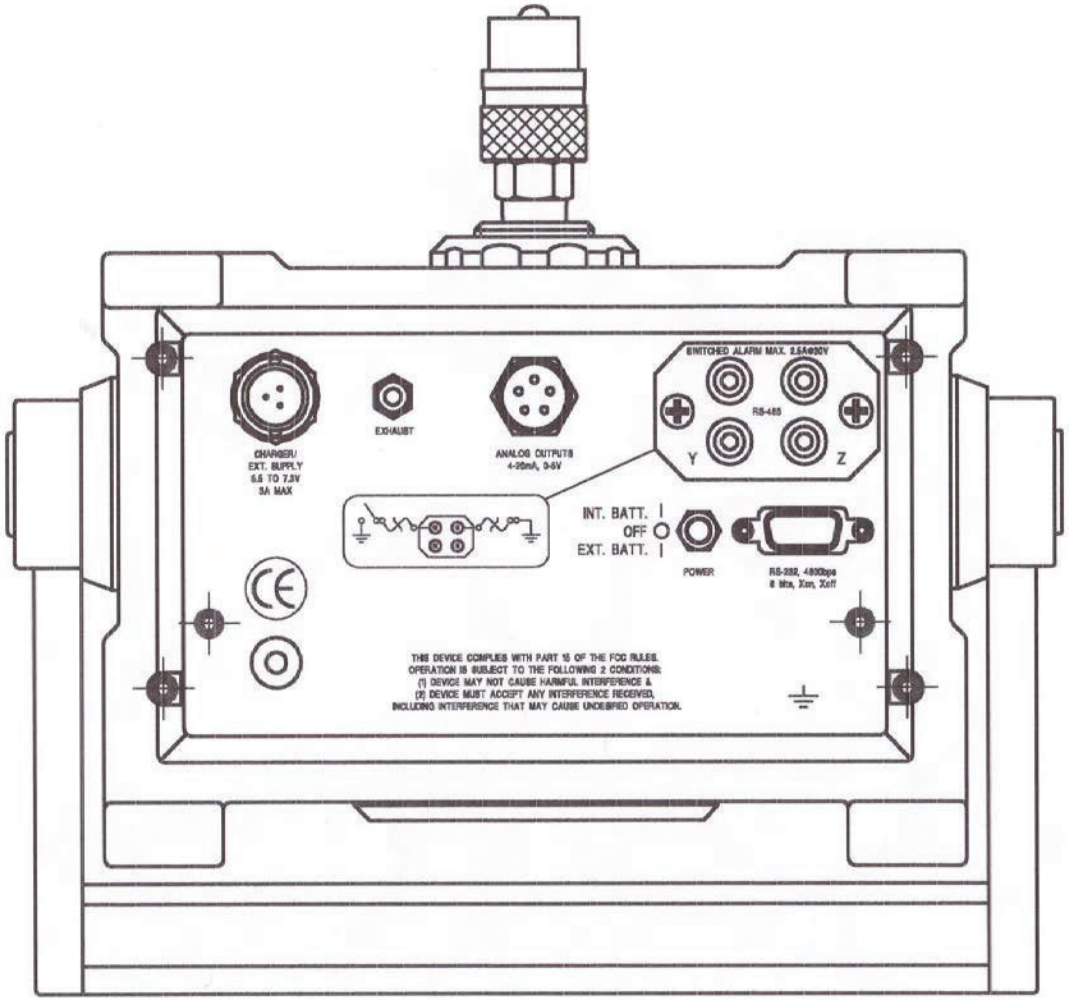


FIGURE 2. BACK–PANEL VIEW OF DataRAM

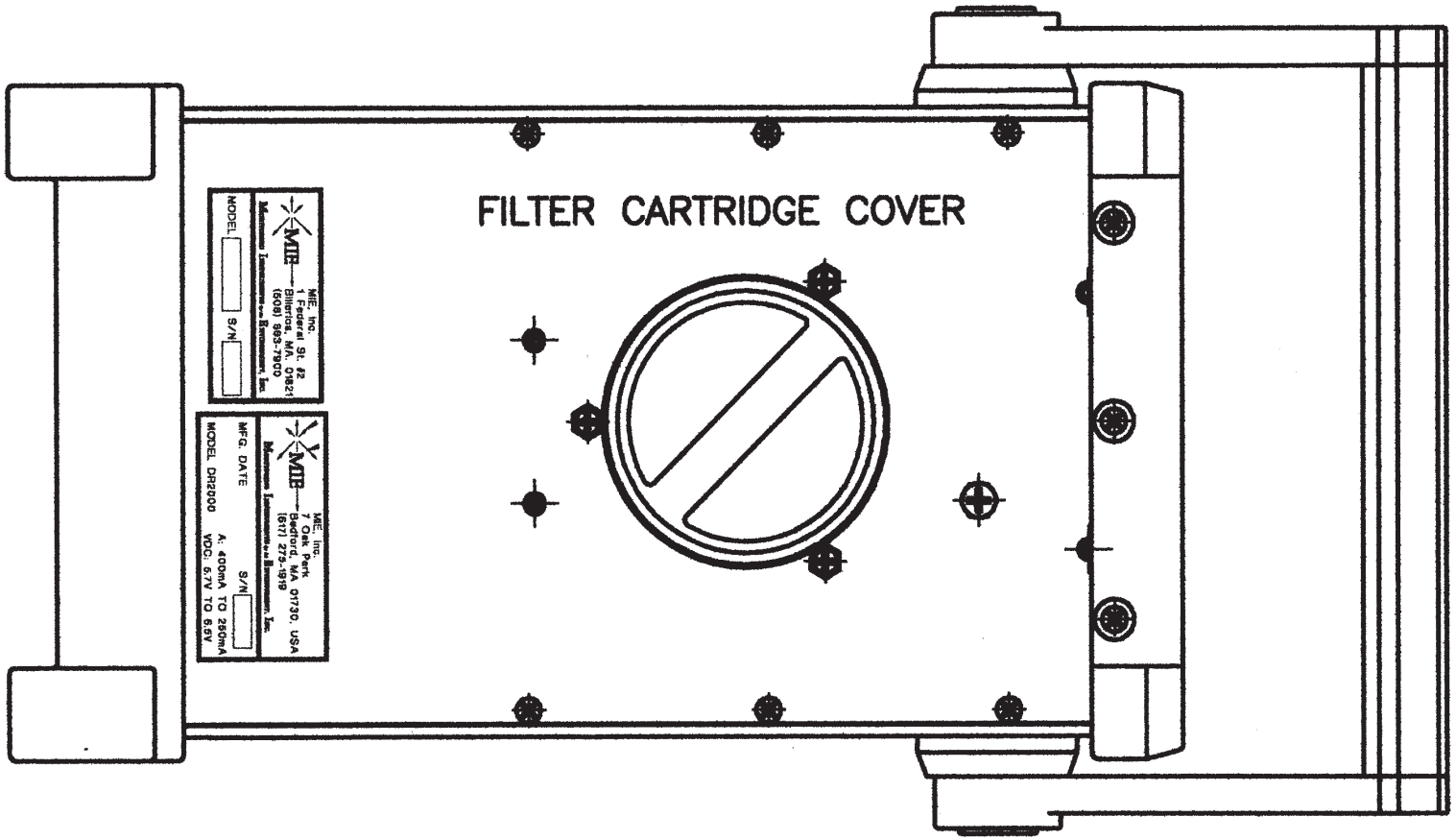


FIGURE 3. BOTTOM VIEW OF DataRAM

5.2 Rear Panel

Refer to Figure 2 for the location of items on the back panel of the DataRAM 4.

All components on the back panel are either labeled to indicate their respective functions, or are self-explanatory. Viewing the back panel from the rear of the DataRAM 4, the user should identify and become familiar with the following items:

- The **CHARGER/EXT. SUPPLY** 3-pin male receptacle. The AC power supply/charger provided with the DataRAM should be connected here whenever the internal battery is to be recharged and/or when running continuously from the AC line. Any other DC source (e.g., solar power supply, external battery, etc.) to be used to power the DataRAM would be connected at this location.
- **Inlet cap storage pod**. Directly below the charger/power supply connector is a gray plastic pod provided for storage of the metal inlet cap whenever the DataRAM 4 is in operation. The cap is snapped onto, or removed from the pod by pulling the knurled sealing ring away from the opening of the cap.
- The **CE** marking above the pod signifies that the DataRAM 4 has been certified to satisfy all requirements that are implied in that marking (please consult with MIE about any questions on the CE certification).
- To the right of the charger/ext. supply receptacle is the **EXHAUST** fitting. This is the point where the sampled air exhausts from the DataRAM 4. This exhaust airflow is particle-free as it has passed through the internal filter of the DataRAM 4.
- To the right of the exhaust fitting is the **ANALOG OUTPUTS** signal connector. Both 4 to 20 mA and 0 to 5 V outputs are available at that connector. In addition, this connector also provides a **VOLTAGE ALARM** output (0 to 5 V).
- At the upper right hand of the back panel is a 4-post connector. The upper two binding posts provide a **SWITCHED ALARM** output activated whenever the measured concentration exceeds a user set level (same as the voltage alarm output). The lower two posts are for **RS-485** communications.
- Below the 4-post connector is a standard 9-pin male connector for **RS-232** communications.
- Directly to the left of the RS-232 connector is a 3-position switch provided for **POWER** selection and shut off. To actuate this locking switch, pull its small handle outwards while moving it up or down. In the mid position (handle horizontal), the DataRAM 4 is shut off from any source of power, internal or external. This position should be used for transport, or when the DataRAM 4 is not to be used for an extended period of time***. The upward position is for normal operation, and should be used whether the DataRAM 4 is powered from its internal battery, being charged or when powered from its AC power supply***. The downward position is only to be used when an external DC source is applied (e.g., solar power supply, external battery, etc.).
- In the lower right hand corner is a chassis ground post to which a grounding connection may be made for fixed-point uses.

5.3 Bottom Base

Refer to Figure 3 for the location of items on the bottom surface of the DataRAM 4.

A large threaded plastic cover that seals the internal filter holder (either the large capacity HEPA metal cartridge, or the analytical plastic filter holder) can be accessed on the DataRAM 4 bottom panel. See Sections 6.3 and 12.4 for filter replacement procedures.

5.4 Carrying Handle

The swivel-type carrying handle can be locked at any of several angles, 30° apart. To unlock, press inwards the large buttons on both hinges, while rotating the handle. Allow these buttons to lock (by springing outwards) at any desired angle. At a 90° downward position the handle will provide an upward tilted position for the DataRAM 4, facilitating access and viewing of the front panel. ***Under no conditions should the handle be rotated without unlocking the hinges on both sides. Otherwise, the internal mechanism of the handle lock will be damaged.***

5.5 Sampling Inlet

The sampling inlet of the DataRAM 4 is located on the upper face of the instrument. This inlet is a quick-connect ¼-inch stem compatible with all inlet accessories available from MIE. When the DataRAM 4 is not in use, the inlet should be closed by means of the metal stem cap provided with the instrument. During DataRAM 4 operation this cap should be stored on its pod on the back panel. This stem cap serves to prevent accidental entry of objects, debris, or other form of contamination into the sensing stage of the DataRAM 4, as well as to protect the inlet stem from any surface damage. Figure 1 shows the inlet covered with the stem cap.

To remove the stem cap from the inlet, slide spring-loaded knurled sleeve backwards, and pull cap away from inlet. To insert cap, slide spring-loaded sleeve back, push cap down on inlet stem until it bottoms, and release knurled sleeve. The same procedure applies when removing cap from or inserting it onto the storage pod on the back panel of the DataRAM 4.

Do not loosen the large notched aluminum nut that secures the inlet stem to the DataRAM 4 case.

6.0 PREPARATION FOR OPERATION

6.1 Battery Charging and Operation

The internal rechargeable battery of the DataRAM 4 is a sealed lead-acid gel-cell type with very long lifetime. Under normal circumstances, the battery will provide reliable operation for several years.

When shipped from the factory, The DataRAM 4 internal battery has been fully charged allowing immediate operation of the instrument as received by the user.

Always recharge the battery after use and before storing the instrument for any length of time. The battery of a stored instrument must be recharged at least every three months.

If the DataRAM 4 has not been used for more than one month, it is advisable to recharge its battery to full capacity before operating.

A fully discharged battery requires at least ***12 hours of charging***, using the MIE supplied charger, in order to attain full capacity.

A new and fully charged battery, at temperatures above 15°C (60°F), approx., is expected to provide at least 20 hours of continuous operation.

During battery charging the DataRAM 4 can be placed in any of its operating positions, ***but not resting on its front (upside down position).***

If, while operating the DataRAM 4 from its internal battery, the battery charge were to be nearly depleted such that its voltage drops below an acceptable level, the DataRAM 4 will automatically switch to internal air purging and then shut itself off.

The DataRAM 4 can be operated continuously and for an indefinite time using its universal charger/power supply. This charger/power supply accepts any line voltage between 100 and 240 VAC, 50 to 60 Hz, without requiring any adjustments. When using this charger/power supply, its connector should be plugged into and fastened to the corresponding receptacle on the rear panel of the DataRAM 4 (see Section 5.2).

6.2 Inlet Uncapping

Before starting a measurement run, the protective stem cap must be removed from the inlet and stored on the pod on the back panel (see Section 5.2). ***The DataRAM 4 should never be in its run mode (pump operating) with the cap covering the inlet.***

6.3 Filter Cartridge Installation

Ensure that one of the two types of filter cartridges has been installed in the filter chamber accessible from the bottom panel of the DataRAM 4 (see Figure 3). The DataRAM 4 is shipped from the factory with the large capacity HEPA (High Efficiency Particulate Air) filter cartridge in place. See Section 12.4.1 for procedures to replace this cartridge or to install the analytic filter holder (Section 12.4.2). ***Except when gravimetric measurements or chemical analysis of the filter collection are to be performed, only the HEPA filter cartridge should be installed in the DataRAM 4.***

In order to gain access to the filter chamber, the large threaded plastic cap covering the filter chamber must be rotated counterclockwise (as viewed from the bottom). Do not leave this chamber open for any extended period of time, otherwise dust may settle on the internal optical surfaces. Hand tighten the plastic cap firmly after filter cassette replacement, to ensure a proper seal. ***At no time should the DataRAM 4 be running without a filter in place, otherwise serious damage to internal components may result.***

6.4 Power Selector Switch

When the DataRAM 4 is received from the factory, the 3-position power selector switch will typically be in its OFF position (mid-position). **To enable operation with either its internal battery or with the charger/power supply provided with the DataRAM 4, this switch must be placed in its INT. BATT. position (handle upward).** Refer to section 5.2 on how to operate this locking-type switch.

6.5 External Electrical Connections

Plugging in or unplugging any external equipment (e.g., computer, modem, alarm circuitry, etc.) should be made only while both the DataRAM 4 and the external equipment are shut off, in order to prevent damage or interference due to transient electrical effects.

6.6 External DC Power Operation

If an external DC source of power is used, for example if AC power is not available and continuous operation over more than 20 hours is required, an external battery or other DC source (e.g., solar power) can be used.

If an external battery is used, its specifications are:

- Voltage: 6.0 to 9.0 VDC
- Instantaneous current capability: 3 A
- Continuous average current requirement: 300 mA
- To calculate the required ampere-hour capacity:
  Ampere-hours = 0.3 x hours of operation

To connect external DC source to DataRAM 4, place 3-position **POWER** switch in its OFF position. Use special cable assembly, MIE model DR-DCS. Insert its 3-pin connector into the **CHARGER/EXT. SUPPLY** receptacle on the rear panel of the DataRAM 4 See Section 5.2 and Figure 2). Connect positive (+) side of external battery to the lead marked (+), and the negative side (-) to the lead marked (-). Once the connections have been completed, place the **POWER** switch in its downward position (EXT. BATT.). Again, before disconnecting external battery, return **POWER** switch to its OFF position.

7.0 OPERATING MODES

The DataRAM 4 has several different operating modes which will be described in what follows. The specific commands and displays within each of these operating modes will be explained in detail in Section 9.0

7.1 Set-Up Mode

The DataRAM 4 enters the Start-Up Mode as soon as the instrument is switched on. The user then has the choice to:
a) Wait before proceeding;
b) Zero the instrument and check its readiness;
c) Review or export previously logged data;
d) Edit data logging parameters; or
e) Edit operating/measurement parameters

All parameter and status changes must be performed while in the set-up mode. Once the DataRAM 4 is in the run (measurement) mode no changes can be made in the parameters or status of the instrument.

While the DataRAM 4 is in the set-up mode the internal pump is not activated, except while zeroing.

7.2 Run/Data Logging Mode

The Run Mode is the measurement/logging mode. The user can operate the DataRAM 4 in this mode either with or without data logging. For example, the instrument may be used first as a survey monitor without logging, for walk-through assessment of an industrial plant, before deciding where to set up the unit for continuous monitoring and logging. While in the run mode, the user will be able to view all current measurement values, operating parameters, diagnostic status, as well as any logged values up to that moment.

While the DataRAM 4 is in the run mode the internal pump is always activated.

8.0 KEY SWITCHES AND SCREEN CURSOR FUNCTIONS

Refer to Figure 1 showing the location of the front panel keys.

8.1 ON/OFF Key

The only function of the **ON/OFF** key is to switch the DataRAM 4 on or off depending on whether the instrument is shut off or operating, respectively. When keying **ON** (while instrument is off) the screen will display an identification screen and then the MAIN MENU (see Section 9.1).

When keying **OFF** the screen will request confirmation by keying **ENTER.** If the DataRAM 4 is in the run mode, this will then terminate the run and initiate the

automatic internal purging sequence with particle free air for about 1 minute, at the end of which the DataRAM 4 will shut itself off. If the DataRAM 4 is not in the run mode, keying **OFF** and then **ENTER** will also initiate the automatic purging sequence followed by automatic shut off. In either case, keying **EXIT** instead of **ENTER** after keying **OFF** cancels the termination command (the DataRAM 4 continues the run). Regardless of whether the DataRAM 4 was in the run mode or any other mode when shutting the unit off, all previously stored data remains in memory.

8.2 Screen Cursor, Arrow and +/- Keys

The cursor on the display screen is a blinking black rectangle marking a specific function, status or parameter value that can be selected or modified. When the cursor marks a **>** on the screen that specific function can be enabled by keying **ENTER**.

To move the cursor from one line to the other on the screen use the ∨ or ∧ keys.

When the cursor marks the first letter of a status, that status can be toggled (changed) by keying **+** or **-**.

When the cursor marks a digit of a parameter, the value of that digit can be incremented by keying **+** or decreased by keying **-**. To move the cursor to the next significant digit, either the **<** or the **>** keys should be used.

8.3 ENTER, NEXT and EXIT Keys

The **ENTER** key serves to implement or activate a specific function indicated by the screen cursor, or when the screen display presents ENTER as a command selection.

The **NEXT** key is used principally to go from one screen to the next either in the set-up or in the run/logging mode.

The **EXIT** key is provided to initiate the run termination sequence, or to return to the basic run screen (Run 1 screen) while the DataRAM 4 is in the run mode, to interrupt zeroing, or to return to a previous screen.

9.0 START-UP PREPARATION

Please ensure that the rear panel power switch is in the upward position (see Section 6.4).

9.1 The MENU Screens

Note: Bold, underlined symbols of the screens printed in this manual will denote blinking cursor location (e.g., **>**).

Press **ON** key. The following screen appears for about 5 seconds:

```
MIE        DataRAM 4
VER        35
S/N        D376
DEV#       1
```

The first line identifies the type of instrument, the second indicates the installed firmware version, the third is the serial number of the instrument, and the fourth line indicates an instrument identification number for serial communication purposes. Then the display automatically changes to the following screen:

```
        MAIN MENU
> START RUN
> ZERO/INITIALIZE
> VIEW/TRANSFER DATA
```

At this point, there are the following options:

- Keying **ENTER** starts a measurement run.
- Keying ∨ moves cursor to the next line (ZERO/INITIALIZE)
- Keying **NEXT** selects the next MENU screen:

```
        EDIT MENU

> LOGGING PARAMETERS
> SETUP PARAMETERS
```

Keying **NEXT** from the EDIT MENU returns the screen to the initial MAIN MENU screen.

9.2 ZERO/INITIALIZE Operation

Before initiating a measurement run it is advisable to perform the automatic zeroing and internal check out sequences, to ensure optimal operation.

- From the MAIN MENU select ZERO/INITIALIZE by moving the cursor to that line.
- Key **ENTER**

The pump starts up and the following screen appears initially:

```
 ZEROING/INITIALIZING
COUNTDOWN:      194 sec
MEMORY LEFT:       100%
BATT. CHARGE     412 mA
```

NOTE: Specific numbers used in his manual are given only as examples; values actually displayed may differ.

The time indicated on the second line is the countdown time required to complete the automatic zeroing/initializing sequence. The MEMORY LEFT indication is the unused percentage of the total logging memory. The BATT CHARGE reading is the charging current when the DataRAM 4 is connected to the a.c. line through its charger/power supply. If the charger is not used, that line on the screen will indicate BATTERY LEFT, i.e., the percentage of charge still available from the battery.

A few seconds after the above display appears, the screen will go to:

```
 ZEROING/INITIALIZING
COUNTDOWN:      186 sec
SOURCE 1:        NORMAL
SOURCE 2:        NORMAL
```

And finally to the following screen, indicating that the zeroing/initializing sequence has been completed:

```
 ZEROING/INITIALIZING
READY!:                0 sec
SOURCE 1:        NORMAL
SOURCE 2:        NORMAL
```

If the second line of the above screen indicates BACKGROUND HIGH instead of READY!, it is probable that the lenses in the sensing chamber require cleaning. Please refer to Section 12.2 for such cleaning procedures.

If the READY! message is displayed, return to the MAIN MENU by keying **EXIT**.

9.3 Selecting Logging Parameters

To select the data logging parameters, key **NEXT** from the MAIN MENU and the EDIT MENU is displayed. The flashing cursor appears on the LOGGING PARAMETERS line. Key **ENTER** to activate that function. The following screen appears:

```
LOG DATA:       DISABLED
LOG PERIOD:     00:00:05
TAG #:                13
AUTO START:  DISABLED
```

In order to activate (enable) the data logging function for the next measurement run, key **+** or **–** and the first line will display ENABLED (either of these two keys can be used to toggle between DISABLED and ENABLED).
Key ∨ and the following screen is displayed:

```
LOG DATA:       ENABLED
LOG PERIOD:     00:00:05
TAG #:                13
AUTO START:  DISABLED
```

The cursor in this line indicates that logging period can be selected (to any period between 1 second to 4 hours). The value of the flashing digit can be changed up or down by keying **+** or **-**, respectively. To change from one significant digit to another, key either **>** or **<**.

To select another tag number (the one displayed automatically is always the next one available, e.g., in this case, 12 tags would have been used already, and tag # 13 is the next one available), key ∨ and the cursor will be on one of the tag # digits. Change/select as desired, or leave unchanged.

The last line of the logging parameters allows for programming a specific start time and date for logging the data (the DataRAM 4 must be operating in the run mode to effect such delayed logging). If the automatic start is disabled (as shown in the above screen) and logging has been enabled, then the logging of data starts as soon as a measurement run is initiated (see Section 9.6). If the user desires to start the logging at a later time (or date), the cursor should be moved to the last line and use either the **+** or **–** keys to enable the logging auto start function (toggling between enabling and disabling is accomplished by these same keys). If this function is enabled, the following screen is displayed:

```
LOG DATA:       ENABLED
LOG PERIOD:     00:00:05
TAG #:                13
AUTO:        16:25 JAN 17
```

As usual, the desired time and date for the automatic start of logging can be selected as described previously.

To return to the EDIT MENU screen, key **EXIT**.

9.4 Selecting Set-Up Parameters

To select operating parameters, set time and date, etc., key ∨ to select SETUP PARAMETERS on the EDIT MENU. Key **ENTER** and the first of 4 set up parameters screen is displayed:

```
DISPLAY AVG:       10 SEC
CAL FACTOR:          1.00
UNITS:       (MASS) ug/m3
SIZE CORRECT:    DISABL
```

As described before, the numerical values are changed by using the **+** and **–** keys, selecting significant digits by using the **>** and **<** keys, and selecting lines by using the∨ and ∧ keys. Toggling or scrolling the units of the third line, or enabling/disabling the relative humidity correction algorithm of the fourth line are performed using the **+** and **–** keys.

The **display averaging time** (first line) determines the smoothing of the displayed measurement values. This time can be selected between 1 and 60 seconds. Short averaging times provide faster response but noisier (more fluctuating) data. Conversely, long averaging times slow down time response but provide smoother (less fluctuating) data.

The **calibration factor** (second line) is the multiplier of the calibration slope programmed at the factory. A factor of 1.00 indicates that the calibration slope is identical to that programmed at the factory. This factor can be changed to agree with a user calibration (see Section 13.2).

The **measurement parameters (units)** can be selected on the third line. The selection alternatives are: mass concentration in $\mu g/m^3$, scattering coefficient in $(Mm)^{-1}$, or visual range in kilometers.

The **particle size correction** refers to the computation of the mass concentration. When this function is enabled, the measured mass concentration automatically takes into account the volume median particle diameter determined in real time from the ratio of the scattering irradiances at the two wavelengths of illumination of the DataRAM 4. When this function is disabled, the monitor behaves as a single wavelength (880 nm) nephelometer with its characteristic size dependence (similar to that of the DataRAM, model DR-2000).

The second set up screen can be displayed by keying **NEXT**:

```
RH CORRECT: DISABL
TEMPERATURE UNITS: C
FLOW RATE:  2.00 LPM
```

The first line of this screen refers to the **relative humidity correction**. When this function is enabled, the particle growth effect due to a high humidity environment is corrected for. This means that the computed mass concentration is based on the original dry environment particle population. This correction only applies when mass concentration units have been selected, but not when scattering coefficient or visual range has been selected.

The indicated **temperature units** can be selected between degrees Celsius (°C) and degrees Fahrenheit (°F).

The air sampling **flow rate** of the DataRAM 4 can be adjusted over the range of 1.00 to 3.00 liters per minute (LPM). The nominal operating flow rate is 2.00 LPM. What ever the selected flow rate, it will be maintained at a constant volumetric rate during the measurement run regardless of any changes in the system flow resistance, up to a maximum pump load.

Key **NEXT** to view the following screen:

```
ANLG OUT:      4.00 mg/m3
SERIAL MODE:     RS-232

DEVICE #:           124
```

The first line refers to the full-scale concentration of the **analog output** signal (0 to 5 V and 4 to 20 mA) available at the back panel of the DataRAM 4. The full-scale concentration ranges that can be selected (if mass concentration units are selected) are: 0.1, 0.4, 1, 4, 10, 40, 100 and 400 mg/m^3. If scattering coefficient units are selected, the ranges are: 10, 100, 1,000, 10,000 and 100,000 (Mm)$^{-1}$. If visual range has been selected the full scale range is fixed at 500 km.

The **serial mode** of digital communication can be selected on the second line between RS-232 and RS-485.

The last line is an **identification number** that the user can select to label this particular DataRAM 4 for future reference. This number will accompany the logged data information.

The next set up screen can be displayed by keying **NEXT**:

```
16:49:11        10 May 2000
TIME                 16:48:55
DATE            10 May 2000
TO SET PRESS => ENTER
```

This screen is used to set the **time and date**, should these require resetting. The first line indicates the time presently registered by the DataRAM 4. The second is the time editing line. To set the time accurately, select a time (on the second line) that is slightly ahead of the actual time (e.g., by 30 seconds) and select the seconds as a multiple of 10. In the U.S., it is convenient to dial 1-900-410-8463 (U.S. Naval Observatory time information), and at the instant when the time announced equals the time preset on the second line of the above screen, key **ENTER**, as instructed on the last line.

To display the next set up screen, key **NEXT**:

```
ALARM            ENABLED
LEVEL (ug/m3)       1000
AUTO ZERO       ENABLED
INTERVAL          48 hrs
```

The first line of the above screen allows enabling or disabling of the alarm function. When the flashing marker is on that first line it is possible to toggle between those two conditions by keying either **+** or **-**. The alarm level in the units of micrograms per cubic meter can be selected on the second line.

The third line of the above screen allows enabling or disabling of the automatic zeroing function whereby the DataRAM 4 automatically purges itself with particle-free air, and registers and then subtracts its optical background from all subsequent measurements. The fourth line allows for the selection of the time interval in hours (in one-hour steps up to 200 hours) between consecutive automatic zeroings.

To return to the MAIN MENU screen, key **EXIT**.

9.5 Review or Transfer Stored Data

To access stored data either for viewing on the DataRAM 4 screen or for transfer to a PC or other external device, select the VIEW/TRANSFER DATA line on the MAIN MENU, and then key **ENTER**. The following screen appears:

```
TAG # 12
> VIEW LOGGED DATA
> TRANSFER TEXT FILE
> DELETE LOGGED DATA
```

The above screen provides a selection of commands with respect to the last logged run (e.g., tag # 12). To select the contents of another tag, select the appropriate number, using the **+ - > <** key strokes, as described previously.

To review the data logged for a selected tag #, key ∨ to select the VIEW LOGGED DATA line, then key **ENTER** and the following screen appears:

```
TAG # 12        43 POINTS
START   11:23  09 May 00
END     11:27  09 May 00
LOG PERIOD      00:00:06
```

The above screen is the first of two available **tag summary** screens. The first line identifies the tag # and the number of data points logged during that run. The second line provides the run start time and date. The third line indicates the end time and date for that run. The fourth line indicates the logging period use during that run. For the above example, 43 data points of 6 seconds each were logged between 11:23 and 11:27 on May 9, 2000.

Keying **NEXT** displays the second tag summary screen:

```
TAG # 12        43 POINTS
AVG SCATR       0.00 1/Mm
MAX 207.33 11:23 09 May
AVG. DIA:       0.653 um
```

The first line of the above screen repeats the information of the first tag summary screen. The second line indicates the average measured value for that run. This average is given in whatever units were selected originally on the first set-up screen (Section 9.4). The third line indicates the maximum registered instantaneous value in the same selected units, and the time and date when this maximum occurred. The last line indicates the average volume median particle diameter in micrometers for that run.

In order to review the individual **data points** within a tag, key **NEXT** and the following screen is displayed:

```
TAG # 12       POINT #     1
11:23:20   09 May 2000
171.46 1/Mm     D = 0.40
um
```

The first line indicates the tag # and the point # within that run, the second line is the time and date of that point, the third line indicates the average measured valued and the average volume median particle diameter for that logging period, and the last line indicates the corresponding temperature and relative humidity values.

Keying **+** advances the point # scrolling the screens through all data points within the selected tag # or run.

Keying **NEXT** returns the screen to the first tag summary table then, keying **EXIT** returns to the VIEW/TRANSFER DATA screen (i.e., the first screen of this section).

In order to delete (erase) logged data, select the DELETE LOGGED DATA line from the VIEW/TRANSFER DATA screen, and key **ENTER**. The following screen appears:

```
DELETE LOGGED DATA
    TAG # 01
> DELETE TAG DATA
> DELETE ALL DATA
```

Select either DELETE TAG DATA or DELETE ALL DATA, as preferred. In the first case, only the data in the selected tag # are erased from memory, whereas in the second case all stored data are erased. After the appropriate selection of the data to be deleted, key **ENTER**, and the following screen is displayed (as an example it is assumed that only the data of tag #1 are to be erased):

```
DELETING LOGGED DATA
    TAG # 01
  ENTER TO CONFIRM
   EXIT TO CANCEL
```

To confirm the deletion command, key **ENTER**, or to rescind the deletion command, key **EXIT**. If **ENTER** is keyed, the following screen is displayed:

```
TAG # 01
HAS BEEN DELETED
PRESS ANY KEY
```

After confirmation that the data have been deleted, pressing any key (e.g., **EXIT** or **NEXT**) reverts the display to the DELETE LOGGED DATA screen if not all the data have been erased. Otherwise, the VIEW/TRANFER DATA screen appears.

9.6 Run Start

From the MAIN MENU (see Section 9.1), select START RUN. When ready to initiate the run, key **ENTER**, and one of the following types of screen appears (depending on which measurement units were selected in the set-up procedure described in Section 9.4):

```
16:08:09        10 May 2000
 CONC:            5.7 ug/m3
 TWA:            11.0 ug/m3
RUN TIME:     00000:02:25
```

or:

```
16:08:09        10 May 2000
 SCATR:          10.33 1/Mm
 TWA:             6.83  1/Mm
RUN TIME:     00000:02:25
```

or:

```
16:08:09        10 May 2000
 RANGE:           17.6 km
 TWA:             15.2 km
RUN TIME:     00000:02:25
```

It should be remembered that the measurement units can only be selected in the set-up mode and not during a run.

The first line of the above run measurement screen shows the real time (24-hour format) and date. The second line displays the real-time (instantaneous) measurement value (mass concentration, or scattering coefficient, or range, depending on the selected units) updated every second. The third line displays the time-weighted average measurement value (TWA) from run start, in whatever units were selected. The last line shows the elapsed run time in hours, minutes and seconds.

In order to view the other run parameters and diagnostic information, key **NEXT** and the following screen appears if the charger/power supply is **not** connected and the DataRAM 4 is being powered by its internal battery.

```
MEMORY LEFT          87%
BATT. LEFT           76%
FLOW RATE       1.99 LPM
TEMP= 25.3C     RH= 59%
```

If the DataRAM 4 is being powered by its charger/power supply, this screen will automatically display the charging current:

```
MEMORY LEFT          87%
BATT. CHARGE     326 mA
FLOW RATE       1.99 LPM
TEMP= 25.3C      RH= 59%
```

Key **NEXT** again and the following screen appears:

```
FLOW:              NORMAL
SOURCE 1:          NORMAL
SOURCE 2:          NORMAL
DETECTOR:         NORMAL
```

If any of the above functions or components is not operating correctly, the corresponding message will change from NORMAL to FAULT.

Key **NEXT** again and the following screen will be displayed:

```
SCATR PARAMETERS
PAR SCAT RATIO     0.5133
ANGSTROM COEF:     2.336
PARTIC. DIA:       0.454 um
```

The above screen shows the scattering parameters and the computed volume median particle diameter in micrometers. The SCA RATIO value is the ratio of the scattering irradiances detected at the two internal source wavelengths, i.e., at 880 nm and at 660 nm, respectively. If mass measurement units are selected (see Section 9.4), the second line of the above screen will display PAR SCAT RATIO which means that the indicated ratio is that due to particle scattering alone. If scattering coefficient or visual range units have been selected (see Section 9.4), that second line will read TOT SCAT RATIO, i.e., the ratio due to particle plus air scattering. The Ångström coefficient is the exponent that defines the wavelength-dependence of the scattering irradiance. This coefficient varies between 4 for pure Rayleigh scattering (molecular scattering), and 0 for wavelength-independent geometric scattering.

9.7 Run Termination

To terminate a run key **EXIT**. The following screen will then appear:

```
TERMINATE RUN ?

TERMINATE:     => ENTER
CANCEL:        =>    EXIT
```

To confirm the run termination, key **ENTER**. To continue the current run, key **EXIT**. If **ENTER** is keyed, the DataRAM 4 performs a purging operation for about 1 minute, and then displaying the initial MAIN MENU screen from which a new run can then be started. A new run can be started during the 1-minute purging cycle, thus interrupting that cycle. Alternatively, if during this purging period (following run

termination) the **OFF** key is pressed, the purging operation will continue while the following screen will appear indicating the countdown time in seconds for the completion of the purging cycle. At the end of that period the DataRAM shuts off automatically.

```
TURN POWER OFF ?
            PURGING:    39
POWER OFF:    => ENTER
CANCEL:         =>    EXIT
```

If **EXIT** is keyed while the above screen is displayed, the MAIN MENU screen will appear and remain after the purging has been completed. If the **OFF** key is then pressed the DataRAM 4 will shut off without further purging since the instrument had already purged itself.

9.8 Resetting and Defaults

The DataRAM 4 memory can be reset through commands entered on its keypad, as follows:

- Starting with the DataRAM 4 shut off, press the EXIT and ENTER keys at the same time, and while holding down those two keys, press ON;
- The screen will then indicate DataRAM 4 SELF-TEST followed in rapid succession by several diagnostic screens, ending with TESTING COMPLETE;
- Shut off unit. When turned on again, the DataRAM 4 memory will have been reset.

Resetting, as described above, accomplishes the following:

- Erases all stored (logged) data from memory;
- Resets all parameters and operating conditions to their default values and conditions (see below); and
- Cancels the zero correction offset.

The **default** values and operating conditions of the DataRAM 4 are:

- Logging period (LOG PERIOD): 60 seconds
- Logging status: disabled (LOG DATA: DISABLED)
- Alarm level (LEVEL): 1 mg/m^3
- Alarm status: disabled (ALARM: DISABLED)
- Analog output full scale: 1 mg/m^3
- Measurement units (UNITS): MASS
- Calibration factor (CAL FACTOR): 1.00
- Real-time display averaging time (DISPLAY AVG): 10 seconds
- Flow rate: 2 liters/minute
- Temperature units: C
- Particle size correction ((SIZE CORRECT): disabled (DISABL)
- Humidity correction (RH CORRECT): disabled (DISABL)
- Auto zero: disabled (DISABL)
- Serial port output format (SERIAL MODE): RS-232
- Data output mode (DATA OUT): continuous

When turning on the DataRAM 4 after resetting the instrument, it will automatically go to the zeroing mode. The DataRAM 4 will not measure (operate in the run mode) unless an initial zeroing operation has been completed.

10.0 ANALOG SIGNAL OUTPUT

10.1 Analog Output Description

The DataRAM 4 incorporates the capability to provide both a voltage and a current signal output directly proportional to the sensed concentration of airborne particulates. Both these analog signal outputs are concurrently available. These outputs are provided, principally, for fixed-point applications with hard-wired installations.

The particulate concentration range corresponding to the output voltage and current ranges (0 to 5 V and 4 to 20 mA) can be user selected on the DataRAM 4 screen (see Section 9.4) or via a PC using the communications software package included with the instrument. The most sensitive range available is 0 to 0.100 mg/m^3 (0 to 100 μg/m^3), and the least sensitive range is 0 to 400 mg/m^3. For example, if the user selects the analog output range of 0 to 0.400 mg/m^3 then the analog output signal levels, at a concentration of 0.200 mg/m^3, would be 2.5 V and 12 mA.

This concentration range is independent of the digital display, data logging and real-time digital output range which are controlled automatically (auto-ranging).

10.2 Analog Output Connection

For the 0 – 5 V output signal, the externally connected load must have an impedance of more than 200 kilo-ohms. For the 4 – 20 mA output signal, the externally connected load must have an impedance of less than 300 ohms.

Since both voltage and current outputs are present at the same time, both can be used concurrently, if so required.

The accuracy of the analog output signals is better than 1% of the reading with respect to the digital reading.

The 4 to 20 mA current output is available between pins # 1 and 4 of the 5-pin ANALOG OUTPUTS connector on the back panel (see Section 5.2). The 0 to 5 V analog voltage output is available between pins # 2 and 4 of that connector. Pin # 4 is common ground.

11.0 ALARM

11.1 Alarm Description and Operation

There are two alarm outputs available on the back panel of the DataRAM 4: a switching alarm and a voltage alarm. The switching alarm output is capable of sinking a current of up to 2.5 amperes to ground. The voltage alarm output goes from 0 to 5 volts when the alarm is triggered. Whenever the alarm is triggered, the on-board sound will be activated.

The alarm function can be enabled/disabled and the alarm level (trigger threshold) can be selected by the user through the DataRAM 4 keyboard (see Section 9.4).

The alarm is triggered whenever the selected alarm level is exceeded. When the displayed concentration falls below that level the alarm conditions stops. While the alarm is on, the user can disable it momentarily by pressing any key on the DataRAM 4. If the concentration continues to exceed the set alarm level after 10 seconds, the alarm condition will be reactivated.

11.2 Alarm Output Connection

There are two alarm outputs on the DataRAM 4:

a) **Switching alarm**. This alarm is available between the two upper terminals of the 4-terminal block on the upper right side of the back panel. The right-most terminal is ground and the left terminal is normally open. When the alarm level is exceeded, this latter terminal becomes grounded. A maximum load current of 2.5 A is allowed.

b) **Voltage alarm**. This alarm signal is available between pins # 3 and 4 on the ANALOG OUTPUTS connector in the upper middle of the back panel. This output consists of a voltage that steps from 0 to 5 V whenever the alarm is triggered. The minimum external load impedance for this output is 10 kilo-ohms.

12.0 MAINTENANCE

12.1 General Guidelines

The DataRAM 4 is designed to be repaired at the factory. No user serviceable components are inside the metal enclosure of the DataRAM 4 with exception of the filter cartridge or the analytic filter holder. Access to the internal components of the unit by others than authorized MIE personnel voids warranty.

Unless a MALFUNCTION message is displayed, or other operational problems occur, the DataRAM 4 should be returned to the factory once every two years for routine check out, test, cleaning and calibration check.

12.2 Battery Charging and Cycling

If the DataRAM 4 is to be operated without its charger/power supply, i.e., deriving power from its internal battery, this battery should be fully charged before initiating a run. The DataRAM 4 charger/power supply can be connected continuously to the instrument whether the DataRAM 4 is on or off. If the charger/power supply is not connected, the internal battery will discharge very slowly depending on storage temperature. Low storage temperature reduces battery capacity. High storage temperatures, however, reduce battery life which is of the order of 8 years at 20°C (68°F), and only 2 years at 40°C (104°F).

In general, the user should maintain the battery charge as high as possible in order to extend its charge/discharge cycling capacity (this characteristic differs from that of nickel-cadmium batteries).

12.3 Instrument Storage

If the DataRAM 4 is to be stored for an extended period of time (i.e., 3 months or more), place the 3-position switch on the back panel in its OFF position (mid-position), in order to minimize gradual battery discharge. This will have no effect on data retention or internal clock function. It is recommended, however, that the battery be recharged every 3 months in order to prolong battery life (see Section 6.1).

During storage always snap on quick-connect cap over the instrument inlet to protect the sensing optics from gradual dust contamination. Store DataRAM 4 in a dry environment.

12.4 Filter Replacement

To replace either of two types of filters used with DataRAM 4, place the instrument on its back rubber feet (front panel facing upward). On the bottom surface of the

DataRAM, locate the large threaded plastic filter cover and holding the cross bar, rotate this cover counterclockwise. Remove cover and the filter holder within the open cavity.

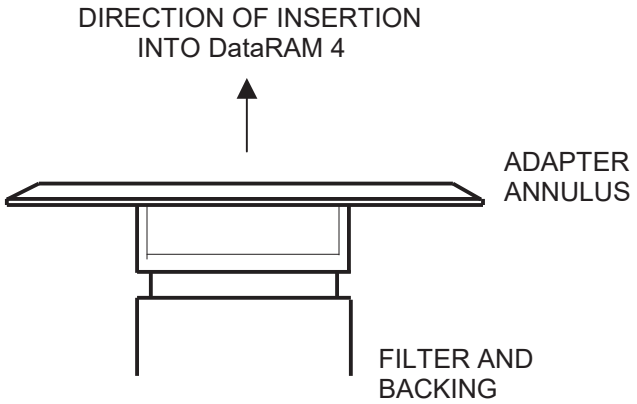
12.4.1 HEPA Filter Cartridge Replacement

The DataRAM 4 is shipped from the factory with the HEPA filter cartridge installed. This cartridge can be identified by its metallic cover. Remove this cartridge as indicated in Section 12.4, above. Clean the internal black rubber gasket against which the cartridge is normally compressed. Install new HEPA-type cartridge (MIE part no. MSA-95302) by inserting its wider ridged end first. Reposition threaded plastic cover engaging threads carefully; rotate cover clockwise, hand tightening firmly. Properly dispose of used cartridge to prevent inadvertent re-use.

12.4.2 Analytic Filter Installation/Replacement

In order to install or replace the analytical filter holder, proceed as follows. Remove the HEPA cartridge normally in place, as described in Section 12.4.1. Remove (separate) the inlet cover (with the blue plug) of the Millipore plastic filter holder from the rest of that holder assembly containing the white membrane filter. Insert firmly the gray plastic adapter annulus into the open face of the filter holder assembly, as shown in Figure 4. Remove the red plastic plug from the exhaust nipple of the filter holder assembly. Ensure that all three components of the holder assembly are fully compressed to preclude any leafage. Insert the assembly into the filter cavity of the DataRAM 4 with the gray plastic adapter annulus bearing against the internal black gasket (adapter annulus inserted first). Reposition threaded plastic cover and hand-tighten carefully and firmly. Set aside HEPA cartridge for future use.

In order to remove and/or to replace the membrane filter within its holder, remove the gray plastic adapter annulus and separate (pry apart) the two transparent plastic rings that compress the membrane filter. Make sure to remove and replace only the membrane filter (using tweezers), leaving the white backing disc in the holder. A new membrane filter should then be placed over that backing and the sealing ring should then be inserted to trap and compress the filter and backing discs. For storage, the inlet cap with the blue plug should be inserted as well as the red plug on the back of the filter holder.



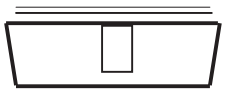


Figure 4. Analytical filter holder with adapter annulus inserted

12.5 Cleaning of Optical Sensing Chamber

Although the DataRAM 4 incorporates filtered air shielding of the critical optical sensing surfaces, continued sampling of airborne particles at high concentrations may result in gradual build-up of contamination on those interior surfaces of the sensing chamber components. This may cause an excessively high optical background level. If this background level does becomes excessive, the DataRAM 4 will alert the user at the completion of the zeroing sequence, as indicated in Section 9.2 by the display of a BACKGROUND HIGH message. If this message is presented, the DataRAM 4 can continue to be operated providing accurate measurements. However, it is then advisable to clean the front surfaces of the optical lenses within the sensing chamber at the first convenient opportunity, as described below. The tools required for this cleaning are: an intense concentrated light source (e.g., flash light) to view the inside of the sensing chamber, denatured alcohol, a soft lint-free cloth, and the special cleaning tool provided with the DataRAM 4 consisting of a cut-off cotton swab inserted in a plastic sleeve and held by a right-angle Allen wrench (see Fig. 5).

Proceed as follows to clean the lens surfaces within the sensing chamber:

- ***Make sure to shut off power completely before proceeding with cleaning***

- Install the stainless steel cover on the inlet of the DataRAM 4 to protect this fitting.
- Place the DataRAM 4 upside down on a table, resting the instrument on the inlet cover and the rear protective bumper.
- Unscrew the gray plastic cover of the filter cavity on the bottom surface of the DataRAM 4.
- Remove the filter cartridge from its cavity.
- Carefully clean the black soft filter-sealing gasket within the filter cavity by wiping it with the lint-free soft cloth. Use alcohol if necessary.
- Shine the concentrated light source into the sensing chamber located about 3 cm (1¼ in.) beyond the soft-sealing gasket in the filter cavity.
- Using the layout of the Figure 5 as a guide, locate the three smaller side cavities inside the sensing chamber, identified by the arrows on that figure. These three cavities contain the lenses of the two sources and the common detector of the DataRAM 4. The frontal surfaces of these lenses are likely to require cleaning if the instrument indicates BACKGROUND HIGH.
- Wet the cotton swab of the lens-cleaning tool with alcohol (e.g., methanol, ethanol, or rubbing alcohol).

- Holding the cleaning tool by its long handle, insert this tool into the sensing chamber without touching the walls of this chamber.
- Direct the cotton swab tip towards the opening of one of the three smaller cavities as indicated by the arrows of Figure 5, and insert the cotton tip into this cavity as far as it will go. Gently wipe that internal surface touched by the swab tip by a rotating motion. Carefully withdraw the swab tip from the cavity.
- Repeat previous cleaning step for the other two small cavities as indicated by the arrows of Figure 5.
- Carefully remove the cleaning tool from the sensing chamber. Allow the alcohol to dry leaving the filter cavity open for about 15 minutes.
- Re-insert the filter cartridge into its cavity and close it with its gray plastic cover, hand-tightening it firmly. Remove the inlet cap and store on its pod on the back panel.
- Place the DataRAM 4 right side up and key **ON**. Proceed to check its optical background by running the ZERO/INITIALIZE check as described in Section 9.2. The message READY! should appear at the end of this check indicating that the lens contamination has been eliminated. Should the message BACKGROUND HIGH persist after completion of the above-described lens cleaning procedure, please contact the factory.

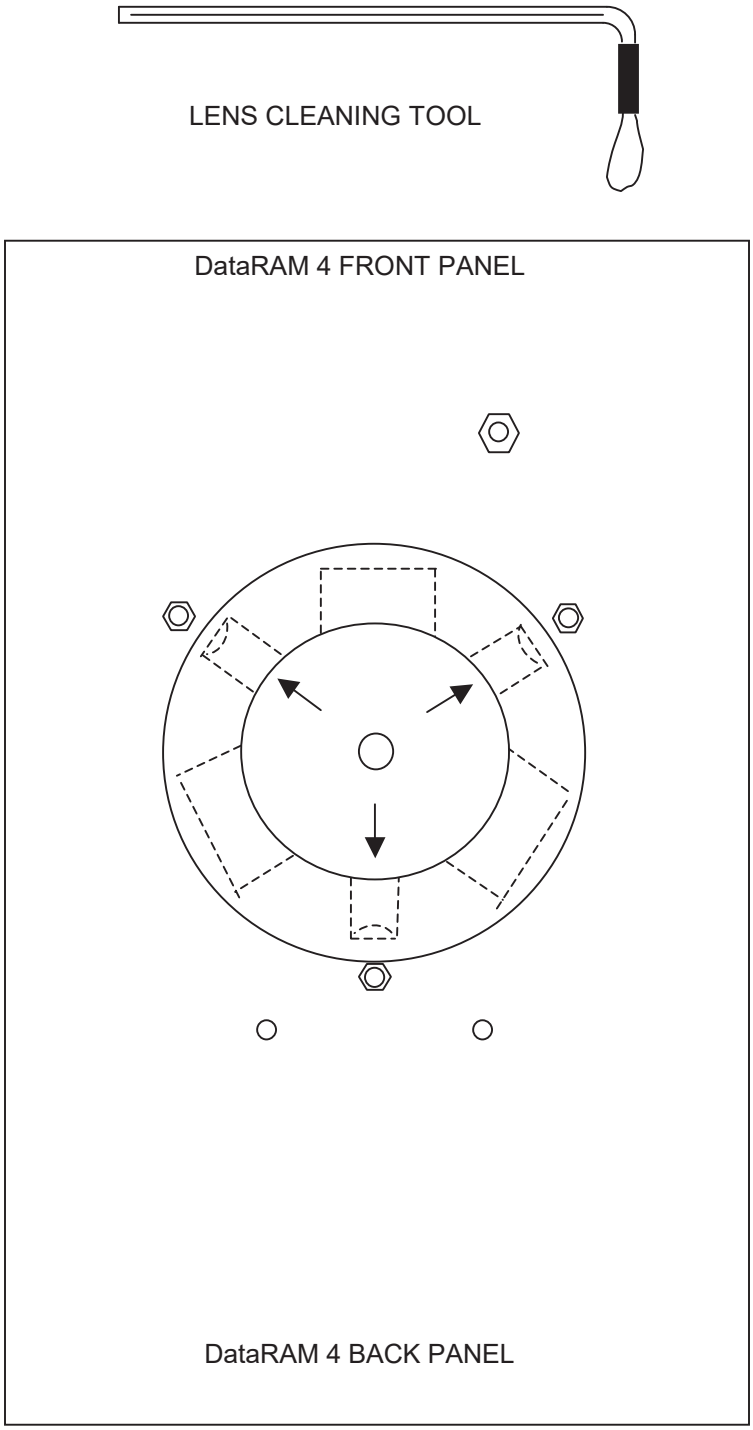


Fig. 5. Lens cleaning tool and bottom view of open filter cavity showing location of sensor chamber lens cavities (arrows).

13.0 CALIBRATION

13.1 Factory Calibration

For mass concentration measurements, each DataRAM 4 is factory calibrated against a set of reference monitors that, in turn, are periodically calibrated against a gravimetric standard traceable to the National Institute of Standards and Testing (NIST).

The primary factory reference method consists of generating a dust aerosol by means of a fluidized bed generator, and injecting continuously the dust into a mixing chamber from which samples are extracted concurrently by two reference filter collectors and by two master real-time monitors that are used for the routine calibration of every DataRAM 4.

The primary dust concentration reference value is obtained from the weight increase of the two filters due to the dust collected over a measured period of time, at a constant and known flow rate. The two master real-time monitors are then adjusted to agree with the reference mass concentration value (obtained from averaging the measurements of the two gravimetric filters) to within ±1%.

Three primary, NIST traceable, measurements are involved in the determination of the reference mass concentration: the weight increment from the dust collected on the filter, the sampling flow rate, and the sampling time. Additional conditions that must be met are: a) suspended dust concentration uniformity at all sampling inlets of the mixing chamber; b) identical sample transport configurations leading to reference and instrument under calibration; and c) essentially 100% collection efficiency of filters used for gravimetric reference for the particle size range of the test dust.

The test dust used for the MIE factory calibration of the DataRAM 4 is SAE Fine (ISO Fine) supplied by Powder Technology, Inc. It has the following physical characteristics (as dispersed into the mixing chamber):

- Mass median aerodynamic particle diameter: 2 to 3 µm
- Geometric standard deviation of lognormal size distribution: 2.5
- Bulk density: 2.60 to 2.65 g/cm^3
- Refractive index: 1.54

In addition to the mass calibration described above, the DataRAM 4 is factory calibrated using a gas with known scattering coefficient in order to adjust the relative scattering irradiance at the two source wavelengths.

13.2 Field Gravimetric Calibration

If desired, the DataRAM 4 can be calibrated gravimetrically for a particular aerosol (dust, smoke, mist, etc.) under field conditions (actual conditions of use).
To effect such calibration in the particle environment of interest, proceed as indicated below:

- Weigh and load into the analytical filter holder a fresh membrane filter (see Section 12.4.2).
- Start measurement run.

The duration of this comparison run should be sufficient to collect a mass of at least 1 mg on the reference filter (in order to permit accurate weighing of the collected mass by means of an analytical balance). The time-weighted average (TWA) reading of the DataRAM 4 can be used to estimate the required sampling time to collect the above-mentioned mass on the filter. To estimate the required sampling time (RUN TIME as measured on the DataRAM 4) in minutes, read the TWA value (see Section 9.6) after a RUN TIME of one minute or more, and apply the following relationship:

$$\text{RUN TIME} \geq 500/\text{TWA}$$

For example, if TWA = 2.5 mg/m^3, then RUN TIME $\geq$ 200 minutes (approximately 3 hours). If the TWA value changes significantly as the run proceeds, recalculate the required RUN TIME accordingly.

At the end of the run record TWA (in mg/m^3), RUN TIME (in minutes), and the flow rate Q (in liters per minute) used to sample the air. Weigh the filter on an analytical balance and obtain Δm, the mass increment due to the collected particles. Calculate the average gravimetric concentration C, as follows:

$$C = 1000\ \Delta m\ /\ [(\text{RUN TIME}) \times Q]$$

Compare the recorded value of TWA and the calculated value C, and calculate the calibration factor to be programmed into the DataRAM 4 (see Section 9.0) as follows:

$$\text{CAL FACTOR} = C / \text{TWA}$$

For example, if C was found to be 3.2 mg/m^3, and TWA had been determined to be 2.5 mg/m^3, the CAL FACTOR equals 1.28. Select this value on the DataRAM 4 screen (or on the PC), as described in Section . This completes the gravimetric calibration of the DataRAM 4 for a specific aerosol.

14.0 COMMUNICATIONS WITH COMPUTER

14.1 Computer Hardware and Software Requirements

The computer requirements to install and run the software provided with the DataRAM 4 (MIE DR4-COM) are the following:

- IBM-PC compatible
- Pentium I or higher processor

- Minimum operating system: Windows 95™ or better
- 32 MB of RAM
- 8 MB hard disk drive
- 3.5” floppy drive
- VGA or higher resolution monitor

MIE custom hardware and software provided with DataRAM 4 as standard accessories:

- Digital communications cable (MIE model DR-DOC))
- Software floppy disk (3.5”, MIE model DR4-COM)

14.2 Software Installation Procedure

To install the MIE provided software (DR4-COM) in the computer, proceed as follows:

- Insert the 3.5” disk labeled DR4-COM into the computer;
- Select **Start** and then **Run** on the computer screen;
- Type in on the **Command Line: a: install** (or **b: install**, as required);
- The computer displayed install shield then serves to guide the rest of the installation.

14.3 Communication Between DataRAM 4 and Computer

To effect the communication between the DataRAM 4 (via the DR4-COM software installed in the computer as described in the preceding section) and the PC proceed as follows:

- Connect the DataRAM 4 to one of the computer’s serial ports using the DR-DOC cable provided by MIE. This cable has a 9-pin female connector for the computer port.
- Key **ON** the DataRAM 4. Select the ZERO/INITIALIZE line on the MAIN MENU screen and key **NEXT** to display the EDIT MENU screen. Then select the SETUP PARAMETERS line and key **ENTER**. Key **NEXT** repeatedly until SERIAL MODE appears. Select RS-232 if this has not been selected already.
- On the computer, double click on the **DR4-COM** icon. A multi-tabbed notebook display should appear on the computer screen. From the Menu Bar, select **Settings** and **Select Serial Port.** Select the port to which the DR-DOC cable has been connected. From the multi-tabbed notebook displayed on the computer screen select the tab with the desired option. The options are:

  - **Main**: This page allows the user to Device Filter and to operate the DataRAM 4 through the serial port;
  - **Logged data**: This page allows the user to download, tabulate, print data, or transfer to a CSV file the data stored in the DataRAM 4. This page also

serves to display real-time numerical data when the computer is connected to the DataRAM 4 in the Run Mode of the instrument;

- **Graph data**: This page enables the downloading and graphing of stored data to the computer screen and to a printer. In the Run Mode, this page displays the real-time data in graphic format;
- **Configure instrument**: This screen allows the user to edit the operating/logging parameters. Click on the item to be edited and select or type in the new value. To review the parameter values currently programmed into the DataRAM 4, click on **Get configuration**. After editing the parameters, click on **Set configuration** to input the newly selected values into the DataRAM 4.

Most operations with the DR4-COM software program are self-evidently labeled, including fly-over dialog boxes. In addition, instructions may be found in the On-line Help files by selecting **Help** and then **Contents**.

The following operating/logging parameters of the DataRAM 4 can be selected (edited) via the computer:

- Current date (year, month and day of the month)
- Current time (hour, minute and second)
- Display averaging time (1 to 60 seconds, in 1-second increments)
- Calibration factor (0.01 to 9.99, in 0.01 increments)
- Analog output full scale concentration (0.1, 0.4, 1, 4, 10, 40, 100, or 400 mg/m^3
- Analog output status (enabled or disabled)
- Alarm level (0.001 to 409.5 mg/m^3, in 1-μg/m^3 increments)
- Alarm status (enabled or disabled)
- Particle size correction (enabled or disabled)
- Humidity correction (enabled or disabled)

The serial number of the DataRAM 4 is transferred automatically to the PC and displayed on the screen.

The year is to be entered as a two-digit number. Leap years are treated correctly until the end of the 21st century.

14.4 Real-Time RS-232 Output

During the RUN mode the DataRAM 4 can communicate real-time concentration data through its serial port via the DR4-COM software package. This software application decodes the data and displays it on the computer screen in both graphical and tabulated form.

In order to use this output with some other application, the following information will enable the user to decipher the encoded output signal. The communication settings for the digital output of the DataRAM 4 are:

- Baud rate: 9,600
- Data bits: 8
- Stop bits: 1
- Parity: none
- Flow control: Xon/Xoff

14.5 Serial Communications Protocols of the DataRAM 4

The DataRAM 4 has two serial ports. These are RS-485 or RS-232. Only one can be active at a time. The active port is selected via the setup screen of the DataRAM 4 (see Section 9.4).

The RS-232 port is for direct connection of a single DataRAM 4 to a PC's comport as described in Sections 14.1 through 14.4.

The RS-485 port is intended for connecting the DataRAM 4 to a "2-wire" network of DataRAM 4's. If there is more than one DataRAM 4 on the network each unit will need to have a unique device number. A PC can be attached to the network with a RS-232/RS-485 interface. The PC will be the master and the DataRAM 4s are all slaves. The interface needs to be set as DCE and support the T-RTS/R-~RTS protocol. (The interface transmitter is turned on with RTS from the computer). The RS-485 runs at 9600 baud.

The communications protocol is the same for both RS-485 and RS-232. It is a TTY type protocol. (i.e., not encoded; communication to a DataRAM 4 is performed with a simple terminal program.) The master PC sends a single line command terminated with a **<cr>.** A slave DataRAM 4 answers the command with possibly many lines, ending with the signal character of "**>**". The master times out after 2 seconds if there is no response from a slave.

The command format follows this general pattern:

<addr> <command> <parameter(s)> <cr>

<addr> is a numeric DataRAM 4 address, 1-125. Only the device named in the address is allowed to respond. This address is required for a network setup. If there is only one device on the network or if RS-232 is being used, then the **addr** can be either blank or "0". Then that device will answer, whatever its number.

<command> is a one keyword command. The commands recognized are listed in Appendix A. Mostly these pertain to setup variables in the DataRAM 4.

<parameters> depend on the command.

The response format will generally repeat the address and command and then follow with the DataRAM 4's current settings.

For example:

- The master PC sends: 27 backlight<cr>
- DataRAM 4 #27 responds: 27 backlight enabled<cr>> (note the following ">")
- The master PC sends: 27 backlight off<cr>
- DataRAM 4 #27 responds: 27 backlight disabled<cr>>

APPENDIX A

LIST OF REMOTE DIGITAL COMMANDS

Please contact MIE for information on external commands to control operation of the DataRAM 4 and to retrieve data.

APPENDIX B

PRINCIPLE OF OPERATION OF THE DataRAM 4

General Description

The DataRAM 4 is a two-wavelength nephelometer (light scattering photometer) with active air sampling (i.e., using an internal pump). The patented optical system (US Patent No. 6,055,052) incorporates two sources of illumination (light emitting diodes). One of these emits at a peak wavelength of 660 nanometers (red) and the other at 880 nanometers (near infrared). The light beams from these two sources is collimated by means of corresponding lens systems such that these beams illuminate the same axial portion of the air flow duct. Figure 1B depicts the sensing configuration of the DataRAM 4.

The axes of the two source beams are angularly symmetrical with respect to the axis of a common detector (silicon-hybrid preamplifier type) that senses the light scattered by particles passing through the illumination beams. The two sources are alternatively activated at a frequency of 27 pulses per second, i.e., only one source

is turned on at a time. The detector output signal is gated in synchronism with the alternating source pulses, providing two signal channels, one for each wavelength.

The scattering angle for both source-detector combinations is centered on 60° (±18°) with respect to the forward direction of the two beams.

MIE

Figure 1β

DataRAM 4 Two-Wavelength Portable Nephelometer

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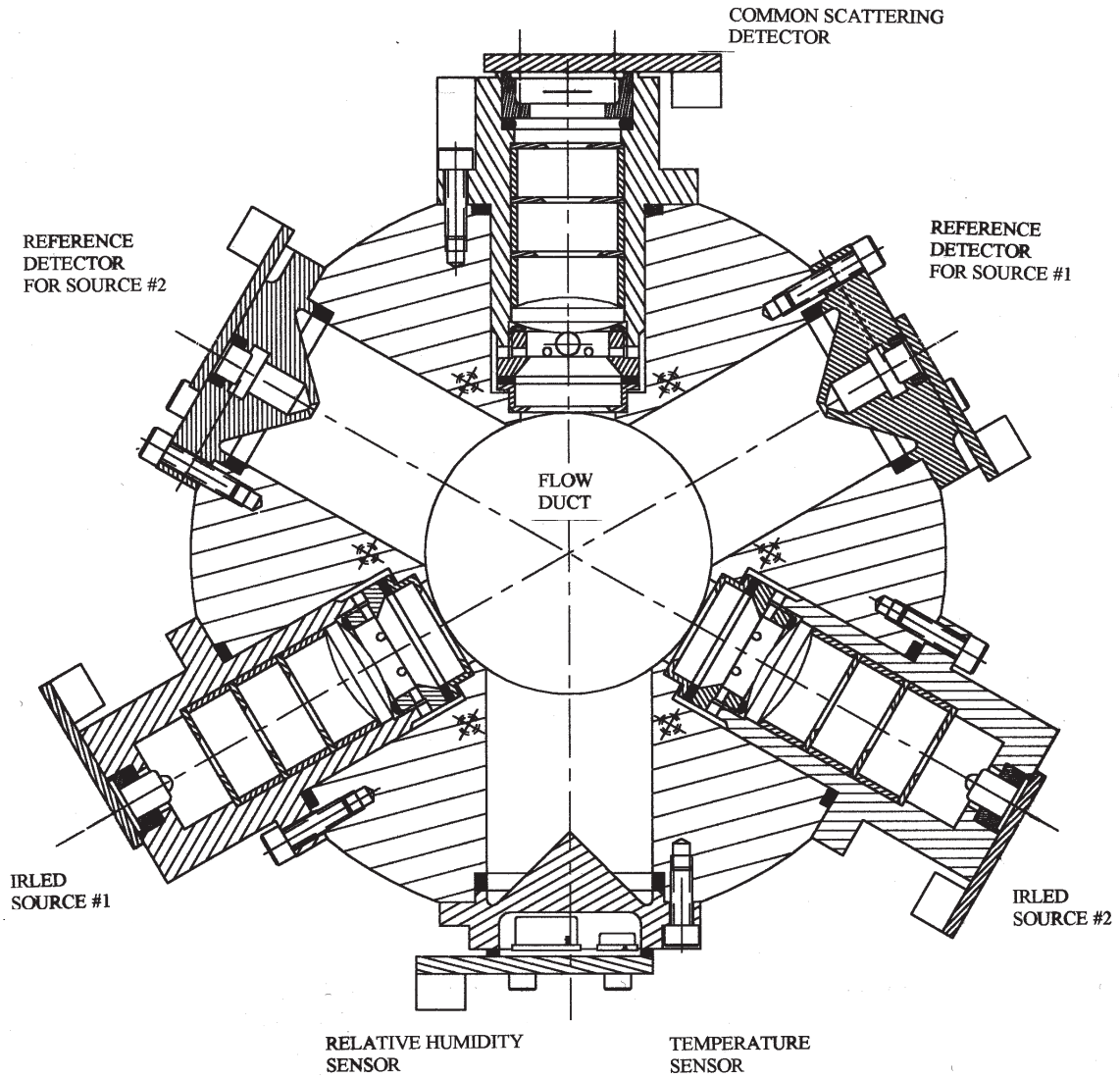
Optical Sensing Configuration



After these two beams traverse the sensing region within the flow duct, they enter their respective light traps at the end of which there are corresponding reference detectors that sense the intensity of each of the illumination beams. Feedback circuits ensure that the light output of both sources remains constant.

The Effect of Particle Size

The magnitude of the detected light scatter at either of the two wavelengths is directly proportional to the amount of particles passing through the sensing region of the DataRAM 4, defined as the volume of intersection between the illumination beams and the field of view of the common scattering detector. This response linearity, however, assumes that the optical properties of the particle population remain constant, i.e., that particle size and shape distributions, and effective particle refractive index do not change appreciably*. In practice however, and especially for the fine particle fraction ($PM_{2.5}$) in ambient environments, particle size can vary appreciably over time and from site to site due to particulate emission and climatic changes. The effect of particle size changes on the scattering signal depends on the ratio of that size to the wavelength used to generate that scatter, and also on the breadth of the size distribution.

Figure 2B shows the relative scattering signal (at the 660 nm wavelength) as a function of the volume median particle diameter for several different geometric standard deviations (σ_g, a measure of the spread of particle sizes) for single-mode log-normally distributed particle populations, for an effective particle refractive index of 1.50 (a typical value for ambient environments). This graph represents the response (output) of the DataRAM 4 assuming constant particle volume concentration (constant mass concentration for a given particle density) as a function of the median size of the particle population being measured. Under most practical situations, this population will not be monodisperse (geometric standard deviation of 1.0) but will be polydisperse, i.e., will have a range of sizes with a single or a multi-mode log-normal distribution. The fine particle fraction of ambient environments ($PM_{2.5}$) can usually be modeled by a single-mode log normal distribution with a geometric standard deviation of 2.0 and a refractive index of approximately 1.50 (for low relative humidity conditions). The response of the DataRAM 4 to that population of particles is represented by the curve labeled 2.0 of Figure 2B.

* Additional conditions that must be satisfied for response linearity are those of independent and single scattering, both of which are fulfilled over the operating range of the DataRAM 4.

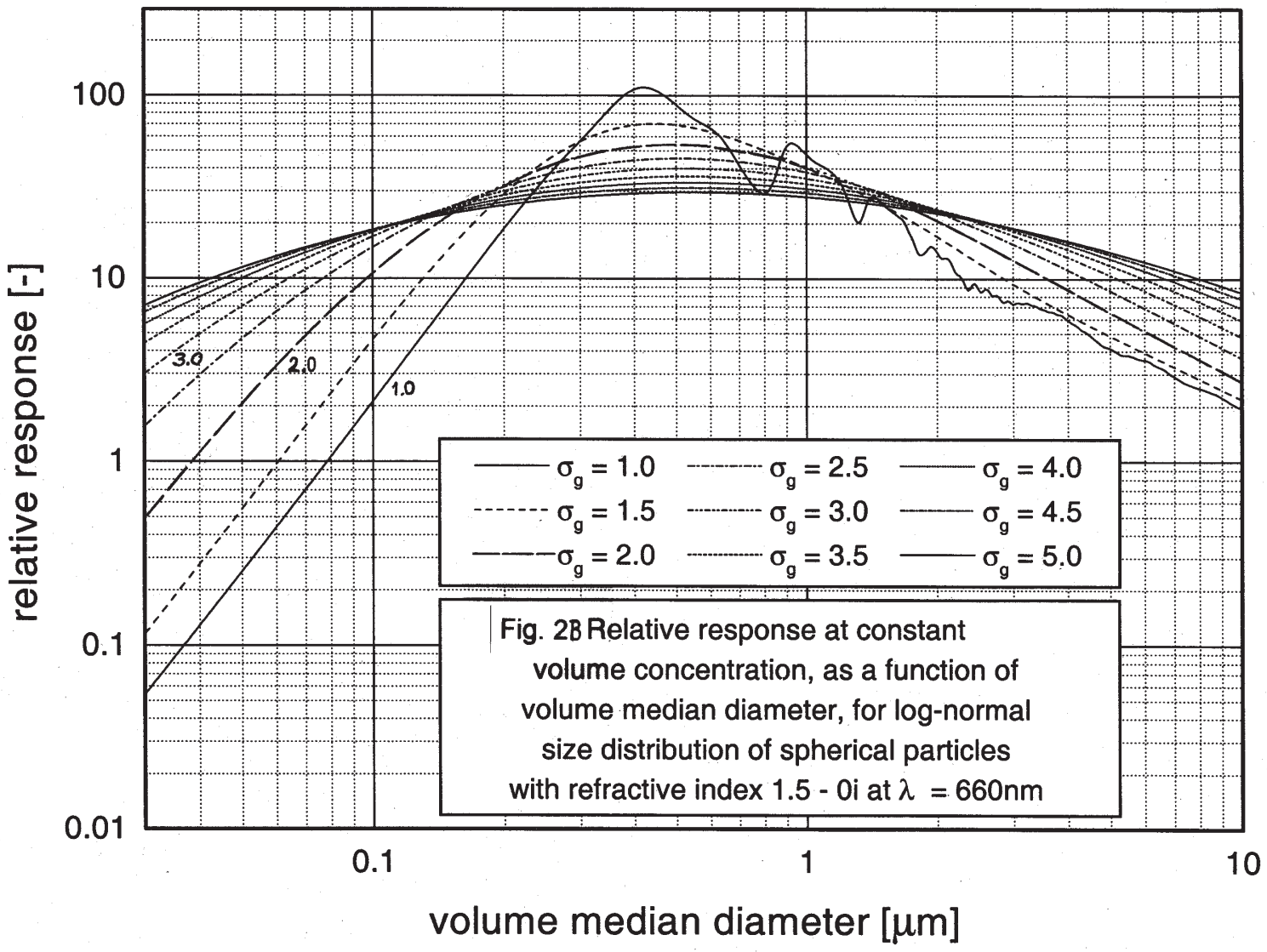


Fig. 2B Relative response at constant volume concentration, as a function of volume median diameter, for log-normal size distribution of spherical particles with refractive index 1.5 - 0i at λ = 660nm

For an idealized mass monitor, the response curves of Figure 2B would be reduced to a single horizontal line, implying that the measurement of mass concentration is independent of particle size. The inherent behavior of light scattering (as modeled by the rigorous Lorenz-Mie theory for spherical particles[*]), however, precludes such size independence. Alternatively, based on that size dependence and by measuring the ratio of the responses at two different wavelengths it is possible to determine the particle size and, consequently, to correct the mass measurement accordingly. This capability has been incorporated in the DataRAM 4 and is intended to be applied to fine particle monitoring, in combination with an inertial coarse-particle precollector (e.g., impactor). This precollector removes the particle population (typically larger than an aerodynamic diameter of 2.5 μm) whose size exceeds that of the fine particle fraction.

When the particle size correction algorithm is enabled (the user has the option to disable it), the DataRAM 4 computes the mass concentration as follows:

a) The scattering signal detected at the wavelength of 880 nm (after subtraction of the zero particle concentration offset) is cross correlated with the corresponding signal detected at 660 nm, and a combined signal is generated;
b) The ratio of the signals at 880 nm and at 660 nm is computed;
c) Based on the ratio determined in step b), the volume median particle diameter is determined (from a stored look-up table derived from Lorenz-Mie calculations based on the DataRAM 4 optical geometry and spectral sensing characteristics) for a particle refractive index of 1.50 and a log-normal size distribution with a σ_g of 2.0[**];
d) The particle size determined in step c) is then used to obtain the particle volume (i.e., mass) correction factor (also stored as a look-up table); and
e) The above determined particle volume correction factor is applied to the combined signal generated in step a) in order to compute the mass concentration.

The equivalence between particle volume and mass used within the DataRAM 4 is based on the calibration dust (SAE Fine) density of about 2.6 g/cm^3 which is representative of a wide range of particle materials in the environment. The user, however, can select a different particle density scaling factor on the DataRAM 4 (i.e., the CAL FACTOR).

The DataRAM 4 performs the above discussed particle size computation in real time on condition that the sensed mass concentration exceeds 0.005 mg/m^3 (5 μg/m^3). If the concentration falls below that threshold, the DataRAM 4 performs this computation and the size correction of the mass measurement based on the last size determination that had been performed when the above concentration threshold was exceeded.

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[*] Field investigations indicate that the fine particulate fraction consists predominantly of spherical particles

[**] For custom applications involving different refractive indexes and/or particle size distributions, please consult MIE

Scattering Coefficient, Visual Range and Ångström Coefficient

The fact that the DataRAM 4 incorporates the capability to measure the wavelength dependence of the scattering of light by airborne particles allows the determination of the atmospheric visibility effects of that population. These effects are customarily referred to a standard wavelength of 550 nm, the approximate center of the photopic response of the human eye as well as the peak of the solar irradiance spectrum.*

The **scattering coefficient** is the primary parameter sensed by the light scattering system of a nephelometer such as the DataRAM 4. This coefficient is a logarithmic exponent that represents the degree of light attenuation due to scattering, per unit path length, expressed in the units of inverse length (e.g., inverse megameters, abbreviated as Mm^{-1}). By measuring the scattering coefficient at two different wavelengths it is possible to establish the wavelength dependence of that coefficient and, consequently, calculate the scattering coefficient at the reference wavelength of 550 nm. This calculation is performed within the DataRAM 4 and this information can be displayed/logged as measurement parameter in lieu of the mass concentration data.

Based on the value of the measured scattering coefficient the DataRAM 4 then computes what is called the **visual range** defined as the distance, under daylight conditions, at which the apparent contrast between a specified target (usually a black surface) and its background (horizon sky) becomes just equal to the threshold contrast of the average observer. This dependence of the visual range on the scattering coefficient assumes that light absorption by the particle population under scrutiny is negligible compared to scattering. Although this assumption is not always satisfied, for a majority of cases it constitutes an acceptable approximation. The empirical relationship between the scattering coefficient sensed by the DataRAM 4 and the visual range is given by the Koschmieder equation. The visual range (in the units of kilometers) can also be displayed/logged as measurement parameter in lieu of either the mass concentration or of the scattering coefficient.

Finally, and based on the ratio of the detected irradiances at the two operating wavelengths, the DataRAM 4 is programmed to compute the **Ångström coefficient**. This coefficient is a dimensionless exponent that expresses the functional relationship between the atmospheric scattering coefficient and the wavelength of light, and is dependent on the size distribution of the fine particle fraction. Theoretically, the Ångström coefficient varies over the range of 0 to 4. The limit value of 4 is for scattering by particles whose size is much smaller than the wavelength of visible light (Rayleigh or molecular scattering regime). The limit of 0 is for particles larger than the wavelength of the illuminating light (geometric regime). This coefficient can also be displayed on the DataRAM 4 screen, as a secondary parameter.

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* The near matching between these two peaks is generally attributed to an evolutionary selection process

The Effect of Ambient Humidity

Fine airborne particles tend to accrete liquid water whenever the relative ambient humidity is high. Therefore, particles grow in size as humidity increases. This growth has been found to be generally negligible up to relative humidity (RH) levels of about 50%. At higher levels, especially over 70% this growth becomes very significant to the point that the majority of the mass of the fine particulate matter is constituted of water.

Figure 3B shows the relationship between the concentration measured by a nephelometer (MIE model DR-2000, DataRAM) and a collocated gravimetric sampler. The curve is an interpolation of experimentally obtained field data. This curve shows that below a RH of 50% the two devices agree whereas above that point the nephelometer indicates a higher value which is the result of the humidity induced particle growth mentioned above.

For atmospheric visibility measurements this high-humidity particle growth effect must be included since the purpose of such measurements is to assess the actual visual effects of airborne particles. For fine particle mass concentration determinations, however, the accreted water interferes with the measurement of interest, i.e., monitoring the mass of the original core particles. Gravimetric methods require sample conditioning (post sampling drying) to eliminate the water accreted by the collected particulate matter sample. Continuous mass monitors such as those based on beta attenuation or on mechanical resonance have heretofore relied on sample heating to enhance water evaporation. This later approach, however, not only reduces the amount of interfering water but also causes partial evaporation of semi-volatile particle components of interest, thus introducing a measurement error. Other methods, such as diffusion drying can be applied without affecting the measurement of semi-volatiles, but are inconvenient in their application to continuous unattended ambient monitoring.

In the case of the DataRAM 4, the user has the option to activate an automatic humidity correction that is based on the experimentally obtained curve of Figure 3B. When the humidity correction process is enabled (by keystroke selection), the DataRAM 4 applies a correction factor to the measured mass concentration that depends on the relative humidity measured within the optical sensing chamber. For example, if the sensed humidity were to be 80%, the DataRAM 4 without correction would over-read by a factor of 1.8 with respect to a gravimetric sampler. If the automatic humidity correction is enabled, the optically sensed concentration will be internally multiplied by 1/1.8, or 0.56, in order to compensate for the humidity induced particle growth. This correction is valid for most fine particle measurements, but should not be applied to measurements of larger particle sizes. This correction takes into account the change (decrease) in the refractive index of the grown particles due to the predominance of water (with its lower index).

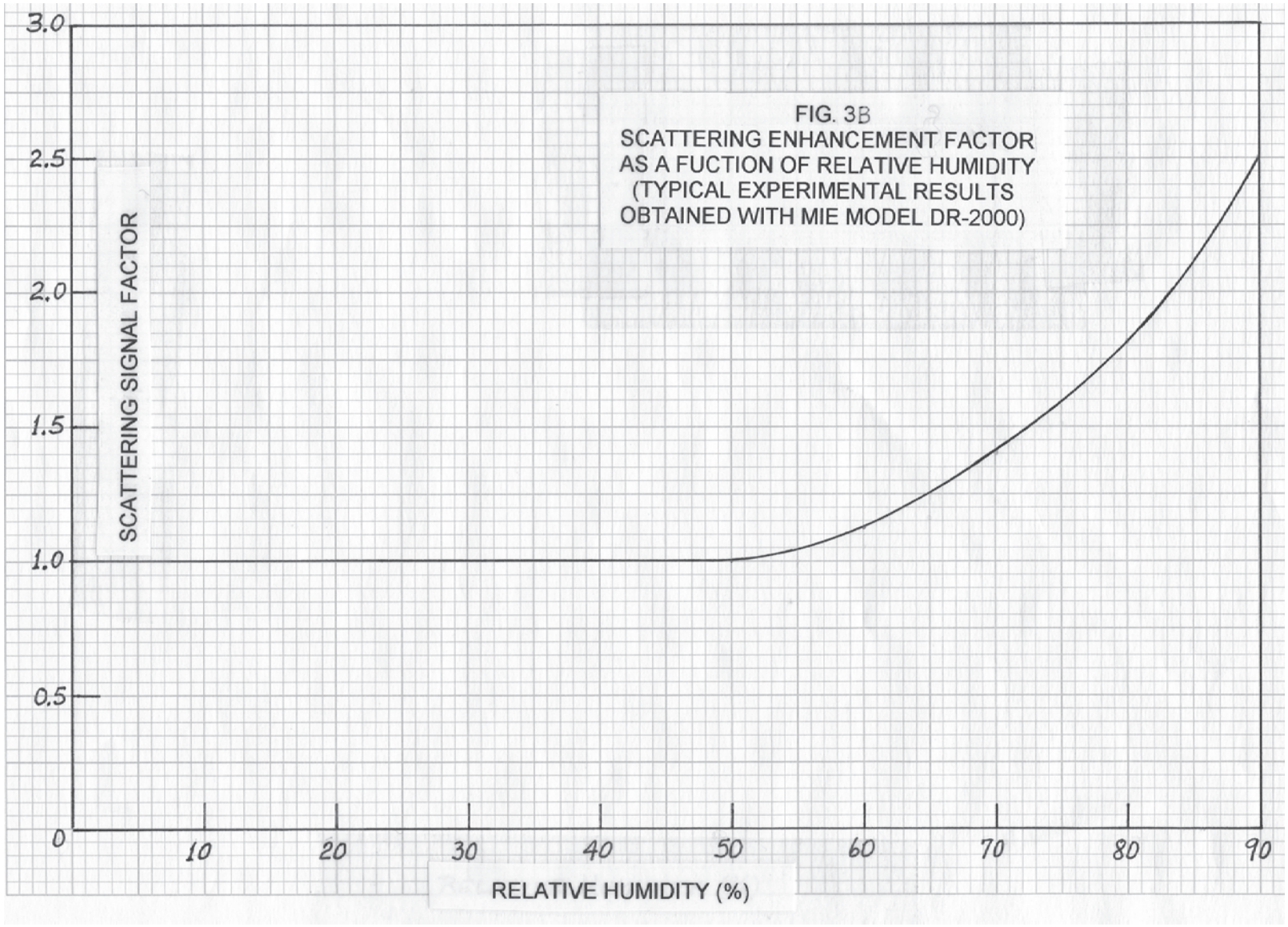

FIG. 3B
SCATTERING ENHANCEMENT FACTOR AS A FUCTION OF RELATIVE HUMIDITY (TYPICAL EXPERIMENTAL RESULTS OBTAINED WITH MIE MODEL DR-2000)

The particle size determination, based on the ratio of signals at the two DataRAM 4 wavelengths (discussed above) is not significantly affected by the change in refractive index associated with the particle uptake of liquid water. In the $PM_{2.5}$ range, a change of particle refractive index from the typical dry value of about 1.50 to that of pure water (1.33) causes a sizing error ranging from 0% for 0.1 μm particles to 7% for 2.5 μm particles. The actual sizing error is likely to be smaller since the refractive index of water-accreted ambient particles generally exceeds 1.40.

It is of interest to note that if the DataRAM 4 is used in conjunction with an in-line sample stream heater (e.g., MIE model DR-TCH), and the resultant measurements are compared with the humidity corrected measurements mentioned above (without the heater), it is possible to assess the loss of particle mass due to evaporation of semi-volatile particles. Alternatively, if there were no difference between measurements obtained with and without the inlet heater, it would indicate that there is no humidity induced particle growth and thus, the humidity correction should not be enabled.

NOTE: For an explanation of some of the terms used in this Appendix, please consult the MIE website: www.mieinc.com and click on **Aerosol Optics Glossary**.

SERVICE LOCATIONS

For additional assistance, Environmental Instruments Division has service available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information.

866-282-0430 Toll Free
508-520-0430 International

Call: **+44 (0)845 270 2707**
Email: **europe@ashtead-technology.com**
www.ashtead-technology.com

Ashtead TECHNOLOGY INSTRUMENT DIVISION

Thermo Andersen MIE DATARAM 4000

The DataRAM 4 (Model DR-4000) continuously monitors the real-time concentration and median particle size of airborne dust, smoke, mist, and fumes. In addition, air temperature and humidity are displayed. With appropriate particle discriminators it provides measurements correlated with PM10, PM2.5 and respirable fractions. Its patented two-wavelength particle detection system provides the volume median particle diameter of the sampled aerosol, over a concentration range of up to 400 mg/m3. Unlike typical particle counting devices, the DR-4000 is totally immune to particle coincidence errors, even at the highest concentrations. Volume median particle sizes down to 0.05 micron can be measured by this unique spectral nephelometric technique. This patented technique provides a continuous measurement of PM 2.5, independent of particle size and moisture- without heating, diffusion drying, or denuding the sample stream.

Key Features

- Datalogging for work-shift monitoring
- Monitors mass concentrations of fine particulate (PM 2.5)
- Compact, rugged, and totally self-contained
- Designed for portable operation, as well as unattended fixed-point operation
- Powered by internal rechargeable battery or by an AC power supply/charger (included)
- Instrument automatically checks its own optical background during the zeroing sequence and indicates any significant deviations requiring maintenance
- Covers a wide measurement range from 0.0001mg/m3 (0.1µg/m3) to 400mg/m3, a four million-fold span ranging from very clean air to air with extremely high particle concentrations
- Complete, large-capacity (50,000 data point) internal datalogging capabilities with data retrieval on screen or through an externally connected computer
- Stored information includes individual point averages, particle size, temperature and humidity with time information as well as overall average and maximum concentration and tag numbers
- Selectable alarm levels with built-in audible signal as well as switched and signal outputs, RS-232 and RS-485 communications ports, and a programmable analog (voltage and current) concentration output

Technical Specification

Title	Values
Range	0.0001 to 400 mg/m3 (autoranging)
Accuracy	+/- 2% of reading
Particle Size Range Maximum Response	0.1 to 10µm
Sample Flow Rate	1.0 to 3.0 liters/minute
Datalogging	50,000 data points in up to 99 data goups
Output	RS-232/RS-485 port
Power	Sealed lead-acid battery, up to 20 hours operation, or AC operation with adapter

Dimensions

Title	(mm)	(inch)	(kg)	(lb)
	166 x 226 x 327 mm	6.54 x 8.90" x 12.87""	5.44 kg	12 lbs

Thermo SCIENTIFIC

Standard Operating Procedure for Operating the DataRAM and VIPER

1. Remove the camcorder battery from its yellow charging base (located on the drafting table in the middle room of the EPA trailer), and place the battery on top of the DataRAM unit. Note: Use the battery that has Velcro so that the battery can adhere to the DataRAM.

2. A cable that has a battery clip on one end and an adapter plug on the other should already be present on the top of the DataRAM. Place the clip of the cable on the battery and adaptor plug of the cable into the 900 MHz transmitter located on the opposite side of the DataRAM. After connecting the cable to the camcorder battery and the transmitter, a red light on the back of the transmitter should turn on.

3. A black antenna should already be attached to the transmitter. Make sure that the antenna is firmly attached, and that the antenna is pointing up. Note: In the event that the distance from the command post is greater than a quarter-mile, the white high-gain antenna may need to be used. In this case, unscrew the black antenna from the 900 MHz transmitter and screw the black cable connected to the white high-gain antenna into the 900 MHz transmitter. Put the black antenna into the DataRAM case.

4. Inside the VIPER component Pelican case, flip the switch of the surge suppressor from off to on. After flipping this switch, the red indicator lights of the various components inside the case should turn on. If the lights do not turn on, then make sure that the plug is firmly attached to the side of the Pelican case.

5. Turn the VIPER-dedicated laptop (silver Panasonic) on by moving the switch located along the left front of the computer from left to right, and holding the switch in place until a green light comes on.

6. On the desktop of the laptop, double-click on the icon entitled "VIPER – Field Survey Controller."

7. Turn the DataRAM on by pressing and holding the "ON/OFF" button. Make sure that the toggle switch on the back of the DataRAM is switched to "Int.Batt."

8. After turning on the DataRAM, the "Main Menu" will appear.

9. While in the trailer, press the down-pointing arrow key to highlight the "ZERO/INITIALIZE" option, and then press the "ENTER" button. The zero/initialize process will take 300 seconds.

10. After the zero/initialize process is completed, press the "EXIT" button to get back to the "Main Menu."

11. Now place the DataRAM at the desired downwind location at the Staging Area (for DataRAM 1) and the excavation area (for DataRAM 2). See Attached aerial photos and attached photographs for Staging Area and SA3A DataRAM Locations. Note: In the event that rain is anticipated, place a clear drum-liner bag over the DataRAM unit so that only the black inlet assembly is outside of the bag. Also make sure to keep the bag open beneath the unit in order to allow exhaust air to escape beneath the DataRAM.

12. In the "Main Menu," the option "START RUN" should already be highlighted by the "greater than" sign blinking alternately between the "greater than" sign and a solid rectangle. Press the "ENTER" button to start a run.

13. In VIPER Survey Controller, click on "Run," then "New Run," then "From Template."

14. In the "Choose a Template…" window, choose "1_dataram_portage.xml" if only one DataRAM will be used or choose "2_dataram_portage.xml" if two DataRAMs will be used. Recommendation: Due to the fact that two DataRAMs will most likely be used, rather than just one, choose the "2_dararam_portage.xml" option.

15. In the "Run Configuration Wizard" window, click on the "Next" button.

16. In the "Run Name/ID:" cell, type "Portage Creek."

17. In the "Run Description" cell, type today's date and the time that the run started. Example: 4/10/13 at 1:45 p.m. Click the "Next" button.

18. In the "LINC Configuration" cell, click the "Next" button.

19. In the "Instrument Clusters" cell, click the "Next" button.

20. In the next window, click once on the "LINC.1" option in order to highlight the line.

21. Click on the "Edit…" button.

22. In the "Select GPS Mode…" window, the "Reading Interval:" should be "All Readings," while the "GPS Mode:" should be "Fixed."

23. In the "Select GPS Mode…" window, in the cell <u>below</u> the "GPS Mode:" cell, place the latitude of the location where the DataRAM is placed (example: 42.28035). In the cell beneath the latitude cell, place the longitude of the location where the DataRAM is placed (example: -85.5797). The latitude and longitude for each DataRAM location are listed in the attached table entitled "Table 1. Latitude and Longitude for the DataRAM Locations: John Street Staging Area and Slope Area 3A."

24. After entering the latitude and longitude for the location, click the "OK" button.

25. In the “Run Configuration Wizard…,” click the “Next” button. The message “Run Configuration Complete!” should appear. Click the “Finish” button.

26. In the “Begin Recording Data?” window, click the “Yes” button in order to start recording DataRAM data into VIPER.

27. After clicking “Yes,” one window entitled “DataRAM LINC 1 EPAERT1 Wifi” will appear if only one DataRAM is being used, or two windows will appear if two DataRAMs are being used. In these windows, four green bars should be seen for “Concentration,” “Time Weight Average,” “Temperature,” and Humidity.”

28. After starting the run, call EPA ERT (1-800-999-6990) in order to (a) inform them that a DataRAM run has begun, and (b) to ensure that they are receiving data.

29. After completing a run, in the “VIPER Survey Controller” window, click the red square button in order to stop the run.

30. In the “Permanently Stop Run?” window, click the “Yes” button. The window will go gray.

31. In order to close “VIPER,” click the red “X” in the upper right hand of the “VIPER: Survey Controller” window. Click the “Yes” button in the “Close Survey Controller?” window.

32. Shut down the VIPER-dedicated computer through the WINDOWS Start option. Once the computer is completely shut down, flip the switch of the surge suppressor from ON to OFF.

33. On the DataRAM(s), end the run by clicking on the “EXIT” button, and then the “ENTER” button. You will now be at the “MAIN MENU.”

34. To turn the DataRAMs off, press the “ON/OFF” button, and then the “ENTER” button.

35. Detach the clip from the camcorder batteries, and the adaptor plugs from the transmitters. Place the batteries back on charge on the yellow battery charger.

Standard Operating Procedure for Downloading DataRAM Data to Computer

1. Install DR4-COM software onto your computer (program e-mailed to you).

2. Disconnect the serial cable from the back of the 900 m/Hz transmitter (located on top of the DataRAM), and attach the serial cable to the back of your computer.

3. Turn the DataRAM on by pressing the "ON/OFF" button on the front of the DataRAM.

4. Double-click on the DR4-COM logo in order to open the DR4-COM software.

5. Click of the "Data text" tab in the "DR4-COM" window.

6. Click the button to the far left of the "DR4-COM" window (this button will show "Get new data once the cursor is placed over this button).

7. On the left side of the "DR4-COM" window, a sub-window will appear that reads "Select a Tag Number."

8. Double-click on any one of the tag numbers. The data associated with the tag number will then appear.

9. In order to save this run to your computer, click once on the button that shows a picture of a floppy disk (third button from the left).

10. A "Save As" window will appear. Provide an appropriate file name for the DataRAM run and then click the "Save" button.

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2. A cable that has a battery clip on one end and an adapter plug on the other should already be present on the top of the DataRAM. Place the clip of the cable on the battery and adaptor plug of the cable into the 900 MHz transmitter located on the opposite side of the DataRAM. After connecting the cable to the camcorder battery and the transmitter, a red light on the back of the transmitter should turn on.

3. A black antenna should already be attached to the transmitter. Make sure that the antenna is firmly attached, and that the antenna is pointing up. Note: In the event that the distance from the command post is greater than a quarter-mile, the white high-gain antenna may need to be used. In this case, unscrew the black antenna from the 900 MHz transmitter and screw the black cable connected to the white high-gain antenna into the 900 MHz transmitter. Put the black antenna into the DataRAM case.

4. Inside the VIPER component Pelican case, flip the switch of the surge suppressor from off to on. After flipping this switch, the red indicator lights of the various components inside the case should turn on. If the lights do not turn on, then make sure that the plug is firmly attached to the side of the Pelican case.

5. Turn the VIPER-dedicated laptop (silver Panasonic) on by moving the switch located along the left front of the computer from left to right, and holding the switch in place until a green light comes on.

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7. Turn the DataRAM on by pressing and holding the "ON/OFF" button. Make sure that the toggle switch on the back of the DataRAM is switched to "Int.Batt."

8. After turning on the DataRAM, the "Main Menu" will appear.

9. While in the trailer, press the down-pointing arrow key to highlight the "ZERO/INITIALIZE" option, and then press the "ENTER" button. The zero/initialize process will take 300 seconds.

10. After the zero/initialize process is completed, press the "EXIT" button to get back to the "Main Menu."

11. Now place the DataRAM at the desired downwind location at the Staging Area (for DataRAM 1) and the excavation area (for DataRAM 2). See Attached aerial photos and attached photographs for Staging Area and SA5A DataRAM Locations. Note: In the event that rain is anticipated, place a clear drum-liner bag over the DataRAM unit so that only the black inlet assembly is outside of the bag. Also make sure to keep the bag open beneath the unit in order to allow exhaust air to escape beneath the DataRAM.

12. In the "Main Menu," the option "START RUN" should already be highlighted by the "greater than" sign blinking alternately between the "greater than" sign and a solid rectangle. Press the "ENTER" button to start a run.

13. In VIPER Survey Controller, click on "Run," then "New Run," then "From Template."

14. In the "Choose a Template…" window, choose "1_dataram_portage.xml" if only one DataRAM will be used or choose "2_dataram_portage.xml" if two DataRAMs will be used. Recommendation: Due to the fact that two DataRAMs will most likely be used, rather than just one, choose the "2_dararam_portage.xml" option.

15. In the "Run Configuration Wizard" window, click on the "Next" button.

16. In the "Run Name/ID:" cell, type "Portage Creek."

17. In the "Run Description" cell, type today's date and the time that the run started. Example: 4/10/13 at 1:45 p.m. Click the "Next" button.

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19. In the "Instrument Clusters" cell, click the "Next" button.

20. In the next window, click once on the "LINC.1" option in order to highlight the line.

21. Click on the "Edit…" button.

22. In the "Select GPS Mode…" window, the "Reading Interval:" should be "All Readings," while the "GPS Mode:" should be "Fixed."

23. In the "Select GPS Mode…" window, in the cell <u>below</u> the "GPS Mode:" cell, place the latitude of the location where the DataRAM is placed (example: 42.28035). In the cell beneath the latitude cell, place the longitude of the location where the DataRAM is placed (example: -85.5797). The latitude and longitude for each DataRAM location are listed in the attached table entitled "Table 1. Latitude and Longitude for the DataRAM Locations: John Street Staging Area and Slope Area 5A."

24. After entering the latitude and longitude for the location, click the "OK" button.

25. In the “Run Configuration Wizard…,” click the “Next” button. The message “Run Configuration Complete!” should appear. Click the “Finish” button.

26. In the “Begin Recording Data?” window, click the “Yes” button in order to start recording DataRAM data into VIPER.

27. After clicking “Yes,” one window entitled “DataRAM LINC 1 EPAERT1 Wifi” will appear if only one DataRAM is being used, or two windows will appear if two DataRAMs are being used. In these windows, four green bars should be seen for “Concentration,” “Time Weight Average,” “Temperature,” and Humidity.”

28. After starting the run, call EPA ERT (1-800-999-6990) in order to (a) inform them that a DataRAM run has begun, and (b) to ensure that they are receiving data.

29. After completing a run, in the “VIPER Survey Controller” window, click the red square button in order to stop the run.

30. In the “Permanently Stop Run?” window, click the “Yes” button. The window will go gray.

31. In order to close “VIPER,” click the red “X” in the upper right hand of the “VIPER: Survey Controller” window. Click the “Yes” button in the “Close Survey Controller?” window.

32. Shut down the VIPER-dedicated computer through the WINDOWS Start option. Once the computer is completely shut down, flip the switch of the surge suppressor from ON to OFF.

33. On the DataRAM(s), end the run by clicking on the “EXIT” button, and then the “ENTER” button. You will now be at the “MAIN MENU.”

34. To turn the DataRAMs off, press the “ON/OFF” button, and then the “ENTER” button.

35. Detach the clip from the camcorder batteries, and the adaptor plugs from the transmitters. Place the batteries back on charge on the yellow battery charger.

NITON XL3t 500 Analyzer

User's Guide

Version 6.5

Thermo SCIENTIFIC

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About This User's Guide

WARNING! Do not attempt to use this analyzer without first reading and understanding the entire User's Guide! ♦

CAUTION NITON Analyzers are not intrinsically safe analyzers in regard to sparking. All pertinent Hot Work procedures should be followed in areas of concern. ♦

Unpacking and Assembling Your NITON XRF Analyzer

- Inspect the shipping carton for signs of damage such as crushed or water damaged packaging. Immediately notify the shipping company and Thermo Fisher Scientific, in the United States, toll free, at (800) 875-1578, or outside the United States, at +1-978-670-7460, if there is any visible damage to the shipping container or any of its contents.

- Open the packing carton. If your analyzer is not packed in its carrying case, please call Thermo Fisher Scientific immediately, in the United States, toll free, at (800) 875-1578, or outside the United States, at +1-978-670-7460.

- Verify the contents of the shipping container against the enclosed packing list. If there are any discrepancies between the actual contents of the shipping container and the enclosed packing list, please notify Thermo Fisher Scientific immediately, in the United States, toll free, at (800) 875-1578, or outside the United States, at +1-978-670-7460.

- Open the carrying case and visually inspect the analyzer for damage before removing it from the case. Call the shipper and Thermo Fisher Scientific if you find any damage to the case or its contents.

- Save the shipping carton and all packing materials. Store them in a safe, dry area for reuse the next time that you ship the analyzer.

The NITON XRF Analyzer Overview

The NITON XL3 Analyzer is a single unit, hand held, high performance portable x-ray fluorescence (XRF) elemental analyzer.

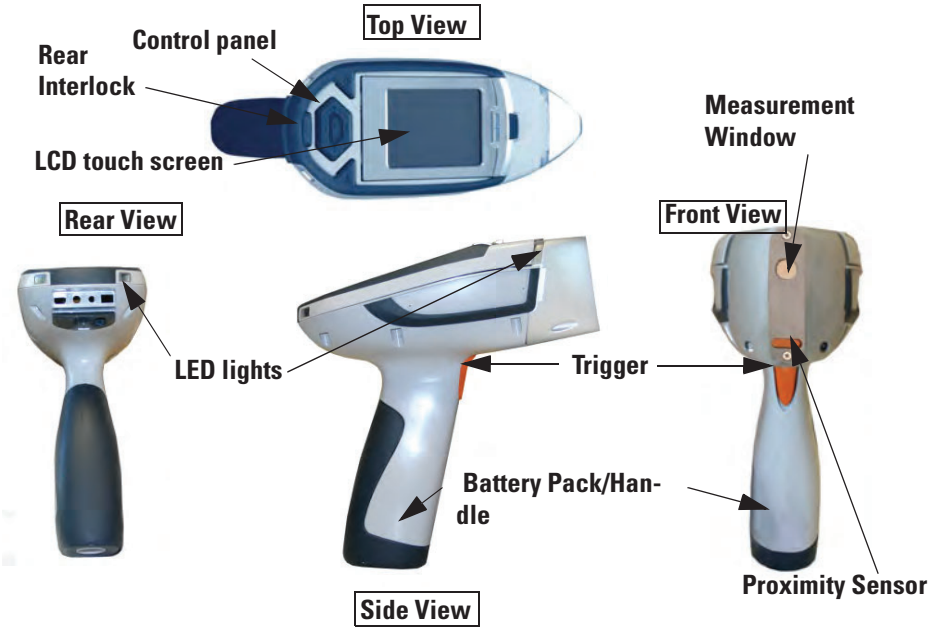


Figure 0-1. Analyzer Overview

The Control Panel

The control panel is located on the analyzer's top housing, directly below the LCD touch screen (see Figure 0-1). The control panel consists of a 4 way touch pad, a center button, and two control buttons, one on each side. Using either the control panel or the touch screen you may navigate through all of the analyzer's screens and menus. You can control the movement of the screen cursor by pressing the four way control pad in one of four directions to highlight each of the menu options. The Select button in the center of the four way touch pad is used to select highlighted menu options. The on/off/escape button both controls the power to the analyzer and serves as an "escape" button. When the on/off/escape button is pushed and immediately released, it functions as an "escape", and brings you back to the Main Menu from the current screen in the menu system.

Figure 0-2. The Control Panel

Push and hold the on/off/escape button for at least 3 seconds to turn the analyzer on.Push the on/off/escape button and hold it down for about 10 seconds to shut off power to the analyzer from any screen in the menu system.

You also have the option of operating the analyzer, including navigating the menu system, by using the built in touch screen. To select a menu option, tap on the icon once. The touch screen icons have the same functionality as the four way touch pad, the on/off/escape button, and the select or enter button. This User's Guide will refer to the process of choosing a course of action by selecting an icon from a menu, either using the touch screen or using the control panel buttons, as “selecting.”

Selecting the **Return** icon works everywhere throughout the User Interface to bring you back to the previous menu from the current menu in the menu system. Use the on/off/escape button to return to the **Main Menu**.

The LCD Touch Screen

The LCD Touch Screen on your XL3 Analyzer is designed to swing up and down to different angles for ease in viewing and interacting with your analyzer. The LCD Touch Screen is connected to your analyzer along the base of the screen, right above the Control panel. The screen is not designed to separate from the analyzer, but can be adjusted to any arbitrary angle between zero degrees - that is, flush with the analyzer - and 85 degrees, which is almost perpendicular. The LCD Touch Screen will stay at any given angle between these extremes until moved to a different angle. When in closed position, the screen is secured by a catch at the top center of the screen housing.

Figure 0-3. XL3 Analyzer Showing LCD Screen Tilted.

- To raise the LCD Touch Screen, disengage the catch at the top-center of the LCD Touch Screen housing and gently pull the screen towards you until it is at the best angle for your use.

- To close the LCD Touch Screen, gently push away from you along the top edge of the screen housing. The screen will swing down until the catch solidly engages with an audible click.

Note The LCD Touch Screen cannot be removed from your XL3 analyzer. Removing or attempting to remove the LCD Touch Screen will damage your analyzer and void your warranty.

Note Always close your LCD Touch Screen before storing or transporting your XL3 analyzer.

The Data Ports

Figure 0-4. Data Ports on the XL3

USB Port The USB Port is a communications and control port, for uploading and downloading data, configuration files, and software to the analyzer.

Remote Trigger Port The Remote Trigger Port controls the analyzer's trigger function, for use with the Extend-a-pole, In Situ Tripod, and test stands.

Serial Port The Serial Port is a communications and control port, for uploading and downloading data, configuration files, and software to the analyzer.

Power Port The power port is used to run the XL3 under external power.

Instrument Startup

To turn on the analyzer, depress the **on/off/escape** button on the control panel for approximately 10 seconds.

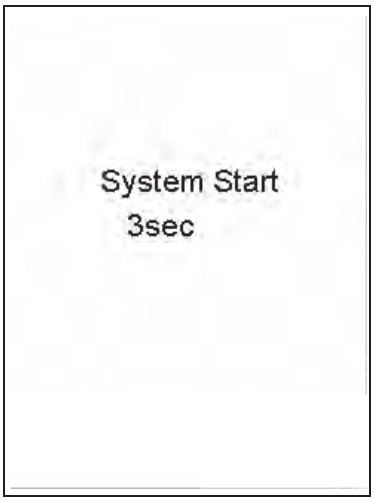


Figure 0-5. System Start Screen

On startup, the screen will be replaced by a **Start Screen** (see Figure 0-5) which will automatically count down from 9 to 0 in increments of one second.

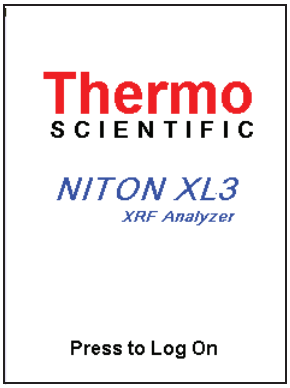


Figure 0-6. Logon Screen

When the Start is complete, the Start Screen will be replaced by the Logon screen (see Figure 0-6.) Tap anywhere on this screen to continue.

The Logon Screen will be replaced by a Warning Screen, see Figure 0-7, advising you that this analyzer produces radiation when the lights are flashing. You must acknowledge this warning by selecting the “Yes” button before logging on. Selecting the “No” button will return you to the Logon Screen.

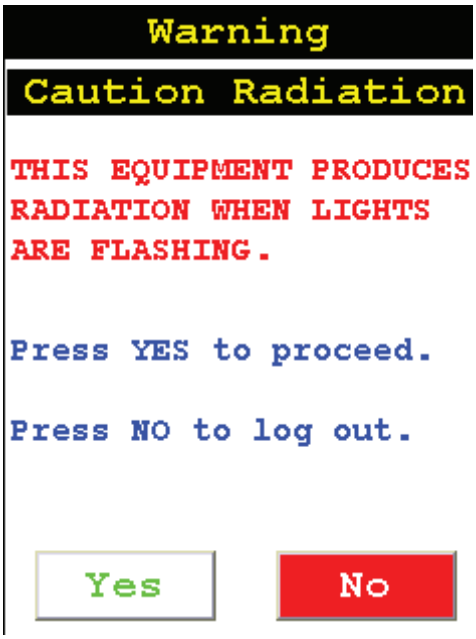


Figure 0-7. Warning Screen

After selecting the "Yes" button, the Virtual Numeric Keypad becomes available for you to log onto the analyzer.

Figure 0-8. Virtual Numeric Keypad for Logon

Select your 4 digit security code, followed by the enter (E) key. The temporary password assigned by default is 1-2-3-4, followed by the “E” key. If you enter an incorrect number, you can use the “<“ key to backspace over it, ot use the “C” key to clear everything. After you have completed the log on procedure, the word "USER" will appear on the bottom of the screen, then the Main Menu will appear. Note that security codes are editable. Please see the NDT manual for instructions on creating user-definable passwords.

Check the date/time. The time should be set correctly for accurate and verifiable record keeping (See Chapter 1 page 72).

Your analyzer can be stored and operated safely in temperatures from -5º C (23º F) to 50º C (122º F). You will not be able to take a measurement if the analyzer overheats. If it is hot to the touch, you should allow it to cool before testing.

The NAV Menu

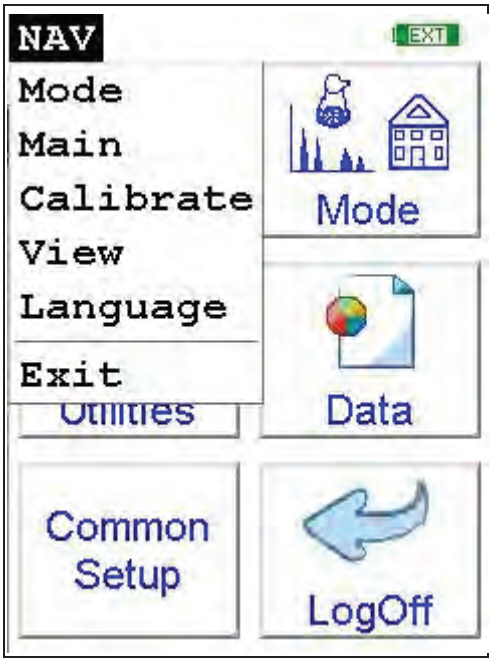


Figure 0-9. The NAV Menu

The Navigation Menu, or NAV Menu, is available in all screens, though only through the touch screen interface. Within a menu, the particular options available from the NAV Menu may change with the context. For example, within the View Menu, the NAV Menu changes options depending on the mode you are currently using.

Access the NAV Menu by selecting the word NAV in the screen. A drop-down menu of choices will appear. Selecting an option from the NAV Menu will take you directly to a particular menu, no matter where you are in the menu hierarchy. Selecting the “View” option from the NAV Menu, for example, will bring you directly to the Data Menu.

The NAV Menu cannot be selected through the Control Panel.

The Battery Life Indicator

The Battery Life Indicator is visible on all screens in the menu system. The indicator is visible in the top right portion of the screen, and graphically shows you how much battery life is left, enabling you to change batteries as needed to avoid unexpected shutdowns.

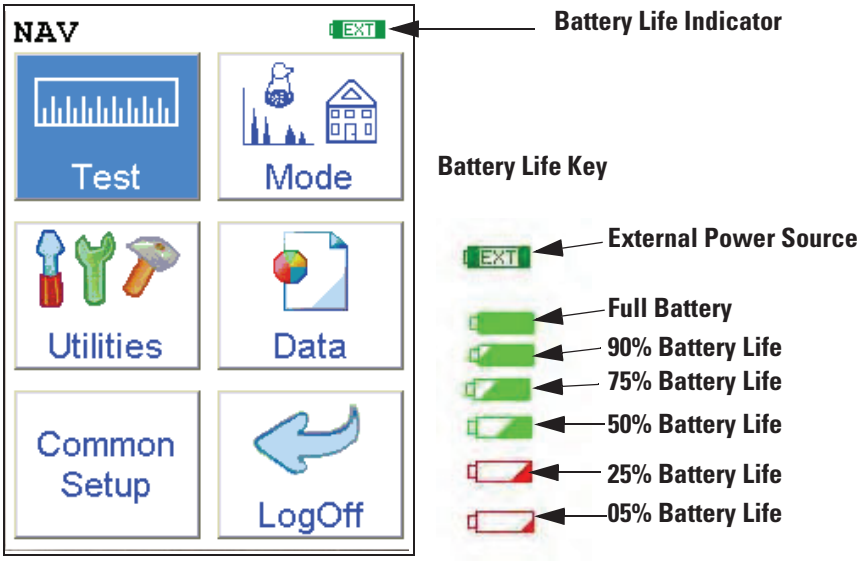


Figure 0-10. Battery Life Indicator

The more green visible in the indicator, the higher the charge. The more red visible in the indicator, the lower the charge. It’s best to charge one battery while using the other, to avoid work slowdowns or stoppages due to battery charge conditions.

WARNING! In the highly unlikely event that the x-ray tube remains on when the trigger is not depressed, disconnect the battery pack immediately to turn off the x-ray tube, and call Thermo Fisher Scientific’s Service Department in the United States, toll free, at (800) 875-1578, or outside the United States at +1-978-670-7460, or your local Authorized NITON Analyzers Service Center. ♦

The Menu Path

The Menu Path shows you graphically how to get to the function being described in several discrete steps from the universal start position, the Main Menu.

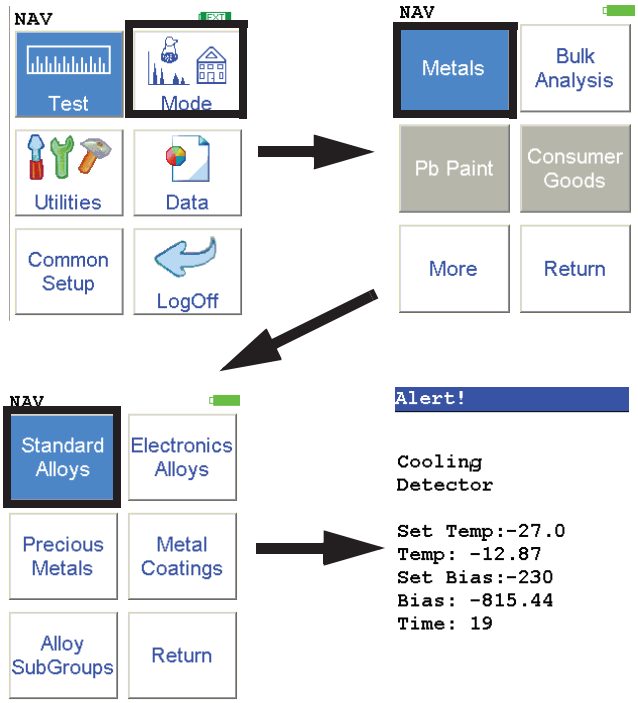


Figure 0-11. Example Menu Path

In the Menu Path, the order is top to bottom, then if needed left to right, starting with the Main Menu and ending with the function wanted. The arrows show the succession of menus, while the icon to be selected is highlighted by a heavy rectangular border.

This Menu path should be read as:

> To get to this screen, starting at the Main Menu, select the Mode icon, select the Metals icon, then select the Standard Alloys icon.

Chapter 1 Applications

The NAV Menu

The **NAV Menu** enables you to move between various menus and screens directly, without going through the intervening screens. Select a destination from the drop down menu and you will be brought directly to that menu or screen.

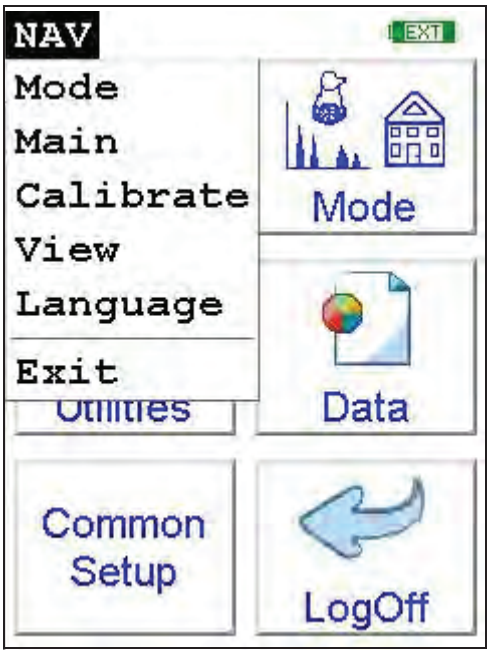
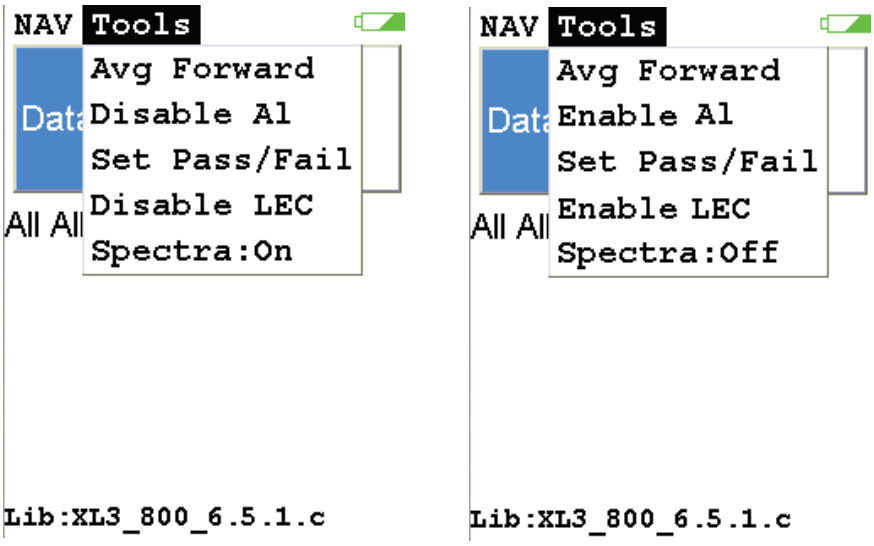


Figure 1-1. The NAV Menu

The Tools Menu

The **Tools Menu** enables you to perform common data-related tasks such as printing and averaging. Select a task from the drop down menu to initiate that task.

.



Tools Menu - All Enabled

Tools Menu - All Disabled

Figure 1-2. The Tools Menu

The Tools Menu, like the NAV Menu, uses context sensitive menus. The following is the most common menu set.

Avg Forward

Enables you to average different readings together from this analysis forward. Select **Avg Forward** to initiate future sample averaging. **Avg Forward** will set up an automatic personal averaging protocol to be followed until your analyzer is shut down, or this feature is disabled. To begin, select the number of readings you want to average from the virtual numeric keypad. Your analyzer will calculate an average reading after that number of tests, and continue this pattern until stopped. For example, if you select 3 on the virtual keypad, the analyzer will automatically calculate, average, and store a reading for every three tests you take, storing the individual readings along the way.

Avg Back

Enables you to average different readings together from this analysis backward. Select **Avg Back** to initiate backwards sample averaging. **Avg Back** will take a number of readings you select and average their analytical results. The range is counted from the last reading backward by the number

of readings selected. If your last reading was #15, selecting 3 would average readings #13, 14, and 15. The average is calculated, displayed, and stored into memory as the next sequential reading number.

The range number is selected using a virtual keypad on your analyzer similar to the keypad used for login. Select the digits in the range number from the keypad, then select the “E” key to enter the number. “C” will clear all, and “<“ will clear the last digit entered. The average will automatically be displayed.

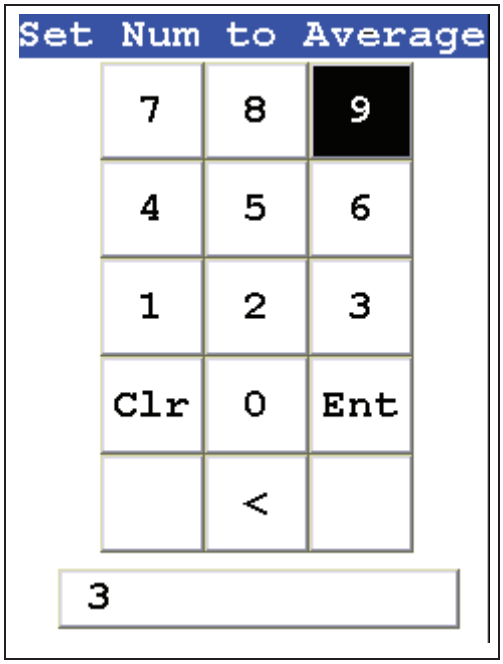


Figure 1-3. The Virtual Numeric Keypad for Averaging

Note You cannot average readings taken with different element lists - or with different filter settings if the settings have different element lists - with either **Avg Back** or **Avg Forward**. Alloy and Mining modes each use the same element lists with the different filter settings, so averaging works when switching between filter settings when in either of these modes. Thin Film and Bulk modes both use different element lists for different filter settings, and readings with different filter settings cannot be averaged when using either of these modes. You can never average readings taken in different modes.♦

Note The **Tools Menu** is only available when viewing readings, and the menu is only accessible through the touch screen interface or NDTr. ♦

Stop Avg Fwd/Back

Avg Back and Avg Forward are toggles. The option on the Tools Menu changes to its opposite when selected. To stop averaging, select Stop Avg Fwd or Stop Avg Back from the Tools Menu as appropriate.

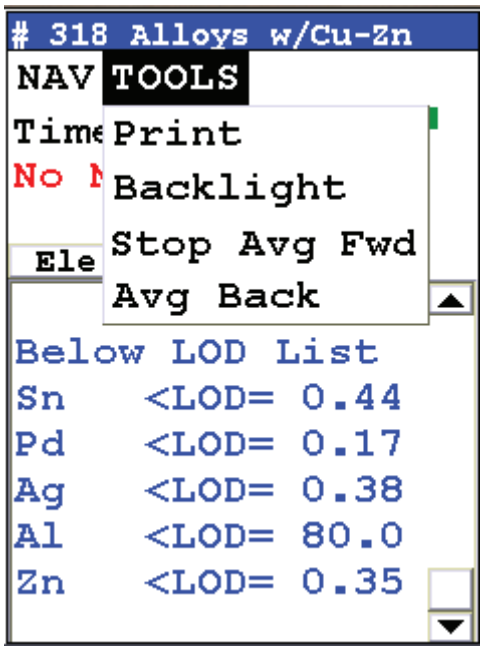


Figure 1-4. The Tools Menu - Averaging Toggles

Example Averaging

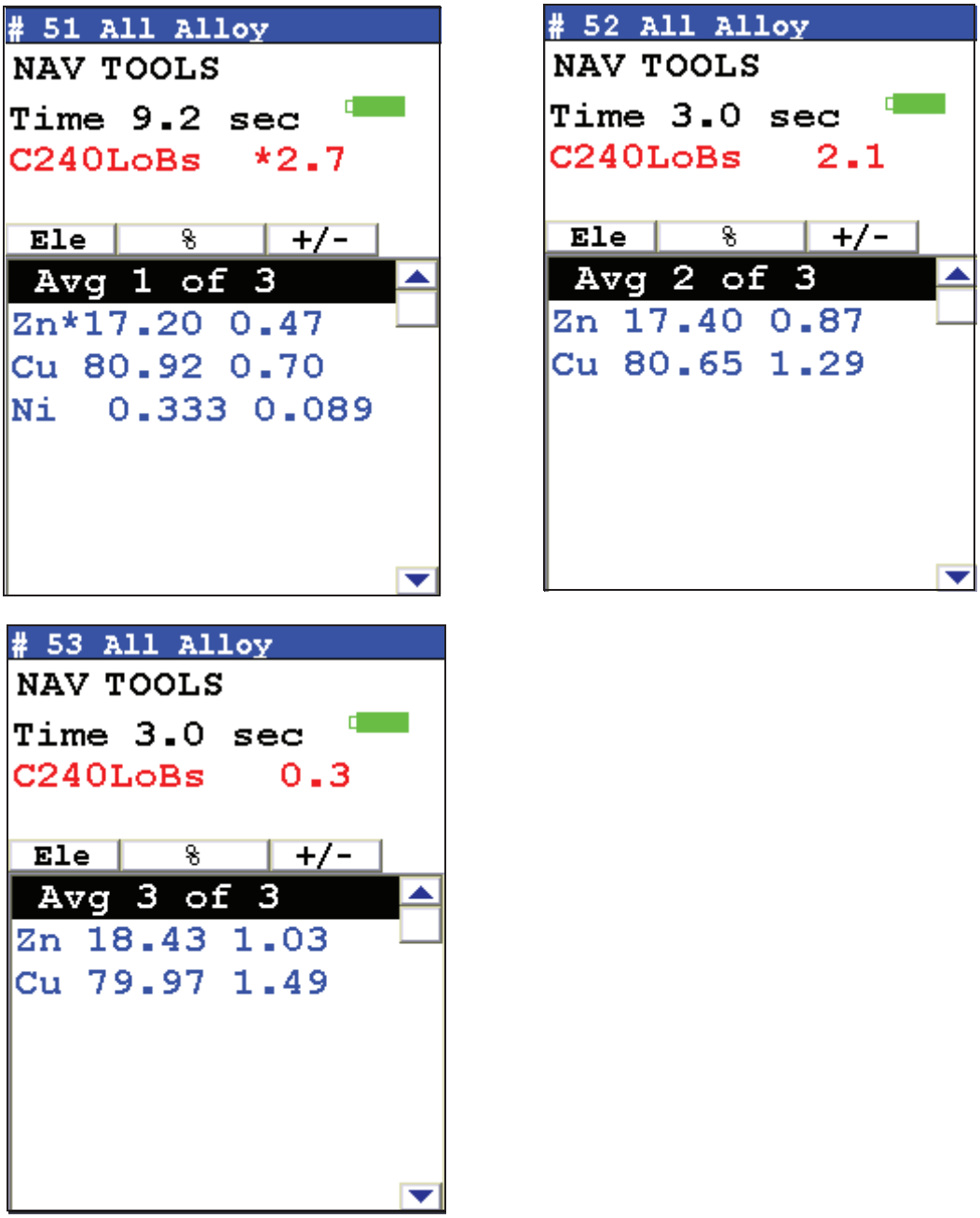


Figure 1-5. Averaging example: 3 readings

Live Spectrum Feed

The Tools Menu may contain a toggle option to display live spectra as sample analysis occurs.

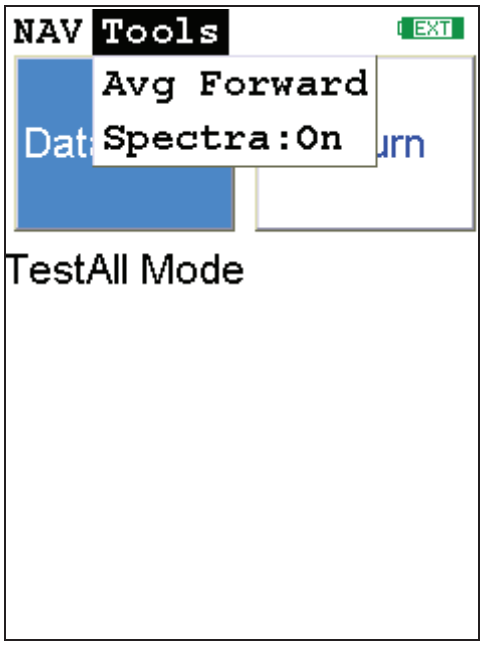


Figure 1-6. The Tools Menu showing the Spectra On/Off Toggle

Activating and Deactivating the Live Spectrum

From the Tools Menu, select Spectra : On to turn the Spectrun feed on. Once the spectrum is displayed, selecting Spectra : Off from the Tools Menu will stop the live spectrum display.

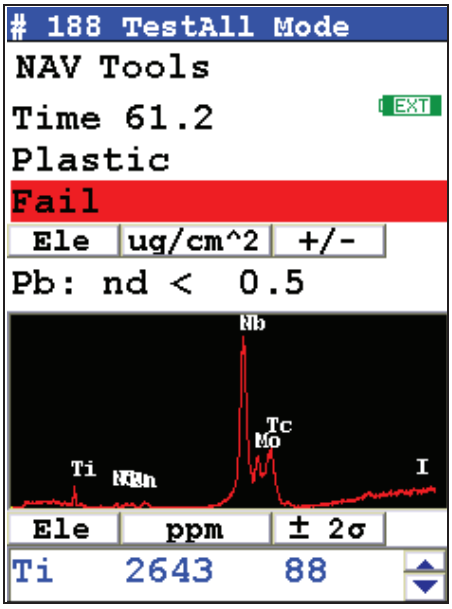


Figure 1-7. Test Screen Showing Live Spectrum

Analyzing Bulk Samples

CAUTION Whenever you turn on your NITON Analyzer after it has been off for more than 30 minutes, you should measure your check sample to assure proper operation. If the instrument is not reading properly, you should re-calibrate your NITON Analyzer's sample analysis electronics before you start to take readings. When the instrument is turned on after being off for more than 30 minutes, your NITON analyzer will require a 10 minute warm-up period before the instrument can be calibrated, unless this 10 minute warm-up period is manually overridden.

There are six different methods of operation for taking a sample measurement, and your analyzer will be configured to use one of those methods for soil samples, depending on the regulatory requirements of your locality. These methods are:

- Trigger-Only method. With the Trigger-Only method, you only need to place the measurement window close to the sample to be analyzed and pull the trigger for sample analysis to be initiated.

- Trigger-and-Proximity-Sensor method. With the Trigger-and-Proximity-Sensor method, you must place the measurement window against the sample to be analyzed to engage the proximity sensor on the front of the instrument, then pull the trigger for sample analysis to be initiated.

- Momentary-Trigger-Touch-and-Proximity-Sensor method. With the Momentary-Trigger-Touch-and-Proximity-Sensor method, you must place the measurement window against the surface to be analyzed to engage the proximity sensor on the front of the instrument, then pull the trigger. The trigger may be released and the reading will continue until you release the proximity button, or other criteria (such as Max Time) are reached.

- Trigger-and-Interlock method. With the Trigger-and-Interlock method, you need to place the measurement window close to the sample to be analyzed, press and keep pressing the interlock button at the rear of the instrument with your free hand, then pull the trigger for sample analysis to be initiated.

- Trigger-Interlock-and-Proximity-Sensor method. With the Trigger-Interlock-and-Proximity-Sensor method, you must place the measurement window against the sample to be analyzed to engage the proximity sensor on the front of the instrument, press and keep pressing the interlock button at the rear of the instrument with your free hand, then pull the trigger for sample analysis to be initiated.

- Easy Trigger method. With the Easy trigger method, you need only place the measurement window against the sample area and pull the trigger once to initiate a sample analysis. Your analyzer will continuously sample the backscatter, using a complex internal algorithm, to determine if the measurement window is against a sample or pointing to the empty air. If it finds that there is no sample directly against the measurement window, the analyzer will stop directing radiation through the window as soon as this determination is made.

Note The analyzer is constantly checking the backscatter characteristics to determine if a sample is against the measurement window, whether or not the Easy Trigger method is being used, and will shut off any radiation directed through the window if it determines that there is no sample present.

With any of these methods, analysis will stop if any one of the preconditions are violated. For example, with the Trigger-Interlock-and-Proximity-Sensor method, if the trigger or the Proximity Sensor or the Interlock is released, the reading will stop immediately, and the X-ray tube will shut down.

After your NITON analyzer is calibrated, initiate a sample reading using the appropriate method. If you attempt to initiate a sample reading using a different method, the analyzer will inform you that one or more of the preconditions need to be met in order for sample analysis to begin. Initiate the proper preconditions for operation to turn on the x-ray tube, and begin a measurement. Although the four LED lights will begin to flash as soon the initiating preconditions are met, as a safety precaution, the x-ray tube will not turn on immediately, and no reading will begin for approximately 0.5 seconds.

Note The four LED lights will blink during calibration. ♦

WARNING! The preconditions for operation must be continued for the duration of the reading. If the preconditions are violated, the x-ray tube will turn off, the calibration shutter will close, and the measurement will end. The four LED lights will stop blinking when the measurement is ended. The flashing of the LED lights is not synchronized to minimize power consumption. ♦

To end the test, simply release the trigger mechanism, or any other applicable preconditions.

WARNING! When all four LED lights are blinking, the x-ray tube is on. This should only occur during a measurement, while the preconditions for operation are met. On startup, the front pair of lights will blink. If the LED lights blink at any other time, disconnect the battery pack and call Thermo Scientific's Service Department in the United States, toll free, at (800) 875-1578, or outside the United States, at +1-978-670-7460, or your local Authorized NITON Analyzer Service Center. ♦

Your NITON Analyzer will display the Results Screen throughout the duration of each reading, The Results Screen is updated regularly throughout the reading. When the reading is complete, a final screen update will appear, and your NITON analyzer will display the final results of the measurement which has just been completed.

WARNING! Do not attempt to take measurements while downloading readings! This will generate an error requiring a system reset, and may corrupt your stored readings, requiring all stored readings to be erased. ♦

The Data Entry Screen

The **Data Entry Screen** is accessed whenever you select the **Data Entry** icon from any screen. This screen allows you to input data in several different fields, or categories, concerning your sample, in several different ways:

- By selecting the Virtual Keyboard button and typing the parameter in using the **Virtual Keyboard**.
- By creating a new, or editing your analyzer's existing, '.ndf' file through the NDT program. You can then select from the various custom options you have created using the Drop-down List button.

These fields are saved along with the subsequent reading, and allow you to associate important information about the sample directly with the reading, so that you have a full description of the sample tied into the reading itself.

Once you have input data into a field, that information carries over into the next reading, so that you only have to input the information that has changed since the last reading. For example, if you are analyzing several samples of a particular lot, you only need to input the lot information once during that series of readings, changing only the sample name.

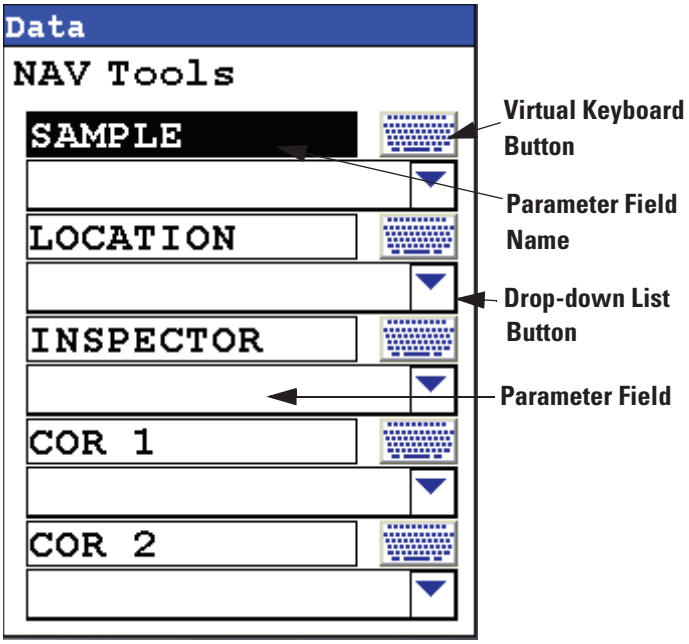


Figure 1-1. The Data Entry Screen - First page

This is the first section of the **Data Entry Screen**. There are five parameters in this section.

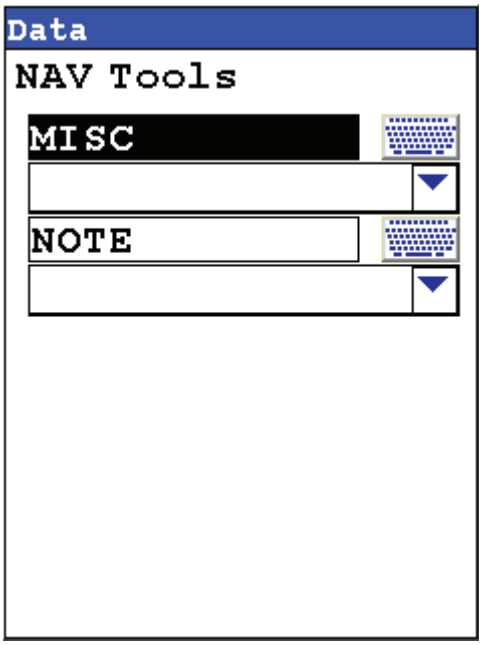
Selecting **Sample** allows you to input the sample name parameter.

Selecting **Location** allows you to input the particular Location information, if known.

Selecting **Inspector** allows you to input the parameter for the Inspector's name.

Selecting **Cor1** allows you to input information on the sample's origin Latitude Coordinate.

Selecting **Cor2** allows you to input information on the sample's origin Longitude Coordinate.

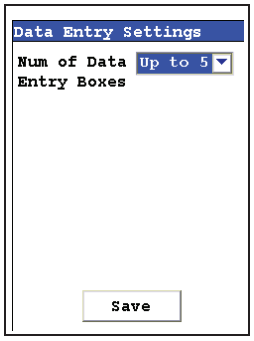


This is the second section of the **Data Entry Screen**. There are two parameters in this section.

Selecting **Misc** allows you to input the any miscellaneous parameters.

Selecting **Note** allows you to input any Note information, if wanted.

Changing the Data Entry Screen to Two Column



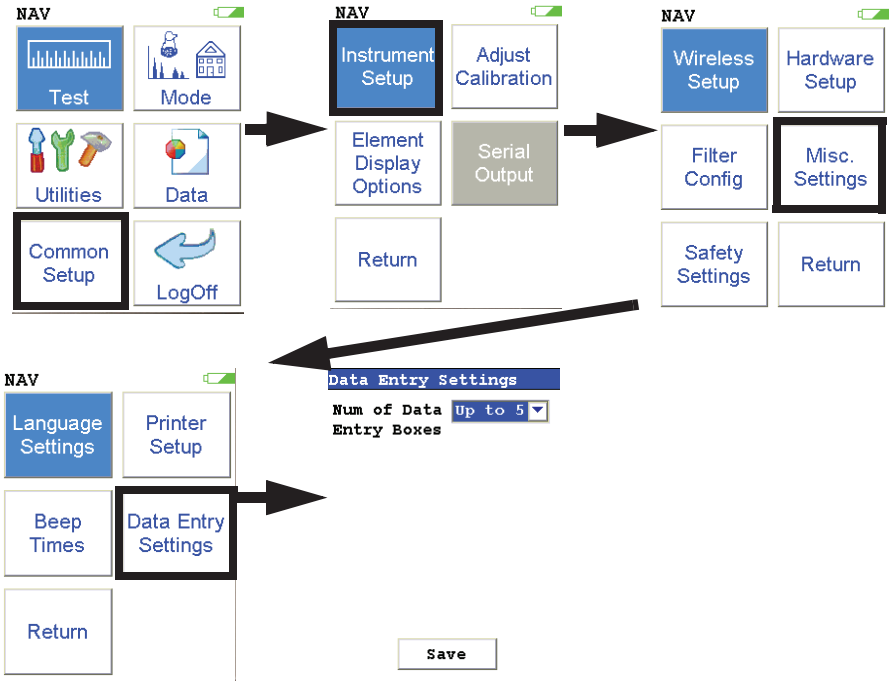


Figure 1-2. Data Entry Settings Menu Path

You can change the Data Entry display from the default single column to two columns in order to fit all the fields on one page, if you prefer. Select the Data Entry Settings icon from the Misc. Settings Menu to change your preferences.

Figure 1-3. Data Entry Settings Screen

Selecting the triangle button to the side of the Num of Data Entry Boxes field will open a drop down menu. From this menu you can choose between showing up to five boxes per page, the default, and up to eight boxes per page. Select the option you prefer, and select the Save button to save the setting.

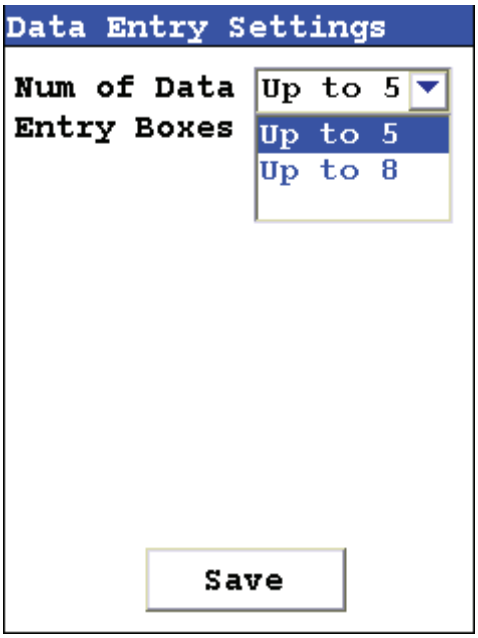


Figure 1-4. The Drop Down Menu

Under the default setting, a mode with more than five boxes will open up a second page to display the remaining boxes. Under the optional setting, a mode with up to eight boxes will display on one page, with the overflow page not opening unless there are nine or more Data Entry boxes.

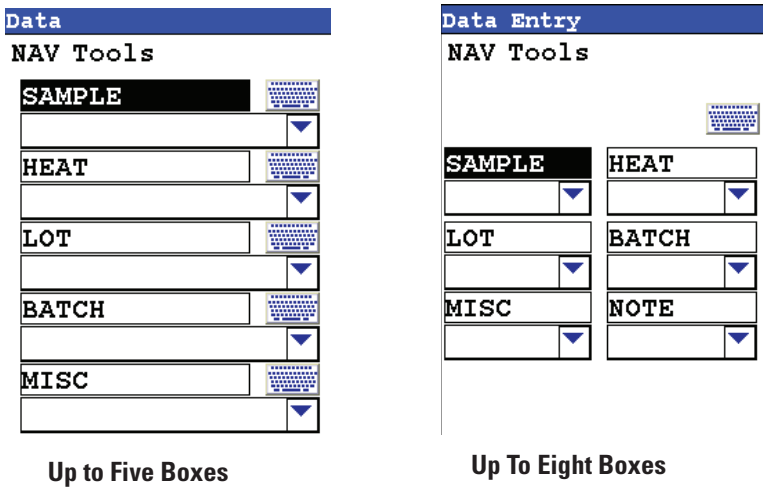
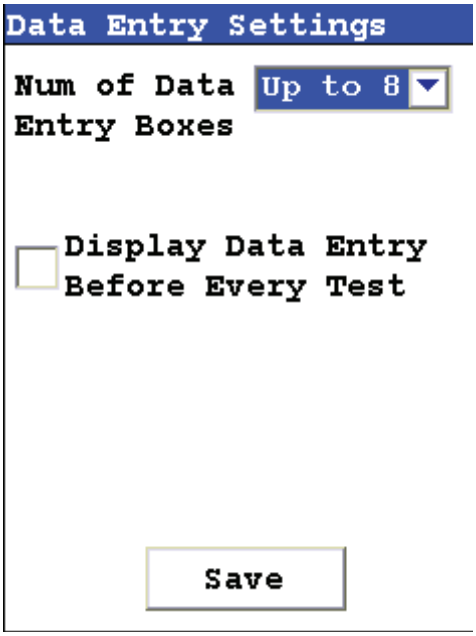


Figure 1-5. Comparing the Data Entry Display Options

With the default, up to five boxes, setting, the boxes are longer, and can display more descriptive test. With the optional, up to eight, setting, the boxes are shorter, but retain the full descriptive text internally. Choose whichever settign you feel most comfoortable working with.

Displaying Data Entry Boxes After Testing By Default



On the Up to Eight boxes screen, there is a checkbox to force the Data Entry screen to display. Checking the Display Data Entry Before Every Test checkbox will enable this, which can serve as a reminder to the user to enter data at test time. Despite the text, though, this checkbox forces the Data Entry screen to display *after* every test, not before every test. This only works with the “Up to Eight” option enabled.

Selecting Data Entry from View Data Mode

You can select Data Entry from the NAV Menu while in View Data Mode, but the ability to edit or enter data is disabled. The screen will show the data already entered, with no buttons for drop down menu selection or Virtual Keyboard.

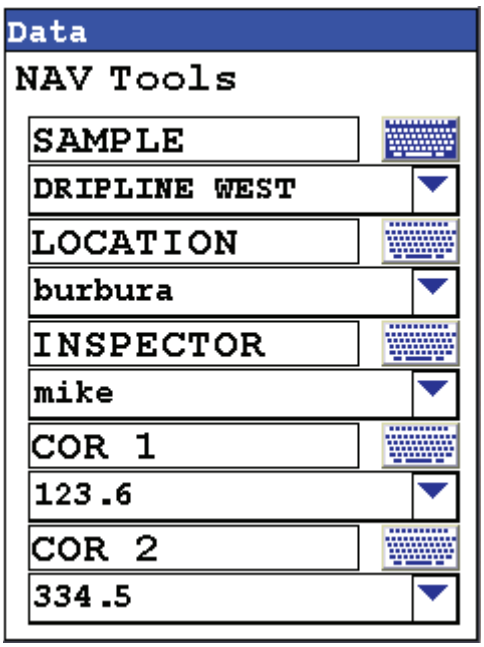


Figure 1-6. Data Entry Screen while Viewing Data

Navigating the Data Entry Screen

Figure 1-7. The Control Panel

The following description of screen navigation using the control panel assumes that the analyzer is held so that the display is held upright as in Figure 1-7.

- To move from column to column, use the Right and Left portion of the 4-way touch pad.
- To move from row to row, use the Up and Down portions of the 4-way touch pad.
- To select the highlighted option, press the Enter button on the control panel.

The **Data Entry Screen** is divided into sections of 5 setting parameters. By using the Down portion of the 4-way touch pad when you are on the last row of a section, the display will change to the next section. By using the Up portion of the 4-way touch pad when you are on the first row of a section, the display will change to the previous section.

By selecting the **On/Off** button, you can exit the **Data Entry Screen**.

The Virtual Keyboard

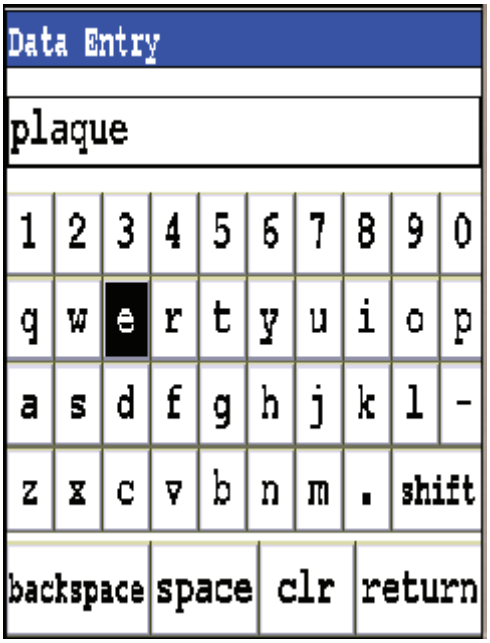


Figure 1-8. Lower Case Virtual Keyboard

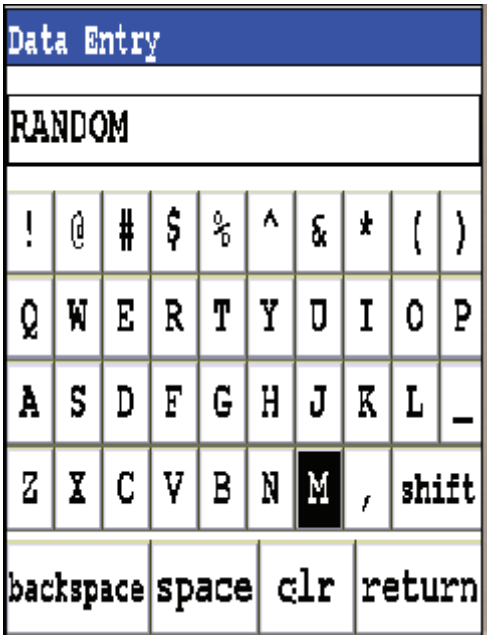


Figure 1-9. Upper Case Virtual Keyboard

The Virtual Keyboard is an alphanumeric keyboard which appears on the LCD Touch Screen Display. You can use the Virtual Keyboard either with the four-way touch pad and control panel buttons, or using the touch screen display directly.

At the top of the screen is the data field you are entering data into, in this case"A1234567890A". Also in this field is the underscore cursor, which graphically shows where the next character will be placed. Up to 25 characters can be stored in the data fields, though only the first 15 will be displayed on the analyzer's touch screen.

Next is the Virtual Keyboard itself, with numbers 0-9, letters A-Z, the special characters *,<,>, and -, and the Shift key, to toggle between upper and lower case keyboards.

Last is the control key line. This contains the keys for Return, Space, Clr, and Backspace. The Return key will enter the data and return you to the Data Entry Screen, the Backspace key will delete the last entered character, the Space key will insert a space at the cursor position, and the Clr screen button will clear the data you have entered.

Since the **Virtual Keyboard** is oriented 90 degrees from the standard in order to use a landscape display, the down portion of the 4-way touch-pad will select the key to the right of the current position, the left portion will select the key immediately below, the up portion will select the key to the left, and the right portion will select the key will select the key immediately above, Use the Select and Enter button to enter the currently selected key.

All screen areas can be directly accessed using the LCD Touch Screen by touch.

The Measurement Screen

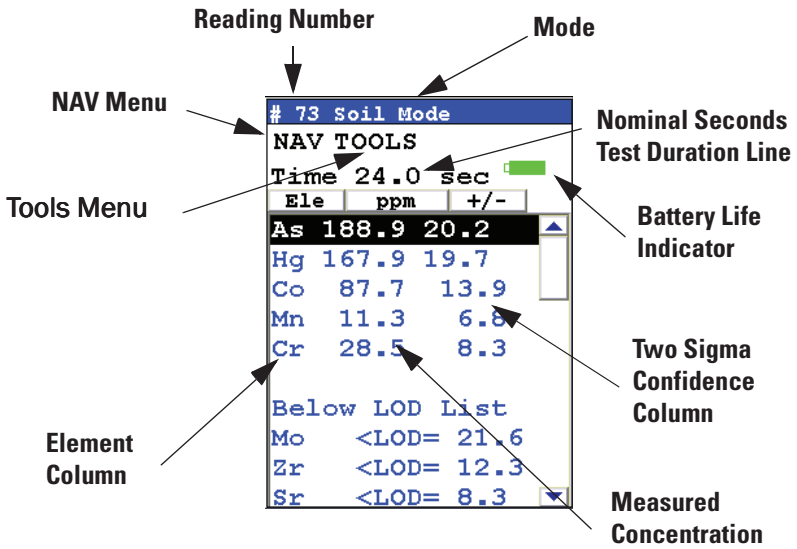


Figure 1-10. The Standard Bulk Measurement Screen

The Results Screen displays the following information:

- The Reading Number line shows a number automatically assigned by your NITON analyzer in order to uniquely identify each reading. The reading number automatically increments up by one with each successive reading.

- The Nominal Seconds Test Duration line shows the number of nominal seconds elapsing since the initiation of the reading. Nominal seconds are true, clock seconds slowed down to compensate for the electronic dead-time that occurs when the analyzer is taking a measurement.

- The Mode line displays the test mode in use during the measurement.

- The **Element** (left) column shows the elements that have been detected in the sample.

- The **Concentration Level** (central) column shows the concentration levels of the corresponding elements in percentages.

- The **Confidence** (right) column displays the 2 sigma (95%) confidence interval for the corresponding elements.

Standard Soil Mode

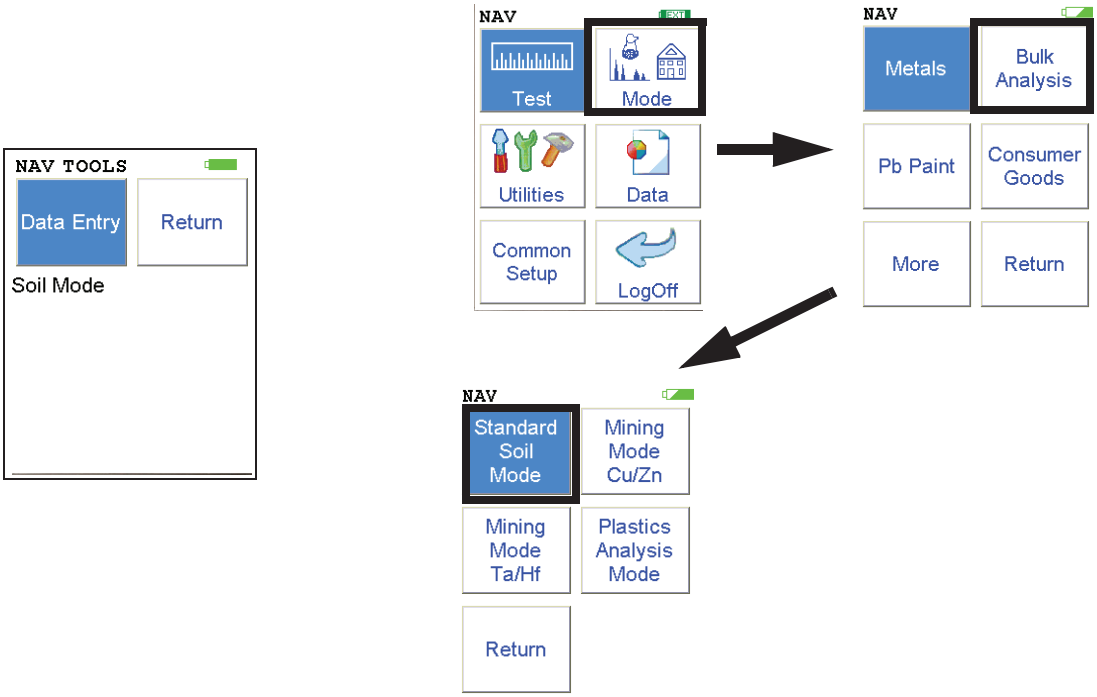


Figure 1-1. Standard Soil Mode Menu Path

To use the **Standard Soil Mode,** simply select the **Standard Soil Mode** icon from the **Bulk Analysis Menu** to place your instrument into **Standard Soil Mode**. Use the **Standard Soil Mode if**:

- The percentage of the elements of interest are <1.0%
- The material is of a light matrix, for example aluminum silicate
- Elements with atomic number greater than iron do not exceed several percent

This mode of operation is optimum for any sample whose elements of interest are present at less than 1%. **Standard Soil Mode** utilizes the Compton Scatter (Inelastic Collisions) of a particular sample. Compton scatter occurs when primary X-rays do not cause fluorescence but instead collide with the atoms of the sample. The Compton Scatter that occurs is directly proportional to the density (average atomic number (Z)) of the sample. A light matrix material, such as an oil or sand, will have a much greater scatter than that of a heavy matrix, such as ore. The analyzer measures this scatter peak and automatically adjusts the concentration based on the matrix of the material and allows for the analysis of a bulk sample without the use of site

specific calibration standards. This mode is used chiefly for the analysis of contaminants in soils.

Standard Soil Mode

NITON provides three soil standards: Lead high, Lead medium, and Lead low, to check the calibration of the instrument when testing in **Standard Soil Mode**.

Note Although the standards do not contain every element that the Environmental Analyzer is capable of testing, when an instrument correctly measures the standards you have received with your instrument, your instrument will correctly measure all other elements.

Test the standards regularly. NITON recommends testing immediately after the instrument finishes self-calibration. Test the standard samples appropriate to the type of tests you are conducting, and once every 1–2 hours thereafter.

Note For defensible Quality Control, keep a record of the time and precision of every calibration**.**

WARNING! Tampering with the 5,500 ppm (lead high) lead-in-soil standard may cause exposure to lead dust. Keep all standards out of the reach of children.

CAUTION Never tamper with Test Standards. They should not be used unless they are completely intact.

During each test, the instrument looks at the full range of x-ray spectrum and continuously corrects for cross-element interference.

The Measurement Screen

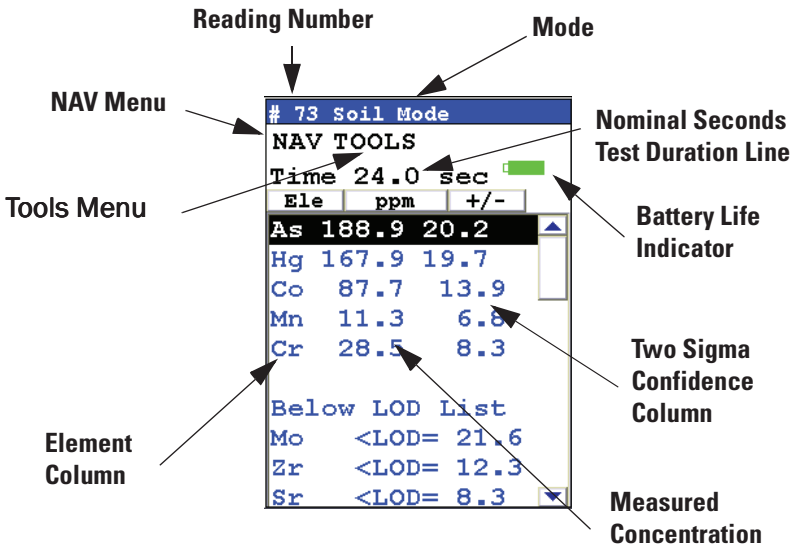


Figure 1-2. The Standard Bulk Measurement Screen

At the top are the elements detected in the sample, and underneath this, elements that are below the detection limit.

Use the 4 way touch pad or touch screen to scroll through the elements.

Detection Limit

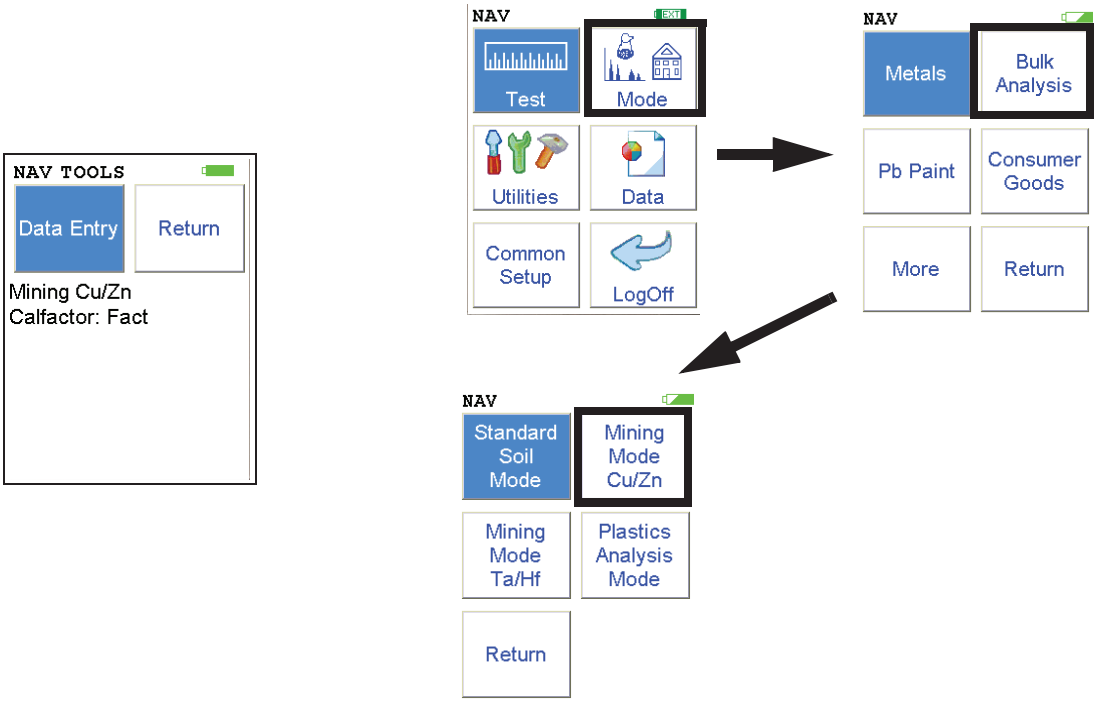
For an element to be detected by your analyzer in a given sample, the measured concentration of the sample must be at least three times the standard deviation of the measurement. This detection limit will depend on the composition of the sample.

Precision

The measurement precision for each element displayed appears to the right of the measured concentration, under the heading "+-". The precision of each measurement is two times the standard deviation (sigma).

An element is classified as "detected" if the measured concentration (in ppm) is at least 1.5 times the precision. Detected elements are displayed in ppm, followed by the measurement precision. Non-detected elements are shown as < the detection limit for that sample. The detection limit for a given element varies depending on the other elements in the matrix.

Mining Cu/Zn Mode



The **Mining Cu/Zn Testing Mode** allows you to perform tests on soil and other bulk samples without adjusting for a particular matrix. **Mining Cu/Zn Testing Mode** is ideal for finding concentrations of analytes in rock or soil. This mode of operation is optimum for any sample whose elements of interest are present at 1% or greater. **Mining Cu/Zn Testing Mode** utilizes Fundamental Parameters to analyze the sample. From the **Mining Cu/Zn Testing Mode Menu**, you can immediately initiate a sample test using the proper preconditions for operation, enter data about your sample using the **Data Entry** icon, or return to the **Main Menu**.

This mode of the operating software is intended primarily for the detection of metal concentrations in light matrices. The full fundamentals parameter (FP) algorithm accurately measures elemental concentrations from trace levels to 100%, and automatically corrects for inter-element effects. However, elements lighter than magnesium cannot be detected by XRF and light element combinations, such as oxides, carbonates, and silicates are common matrix components. To fine-tune results, you may enter calibration factors for individual elements to adjust for effects of light element interference. These calibration factors are linear corrections, which adjust the FP calculation. Calibrations only need to be entered once per matrix. However, as matrices can vary considerably from one sampling area to another, it is recommended that new calibrations be done for each change in matrix.

Concentrations for the following analytes can be determined:

Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, W, Pb, Bi, Zr, Nb, Mo, Sn, Ba, Sb, Cd, Pd, Sr, Rb, Se, and Ag.

All concentrations are displayed in units of wt. % by default, but can be changed to ppm.

Note For defensible Quality Control, keep a record of the time and precision of every calibration**.**

WARNING! Tampering with the 5,500 ppm (Lead high) lead-in-soil standard may cause exposure to lead dust. Keep all standards out of reach of children. ♦

CAUTION Never tamper with Test Standards. They should not be used unless they are completely intact. ♦

During each test, the instrument looks at the full range of x-ray spectrum and continuously corrects for cross-element interference.

Testing Prepared Samples

Set the NITON test platform on a flat, solid surface. Open the lid and place the sample cup in the holder, then shut the lid. Insert the instrument into the nose cone adaptor and follow in-situ bulk sample instructions

The Measurement Screen

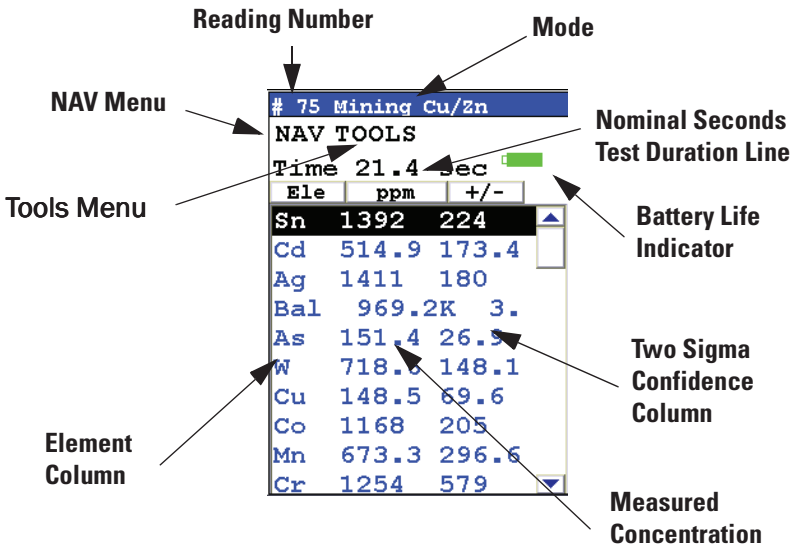


Figure 1-1. The Standard Bulk Measurement Screen

The Result Screen

When you end a reading, the **Measurement** screen will be replaced by the **Result** screen. These screens displays the reading grouped as follows:

At the top, elements detected in the sample, and, underneath this, elements that were below the detection limit.

Use the 4 way touch pad or touch screen to scroll through the elements.

Detection Limit

For an element to be detected by the analyzer in a given sample, the measured concentration of the sample must be at least three times the standard deviation of the measurement. This detection limit will depend on the composition of the sample.

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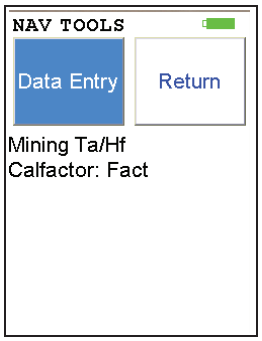
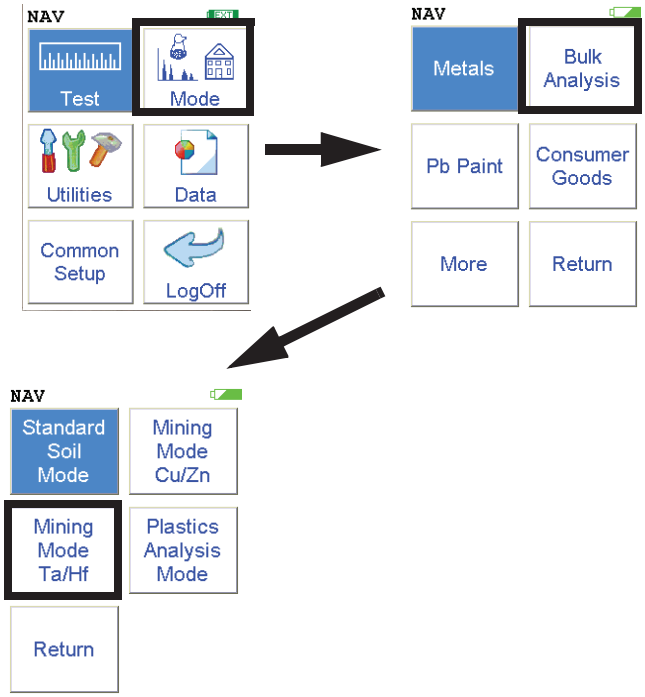
The measurement precision for each element displayed appears to the right of the measured concentration, under the heading "+-". The precision of each measurement is two times the standard deviation (sigma).

An element is classified as “detected” if the measured concentration (in ppm) is at least 1.5 times the precision. Detected elements are displayed in ppm, followed by the measurement precision. Non-detected elements are shown as < the detection limit for that sample. The detection limit for a given element varies depending on the other elements in the matrix.

Mining Ta/Hf Mode





The **Mining Ta/Hf Testing Mode** allows you to perform tests on soil and other bulk samples without adjusting for a particular matrix. **Mining Ta/Hf Testing Mode** is ideal for finding concentrations of analytes in rock or soil. This mode of operation is optimum for any sample whose elements of interest are present at 1% or greater. **Mining Ta/Hf Testing Mode** utilizes Fundamental Parameters to analyze the sample.From the **Mining Ta/Hf Testing Mode Menu**, you can immediately initiate a sample test using the proper preconditions for operation, enter data about your sample using the **Data Entry** icon, or return to the **Main Menu**.

This mode of the operating software is intended primarily for the detection of metal concentrations in light matrices. The full fundamentals parameter (FP) algorithm accurately measures elemental concentrations from trace levels to 100%, and automatically corrects for inter-element effects. However, elements lighter than calcium cannot be detected by XRF and light element combinations, such as oxides, carbonates, and silicates are common matrix components. To fine-tune results, you may enter calibration factors for individual elements to adjust for effects of light element interference. These calibration factors are linear corrections, which adjust the FP calculation. Calibrations only need to be entered once per matrix. However, as matrices can vary considerably from one sampling area to another, it is recommended that new calibrations be done for each change in matrix.

Concentrations for the following analytes can be determined:

Ti, V, Cr, Mn, Fe, Co, Ni, Hf, Re, W, Pb, Bi, Zr, Ta, Nb, Mo, Sn, Ba, Sb, Cd, Pd, Sr, Rb, Se, and Ag.

All concentrations are displayed in units of wt. % by default, but can be changed to ppm.

Note For defensible Quality Control, keep a record of the time and precision of every calibration.

WARNING! Tampering with the 5,500 ppm (Lead high) lead-in-soil standard may cause exposure to lead dust. Keep all standards out of reach of children. ♦

CAUTION Never tamper with Test Standards. They should not be used unless they are completely intact. ♦

During each test, the instrument looks at the full range of x-ray spectrum and continuously corrects for cross-element interference.

Testing Prepared Samples

Set the NITON test platform on a flat, solid surface. Open the lid and place the sample cup in the holder, then shut the lid. Insert the instrument into the nose cone adaptor and follow in-situ bulk sample instructions

The Measurement Screen

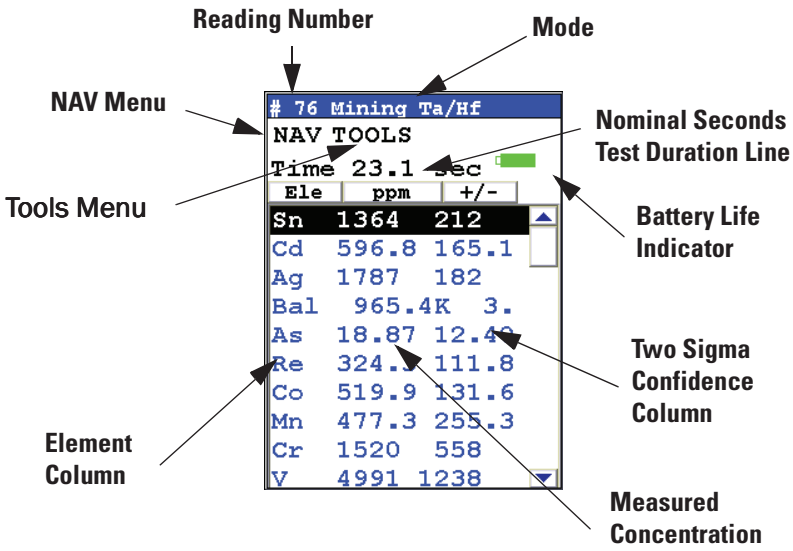


Figure 1-1. The Standard Bulk Measurement Screen

The Result Screen

When you end a reading, the **Measurement** screen will be replaced by the **Result** screen. These screens displays the reading grouped as follows:

At the top, elements detected in the sample, and, underneath this, elements that were below the detection limit.

Use the 4 way touch pad to scroll through the elements.

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An element is classified as “detected” if the measured concentration (in ppm) is at least 1.5 times the precision. Detected elements are displayed in ppm, followed by the measurement precision. Non-detected elements are shown as < the detection limit for that sample. The detection limit for a given element varies depending on the other elements in the matrix.

To Prepare or Not to Prepare - In Situ vs. Ex Situ

Bulk media are generally tested either on-site (*in situ*) for screening purposes, or removed and prepared (*ex situ*) to enhance the accuracy of the measurement. The degree of preparation may vary depending on the accuracy desired, the characteristics of the sample, and the characteristics of the site.

Understanding the advantages of *in situ* testing and of various degrees of preparation is crucial to obtaining useful data. *In situ* measurements should be used to profile an area, to locate areas of interest, to determine the boundaries of such areas, or to gather data that will subsequently be used to design a sampling plan.

In situ measurements are usually only approximations, though they may correlate very well with lab analysis if the site tested is highly homogeneous. If the site is non-homogeneous, as is often the case, then in situ measurement results may differ greatly from laboratory obtained results. Both sets of results may be correct. The difference arises from the fact that actual samples tested were different.

Analysis of Unprepared Samples – In Situ

Figure 1-1. In-Situ Soil Testing

♦Screening Techniques

There are many techniques you can use in analyzing samples in-situ. None of them are correct or incorrect - the only thing that matters is if they suit your particular interests. Following are some typical sampling techniques used in the field.

Exploration - Greenfields

Greenfields sampling is done as a preliminary mineral survey of a plot of land, to get an overview of surface deposits and signs of sub-surface deposits. The area to be surveyed is gridded at a constant spacing - usually 100m apart. Samples are taken at each grid intersection, first cleaning off the surface to a depth of 1 cm or so to avoid windblown contamination. GPS links via Bluetooth assures location and elevation information are recorded with each sample, which can be loaded into GIS mapping software to give a 3D map of the site with mineral readings plotted.

- Clean the measurement window of your analyzer before and after taking a sample to prevent cross-contamination.
- Check the Bluetooth connection to your GPS locator.

- Clear the sample area of vegetation and the top cm or so of soil to avoid windblown contamination.
- Press the measurement window of your analyzer against the soil and take a reading for the required sample time. This time may vary due to local conditions and/or customer preferences. In general, the longer the test, the more precise the result.
- Your GPS unit will log the sample location and elevation to your analyzer.
- Clean the measurement window of your analyzer before and after taking a sample to prevent cross-contamination.

Repeat this process at each grid intersection.

Infilling Areas of Interest

If there are areas of interest - particularly high readings of the minerals you are looking for - you can infill the sampling by taking readings at a closer spacing, for instance every 20 m. You may want to do this to get a better idea of the extent of the signs of any sub-surface deposit.

Tracking Placer Deposits

Streambeds and gullies can concentrate placer deposits as markers of minerals found upstream. It may be valuable to work up water-erosion channels separately to find the location of these deposits. Rather than working off a grid, such a survey would sample at a constant spacing, working upstream from outflow to the source.

Note Be mindful of the possibility of windblown contamination, especially if there is a working mine or processing plant upwind of the survey area.

Note Be careful not to puncture the measurement window. Replace any punctured window immediately.

Note Keep the measurement window clean to prevent cross-contamination from other sample areas.

Note Be careful of water content in the sample, particularly in srreambeds and water courses. You want the sample to be dry as possible.

Exploration - Drilling

These techniques are used after initial surveying to identify the location, extent, and configuration of mineral deposits. Drill holes are sunk in the areas of mineral concentration likeliest to correlate with an underground

deposit. The drill cores are analyzed stratigraphically to map in three dimensions the extent and concentration of ore throughout the site's volume.

Drill Cores

There are several types of drilling, which result in different types of core.

Figure 1-2. Core sample analysis

Diamond Drilling

Diamond drilling generally results in a solid core, cut into meter-long cylindrical segments, though drill core from loosely compacted strata can fragment easily. The cores are usually split along their length, giving half- or sometimes quarter-round sections. There are several ways you can analyze these cores, depending on what you want to know about them.

Spaced dots - Take a sample every 10 cm, If you bypass visibly different sections, it's a good idea to infill with analyses in these sections. This gives a trend overview over the length of the core.

Slide - Take a single sample over the whole length of the core segment by starting the sample at one end and sliding the analyzer over the surface at a constant speed, ending the analysis when you reach the end of the core segment. The sample should take approximately 30 seconds. This gives an averaged overview of the whole segment at once.

Slide and retest - Perform a Slide test, then resample spots of visibly different materials.

Note Change the filter timing on Slide type tests to correlate properly with the testing times. Otherwise, you may end up with faulty readings.

Rapid End Blast (REB) Drilling

REB drilling results in a fragmented core sample. The usual way to analyze these cores is through a cloth sample bag, taking several analyses from different parts of the bag. You can either use the samples as is, or average them for the entire content of the bag.

Wet Drilling

Wet Drilling results in a slurry. Slurries need to be dried before they can be analyzed,

Mining - Drilling Exploration/ Expansion/ Defining Ore Body

These techniques are much the same as those used in Exploration Drilling. The purpose, however, is different. The cores are taken around the edges of an already developed mine to define the extent and shape of the ore body.

Testing In Situ

These are readings taken directly from rockfaces and mine walls to determine the composition of the ore prior to removal and processing.

- Clean the measurement window of your analyzer before and after taking a sample to prevent cross-contamination.
- Check the Bluetooth connection to your GPS locator.
- Press the measurement window of your analyzer against the rockface and take a reading for the required sample time. This time may vary due to local conditions and/or customer preferences. In general, the longer the test, the more precise the result.
- Your GPS unit will log the sample location and elevation to your analyzer.
- Clean the measurement window of your analyzer before and after taking a sample to prevent cross-contamination.

Repeat this process at specified intervals, as appropriate.

Figure 1-3. Taking a reading from a rockface

Mining - Grade Control

Grade Control is the analysis of mined ore for the purpose of assuring that the metal content of the ore is within desirable limits. Samples are taken from the lot of ore and tested. The following technique may be used:

- Clean the measurement window of your analyzer before and after taking a sample to prevent cross-contamination.
- Crush the sample to roughly gravel sized pieces.
- Place the pieces into a cloth bag.
- Take several readings of the bagged sample. For a 7 inch by 12 inch bag, take at least three sample readings. If the readings vary widely, take more readings, as the sample is not very homogeneous. The more readings you take, the more accurate the estimate will be.
- Average the readings.
- Send the samples on for laboratory analysis if the averaged reading looks interesting.
- Clean the measurement window of your analyzer before and after taking a sample to prevent cross-contamination.

Because you are testing through a bag, test results will tend to be lower than test results obtained from direct analysis. This effect will vary depending on the element analyzed and the thickness and composition of the cloth through which the sample is tested. Bagged samples can be retested and/or be further prepared and then retested, allowing samples of particular interest to be more accurately analyzed.

Environmental

Environmental testing is used to assure that the site stays within the environmental guidelines of the government overseeing the operation. Environmental testing can give warning of possible environmental guideline violations, giving the site ownership opportunity to fix the problem before regulatory processes intervene. Areas downwind and downstream from the site should be patricularlyclosely moitored for higher than normal levels of metals.

Screening Techniques

Use direct measurement when you need to determine whether an element is present (rather than in accurately measuring how much is present). Use preliminary direct measurements to survey a site quickly even if you intend to take samples

WARNING! When taking samples from a site where toxic chemicals may be present, always use gloves and respiration equipment for your own protection. ♦

1. **Select a measurement site, and clear away any surface debris and vegetation.**

Note Valid results will depend on a sufficient and appropriate selection of sites to sample. Lead-in-soil from paint, for instance, will usually be concentrated within a few feet of the painted structure.

2. **Choose an area to test where the measurement window of the analyzer will be flush with the test media. Position the nose against the surface to be analyzed and initiate a reading by squeezing the shutter release, and firmly pressing the instrument flat against the surface.**

3. **After the test, inspect the nose of the instrument for contamination, which may affect future analysis. If the nose appears to be soiled, clean it with a soft cloth or tissue.**

WARNING! Always treat radiation with respect. Do not hold your instrument near the measurement window during testing. Never point your instrument at yourself or anyone else when the tube is on. ♦

Note Never use in situ testing with field portable XRF when comparing field results with laboratory results to justify XRF usage. Always collect samples and prepare them before testing. Refer to the instructions on sample collection and preparation in *Ex Situ* Testing.

In Situ Depth Profiling

XRF analysis for soil is a surface technique. To perform a depth profile, remove a vertical slice of soil and test several samples taken from different depths. This procedure will yield information, rapidly, about the depth of contamination.

WARNING! Always treat radiation with respect. Do not hold your instrument near the measurement window during testing. Never point your instrument at yourself or anyone else when the shutter is open. ♦

Note Never use in situ testing with field portable XRF when comparing field results with laboratory results to justify XRF usage. Always collect samples and prepare them before testing. Refer to the instructions on sample collection and preparation in *Ex Situ* Testing. ♦

On-site vs. Lab Analysis

When comparing field screening to laboratory analysis, it is preferable to compare results obtained from the same samples. Start by collecting a sample large enough to be divided into two parts, with one portion stored for future reference and the other submitted to a laboratory for independent analysis. For best results, follow the complete protocol for sample preparation, including drying and grinding of the sample. Grinding is essential for homogenizing the sample, ensuring that the portion sent to the lab is the sample as that analyzed on-site.

Analysis of Prepared Samples – Ex Situ

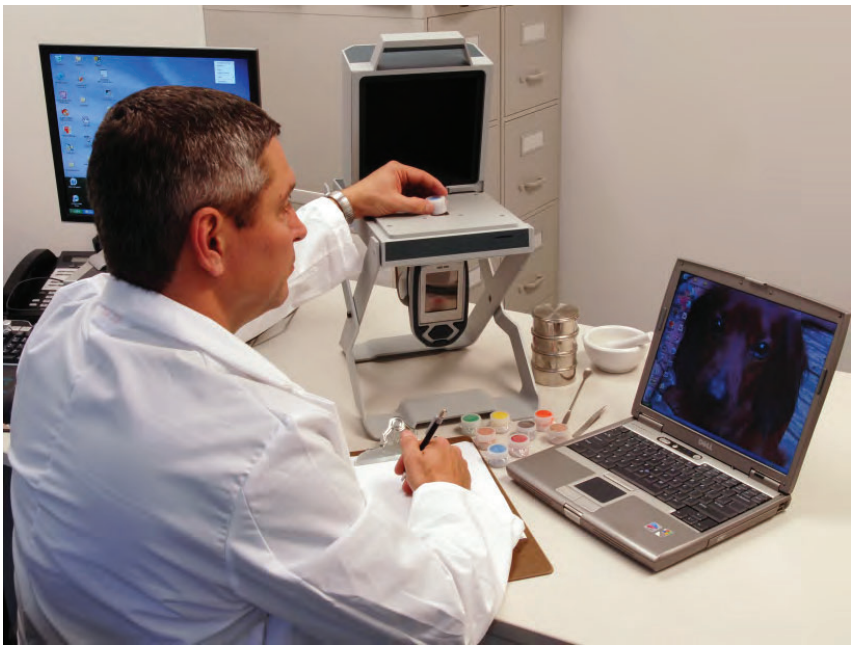


Figure 1-4. Ex-Situ Analysis of Prepared Samples

Sample Collection

Examine the site for differences in surface characteristics before sampling. Valid results depend on a sufficient and appropriate selection of sites to sample. Incorrect sample collection may give rise to misleading or meaningless results, regardless of the analysis method. Delineate sections with different characteristics and treat them as different areas. It may be desirable to subdivide larger areas even if they have the same characteristics to ensure a thorough examination.

Make certain to label each bag thoroughly. Common information included on each bag includes the person and/or the company who collected the sample, the location and area where the sample was taken, and the date the sample was collected.

Prepared sample analysis is the most accurate method for determining the concentration of elements in a bulk medium using the instrument. Sample preparation will minimize the effects of moisture, large particle size, variations in particle size and sample non-homogeneity.

Note More sample preparation (drying, milling and sifting) will yield greater accuracy. The drier, finer, and more homogeneous the particles, the better the measurements. ♦

Specimen Preparation - Fused Glass Disk;

The samples need to be predried for 2-6 hours in 105°C depending on the moisture content.

1. **Grind the dried samples to ~200mesh (74 µm).**

2. **Calcination (Ashing) the sample;**

   a. About 4-6 g of dry pulverized sample is calcinated in an alumina or platinum crucible in a muffle furnace at 1000°C for 1 hour.

   b. The sample is cooled in a dedicator and loss on ignition (LOD) is calculated from weight difference before and after Calcination.

3. **Weight 1.0g of calcinated sample into fusion crucible add 5.0 g of lithium tetraborate and 0.3 lithium fluorife, and 10-20 mg lithium bromide as a nonstick agent.**

4. **Fuse in a fluxer for at least 4 min in the flame.**

5. **The resulting disk is released from the mold, cooled the presented to the spectrometer.**

Specimen Preparation - Pressed powder briquette preparation;

1. **Thoroughly remix the sample in its jar by rotating in a figure-eight motion with two hands**

2. **Weight 7.0g of sample into weighting boat by taking several separate gram-size portions then fine grind sample using a swing mill.**

3. **Add 2 small drops of propylene glycol on the top of the powder sample in the mill as a grinding aid, grind 4min at 1000rpm to obtain 10 µm particle size.**

4. **Add 0.5g binder to the sample and continue grinding for 30sec more.**

5. **Brush the finely grounded samples into 31 mm aluminum sample cap and press at 50,000psi for 1 min.**

Preparing Bulk Soil Samples

We recommends establishing a specific sample protocol. Following this protocol for preparing and testing samples is vital for achieving a level of accuracy comparable with laboratory results.

The equipment you need to prepare samples is included in your kit. Among these are a mortar and pestle, several different sized metal sieves, cups to hold the samples, and the soil test platform.

CAUTION All test equipment must be kept clean to prevent contamination of samples. ♦

Cleaning Your Equipment:

The mortar, pestle, and grinding mill may be cleaned with dry paper towels. You can also clean the mortar, pestle, and the mill's container with water, but be sure each is absolutely dry before using them on another sample. The mortar and pestle may be cleaned by grinding clean, dry sand in the mortar. Use the short bristle brushes (included in your Soil Testing Kit) to clean the sieves. If you have an electric soil grinder in your kit, when the soil grinder blades wear out, unbolt the worn blades and replace them. Call the Thermo Sales Department at 1-800-875-1578 for replacement blades.

Note Using the soil grinder may artificially increase the amount of Fe in soil samples. ♦

Sample Preparation

Prior to analysis, the material should be dry and well homogenized. Ideally, the entire sample should be dried to constant weight, sifted to remove gravel and debris, and ground or milled to a fine powder.

Dry the sample if it is moist and cohesive. The sample can be dried in any of several ways. Choose one of the following:

- Oven dry the sample for approximately 2 hours at 150° C, until the sample reaches a constant weight. Note: Oven drying is inappropriate when volatile compounds may be present in the sample. For example, lead present as tetraethyl lead would be driven off by the heat of drying. Some forms of mercury and arsenic are volatile. Air drying will preserve more of these volatile substances.

- Air dry the sample overnight at room temperature in a shallow pan.

- Stir gently and warm the sample in a pan over a hot plate or burner.

Coning and Quartering

You may need to divide your sample at various times during preparation. Coning and quartering is a method for dividing the sample into homogenous quarters.

- Pour the dry material slowly and carefully onto a flat sheet or pan, forming a symmetrical cone. Divide the cone into equal piles using a flat thin-bladed tool, such as a knife or ruler. Divide these in half again.
- Now you have four samples, each one-quarter the size of the original and each more homogenous than the original.
- Grind the sample to break up dirt clods and/or paint chips.

WARNING! Grinding and sifting dried samples produces dust. Even clean soil contains silica, which may be hazardous when airborne. Prepare all samples in a ventilated area; wear a mask, gloves, and an apron; and spread a drop cloth. ♦

Sift using the #10 (2mm) mesh and separate out the larger pieces (stones, organic matter, metallic objects, etc. Examine the larger particles by eye but do not include in the sample. Grind the sample again so its particles will be finer and more homogenous. Use mortar and pestle, or an electrically powered grinding mill. Sift at least 10 grams of the sample through #60 (250 µm) and #120 (125 µm) mesh. Re-grind the un-passed material until the entire fraction is able to pass. Mix the resulting sample.

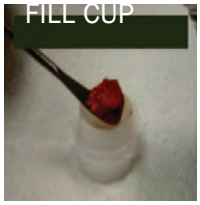
Placing the Sample in an XRF Sample Cup

Note The sample container should be a sample cup of a type that can be filled from the rear; that is, the side opposite the window (e.g. Thermo NITON Part Number 187-466). Thermo recommends using a 1/4 mil Polypropelene film (e.g. Thermo NITON Part Number 187-461). A supply of cups and films are included.

The container used to hold the sample will affect the accuracy of the measurement. Use a container with as thin-walled a window as is convenient and use the same kind of container and window for each sample. Consistency and careful attention to detail are keys to accurate measurement.

Place a circle of polypropelene film on top of an XRF sample cup. This film goes on the end of the cup with the indented ring. Thermo recommends preparing the cup ahead of time, if possible.

Secure the film with the collar. The flange inside the collar faces down and snaps into the indented ring of the cup. Inspect the installed film window for continuity and smooth, taut appearance.



Set the cup on a flat surface film-window-side down. Fill it with at least five grams of the prepared sample, making sure that no voids or uneven layers.

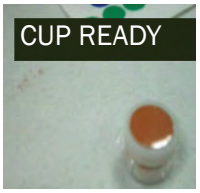
Lightly tamp the sample into the cup. The end of the pestle makes a convenient tamper.

Place a filter-paper disk on the sample after tamping it.

Fill the rest of the cup with polyester fiber stuffing to prevent sample movement. Use aquarium filter or pillow filling as stuffing. A small supply of stuffing comes with your bulk sample kit.

Cap the cup.

Place a label on the cup. Using a pen with indelible ink, write identifying information on the cup. Keep a record of the sample designation, the site and location, the date of the sample, and any other relevant comments.



Cup is ready for testing.

Preparing Liquids and Sludge

Liquids

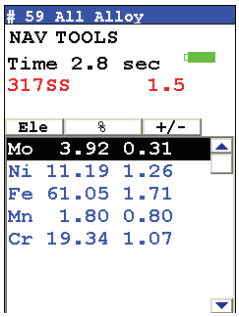
Fill an XRF sample cup with the liquid to be tested (do not pad the sample with cotton). The cup must be full so it is best if some liquid is allowed to overflow when the cap is put on.

Sludge

Sludge can be placed directly into an XRF cup for screening. This is considered in-situ testing because no attempt has been made to prepare the sample. For more accuracy, the sludge can be dried, sieved, and ground.

Prepare in an XRF sample cup and test the same way you would with a soil sample. For risk analysis, it is advisable to use a 60-mesh sieve to isolate and test only fine particles.

The View Data Screen



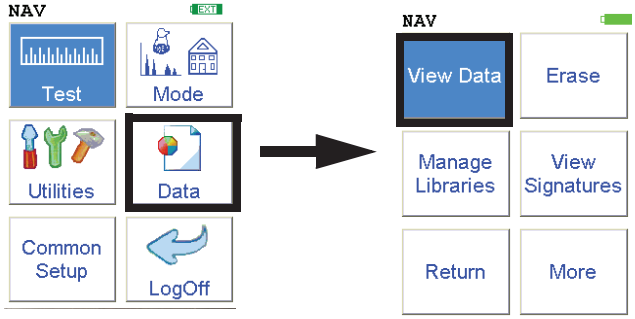
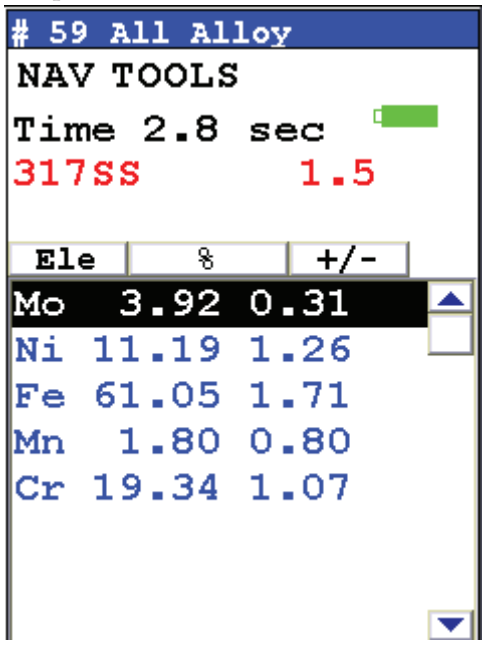


Figure 1-5. The View Data Menu Path

Use the Data Screen to view previously taken test result readings. When the **View Data** icon is selected, the Results screen of your most recent test is shown on the LCD display.



Using the buttons on the control panel, you may view different readings or additional data for individual readings.

Your analyzer will display the standard screen analysis. Pressing the "Down" arrow on the 4-way touch pad will display a complete scrolling elemental chemistry listing. Each press of the “Down” arrow scrolls the screen down to the next element. You can also use the scroll bar along the right side to scroll or page through the elements.

Scrolling Down Through the Complete Listing of Elements

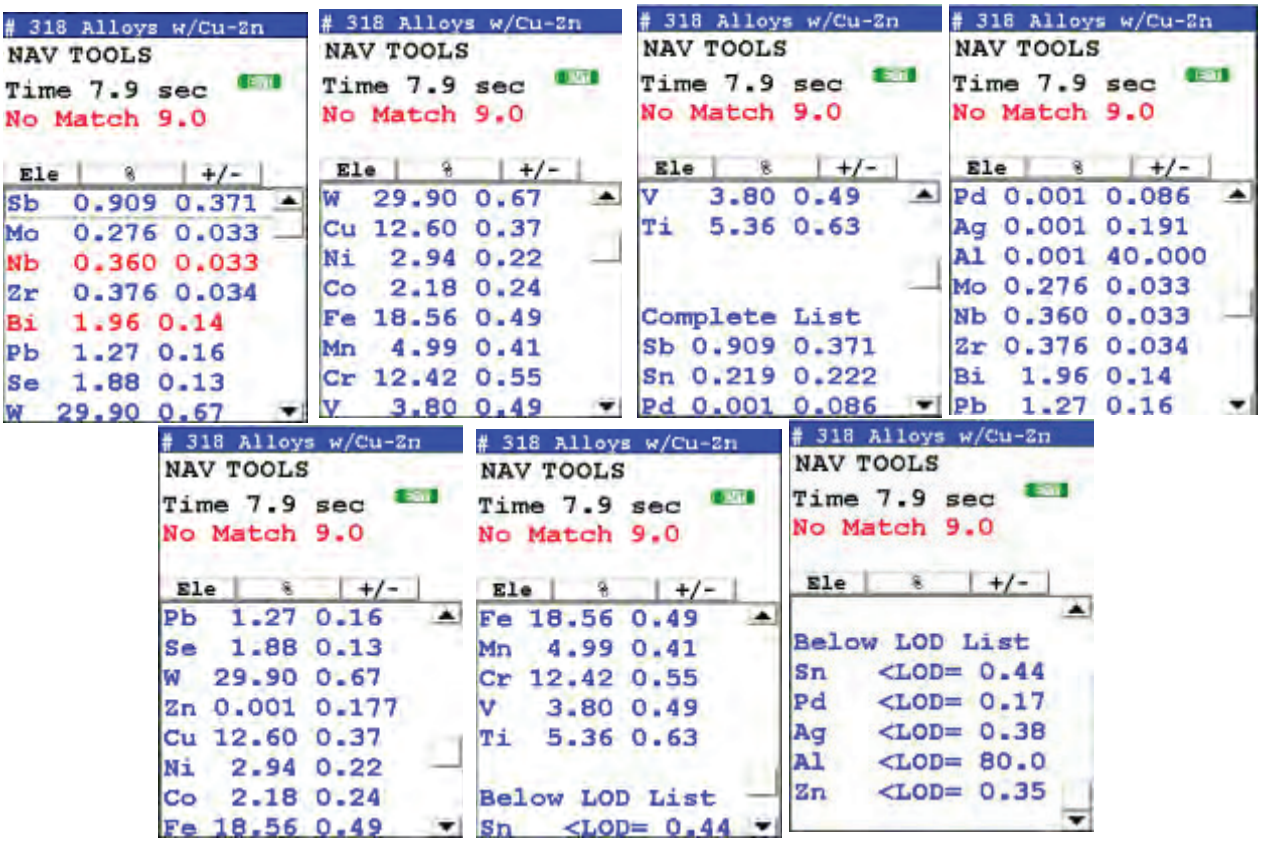


Figure 1-6. Complete Listing of Elements

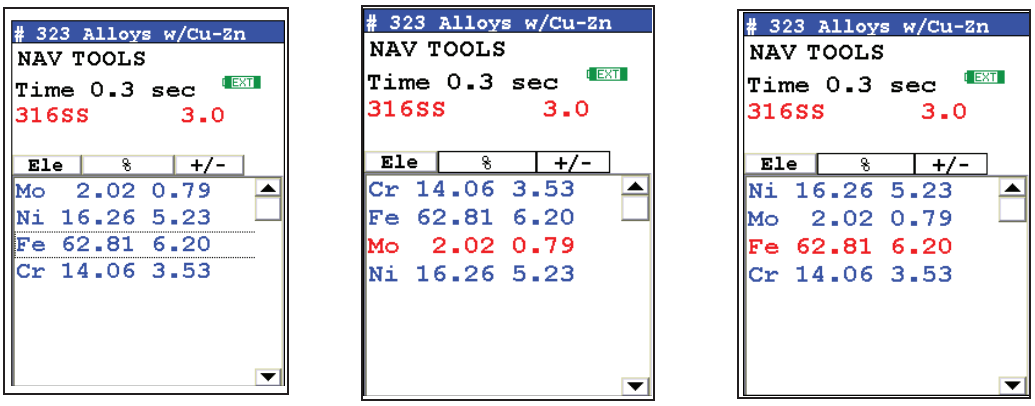
Pressing the "Left" arrow on the 4-way touch pad of your analyzer will display the previous reading, or if the first reading is currently displayed, the last reading. Pressing the "Right" arrow on the 4-way touch pad will display the next reading, or if the last reading is currently displayed, the first reading in memory. NITON Analyzers can store between 3000 to 6000 readings.

You can also look at the complete x-ray spectra for each reading stored in the analyzer's memory.

Sorting Elements

You can sort element rows by various criteria in order to view your data in the manner you prefer.The Sort Buttons, which double as column headings, can be used to re-sort the data in different ways. The Data Screen always begins as a Standard Sort, as you have defined it. Selecting the appropriate

sort button once toggles the sort order to High-to-Low. Selecting the sort button again toggles the sort order to Low-to-High. To return to the Standard Sort, view a different reading and return.



Standard Sort | Low-to-High Sort | High-to-Low Sort

Figure 1-7. Element Sorts

Element Sorts

Element sorts are performed alphabetically based on the element name.

Composition Sorts

Composition sorts are performed numerically based on the percentage of composition.

Error Sorts

Error sorts are performed based on the range of error in the reading.

Spectrum Graph

For any reading result, simply use the **NAV Menu** to gain access to the reading's spectrum graph. Selecting Spectra will show a graphed spectrum of this reading, called SpectraView. SpectraView can be a useful tool for rapid, qualitative analysis of a sample. See "SpectraView" on page Appendices-vii for details.

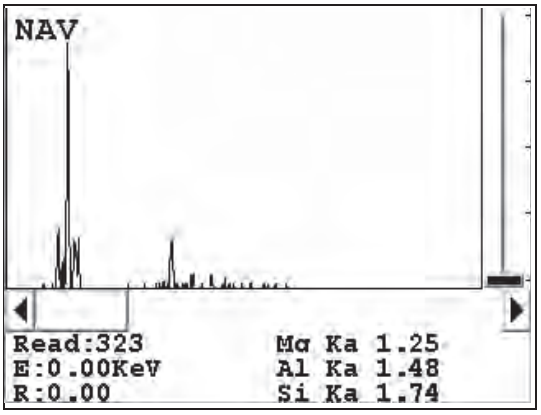
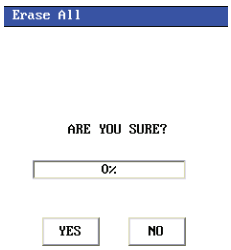


Figure 1-8. The SpectraView Screen

The Erase All Data Screen



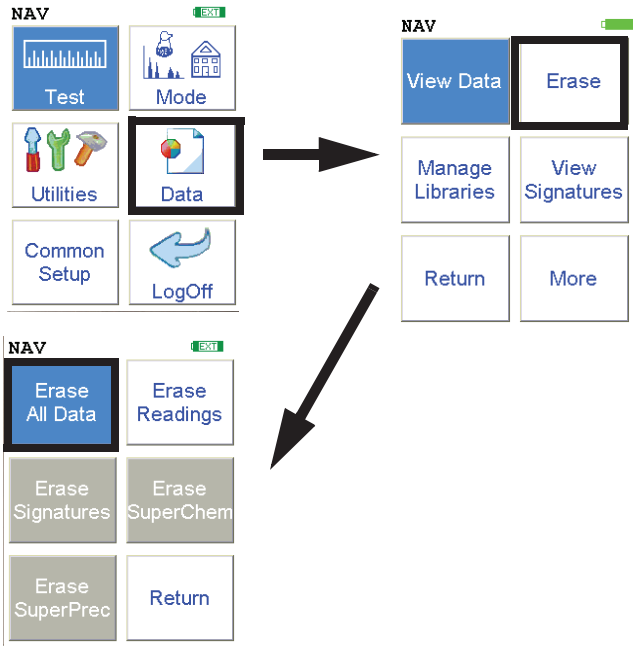


Figure 1-9. The Erase All Data Menu Path

Select the **Erase All Data** icon to erase all data, including signatures and SuperChem reference readings, from your analyzer. Selecting the **Erase All Data** icon will bring up a confirmation screen (see upper left) asking you "Are you sure?" with options to select "YES" or "NO". Selecting "YES" will erase all reading data from your analyzer. Selecting "NO" will return you to the **Erase Menu**.

CAUTION Never turn off the analyzer while data is being erased! ♦

WARNING! Do not attempt to take measurements while downloading readings! This will generate an error requiring a system reset, and may corrupt your stored readings, requiring all stored readings to be erased. ♦

The Erase Readings Screen

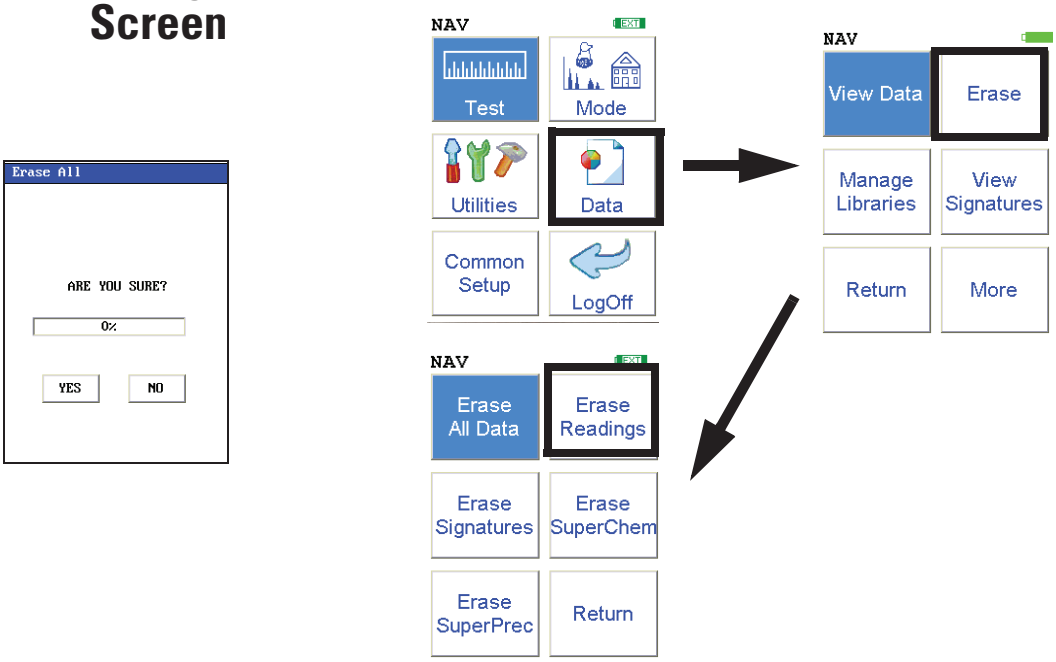


Figure 1-10. The Erase Readings Menu Path

Select the **Erase Readings** icon to erase all accumulated test readings from your analyzer. Selecting the **Erase Readings** icon will bring up a confirmation screen (see upper left) asking you "Are you sure?" with options to select "YES" or "NO". Selecting "YES" will erase all test reading data from your analyzer. Selecting "NO" will return you to the **Erase Menu**.

Note We recommend that you download all your readings into an NDT file for recording purposes before erasing all data. ♦

Figure 1-11. Select the **Switch Libraries** icon to toggle between the standard library and the currently loaded alternate library. Select the **Switch Libraries** icon again to toggle back.**Main Library and Alternate Library**

Click OK to return to the **Manage Libraries Menu**.

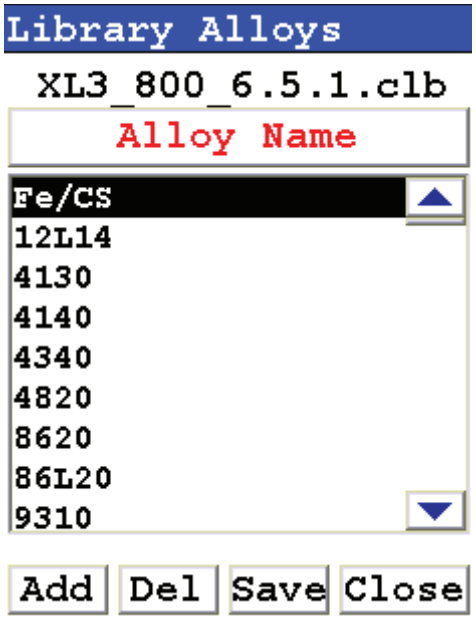


Figure 1-12. The Library Editor

Using the Library Editor

The Library Editor enables you to edit any library to conform to your specifications.

Alloy Name Button

Selecting this button sorts the list alphanumerically.

(Name in List)

Selecting the actual name of the alloy - i.e. “Fe/CS” - will bring up the **Element Specification Screen**.

Add

Selecting the Add button will add a new alloy to the Library. First the Alloy Name Editor will appear, enabling you to enter the name of the new alloy.

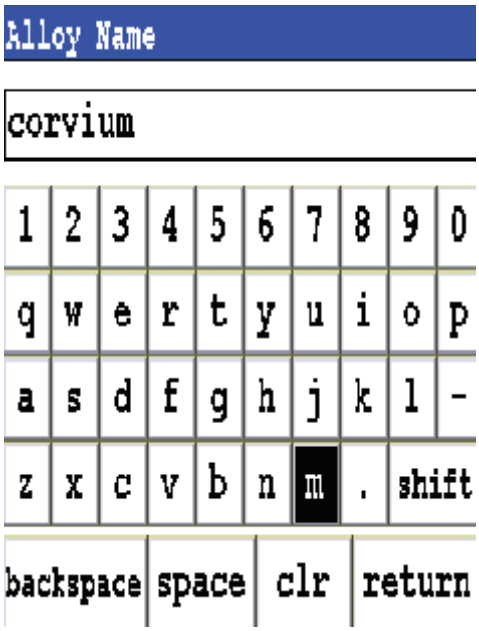


Figure 1-13. The Alloy Name Editor

The **Alloy Name Editor** is a standard Virtual Keyboard. Use it as you would any Virtual Keyboard.

Hitting the return key enters the name into the alloy list. Select the name to enter the **Element Specification Screen** and enter the specification of the alloy.

Del Selecting the Del key will delete the currently selected alloy. First a confirmation screen appears.

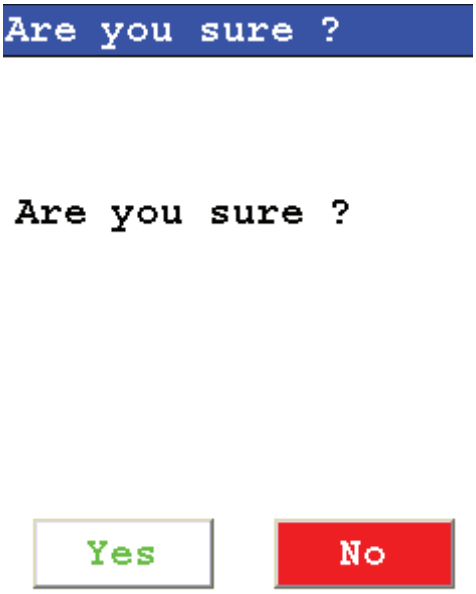


Figure 1-14. Confirmation Screen

Selecting Yes will delete the alloy from the list. Selecting No will return you to the Alloy List.

Save Selecting the Save button will save the current Library.

Close Selecing the Close button will close the current Library without saving it.

The Element Specification Screen

The Element Specification Screen allows you to edit the elemental content of any alloy.

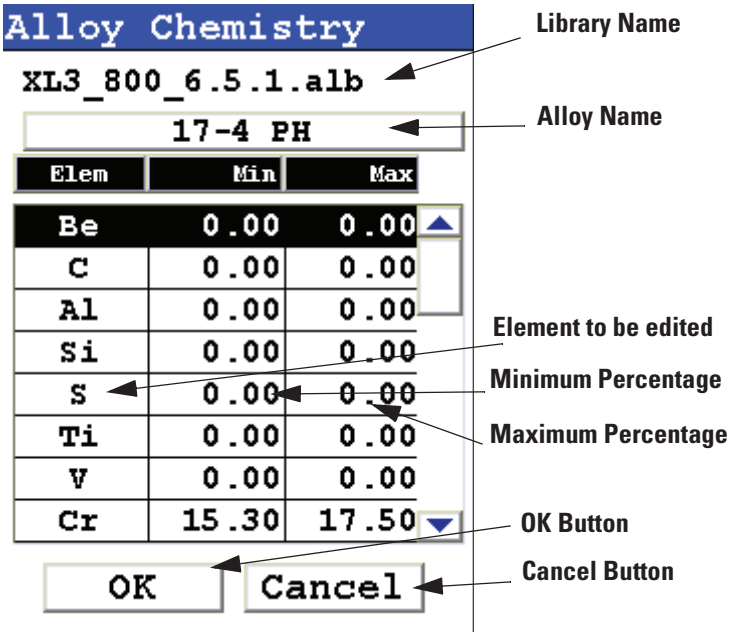


Figure 1-15. The Element Specification Screen

Library Name This is the name of the library you are editing. Make sure you are editing the correct library before proceding further.

Alloy Name This is the name of the alloy you are editing. Make suere you are editing the correct alloy before proceding further.

Element to be Edited This is the element you need to edit for this alloy.

Minimum Percentage This is the lowest amount of the element in question you want to be in the alloy. If the element in the analyzed sample is any lower, the sample will not be recognized as this alloy. Selecting the element minimum will open the Minimum Editor.

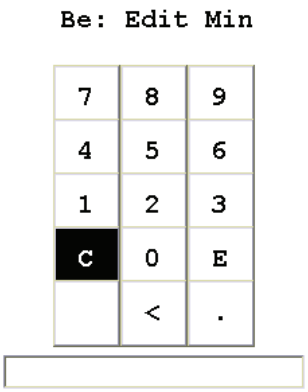


Figure 1-16. Minimum Editor

This is a standard numerical entry keypad. “C” = clear the current display, “<“ means backspace one space, and “E” means enter this number as the minimum. After selecting “E”, you will be returned to the Element Specification Screen.

Maximum Percentage

This is the highest amount of the element in question you want to be in the alloy. If the element in the analyzed sample is any higher, the sample will not be recognized as this alloy. Selecting the element maximum will open the Maximum Editor.

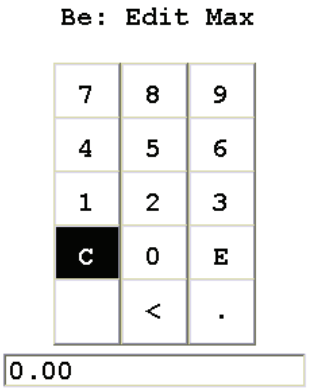
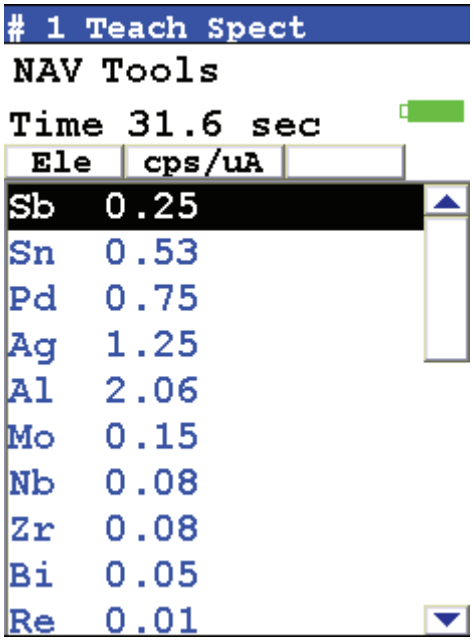


Figure 1-17. Maximum Editor

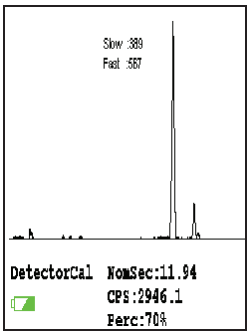
This is a standard numerical entry keypad. “C” = clear the current display, “<“ means backspace one space, and “E” means enter this number as the maxiimum. After selecting “E”, you will be returned to the Element Specification Screen.

OK Button Selecting this button will save the editied library.

Cancel Button Selecting this button will exit the Element Specification Screen for this alloy, returning you to the Library Editor.



The Calibrate Detector Screen



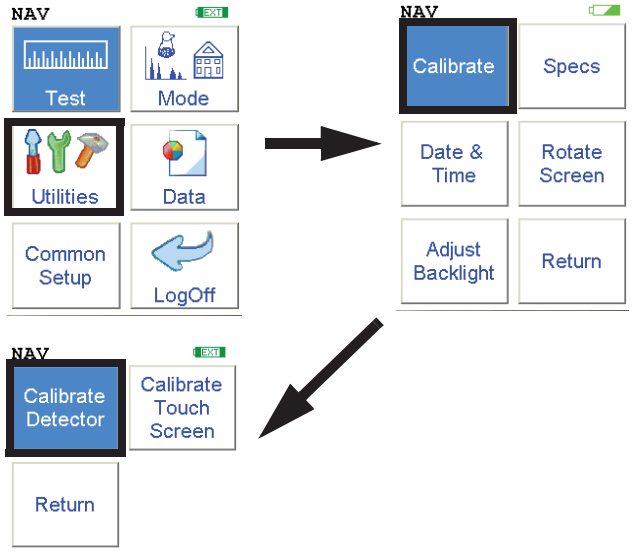


Figure 1-18. The Calibrate Detector Menu Path

Select the **Calibrate Detector** icon to begin a standard calibration of your analyzer's detector. Once you select the **Calibrate Detector** icon, calibration will begin immediately. The analyzer is programmed to calibrate for a specific, predetermined period in order to ensure proper operation of your NITONXL3 analyzer in the field.

CAUTION Avoid any vibration, loud noise, strong electronic fields, or other possible interference when your analyzer is calibrating its detector. ♦

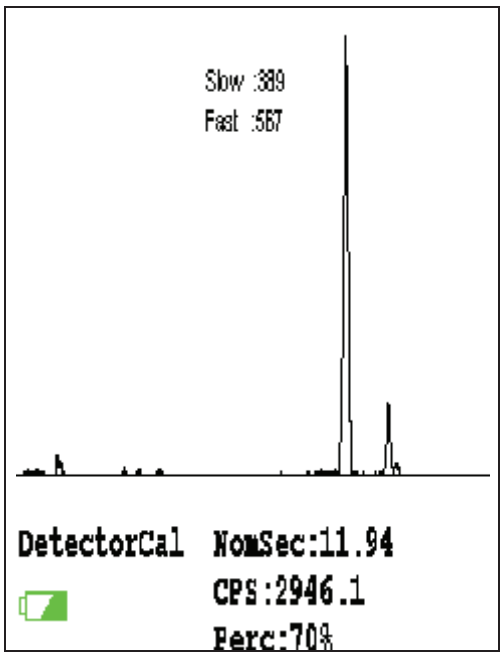


Figure 1-19. Detector Calibration Screen

The analyzer calibration screen will be displayed until calibration is complete. After the calibration has finished, the calibration results will be displayed.

Press the on/off/escape button or the **Return** icon to return to the **Main Menu**. In order to ensure good test results, it is essential that you calibrate your XL3 Analyzer's detector daily, and if a check sample test reveals discrepancies in the reading.

The Calibrate Touch Screen Screen

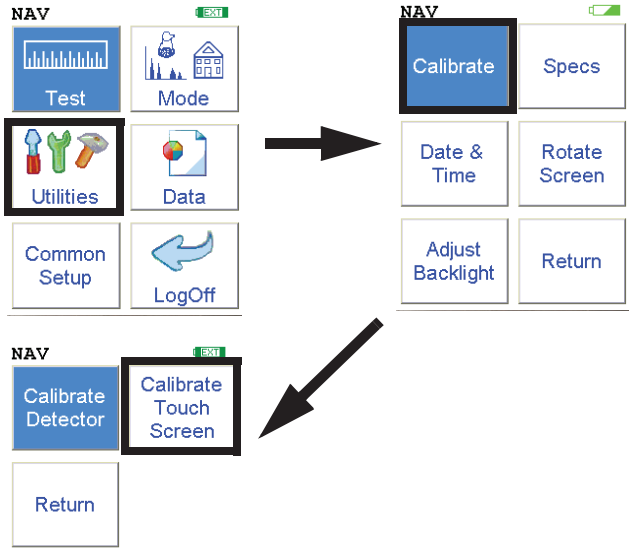


Figure 1-20. The Calibrate Touch Screen Menu Path

Select the **Calibrate Touch Screen** icon to re-calibrate the analyzer's touch screen display. This procedure establishes the display boundaries for the touch screen interface. When the **Calibrate Touch Screen** icon is selected, the display will show the message: "Calibrate Touch Screen". There will be a small cross in the upper left-hand corner of the display. Tap on this cross with the stylus, and the cross will disappear and reappear in the upper right-hand corner of the screen. Tap on the cross again, and it will reappear in the lower right-hand corner of the screen. Tap on the cross again and it will reappear in the lower left-hand corner of the screen. Tap on the cross once more, and you will be presented with the **Calibrate Menu**

Figure 1-21. The Touch Screen Calibration Screen

Calibrating the Touch Screen Without Using the Touch Screen

Because there may be a severe issue with the touch screen itself, you may need to use the buttons below the screen to complete this process. There are 3 single buttons and a 4 way switch located to the rear of the display screen. The button at the left is the On/Off/Escape button. The button to the right is the enter button and the center keypad is a 4 way switch.

The 4 way switch has 4 positions, Up, Down, Left and Right. The select and interlock buttons are not used in this procedure.

Figure 1-22. The Control Buttons for the XL3

1. **Please, turn on your XRF analyzer using the On/Off button.**

Note From this point please DO NOT touch the touch screen.

2. **Press the enter button. You are now at the Radiation warning screen.**

3. **Using the 4 way touch pad on the on the cover of the instrument, move the cursor around the screen by pressing the appropriate Up down left or right button. Please move the cursor such that the Yes option is highlighted in green.**

4. **Press the "enter" button. You are now at the Enter Password Screen.**

5. **Move the cursor to the appropriate first number in your password and then using the enter button on the right (it has the arrow/enter key symbol on it) press this "enter" key. The first number of your password should appear in the lower left of the LCD screen.**

6. **Repeat step 5 until you have entered the entire password. Then move the cursor to the letter "E" and press the "enter" key to enter it.**

7. **You will now be at the main screen.**

8. **Again using the four way touch pad, move the cursor to highlight the "Utilities" icon and press the "enter" key to select.**

9. **You will now be at the Utilities screen**

10. **From the Utilities screen, move the cursor to highlight the "Calibrate" icon and press the "enter" key.**

11. **Now move the cursor to highlight "Calibrate Touch Screen" and press the enter key.**

12. **You are now at the Touch Screen Calibration screen.**

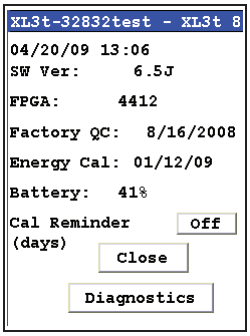
Note You must now use the touch screen for the balance of this procedure

13. **In the upper left hand corner you will see a crosshair "+", using the stylus or a pen, tap the center of the "+".**

14. **Repeat this for each "+" sign that appears, there should be one for each of the 4 corners.**

Your touch screen should work properly after this and you may use it from this point forward. If it does not, please repeat the process.

The Specs Screen



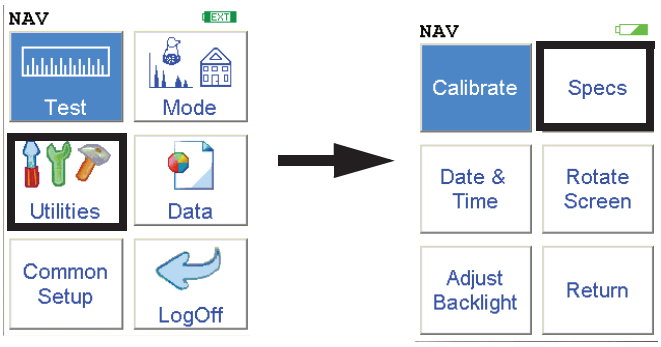


Figure 1-23. The Specs Menu Path

Select the **Specs** icon to display the analyzer's specifications. These specifications include your NITON analyzer's serial number, software and firmware versions, temperature, bias, and data coprocessors. Press the Close button to return to the Utilities Menu.

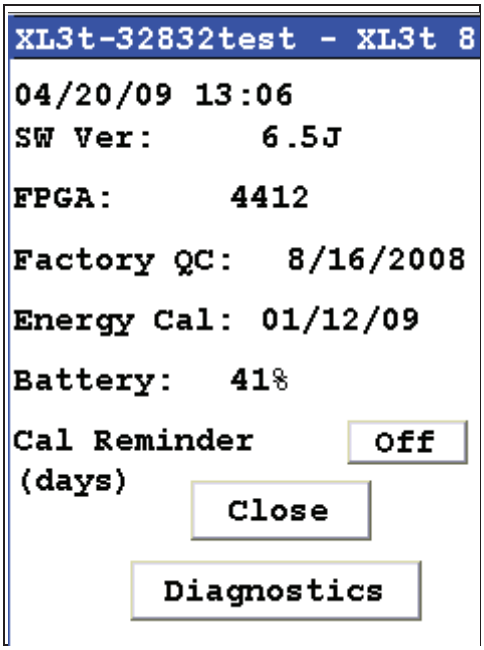


Figure 1-24. The Specs Screen

On the Specs Screen, standard information on the state of your analyzer is shown for your reference. This information should be reported to Service if there is a problem.

Specs Information

The following is the information supplied on the Specs Screen:

Instrument Specific Serial Number

This is located in the left part of the blue band at the top of the screen.

Model Number

This is located in the right part of the blue band at the top of the screen.

Date And Time

This is the current Date and Time. This is particularly important for date stamping.

SW Version

This is the currently loaded software version, which should be reported to Service if there is any problem.

FPGA

This is the currently loaded FPGA software version, which should be reported to Service if there is any problem. FPGA versions are always a four digit number. Any other number of digits may be a sign of a problem in the FPGA code.

Factory QC

This is the date that the machine was QCed at the factory.

Energy Cal

This line notes the last time a user detector calibration was performed.

Battery

This line gives the proportional charge remaining to the battery.

Cal Reminder

Select the Cal Reminder Button to set a reminder to calibrate your analyzer. Selecting the button will open the Cal. Reminder Editor. Select the number of days you want between reminders with the numeric keys. Of the other keys, C = Clear All, E = Enter, and OFF shuts off the Reminder Function. Selecting E will enter the current value as the reminder interval and return to the Specs Screen.

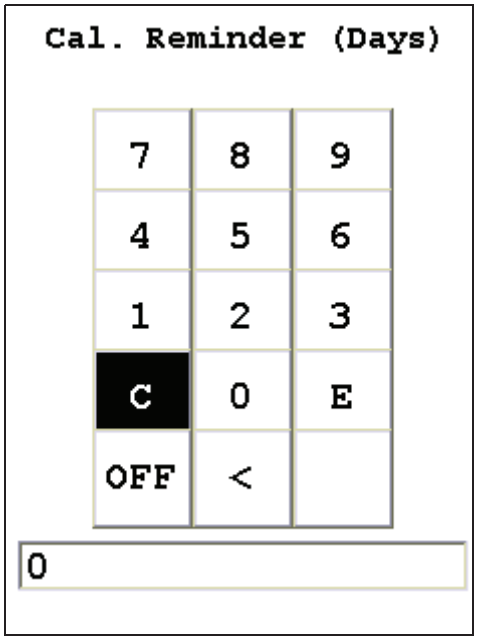


Figure 1-25. Cal Reminder Edit Screen

Diagnostics

Select the Diagnostics Button to load the Diagnostics Screen. the Diagnostics Screen shows Detector Temperature, Bias, Cooler Voltage, SubBias, Energy Scale, and Temperature in C and F scales.

The Diagnostics Screen can be of great utility in assuring proper operation of your analyzer.

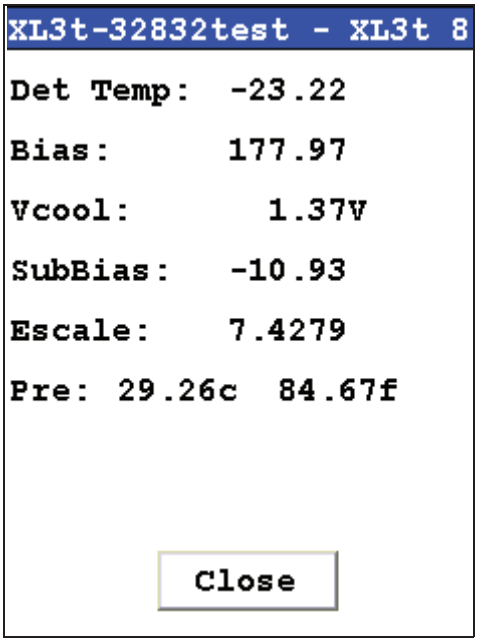


Figure 1-26. Diagnostics Screen

The proper ranges of operational values on the Diagnostics Screen follow.

Det Temp:

Detector Temperature should be within these ranges:

Standard 6 mm Detector: -25 ± 5 degrees F

GOLDD SDD Detector: -27 ± 3 degrees F

Bias: Bias should be within these ranges:

Standard 6 mm Detector: 175 ± 10

GOLDD SDD Detector: -220 ± 15

VCool: VCool will vary with the ambient temperature.

SubBias: SubBias should be within these ranges:

Standard 6 mm Detector: -11 ± 3

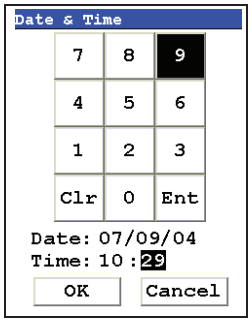
GOLDD SDD Detector: -8 ± 3

Escale: Escale should be within these ranges:

Standard 6 mm Detector or GOLDD SDD Detector: 6.6 - 9

Preamp: Preamp value should only be noted, and reported to Service if there is a problem.

The Date and Time Screen



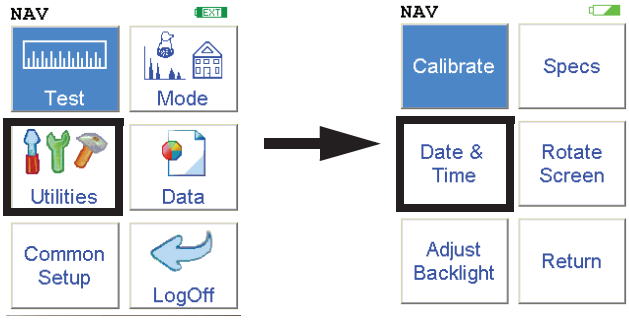


Figure 1-27. The Date and Time Menu Path

Select the **Date & Time** icon to set the date and time as needed for different time zones, daylight savings time, or any other reason. The date and time are factory preset prior to shipping. The format used is month/day/year - MM/DD/YY, and hour/minute - HH/MM, for the 24 hour clock.

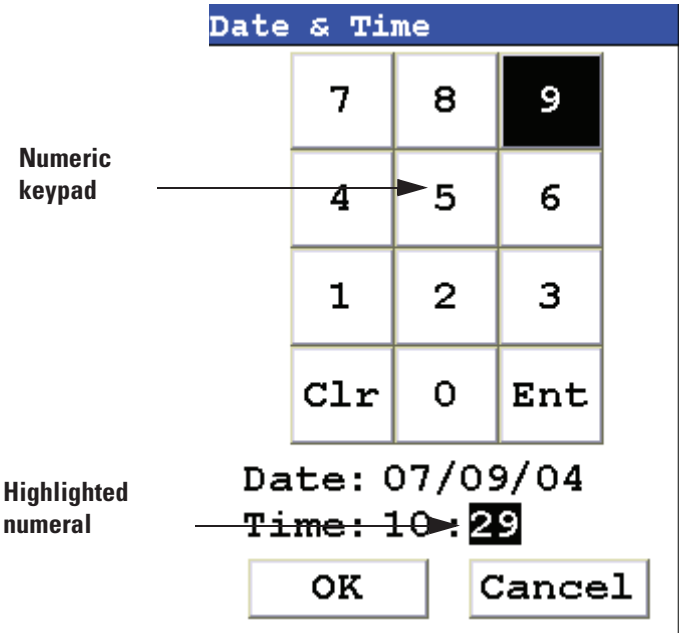


Figure 1-28. Setting the Date & Time

When the **Date & Time** icon is selected, the **Date & Time Screen** comes up on your analyzer's LCD Screen. Initially, the first character of the month is highlighted in reverse video (white on black), as in the sample display shown here. To change a character, select the digit you want to replace the character with from the virtual numeric keypad displayed on the screen,

then select the Enter (Ent) character from the virtual numeric keypad. Your analyzer will then accept the entry and automatically advance to the next digit. To skip a character, simply select the Enter (Ent) character from the virtual numeric keypad without selecting a replacement character.

For example, on the sample display, if you wish to change the "06" of the month to "07", the display appears with the first character (0) highlighted. Select the Enter (Ent) character to skip the zero. The "6" will now be highlighted. Select the "7" digit from the virtual numeric keypad, then select the Enter (Ent) key from the virtual numeric keypad. The change is accepted and the next digit is highlighted. Continue to select the Enter (Ent) symbol from the virtual numeric keypad to skip over the remaining characters of the date and time until the last character is reached. When you select the Enter (Ent) key from the virtual numeric keypad to confirm the last character, the word "SUCCESS" will appear beneath the Time field, and you will be returned to the Main Menu. The date is given in month/day/year format.

Note The analyzer will automatically return you to the **Main Menu** when the entry is complete. ♦

The Rotate Screen 180 Toggle

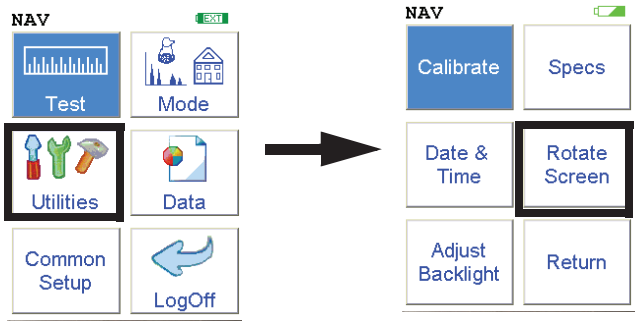
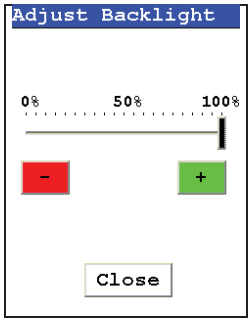


Figure 1-29. The Rotate Screen 180 Menu Path

Select the **Rotate Screen 180** icon to toggle the orientation of the screen between right side up and upside down.

The Adjust Backlight Screen



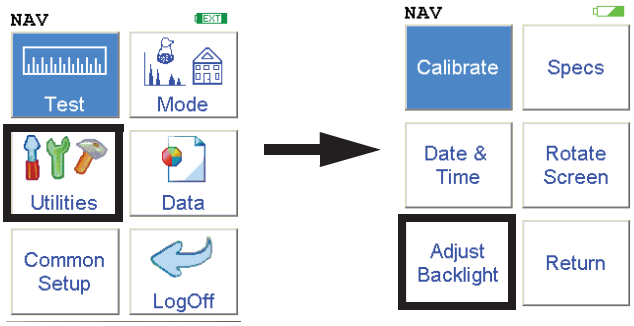
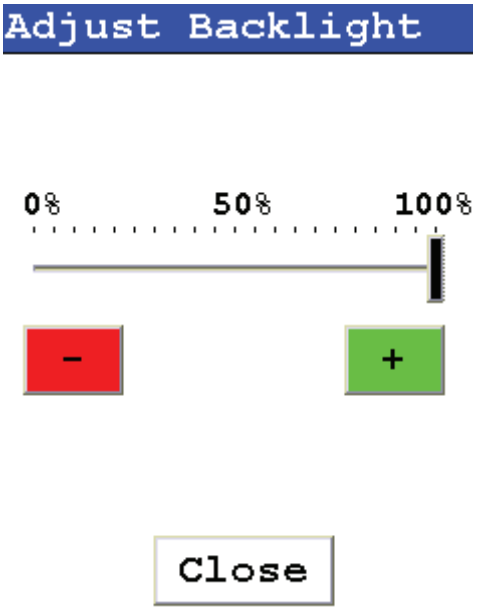


Figure 1-30. The Adjust Backlight Menu Path

Select the **Adjust Backlight** icon to adjust the brightness of the analyzer screen.



Selecting the red [-] box will cause the slider to move some to the left and the screen to dim a bit. Selecting the green [+] box will cause the slider to move a bit to the right and the screen to brighten somewhat. Find the setting most harmonious with the ambient lighting. Selecting Close saves the backlight setting in the current state, and returns you to the Utility Menu.

Camera and Small Spot Video

The Camera feature is only usable with properly configured analyzers, and the Small Spot feature is only available on Small Spot analyzers.

If your analyzer is equipped with an internal video camera, you can turn that camera on and off, and turn the saving of images with the readings on and off through an interface. When the camera is on, the image will show in the Ready to Test screen, as in Figure 1-4. If the camera is off, saving of images will also be off. If the camera is on and the image saving function is also on, the images will automatically be saved with the reading. Saving images will curtail the maximum number of readings stored.

How to Use the Camera

When a Camera equipped XL3 analyzer is in the Ready to Test screen, the video feed appears live on the analyzer's touch screen. This is the image that can be saved with the sample analysis. When you take a measurement, if you choose to do so, the bitmap image will be saved on the analyzer along with the analysis results. The interface is accessible through the Instrument Setup/Hardware Setup menu, as in Figure 1-2.

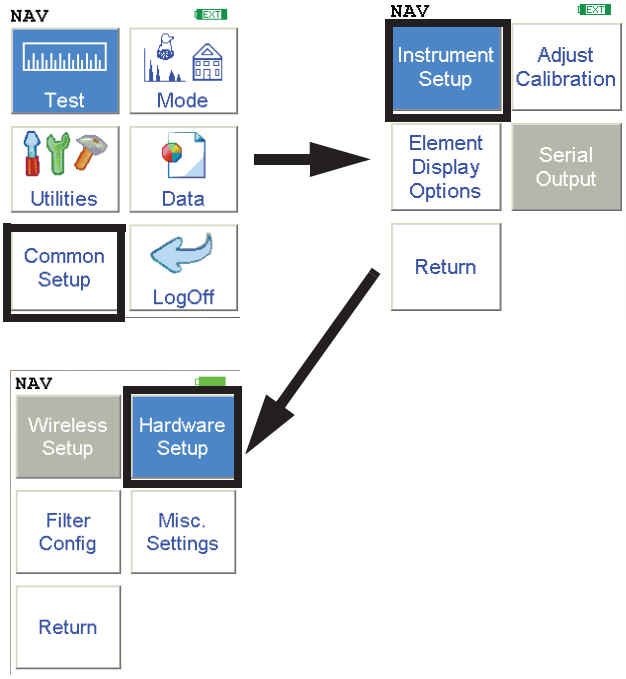


Figure 1-1. The Hardware Setup Menu Path

Figure 1-2. Setting Up the Camera View and Image Saving

Stored camera images from previous measurements can be viewed on the analyzer.

How to Use the Small Spot Technology

With a properly equipped Small Spot analyzer, you can restrict the analysis to a small spot within the camera view. You can toggle the Spot on and off from the Tools Menu as in Figure 1-3.

A red circle with a small hash mark (#) will appear on the display. The small hash marks the center of the x-ray analysis spot, while the larger circle marks the area analyzed.

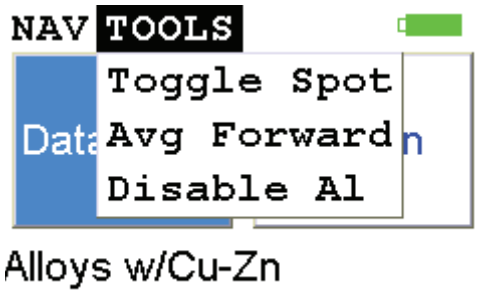


Figure 1-3. Toggling the Small Spot from the TOOLS Menu

Figure 1-4. Camera View

Using the Small Spot

The Small Spot can be used in several different modes.

Mining

3mm spot size allows analysis of veins and inclusions in mineral samples

Initiate from Tools - Small Spot

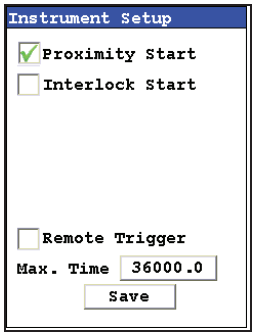
He Purged

Helium purge allows analysis of light elements (Mg, V and Ti)

Small spot enables analysis of light elements in welds and inclusions

Helium and Small Spot modes can be used simultaneously for Alloy and Mining modes

The Hardware Setup Screen



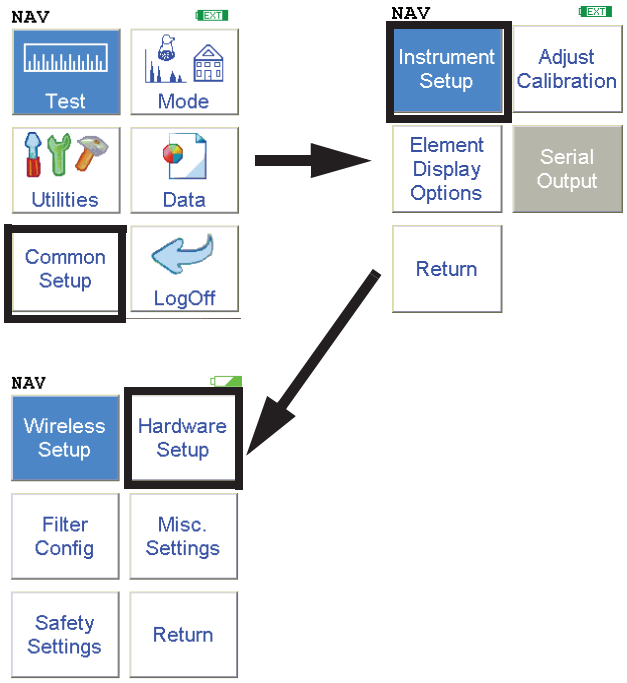


Figure 1-5. The Hardware Setup Menu Path

The **Hardware Setup Screen** enables you to toggle various options on or off, as well as select certain hardware dependant modes. Selecting an empty checkbox enables the option and places a check in the box. Selecting a checked box disables the option and clears the box.

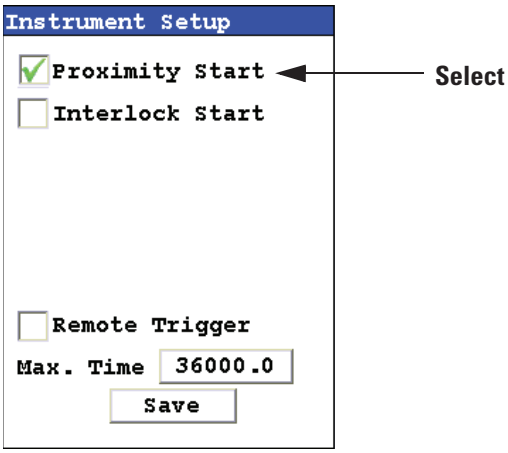


Figure 1-6. Selecting Options

Select the Proximity Start checkbox to toggle the use of the front proximity button. This enables the proximity button to be used to start taking a sample on contact. Some nations have laws or regulations which prohibit use of this feature. In this case, the feature will be disabled before shipping.

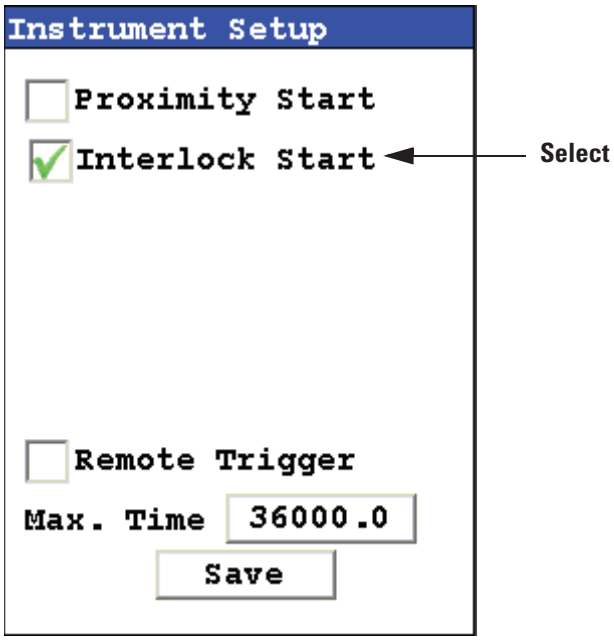


Figure 1-7. Selecting Interlock Start

Select the Interlock Start checkbox to toggle the use of the rear interlock button. This requires the interlock button to be used to start taking a sample on contact. Enabling the "Interlock Start" feature allows the user to start an analysis by depressing the rear interlock button on the analyzer.

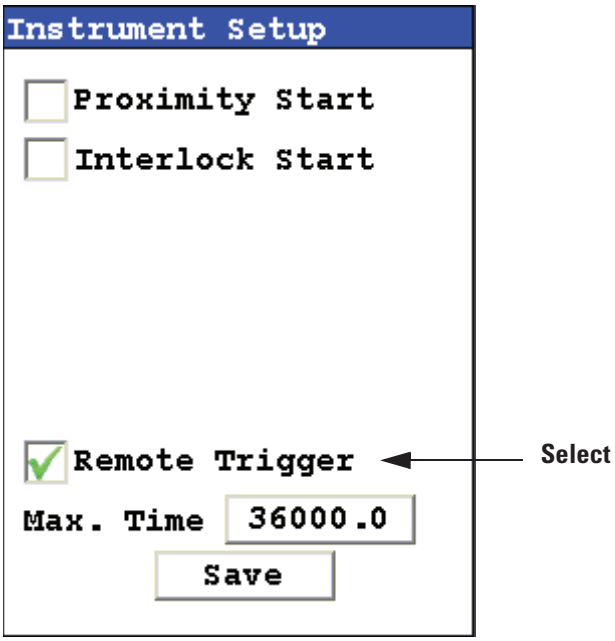


Figure 1-8. Selecting Remote Trigger

Select the Remote Trigger checkbox to toggle the use of the Remote Trigger. This is used when your XL3 is in a test stand or with the Extend-a-Pole. Enabling the "Remote Trigger" feature allows you to start an analysis by remote control.

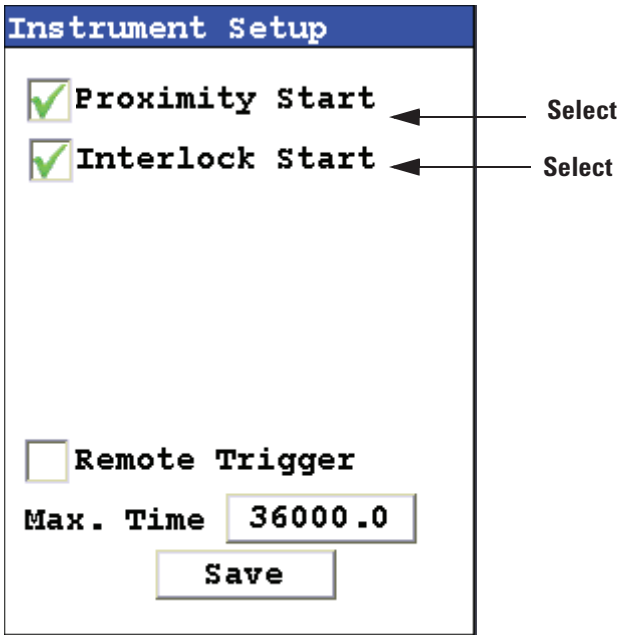


Figure 1-9. Selecting Option Combinations for Multiple Effects

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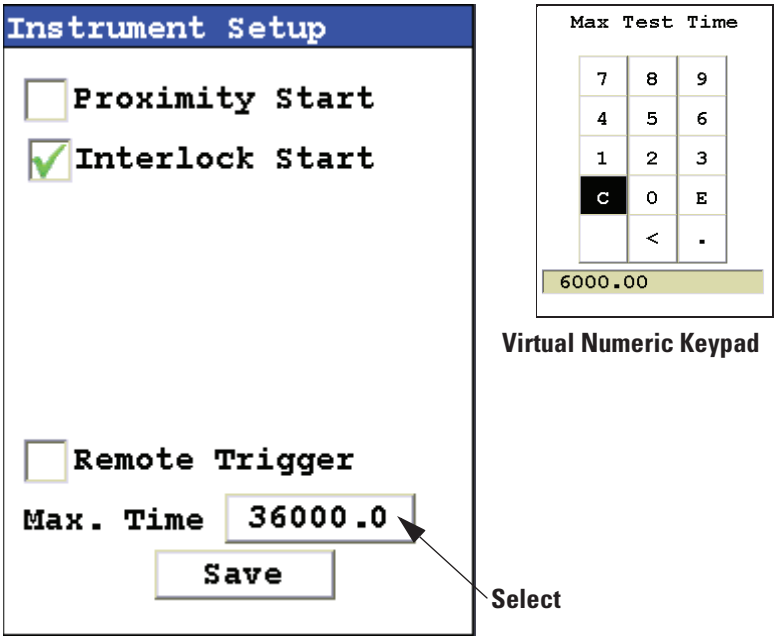
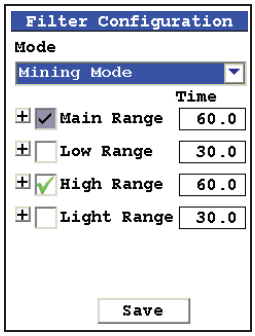


Figure 1-10. Changing the Max Time Parameter

Select the numbers box in the Max Time field to change the maximum seconds per reading. A virtual numeric keypad will appear, allowing you to set the number to whatever value you want, up to the maximum of 36000. When the max testing time is reached during an analysis, the analyzer reading will be automatically ended. Your analyzer will continue switching filters as needed until you terminate the reading or the Max Time is reached.

The Filter Config Screen



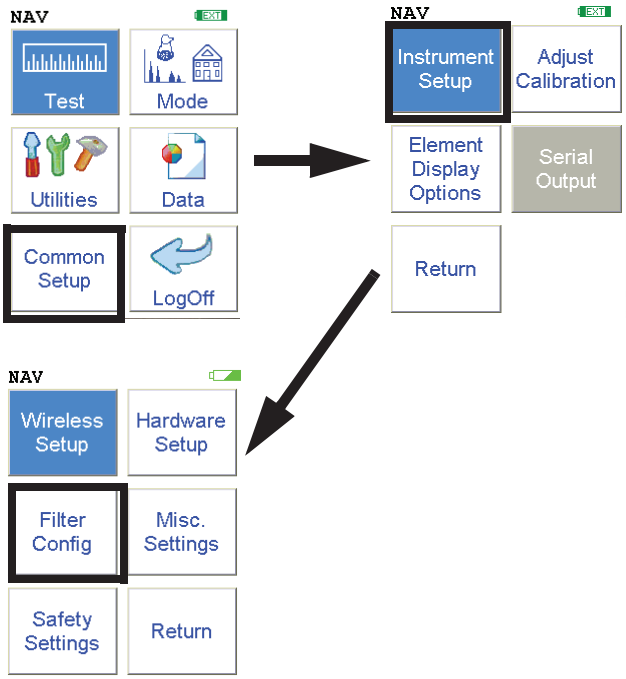


Figure 1-11. The Filter Config Menu Path

Multi-Filter tests are used to either preferentially excite specific elements for increased sensitivity, or to cover a wider element range than one filter alone can provide. Most modes, when enabled, will use two filters in sequence to produce a combined analysis result. In typical alloy analysis applications, Main Range is used for the analysis of most elements, and Low Range is utilized for the subsequent high sensitivity analysis of V, Ti, and Cr. Multi-filter switching can be set to activate off time alone, or, when time switching is disabled, off settings in the alloy grade library. In environmental modes, Low Range adds the capability to analyze light elements which cannot be efficiently excited by Main Range.

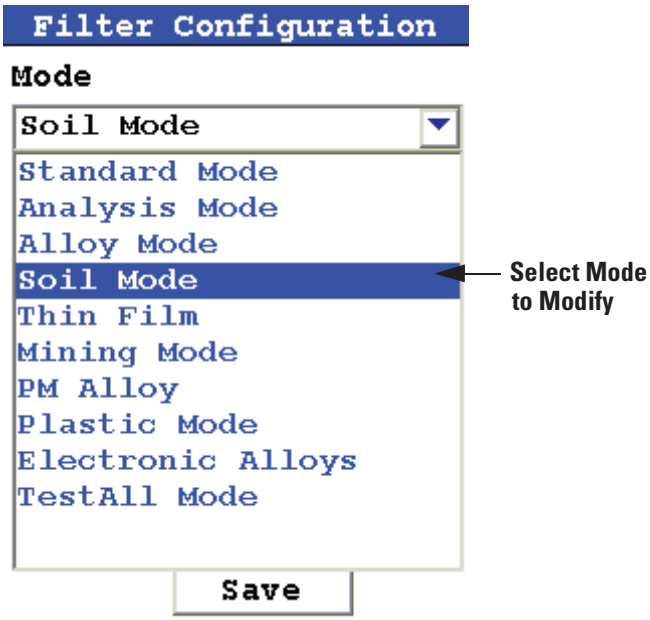


Figure 1-12. Selecting the Mode

Select the mode you wish to configure. You can set different configurations for different modes.

The **Filter Config Screen** enables you to directly enable or disable any filter, or control the time that a filter alters the irradiation of the sample before auto-switching to another filter. Not all filters are available in all modes.

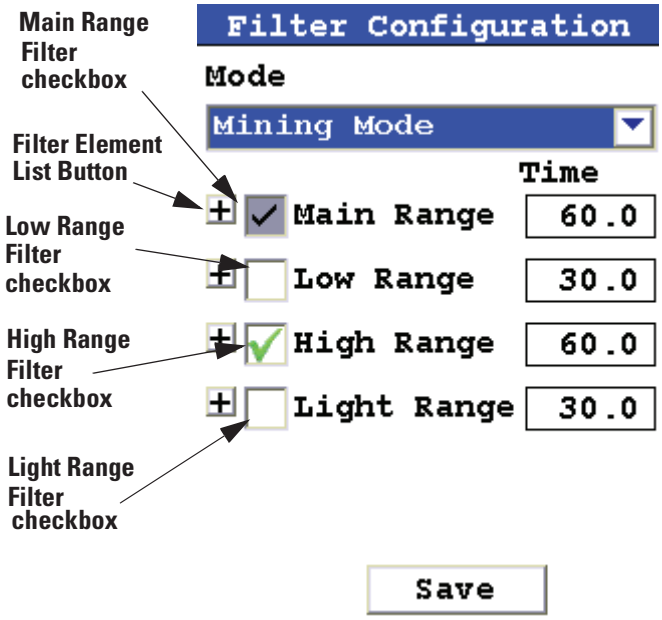


Figure 1-13. The Filter Checkboxes In Mining Mode

Select the checkbox next to the filter you want to use to determine exactly which of the filters contained in your NITON Analyzer is used for sample testing. Selecting an empty checkbox will enable that filter and place a check into the box as an indicator. Selecting a checked box will disable the filter and clear the box.

In typical alloy analysis applications, Main Range is used for the analysis of most elements

Low Range is utilized for the subsequent high sensitivity analysis of V, Ti, and Cr.

High Range is not used in alloy and plastic analysis.

Light Range is available only with He-purged and 900 series GOLDD technology analyzers, and is typically used in light element analysis.

Filter Change on Time Only

In Alloy and Electronic Alloy modes, there is an additional option which enables you to control whether the time you set or the alloy library controls the switching of the filters.

Select the Filter Change on Time Only checkbox to override the alloy library's settings. When this box is checked, your analyzer will ignore the alloy library settings and change filters only according to the time intervals you have set for each filter.

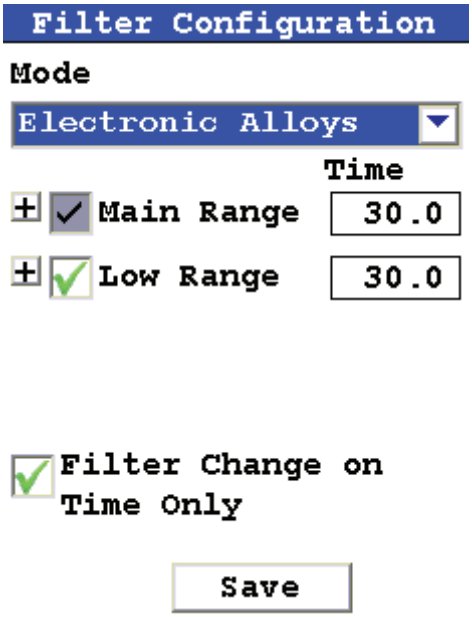


Figure 1-14. The Filter Checkboxes In Electronic Alloy Mode

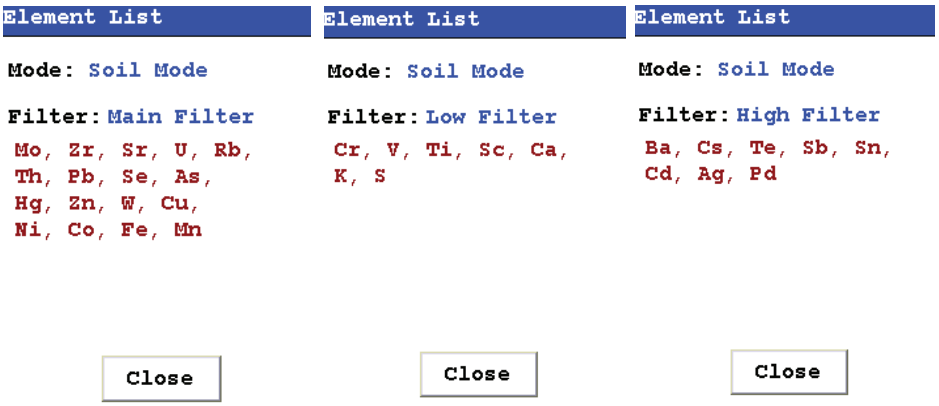


Figure 1-15. The Filter Element Lists

Select the Filter Element List Button to display the Element List for that filter. This list shows the elements that the filter is best designed to detect.

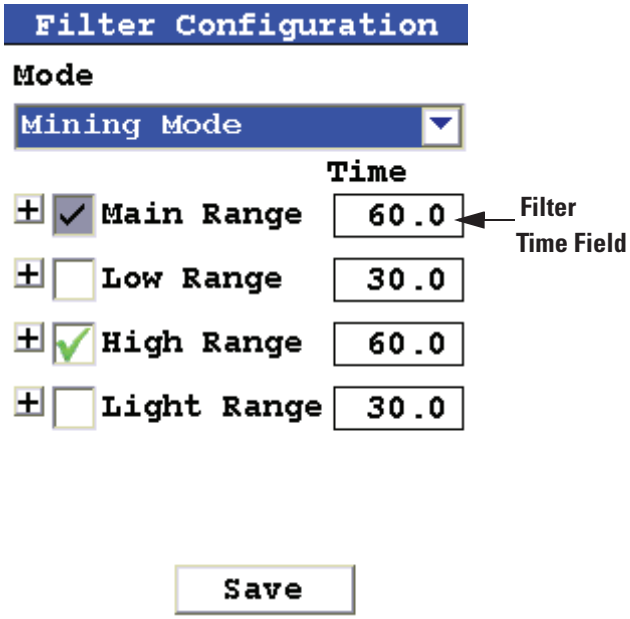


Figure 1-16. The Filter Time Fields

Select the Time field for the intended filter to change the filter switch time for that Filter. The Filter Time Editor will appear. This enables you to set the number of seconds each enabled filter is allotted before auto-switching will occur when needed during sample testing. Your analyzer will auto-switch from one filter to another when the testing time for that filter is greater than or equal to the time you have chosen, and the identified alloy is flagged as needing the switch in the NITON Alloy Library.

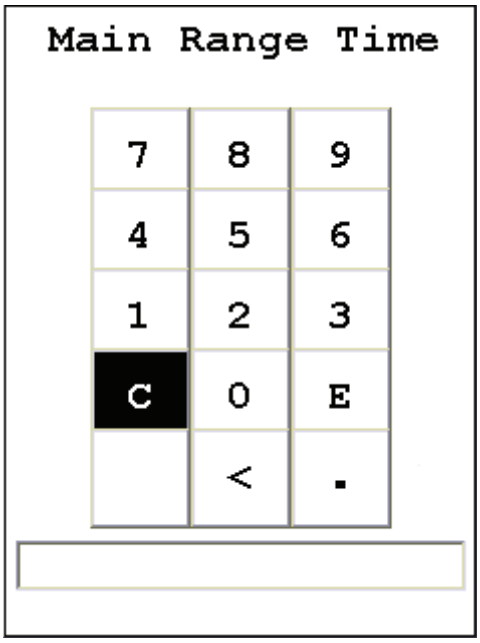
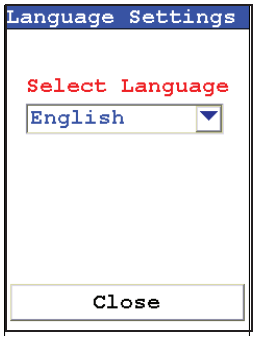


Figure 1-17. The Filter Time Editor

Select the “C” key to clear the current time, then from the virtual numeric key pad, select each digit you want to input, then select “E” to enter.

The Language Settings Screen



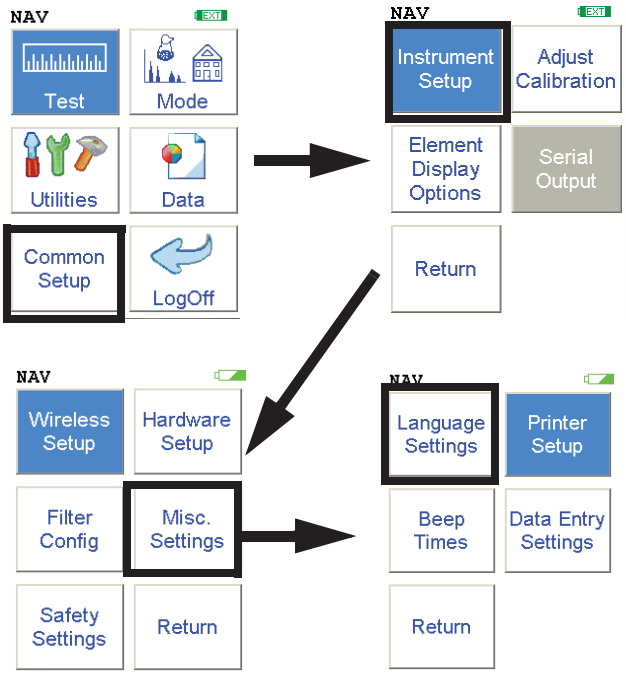


Figure 1-18. The Language Settings Menu Path

Selecting the **"Language Settings"** icon will load the **Language Screen,** allowing you to change the language from the default English to French, Spanish, Portuguese, or German.

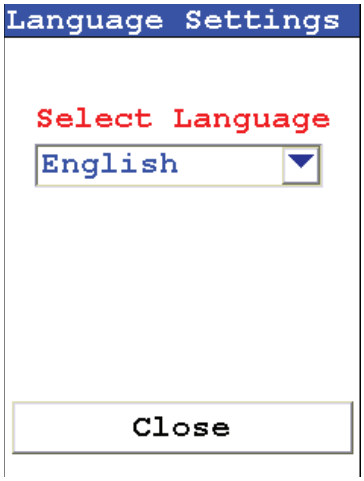


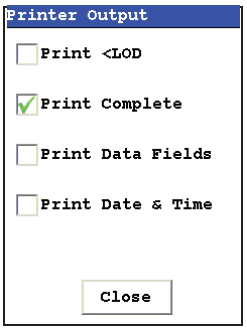
Figure 1-19. The Language Setting Screen

Select the down-pointing triangle, and then select the language you want from the drop down menu. The Menu system will now show on screen in the language you have selected.

Figure 1-20. Selecting Language From the Drop Down Menu

Figure 1-21. The Main Menu in Chinese

The Printer Setup Screen



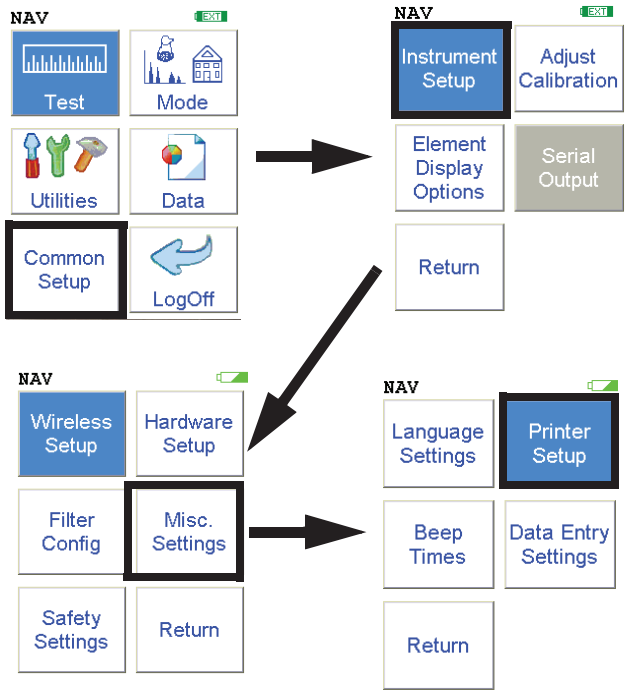


Figure 1-22. The Printer Setup Menu Path

The Printer Setup Screen allows you to adjust which sections of your reading data are sent to your optional printer. By default, your analyzer prints the detected list, reading number, reading length, reading mode and any applicable measurement data such as Alloy match grade names. You can select any combination of options on the Printer Setup Screen to change what is printed.

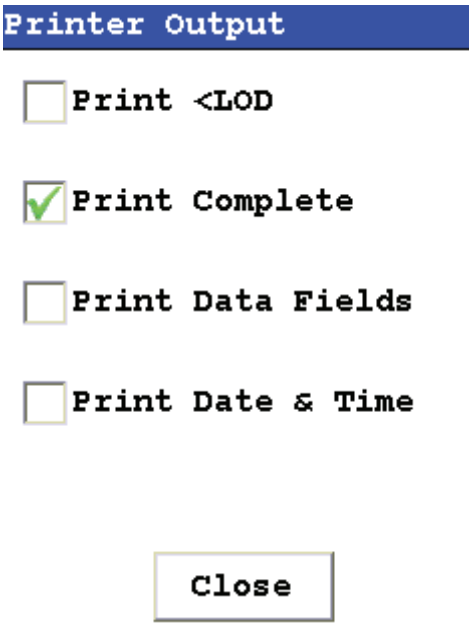


Figure 1-23. The Printer Setup Screen

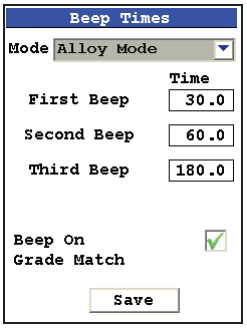
Print < LOD Selecting this option will enable printing of readings which are lower than the Limit of Detection.

Print Complete Selecting this option will enable printing of all the data fields in the reading.

Print Data Field Selecting this option will enable printing of all entered data fields.

Print Date & Time Selecting this option will enable printing of the Date and Time.

The Beep Setup Menu



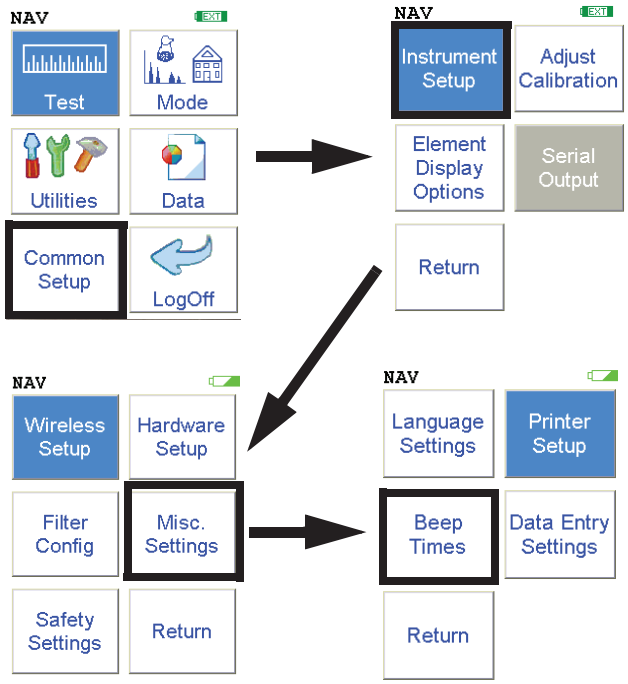


Figure 1-24. The Beep Setup Menu Path

Selecting the Beep Times icon opens the Beep Setup Screen, enabling changes to the beep settings for various modes. The beeps sound as follows:

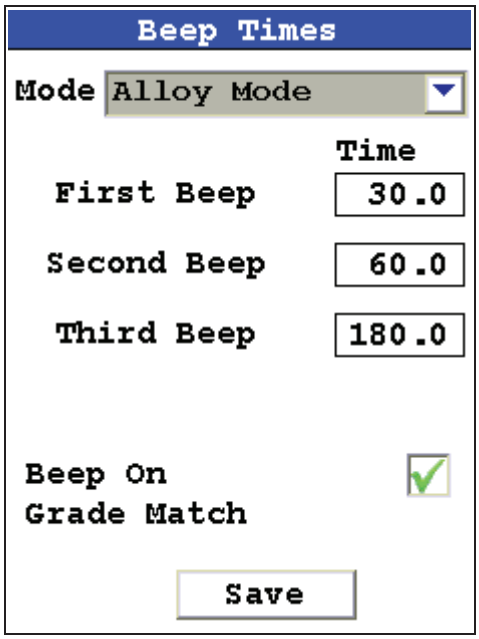


Figure 1-25. The Beep Setup Screen

Mode This option allows you to change the beep settings for different modes independently. Select the down arrow to access the list of modes.

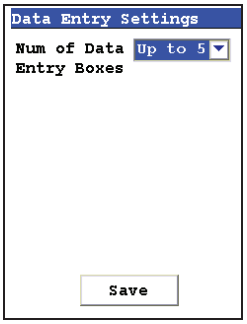
First Beep This option allows you to change the delay before the First Beep.

Second Beep This option allows you to change the delay before the Second Beep.

Third Beep This option allows you to change the delay before the Third Beep.

Beep on Grade Match Selecting this option will enable a special beep when the reading chemistry matches and alloy grade.

The Data Entry Settings Menu



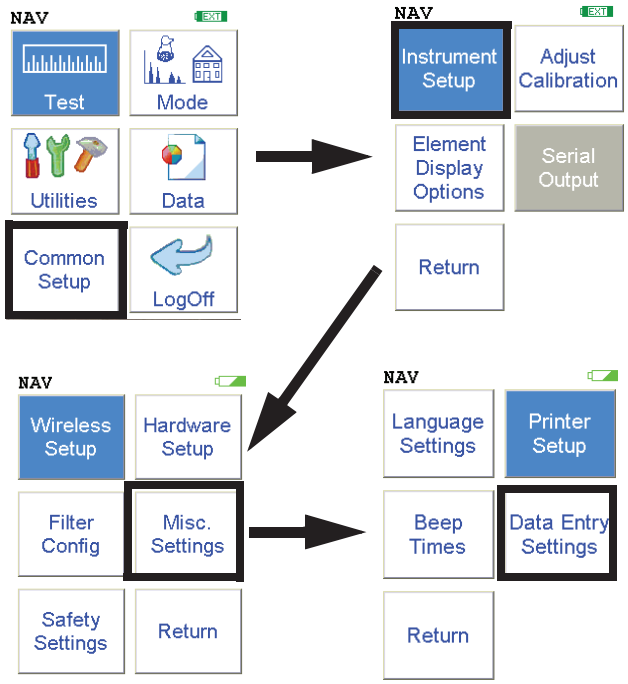


Figure 1-26. The Data Entry Settings Menu Path

Selecting the **Data Entry Settings** icon opens the **Data Entry Settings Screen,** enabling changes to the data entry settings for various modes.

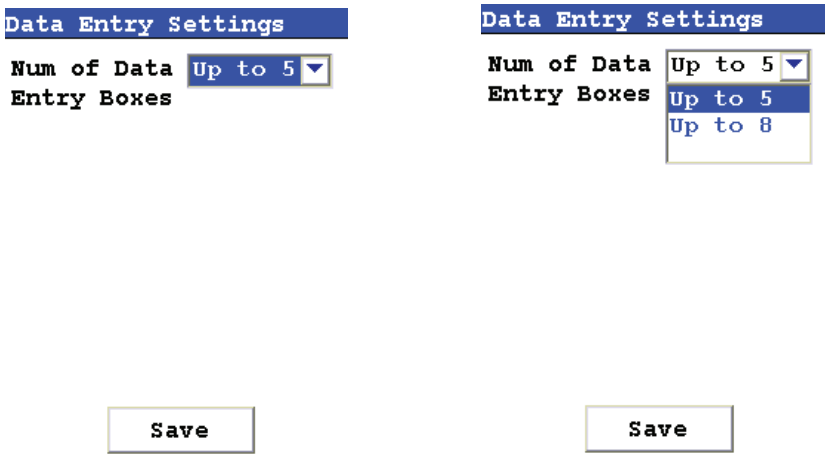
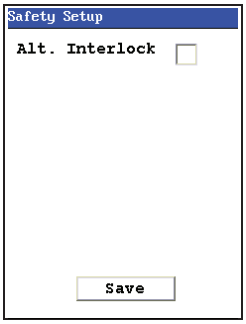


Figure 1-27. The Data Entry Settings Screen

By selecting the down arrow at the right of the “Num of Data Entry Boxes” field, you may choose between Up to 5 or Up to 8 from the drop down menu, changing the number of data entry boxes in the Data Entry Screen.

The Safety Settings Menu



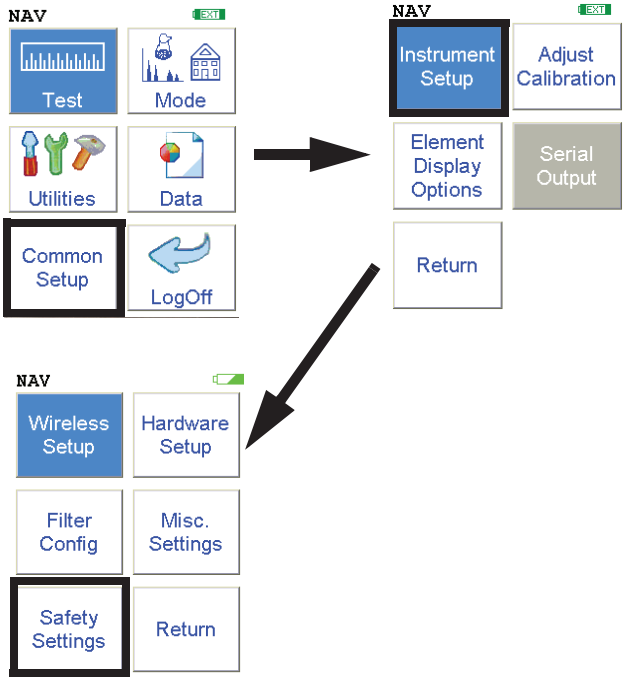


Figure 1-28. The Safety Settings Menu Path

Selecting the **Safety Settings** icon opens the **Safety Settings Screen,** enabling changes to the location of the rear interlock button.

Alt Interlock Disabled (Default) **Alt Interlock Enabled**

Figure 1-29. The Safety Settings Screen

By selecting the checkbox, you can toggle between the rear interlock button's normal location, and it's alternate location as the center "Select" button on the four-way touch pad.

The Adjust Calibration Screen

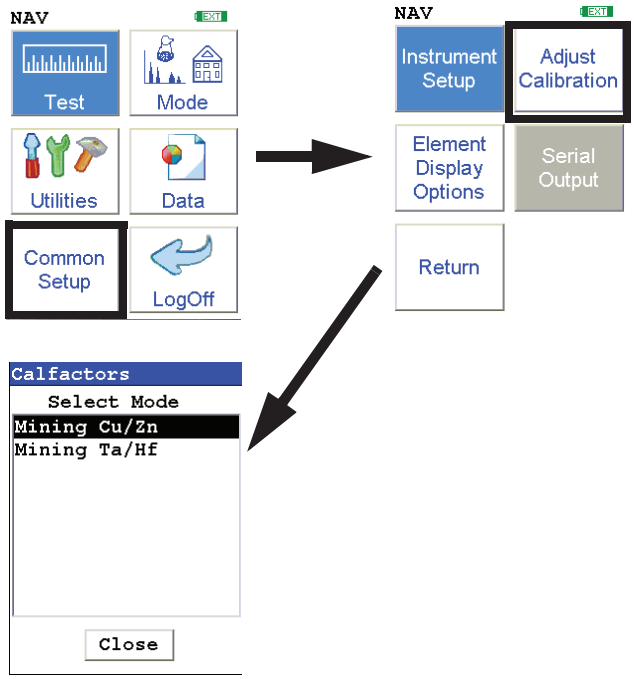


Figure 1-30. The Adjust Calibration Menu Path

The **Adjust Calibration Screen** enables you to change calibrations for Mining Modes. Select the mining mode you are using from the list.

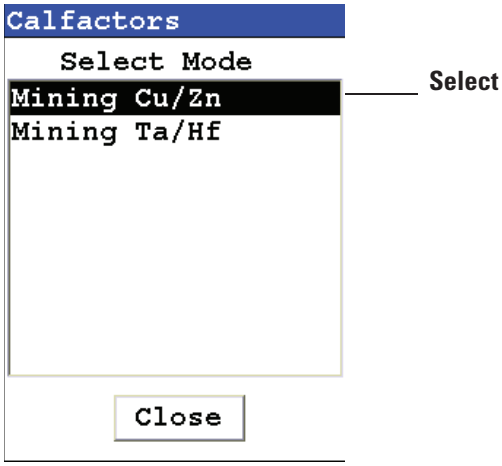


Figure 1-31. Select Mode Screen

The Calfactors Screen will now appear.

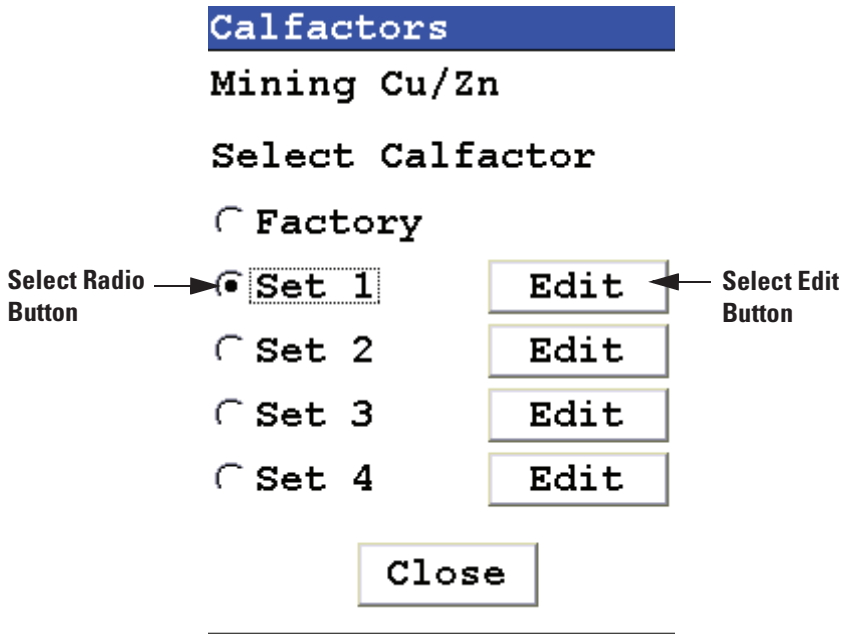


Figure 1-32. The Calfactors Screen

Select the radio button of the Calibration Factor you wish to edit, then select the appropriate Edit Button. The Calibration Edit Screen will open.

You cannot edit the Factory Calibration. You may edit and store up to four alternate calibrations per Mode.

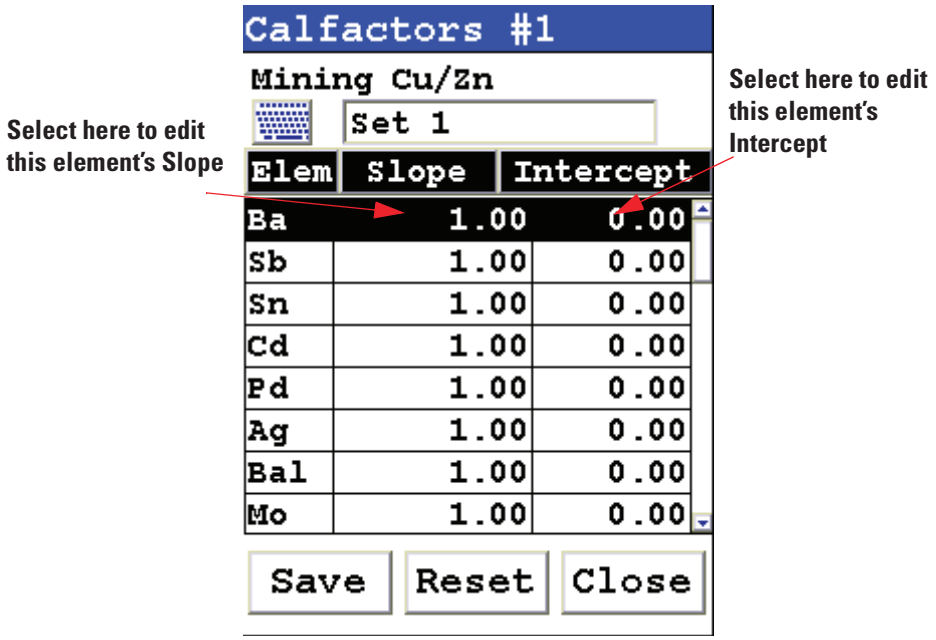


Figure 1-33. The Calibration Edit Screen

Calibration Factors

Although the FP software automatically corrects for most inter-element matrix effects, NITON tube-based analyzers cannot currently detect elements lighter than magnesium. As a result, the oxidation state of elements can bias measurements of other elements. In many cases, this bias is small, and uncorrected results provide sufficient accuracy, especially when data is for screening purposes only. For cases when more accurate results are required, NITON has provided slope/intercept calibration software with the instrument to improve the quality of the data. The calibration software is element specific, and calibration factors can be entered for individual elements, independent of the other elements. A user may choose to correct a single element or a suite of elements.

The degree of severity of the bias should be evaluated before proceeding with routine measurement. A few test samples should be carefully measured by another technique, or by an outside lab. These samples should then be analyzed using the analyzer. If the agreement is good enough to provide the accuracy required for the application, the instrument can be operated as shipped. If it is determined that a bias correction is necessary, the procedure for establishing calibration factors should be followed. As site characteristics change, it is good practice to run a few check standards to ensure that the instrument results are still within an acceptable error range.

Note With the exception of Mining Mode, Calibration Factors cannot be changed at the User Log-in level. This must be done while logged in at Supervisor level. See the NDT manual for details.

Oxides vs. elemental concentrations

Labs and other XRF instruments often report data as oxides. We can only report data as elemental concentration. Therefore, oxide data must be converted to elemental concentration for comparison with NITON results using the conversion factors and equation below. This factor can be multiplied by oxide concentration to convert to elemental.

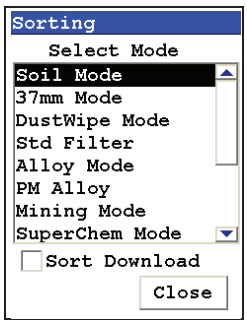
Formula

Conc. (metal) = Conc. (oxide) * Mol.Wt. (metal)/Mol.Wt. (compound).

Table 1-1. Oxide Conversion

Oxire	Conveersion Factor
MgO	0.603
Al2O3	0.529
SiO2	0.467
SO3	0.400
K2O	0.825
CaO	0.715
TiO2	0.5995
V2O5	0.5602
Cr2O3	0.6842
Mn3O4	0.7203
MnO	0.7745
Fe2O3	0.6994
FeO	0.7773
Co3O4	0.7342
NiO	0.7858
CuO	0.7988
ZnO	0.8034
PbO	0.9283
Fe2O3	0.6994
Bi2O3	0.8970
ZrO2	0.7403
MoO3	0.6665
WO3	0.7930
Ta2O5	0.8190
Nb2O5	0.6990
SnO2	0.7876

The Sort Element Display Menu



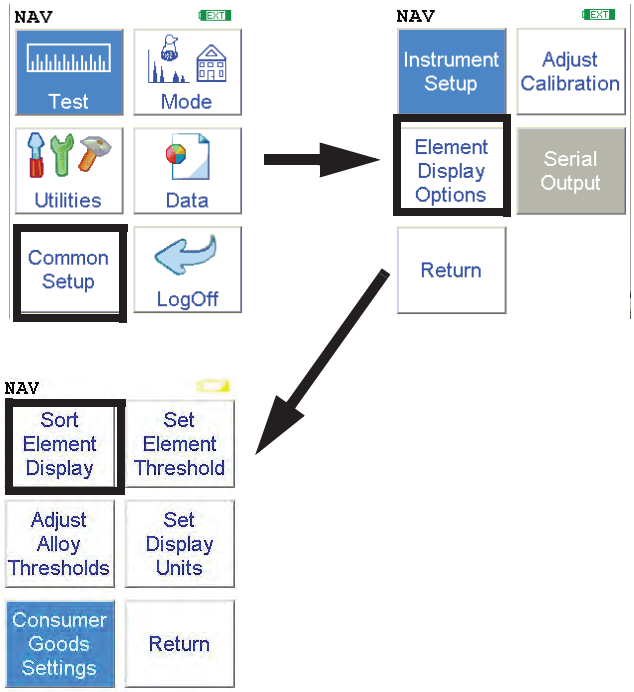


Figure 1-34. The Sort Element Display Menu Path

Select the **Sort Element Display** icon to configure sorting criteria used for analysis display. Selecting the **Sort Element Display** icon opens up the **Sort Criteria Screen**.

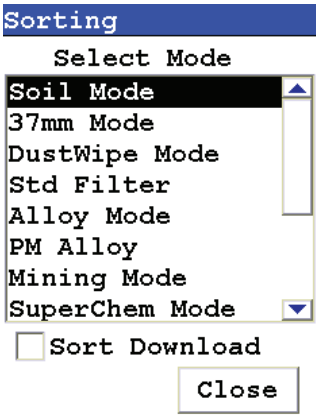


Figure 1-35. Selecting the Mode from the Sort Element Display screen

Select the mode you wish to change, and the **Sorting Options Screen** will appear.

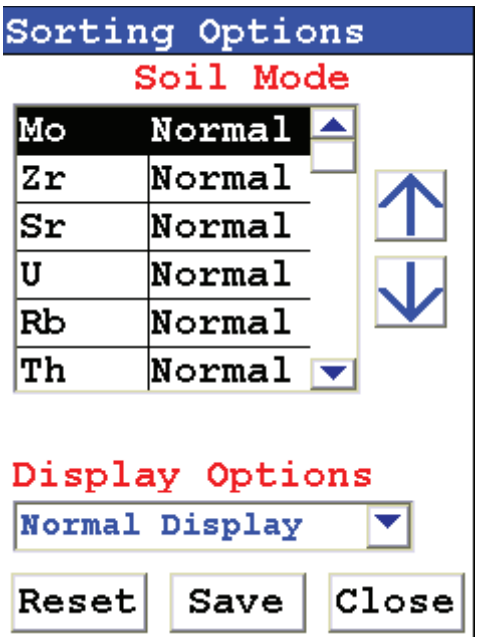


Figure 1-36. The Sort Element Display

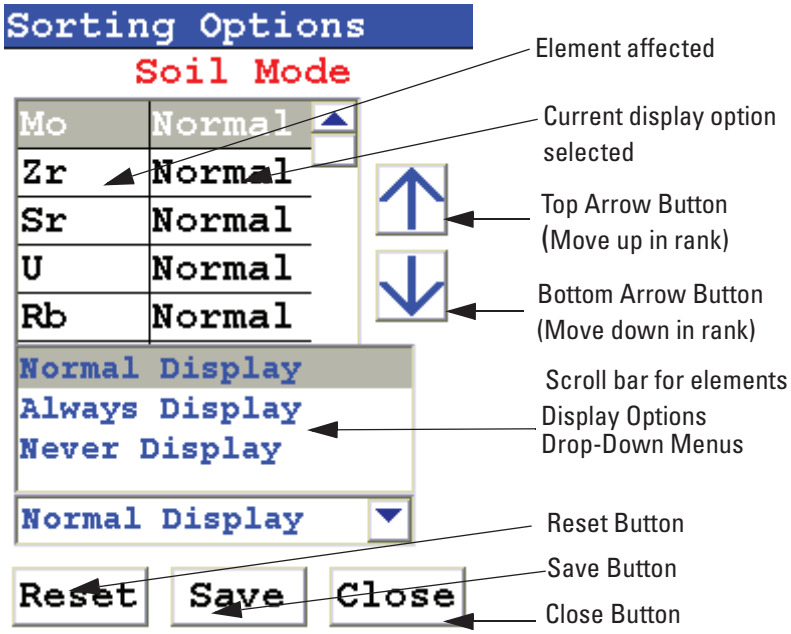


Figure 1-37. The Sorting Options Screen

On the left of the display are elements, each with its currently selected display option beside it to the right. The element list is ranked by importance, with the most important element on top, and each one lower down of less importance than the one above it.

By selecting an element and using the arrow buttons to the right of the list, you can change its ranking. Use the Top Arrow Button to move an element one rank closer to the top with each click. Use the Bottom Arrow Button to move an element one rank closer to the bottom with each click.

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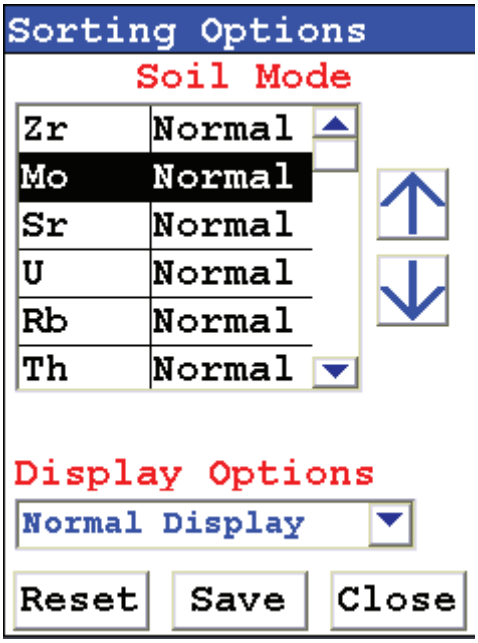


Figure 1-38. Changed Sort Order

Display Options

The Display Options Drop Down Menu allows you to change the display status of any element to one of three states:

- Normal - The standard state. Element displays only when the elemental value is greater than the limit of detection.
- Always - Always display the results for this element. Use this state for elements critical to all of your analyses.
- Never - Never display the results for this element. Use this state for elements which are unimportant to your work. This makes your instrument display less complex.

Select the element you want to change, then select the menu option corresponding to your choice of display status. The currently selected element is displayed in white on black.

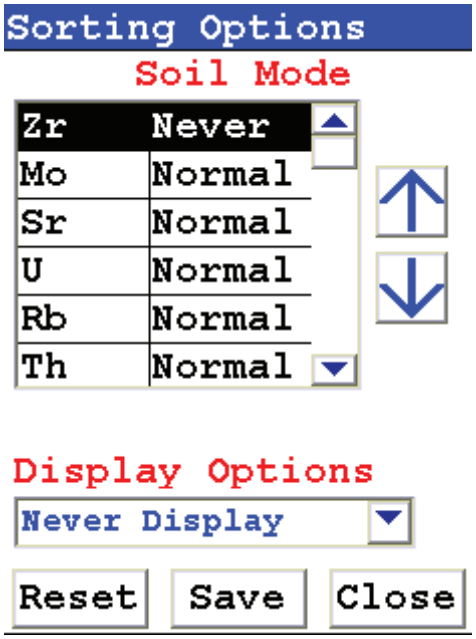


Figure 1-39. Changed Display Options

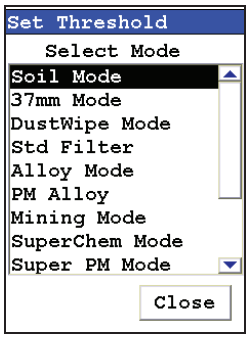
Select the Save Button to save your current status as the new default. After saving, you will go back to the **Element Display Menu**.

Close Button

Select the Close Button to exit without saving. When you select the Close Button after changing the display state of any element, a screen will open asking you if you want to save the changes you made. Selecting “Yes” will save these changes as the new default. Selecting “No” will return you to the **Element Display Menu** without saving the changes.

Figure 1-40. Save Changes

The Set Element Threshold Menu



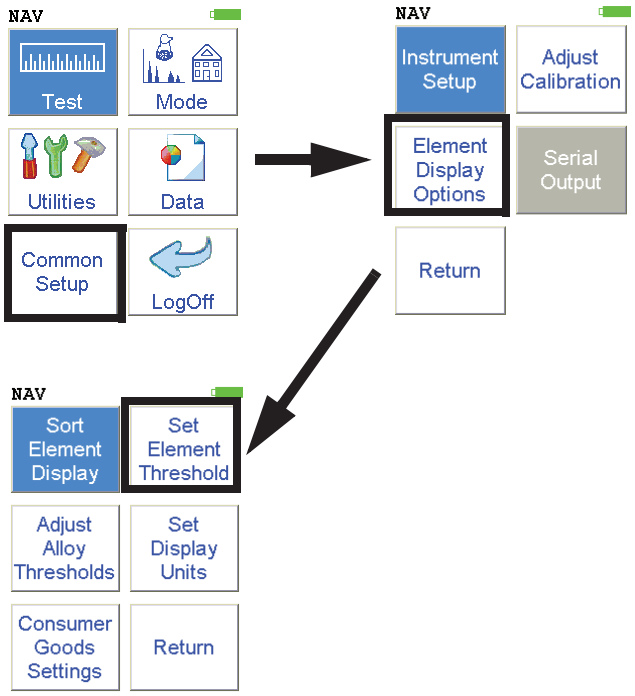


Figure 1-41. The Set Element Threshold Menu Path

Select the **Set Element Threshold** icon to configure pass and fail criteria for elemental analysis. Selecting the **Set Element Threshold** icon opens the **Set Threshold Screen**.

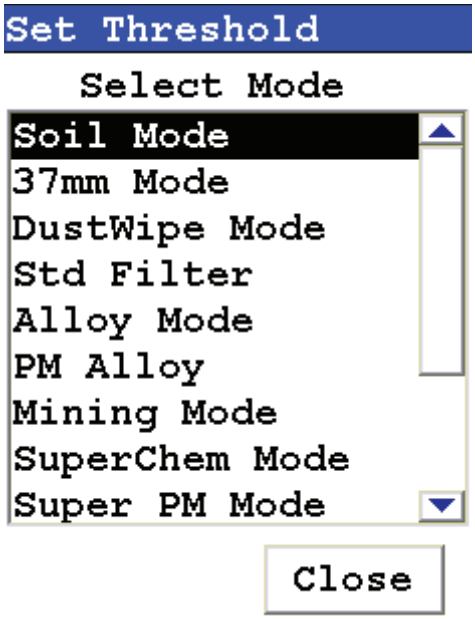


Figure 1-42. Set Threshold Screen

Select the mode you wish to work with from the scrollable list. This will open up the **Settings Screen** for that mode.

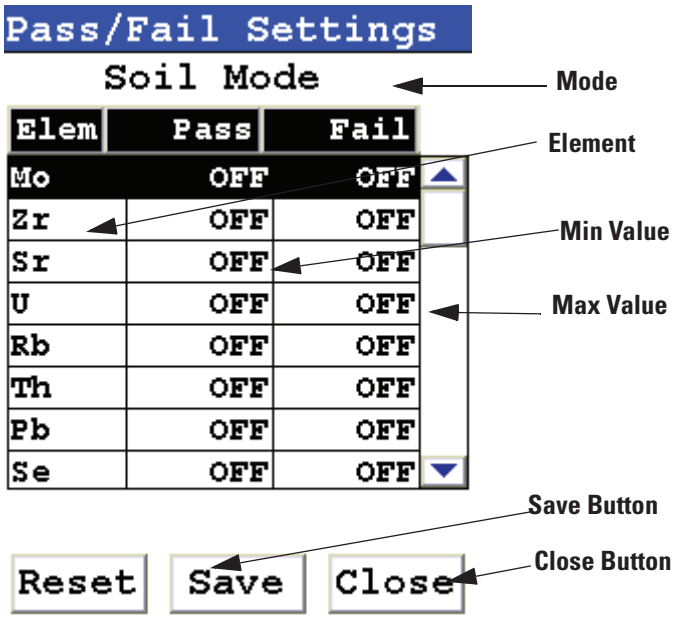


Figure 1-43. Pass/Fail Settings Screen

Selecting the Pass Value will open up the Pass Editor for the selected element.

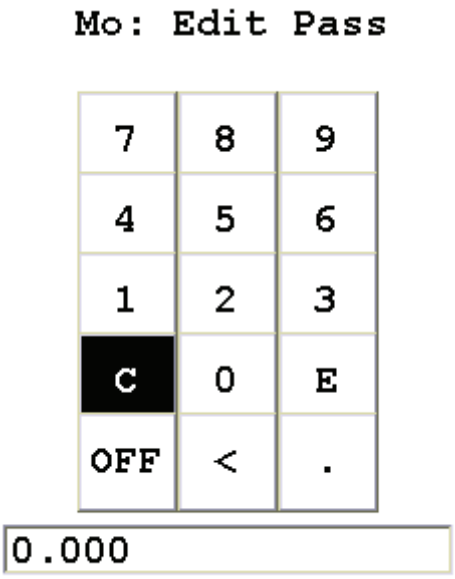


Figure 1-44. The Pass Editor

The Editor is very similar to the Logon Screen. The “C” button clears the field, and the “<“ button clears the last numeral. Select the numerals you want, then press “E” to enter the number. “OFF” resets the value to “OFF”

Selecting the Fail Value will open up the Fail Editor for the selected element.

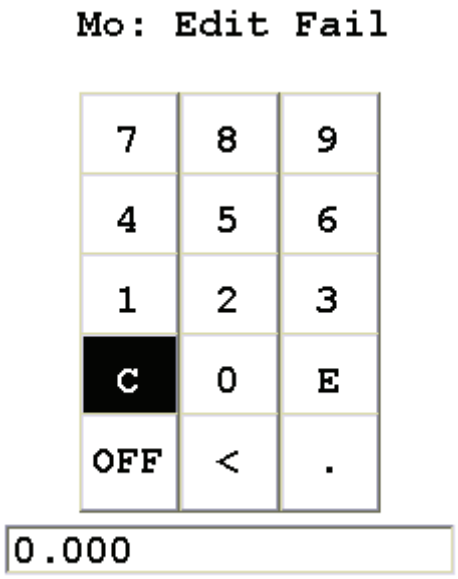


Figure 1-45. The Fail Editor

The Fail Editor works the same as the Pass Editor.

When you press the “E” button in either editor, you are returned to the Pass/Fail Settings Screen, with your new values in place.

Selecting the “OFF” button not only sets the value to “OFF” but also saves the new value.

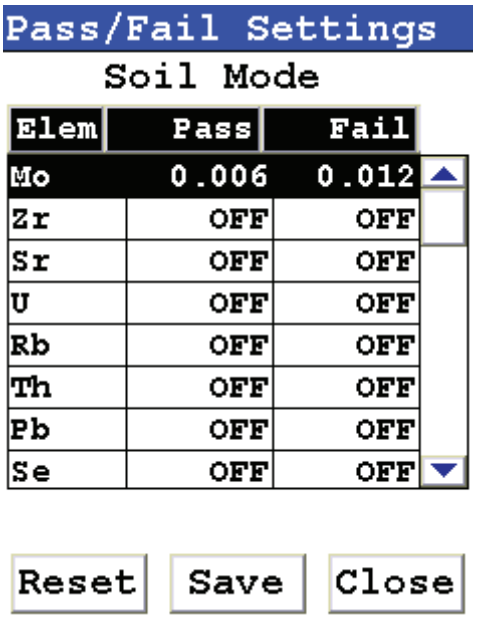


Figure 1-46. The Settings Screen with new parameters

Select the Save Button to save your current status as the new default. After saving, you will go back to the **Element Display Menu**.

Select the Close Button to exit without saving. When you select the Close Button after changing the display state of any element, a screen will open asking you if you want to save the changes you made. Selecting "Yes" will save these changes as the new default. Selecting "No" will return you to the **Element Display Menu** without saving the changes.

Figure 1-47. Save Changes Screen

Selecting the triangle next to the Analysis Options Field will open a pop up menu allowing you to choose between the three Analysis Option Modes. Select the mode you wish to edit.

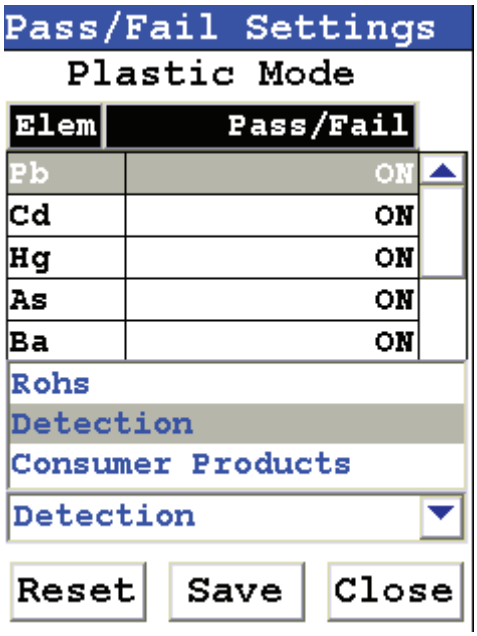
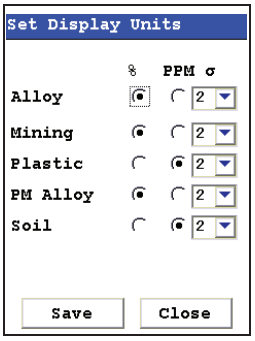


Figure 1-48. The Analysis Options Pop-up Menu

Changing the settings for one mode will not affect the settings for other modes, and the configurations can be saved independently.

The Set Display Units Menu



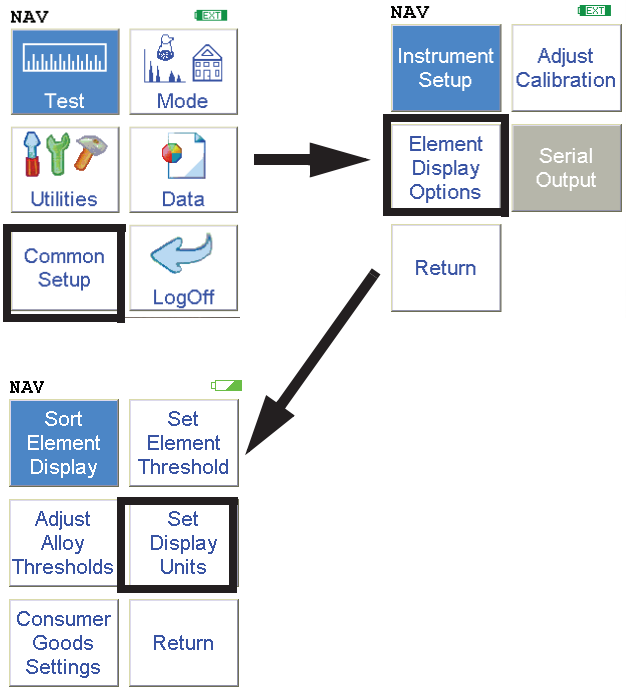


Figure 1-49. The Set Display Units Menu Path

Select the **Set Display Units** icon to choose between ppm (parts per million) and percentage (hundredths of whole) displays when taking readings, and to change the Sigma value you want for the reading. Selecting the **Set Display Units** icon opens the **Set Display Units Screen**.

Setting Display Units

In the Set Display Units Screen, you can select between Percent composition and Parts per Million as the units displayed in a measurement, and you can change this setting independently for Alloy, Mining, Plastic, Precious Metal, and Soil modes. You can also change the Sigma for each of these modes independently. See . Note that you can now set display units for Mining and Plastic modes.

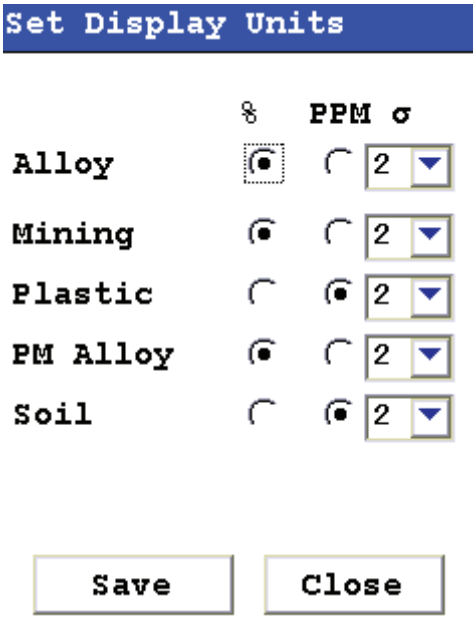


Figure 1-50. The Set Display Units Screen

Changing Sigma

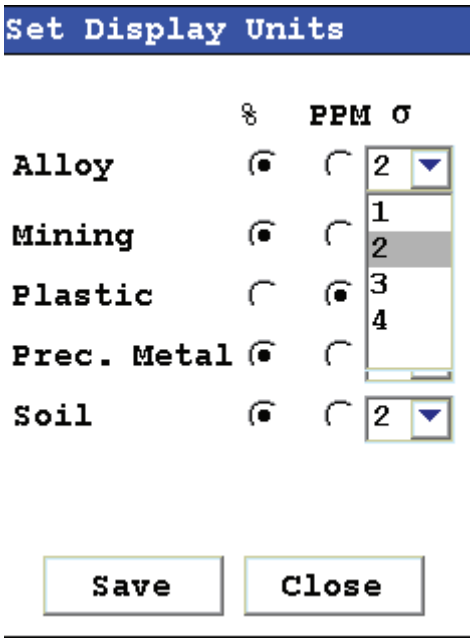


Figure 1-51. Selecting new Sigma values

Sigma

Sigma is the symbol used for Standard Deviation, a measure of how much a set of numbers deviates from the mean. For example, each of the three data sets {0, 0, 14, and 14}, {0, 6, 8, and 14} and {6, 6, 8, 8} has a mean of 7. Their standard deviations are 7, 5, and 1, respectively. The third set has a much smaller standard deviation than the other two because its values are all close to 7. In a loose sense, the standard deviation tells us how far from the mean the data points tend to be.

The number of standard deviations between the process mean and the nearest specification limit is given in sigmas. As process standard deviation goes up, or the mean of the process moves away from the center of the tolerance, the sigma number goes down, because fewer standard deviations will then fit between the mean and the nearest specification limit.

Confidence Intervals

Confidence intervals assume that the data are from an approximately normally distributed population - generally, sums of many independent, identically distributed random variables tend towards the normal distribution as a limit. Using this assumption, about 68 % of the values must be within 1 standard deviation of the mean, about 95 % of the values must be within two standard deviations, about 99.7 % must lie within 3 standard deviations, and about 99.99% of the values must lie within 4 standard deviations.

The greater the sigma value of the test, the more confident you can be that the sample is as it appears, but the more difficult and time consuming the testing must be to verify this. That's why it's important to use the most appropriate sigma value for the test. By adjusting the sigma value for each type of test, you can optimize the process for your needs.

Adjusting the Sigma Values

The sigma values are listed in the column headed " -- ". The default value is 2 sigma. You can change this value by selecting the down arrow next to the value, which opens up a drop-down menu from which you can select the desired sigma value by clicking on it.

When you have changed the sigma values to the appropriate number, select the Save button to save these settings for use. Select the Close button to return to the previous screen without saving any changes.

Chapter 2 Routine Maintenance Guidelines

Battery Pack and Battery Charger

Each NITON Analyzer is shipped with two lithium ion battery packs. When fully charged, the battery pack provides approximately 6-8-12 hours of use, depending on duty cycle.

Replacement battery packs (NITON part number 420-002) may be ordered from NITON in the United States, toll free, at (800) 875-1578, or outside the United States, at +1-978-670-7460, or from your local Authorized NITON Analyzers Service Center.

Note Before beginning a test, be certain that the battery has sufficient charge. ♦

CAUTION Do not leave the battery pack connected to the charger for excessive periods of time. Overnight recharging is recommended. ♦

CAUTION Store the analyzer and the spare battery packs in a cool place, away from direct sunlight. ♦

Replacing The Battery Pack

1. **Slide back the catch on the bottom of your analyzer's pistol grip and drop the battery out into your hand.**

2. **Place the old battery aside and slide the new battery up into the cavity in the bottom of the pistol grip. The battery is keyed, and will only insert fully one way.**

3. **Press in until the latch resets.**

Recharging The Battery Pack

Fully recharging a battery pack takes approximately 2 hours.

1. **Remove the battery pack from the analyzer.**

2. **Place the battery pack upside down into the charger. The battery pack is keyed, and will only fit into the charger fully one way. If your battery pack is resting on the back of the back of the charger rather than sliding all hte way to the bottom, remove the battery pack, turn it around, and re-insert it into the charger.**

3. **The red light is on when the charger is plugged in. This is the power indicator light.**

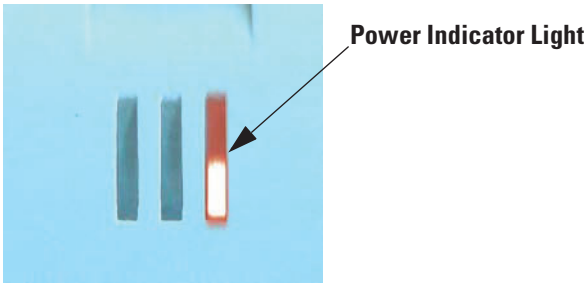


Figure 2-1. Power Indicator Light

4. **The yellow light indicates that the battery pack is currently being charged..**

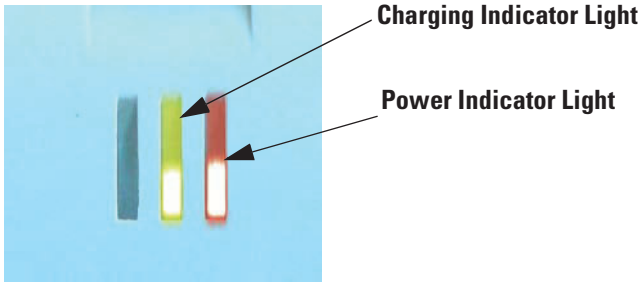
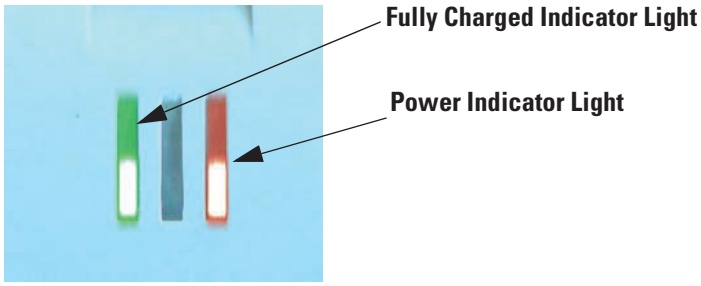


Figure 2-2. Charging Light

5. **The green light indicates that the battery pack has finished charging and is ready for use.**



6. **If there is a fully seated battery pack in the charger and only the red light is on, there is a fault with the battery pack or charger.**

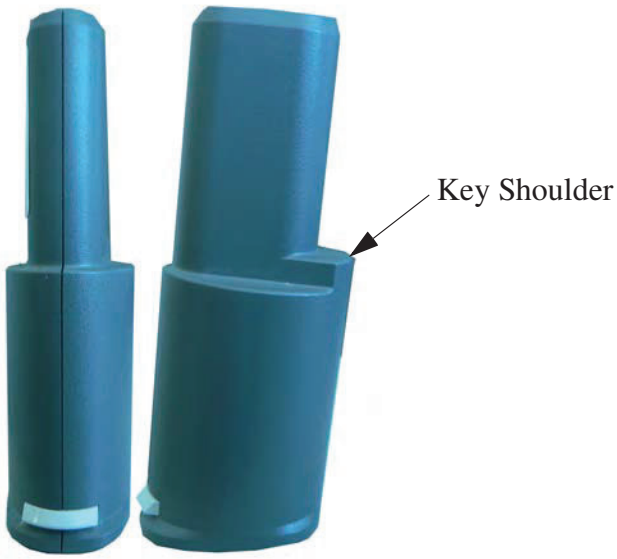


Figure 2-3. Rear and Side views of Battery Pack showing key

Figure 2-4. Battery Pack in the Charger

CAUTION Do not store battery packs or charger in direct sunlight. ♦

CAUTION Do not let the battery pack recharge for excessive periods of time. ♦

Maintenance, Cleaning and Repairs

To ensure the reliability, durability, and performance of your NITON Analyzer, keep it clean—especially the transparent measurement window covering the analysis window. Clean the measurement window gently with a cotton swab. Clean the body of the analyzer with a soft cloth. Never use detergents, or solvents on your analyzer, or immerse your analyzer in water. If the measurement window becomes frayed, ripped, or contaminated with metal particulates, replace it with a new window. measurement windows (Standard Window Niton P/N 187-1555 or Helium Purge Window Niton P/N 187-1454) may be ordered from Thermo Fisher Scientific's Service Department in the United States, toll free, at (800) 875-1578, or outside the United States, at +1-978-670-7460 or from your local Authorized NITON Analyzers Service Center.

From time to time, your touch screen will need cleaning. NITON recommends that you use a lens cleaning solution with a soft cloth. Do not use water to clean your NITON Analyzer.

WARNING! All Service, except exterior cleaning and measurement window replacement, must be performed by Thermo Scientific or an Authorized NITON Analyzers Service Center. Do not attempt to make repairs yourself. Opening the case of your NITON will void the analyzer Warranty in its entirety. ♦

CAUTION Always obtain a Return Authorization (RA) number from Thermo Fisher Scientific's Service Department in the United States, toll free, at (800) 875-1578, or outside the United States, at +1-978-670-7460 before returning your analyzer to the NITON Service Department or local Authorized NITON Analyzers Service Center. ♦

Replacing the Measurement Window

1. **Remove the two Phillips head screws.**

Figure 2-5. View of Face Plate and measurement window

2. **Remove the face plate and place it face down.**

Figure 2-6. Face Plate Removed showing measurement window on Reverse

3. **Remove the old measurement window.**

4. **Clean the back surface of the face plate and install the new Window.**

5. **Turn the face plate over and replace it on the analyzer's front end, fitting the plate carefully over the Proximity Button.**

Figure 2-7. Fitting Face Plate over Proximity Button

6. **Reinstall the two screws, being careful not to over-tighten them.**

Figure 2-8. Replacing the Screws.

Storing and Transporting Your XL3 Analyzer

All NITON Analyzers are transported in waterproof, drop-resistant, fully padded carrying cases with padlocks. In most countries, NITON XRF analyzers may be transported by car or plane or shipped as an *ordinary* package. For most courier services, no special labels are required on the outside of the NITON analyzer case or on additional packaging.

Figure 2-9. The NITON Carrying Case

All padlocks are shipped with a default combination of “0-0-0”. If you change this combination, please inform Thermo of the new combination if you return the unit for service.

To change the combination:

1. **Dial the default combination to open the lock, and pull out the shackle.**

2. **Rotate the shackle 180 degrees and push it down as far as it can go.**

3. **While holding the shackle down, rotate it 90 degrees back in either direction and release shackle.**

4. **Change the dial settings to the desired combination, record the combination, and without disturbing the dials, rotate the shackle back 90 degrees to the position it had in step 2.**

5. **Pull shackle out and rotate it 180 degrees and secure it. Your lock now has its own secret combination.**

CAUTION Always transport the unit in its padded carrying case, and store the NITON Analyzer in its case whenever it is not being used. ♦

CAUTION In most cases, no notification is required if transporting within state boundaries. This may not be the case when entering federal properties. ♦

CAUTION Within the United States, always keep a copy of the US DOT compliance statement in your NITON analyzer case at all times. A copy is included with your analyzer. ♦

CAUTION Always follow all pertinent local and national regulations and guidelines, wherever your analyzer is transported or used. ♦

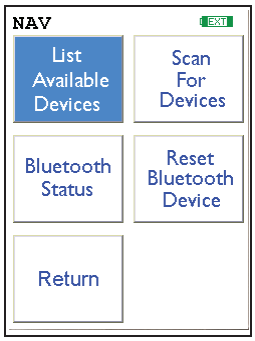
CAUTION Always obtain a Return Authorization (RA) number from Thermo Fisher Scientific's Service Department in the United States, toll free, at (800) 875-1578, or outside the United States, at +1-978-670-7460 before returning your analyzer to the Service Department or to your local Authorized NITON Analyzers Service Center. ♦

CAUTION If you return your NITON analyzer without the carrying case, you will void your warranty in its entirety. You will be billed for a replacement case plus any repairs resulting from improper shipping. ♦

CAUTION Always remove the battery pack when transporting or storing your analyzer. ♦

Networking and Connectivity

Setting up Wireless Networking



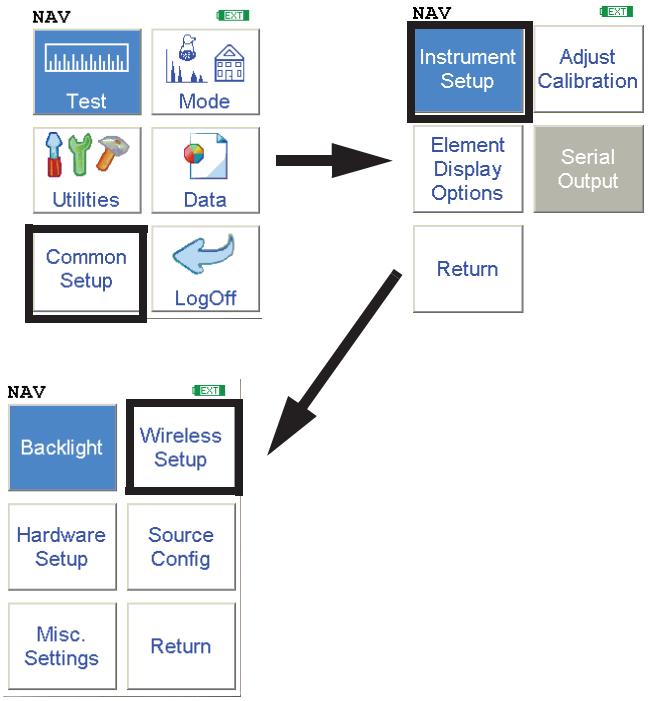
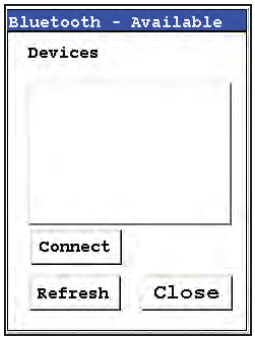
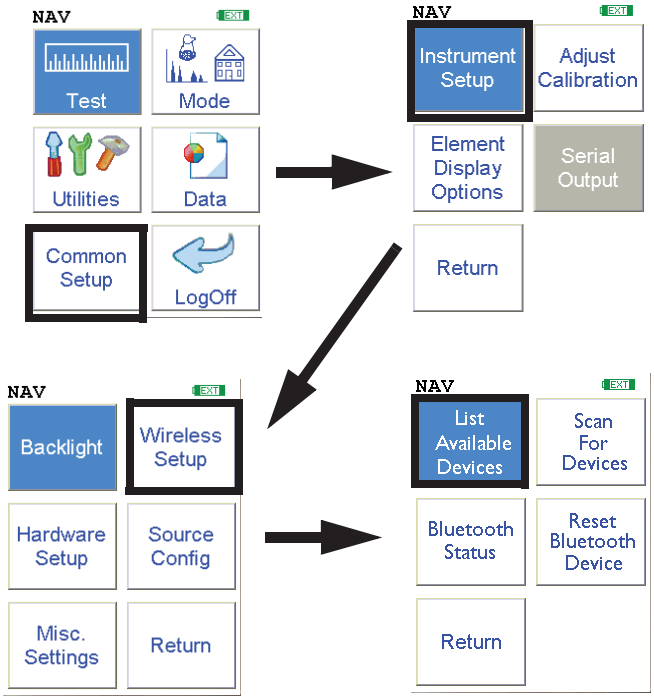


Figure 2-10. Wireless Networking Menu Path

Bluetooth Wireless Networking enables you to connect to your computer and other Bluetooth-enabled devices such as printers and GPS devices without the need of cabling, ports, or hubs.

Available Devices Screen





Select the List Available Devices icon to show a list of Bluetooth devices previously discovered. The Bluetooth devices listed are only those which were present at the last time you ran a discovery scan for Bluetooth devices, as the list is not automatically updated. Selecting the List Available Devices icon brings up the Available Devices screen. From the list, you can connect your analyzer to those devices.

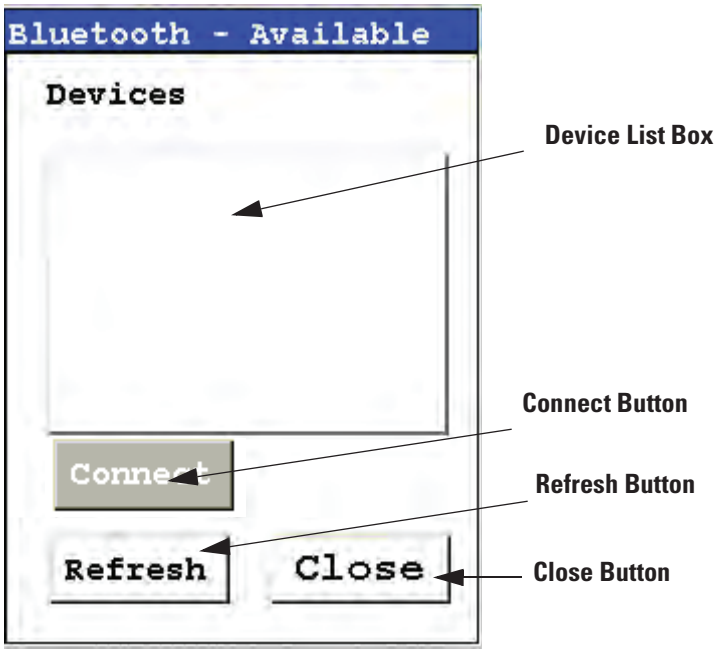


Figure 2-11. Available Devices Screen

Under "Devices," in the Device List Box, the Available Devices Screen lists all known applicable Bluetooth devices in the area found during the last refresh or scan.

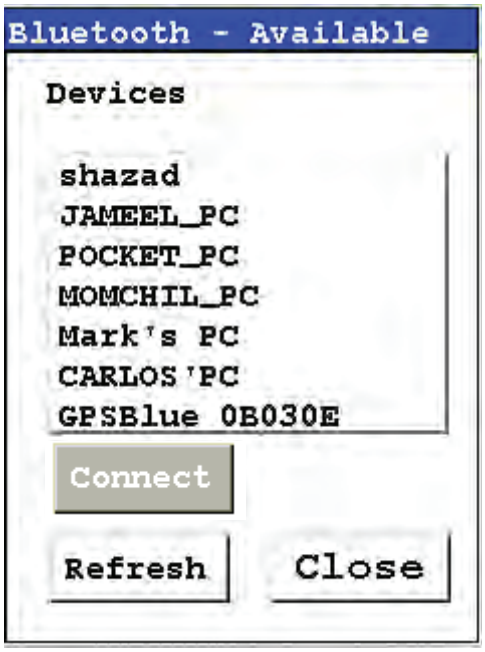


Figure 2-12. Example Device List

- Selecting the Refresh Button initiates a scan of the area for new Bluetooth devices. Devices no longer present are removed.

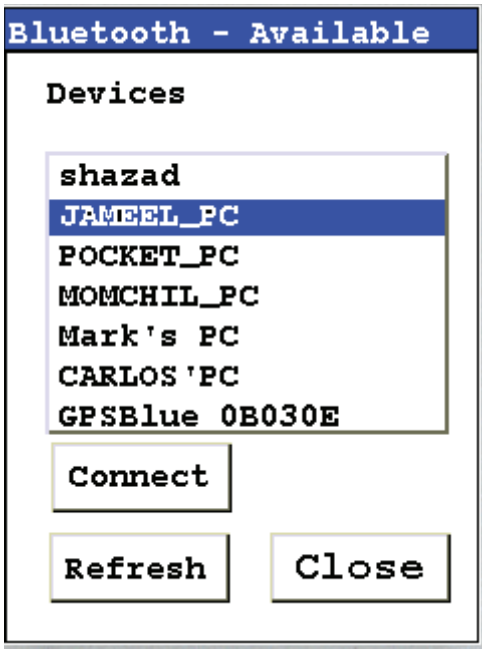
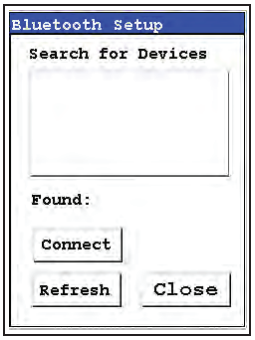
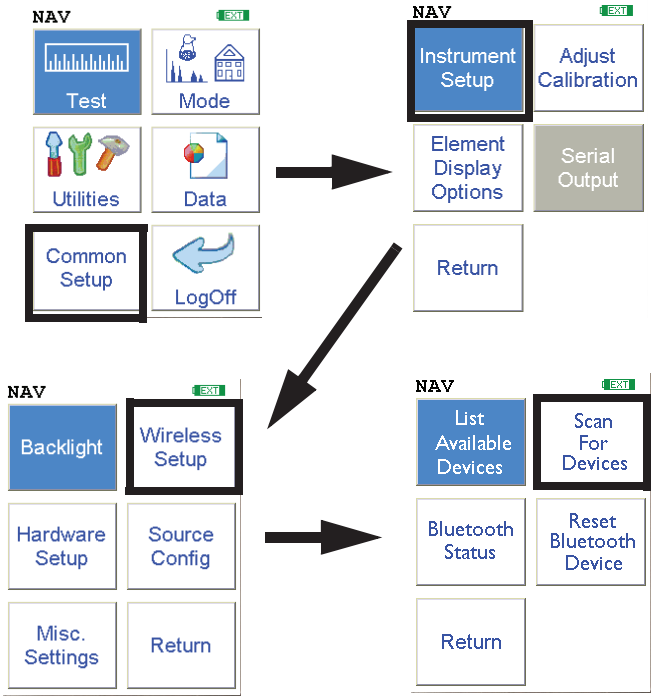


Figure 2-13. Available Device Refresh

- Selecting a listed Bluetooth Device enables the Connect Button.
- Selecting the Connect Button will connect your analyzer to the selected device. See the Connected Screen.

Bluetooth Search Screen





Select the Scan For Devices icon bring up the Bluetooth Search Screen, enabling you to initiate a discovery scan of Bluetooth devices in the operational area. This scan will find all appropriate Bluetooth devices in the operational area, enabling you to connect to those devices.

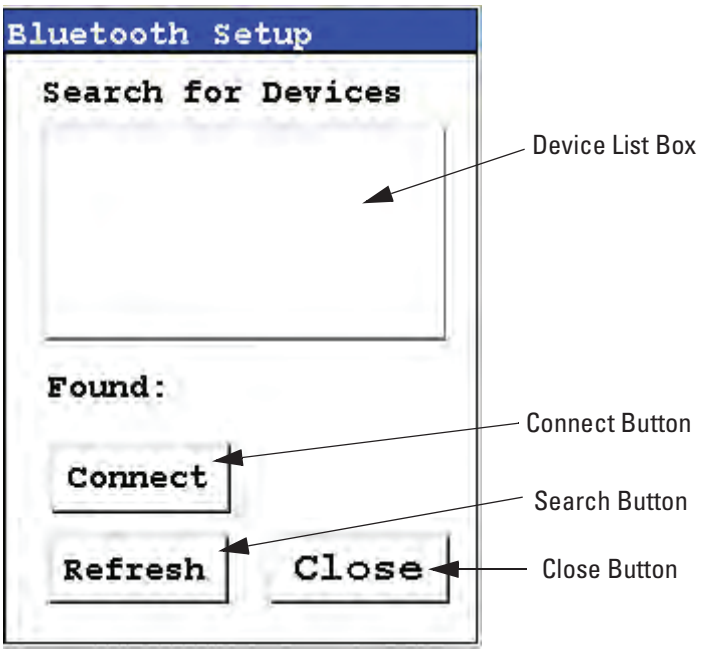


Figure 2-14. Bluetooth Search Screen

The Bluetooth Search Screen does not retain information about previously detected Bluetooth Devices. Each time the Bluetooth Search Screen is opened, the Device List Box is empty.

- Selecting the Search Button initiates a scan for Bluetooth Devices in the area.

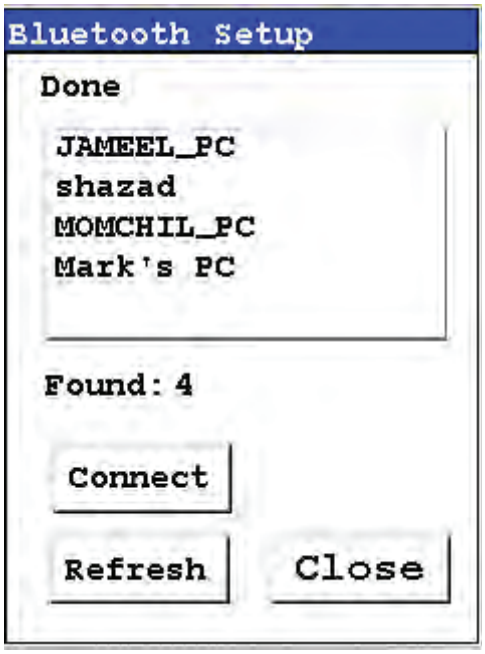


Figure 2-15. Example Search List

Depending on where and when the Search Scan is conducted, certain devices may or may not be detected. You can select a device and connect to that device in exactly the same manner as in the Available Devices Screen, once the search is finished.

Figure 2-16. Search List with New Device Found

The Connected Screen

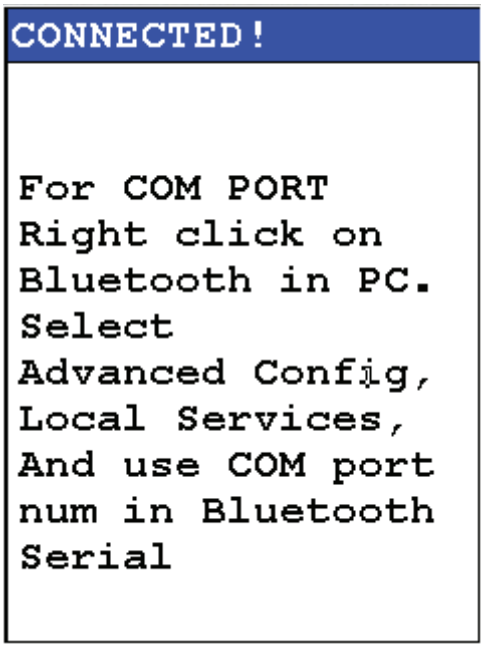


Figure 2-17. The Connected Screen

When you have connected your analyzer to a Bluetooth Device, you get the Connection Screen. The Connection Screen serves as a reminder of what needs to be done to use the connection. With simple devices like GPS devices, a notification that you are connected is given, and everything just works, but working with a PC is a bit more complex.

In order to use a Bluetooth Serial Connection with a PC, you need to know which COM port Bluetooth is connected through. To determine this, right click on the Bluetooth logo in your system tray on your PC. From the popup menu which appears, select Advanced Config., then select Local Services.

Figure 2-18. Advanced Configuration selection on PC

Service Name	Startup	Secure Connection	COM Port
Audio Gateway	Auto...	Not Required	
Headset	Auto...	Not Required	
PIM Synchronization	Manu...	Required	
Fax	Manu...	Required	
File Transfer	Auto...	Required	
PIM Item Transfer	Manu...	Not Required	
Dial-up Networking	Manu...	Required	
Network Access	Auto...	Required	
Bluetooth Serial Port	Auto...	Not Required	COM3

Figure 2-19. Bluetooth Service Listing on PC

In the Bluetooth Serial Port row, the COM port used by Bluetooth is identified. Use this port for any interactions between your analyzer and your computer, such as NDT or NDTr.

Make sure that the Secure Connection setting for the Bluetooth Serial Port is set to “Not Required.”

Service Name	Startup	Secure Connection	COM Port
Audio Gateway	Auto...	Not Required	
Headset	Auto...	Not Required	
PIM Synchronization	Manu...	Required	
Fax	Manu...	Required	
File Transfer	Auto...	Required	
PIM Item Transfer	Manu...	Not Required	
Dial-up Networking	Manu...	Required	
Network Access	Auto...	Required	
Bluetooth Serial Port	Auto...	Not Required	COM3

Figure 2-20. Selecting Bluetooth Serial Port on PC

To edit the setting, double click the row.’

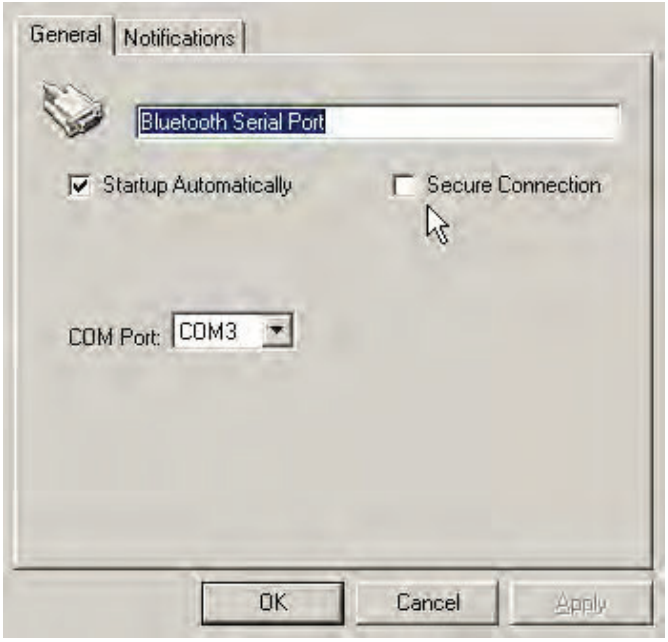
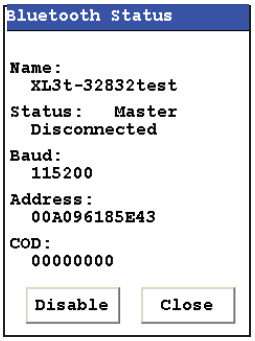
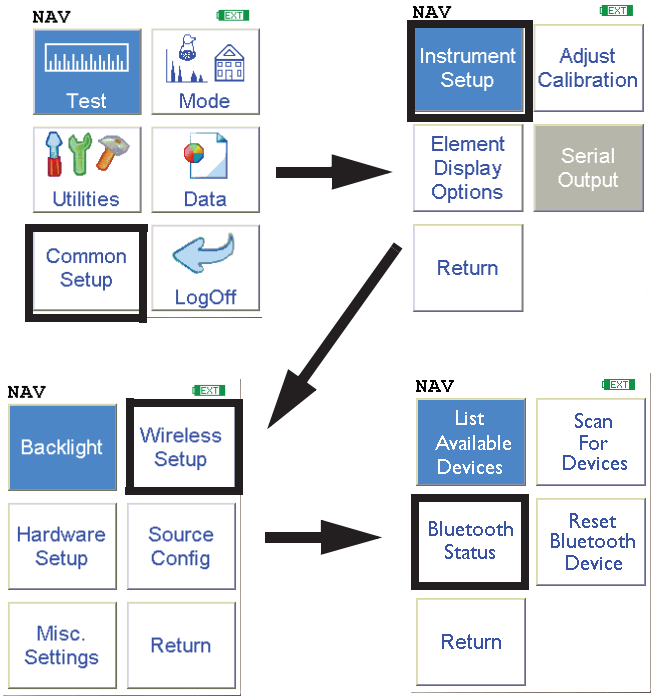


Figure 2-21. Changing the Bluetooth Secure Connection Checkbox on PC

Unselect the Secure Connections checkbox if it is already selected, then select the “OK” button.

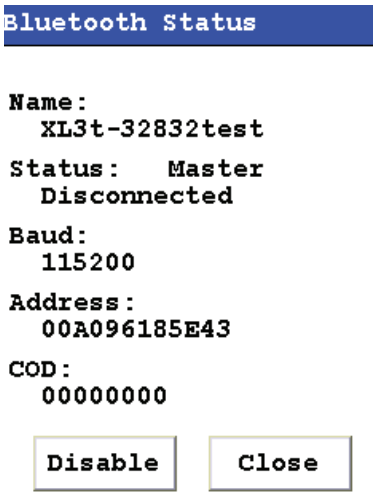
Bluetooth Status Screen





The Bluetooth Status Screen enables you to see at a glance if and how your analyzer is connected to your computer.

Please Wait Status Screen



Normal Status Screen

Figure 2-22. Example Bluetooth Status Screen

Select the Bluetooth Status icon to view the current status of your Bluetooth connections on the Bluetooth Status Screen. The Bluetooth Status Screen will display your analyzer's serial number, connection status, the transfer rate, and your analyzer's address

In Figure 2-22, the first screen shown is the Please Wait screen. This screen is shown while the status inquiry is in process. When the inquiry is complete, the normal Status Screen will show.

The Bluetooth Status Screen shows your analyzer's identification label, its connection state, the speed of the communication port setting, your analyzer's network address, and the COD.

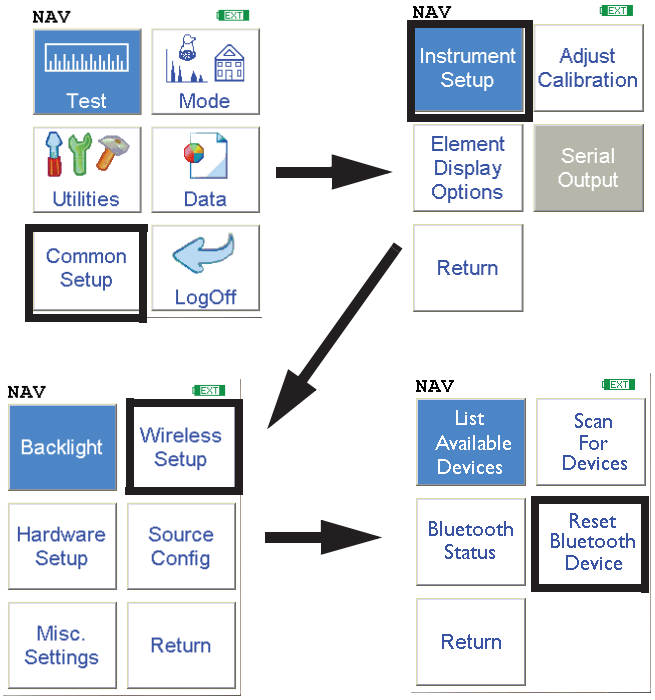
In Figure 2-22, the analyzer "XL3t-32832test" is not connected to any computer, was last in Master state - i.e. the last connection was initiated by the computer and not by the analyzer, has a com port set to communicate at 115200 baud, has the unique network (MAC) address of 00A096185E46, and has a COD (Class Of Device) of 00000000.

Selecting the Disable Button will shut down the Bluetooth device entirely. A "Bluetooth Disabled" mesage appears, and the Disable Button changes to "Enable".

The Close screen button will return you to the Wireless Setup Menu.

Figure 2-23. Bluetooth Status Screen Showing Bluetooth Disabled

Reset Bluetooth Device



Select the **Reset Bluetooth Device** icon to initiate an immediate reset of the Bluetooth Wireless Networking. Selecting the **Reset Bluetooth Device** icon will clear out old settings and data, as well as enabling you to switch between Bluetooth and standard serial cable. While resetting, your analyzer will show the following screen:

Figure 2-24. Bluetooth Reset Alert

GPS Data Tracking

Bluetooth equipped NITON XRF Analyzers are capable of communicating with GPS modules and saving GPS coordinates with every reading. Follow the Bluetooth connection instructions found in the Users Manual to scan for and connect to a Bluetooth enabled GPS device.

Once connected, the GPS unit sends out a number of signals that can be read. The analyzer will display the relevant information from the GPS after connection, as shown in Figure 2-25

As shown in Figure 2-26, these coordinates can be viewed in the Data screen in entry positions eight, nine, and ten. (Scroll down to reach these fields.) When the results are downloaded using the NDT software the GPS coordinates are also stored and downloaded in data entry fields eight, nine and ten.

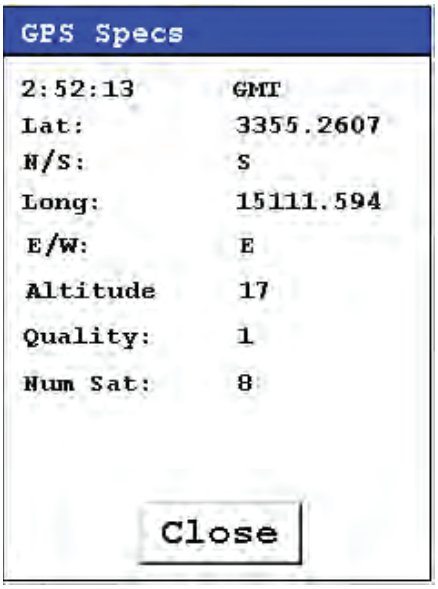


Figure 2-25. Example of GPS Data

Example of GPS Data

- 2:52:13 GMT - Greenwich Mean Time obtained from the GPS satellites.
- Lat: 3355.2607 -Latitude coordinate of current location. This should be read as:
  - All digits to the right of the decimal point are seconds.
  - First two digits to the left of the decimal point are minutes.

  - The next two or three digits to the left of the decimal point are degrees.
  - Thus 3355.2607 is read 33 degrees 55 minutes 26.07 seconds.
- N/S: S - Compass direction of Latitude.
- Long: 15111.594 - Longitude coordinate of current location.
  - All digits to the right of the decimal point are seconds.
  - First two digits to the left of the decimal point are minutes.
  - The next two or three digits to the left of the decimal point are degrees.
  - Thus 15111.594 is read 151 degrees 11 minutes 59.4 seconds.
- W/E: E - Compass direction of Longitude.
- Altitude: 17 - Height above sea level in meters.
- Quality: 1 - Quality of signal strength.
- Num Sat: 8 - Number of satellites signals being received by GPS. This number varies depending on your position, the current position of the satellites, and the signal strength.

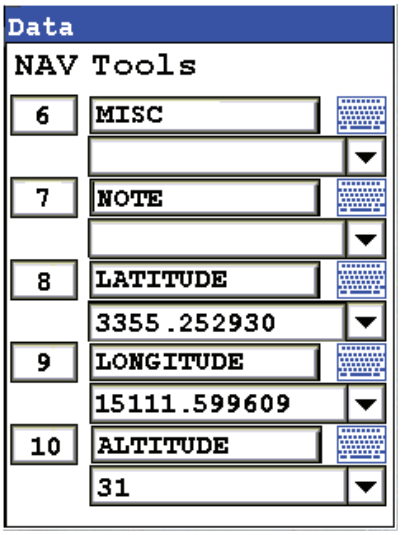


Figure 2-26. GPS Data Integrated Into Reading Data

GPS Options

The communication system standard required for compatibility is NMEA0182 ver. 3.0, using GPGGA, GPGSA, GPRMC, and GPGSV formats. This type of GPS is most commonly used for motor and marine directional mapping systems.

Tested Units include:

Copilot BTGPS3

http://www.alk.com/copilot/pocketpc.asp

RoyalTek Star111

http://www.royaltek.com/index.php/content/view/98/80/

IOGEAR Bluetooth GPS

http://www.iogear.com/main.php?loc=product&Item=GBGPS201W6

Note These GPS systems have an accuracy of about 10 meters.

Haicom HI-408BT GPS

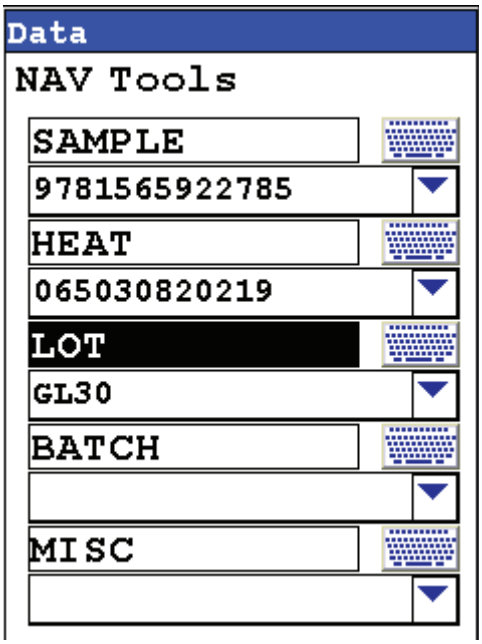
http://www.haicom.com.tw/hi_408bt.aspx

Note Claimed accuracy is 3 meters

Entering Data with a Barcode reader

You can also use Bluetooth barcode readers with your analyzer. Connect your reader to your analyzer in the usual way, see See Chapter 2 page 11 for details. Once the reader is connected, you can use it to input data into your analyzer.

- On the data entry screen, highlight the desired field.
- While pressing the button on the Barcode Pencil, swipe the desired barcode. If the pencil successfully reads the barcode, it will beep.
- The barcoded data will show up in the data field after the beep. There is a short delay while the information is being transmitted
- You may also use the Virtual Keyboard Screen to enter barcoded data.



You can replace, append or clear any field with a custom barcode:

- R05TEXT replaces field 5 with the TEXT
- A05C – appends field 5 with the letter C
- C05 – clears field 5
- C00 – clears all fields

Supported Barcode Readers

At the time of publication, supported readers include:

- The Baracoda Barcode Pencil

  The Baracoda Barcode Pencil supports these barcodes for use with the XL3 system.

- Code 96
- Code 128/EAN 128
- EAN13/UPCA
- UPCE/EAN8
- Code 39
- Codabar
- Interleaved 2 of 5
- Standard 2 of 5
- Code 11
- MSI RSS14
- RS Limited

  Consult your Baracoda Pencil Users Manual for more information and information on successful barcoding.

Setting Up and Using the USB port

The USB port is the narrow inverted trapezoidal port on the back of your XL3 Analyzer. You can use this port, along with the supplied cable, to communicate with your analyzer.

Figure 2-27. Location of Mini-USB port

Insert the smaller end of your USB cable into the Mini-USB port on the back of your XL3, and the larger end into any USB port on your computer.

When you turn your analyzer on after it is connected, or if you connect it while the analyzer is on, a "Found New Hardware" Wizard will open, as in Figure 2-28.

Figure 2-28. Found New Hardware Wizard

Note If, after installation, you plug your USB cable into a different USB port on your computer, you will get this Wizard again.

The Installation Wizard

Place the installation CD in the drive, select "No, not this time" then select "Next." The Wizard will now ask you what you want it to do, as in Figure 2-29. Select "Install the software automatically."

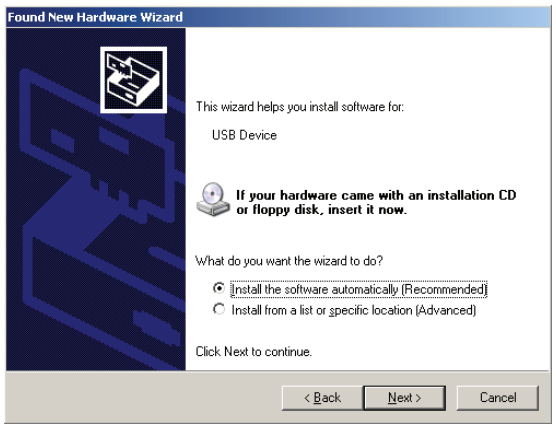


Figure 2-29. Wizard Choice

The Wizard will now search the CD for the proper software, as in Figure 2-30. When the Hardware Installation window comes up stating that the software has not passed XP logo certification, don't worry. The driver is from Microsoft. Select "Continue Anyway."

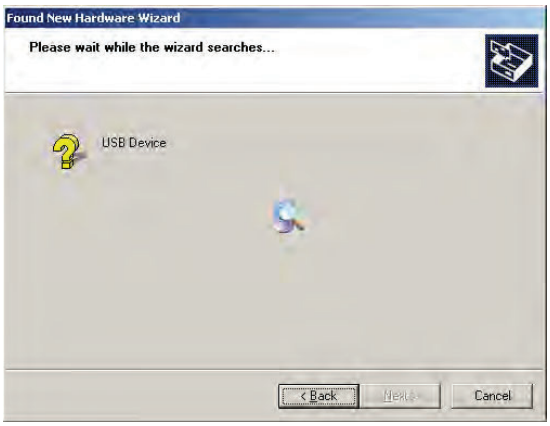


Figure 2-30. Installation Wizard Search

The Wizard will now install the software. This may take several minutes. At the end of this process, you will see the final Wizard screen, as in Figure 2-31, informing you the process is complete. Select "Finish."

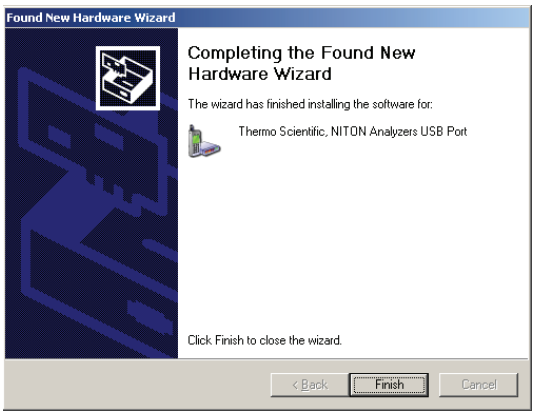


Figure 2-31. Final Installation Wizard Screen

The driver will install as the next free COM device - for example, if you have devices installed as COM1 through COM 5, the driver will install as COM 6. You can find how the software has been installed by starting up NDTr and selecting Settings. The Connect Using box shows you to which Comm port you are using - as in Figure 2-32.

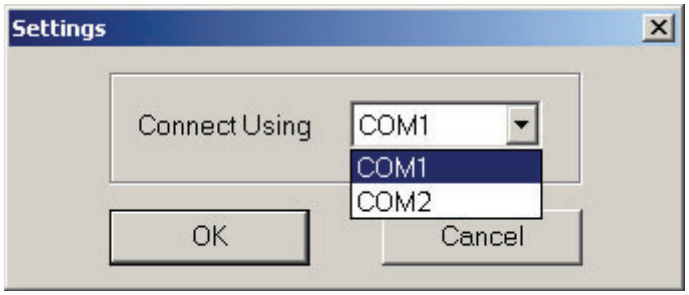


Figure 2-32. The Settings Pop-up Window

Chapter 3 Radiation and General Safety

This chapter covers topics related to radiation safety and general safety when using a Thermo Scientific NITON XL3t analyzer. At a minimum all operators of the XL3t should be familiar with the instructions provided in this chapter in order to handle the XL3t in a safe manner. In addition to reading the information presented on the following pages, Thermo Fisher Scientific recommends that instrument users participate in a radiation safety and operational training class.

WARNING! Always treat radiation with respect. Do not hold your analyzer near the measurement window during testing. Never point your analyzer at yourself or anyone else when the shutter is open. ♦

Radiation and General Safety

This chapter covers topics related to radiation safety and general safety when using a Thermo Scientific NITON XL3t analyzer. At a minimum all operators of the XL3t should be familiar with the instructions provided in this chapter in order to handle the XL3t in a safe manner. In addition to reading the information presented on the following pages, Thermo Fisher Scientific recommends that instrument users participate in a radiation safety and operational training class.

Radiation Protection Basics

The NITON Model XL3t analyzer contains an x-ray tube which emits radiation only when the user turns the x-ray tube on. When the x-ray tube is on and the shutter is open, as during a measurement, the analyzer emits a directed radiation beam (See Figures 0-6 and 0-7). Reasonable effort should be made to maintain exposures to radiation as far below dose limits as is practical. This is known as the ALARA (As Low as Reasonably Achievable) principle. For any given source of radiation, three factors will help minimize your radiation exposure: Time, Distance, and Shielding.

Time

The longer you are exposed to a source of radiation the longer the radiation is able to interact in your body and the greater the dose you receive. Dose increases in direct proportion to length of exposure.

Distance

The closer you are to a source of radiation, the more radiation strikes you. Based on geometry alone, dose increases and decreases with an inverse-squared relation to your distance from the source of radiation (additional dose rate reduction comes from air attenuation). For example, the radiation dose one foot from a source is nine times greater than the dose three feet from the source. Remember to keep your hands and all body parts away from the front end of the analyzer when the shutter is open to minimize your exposure.

Shielding

Shielding is any material that is placed between you and the radiation source. The more material between you and the source, or the denser the material, the less you will be exposed to that radiation. Supplied or optional test stands are an additional source of shielding for analysis. A backscatter shield accessory is also available and may be appropriate in some applications.

Exposure to Radiation

Human dose to radiation is typically measured in rem, or in one-thousandths of a rem, called millirem (mrem), 1 rem = 1000 mrem. Another unit of dose is the Sievert (Sv), 1 Sv = 100 rem. The allowable limit for occupational exposure in the U.S (and many countries internationally) is 5,000 mrem/year (50 mSv/year) for deep (penetrating) dose and 50,000 mrem/year (500 mSv/year) for shallow (i.e., skin) dose or dose to extremities. Deep, shallow, and extremity exposure from a properly used NITON XL3t analyzer should be less than 200 mrem per year, (2.0 mSv per year) even if the analyzer is used as much as 2,000 hours per year, with the shutter open continuously. The only anticipated exceptions to the 200 mrem maximum annual dose are: 1) routine and frequent analysis of plastic samples without use of a test stand, backscatter shield, or similar additional protective measures, or 2) improper use where a part of the body is in the primary beam path. NEVER OPERATE THE DEVICE WITH A PART OF YOUR BODY IN THE PRIMARY BEAM PATH OR WITH THE PRIMARY BEAM PATH DIRECTED AT ANYONE ELSE. Also, consider the use of protective accessories such as a shielded test stand or backscatter shield (or equivalent) when performing routine and/or frequent analysis of any of the following:

- plastic (or similarly low density) samples,
- thin samples (such as foils, circuit boards, and wires), or
- samples that are smaller than the analysis window.

Shown in Table 3-1 below are the typical background radiation doses received by the average member of the public. The radiation dose limits for radiation workers in the US are also shown in Table 3-2.

Table 3-1. Typical Radiation Doses Received (Source: NCRP 1987)

Category	Dose in mrem	Dose in mSv
Average total dose in US (annual)	360	3.6
Average worker exposure (annual)	210	2.1
Average exposure for an underground miner	400	4.0
Exposure for airline crew (1,000 hours at 35,000 ft)	500	5.0
Additional from living in Denver at 5300' (annual)	25	.25
Additional from 4 pCi/l radon in home	1,000	10.0
Typical Chest X-Ray	6	0.06
Typical Head or Neck X-Ray	20	0.2
Typical pelvis/hip x-ray	65	0.65
Typical lumbar spine x-ray	30	0.3
Typical Upper G.I. x-ray	245	2.45
Typical Barium enema x-ray	405	4.05
Typical CAT scan	110	1.10

Table 3-2. Annual Occupational Dose Limits for Radiation Workers (Source: Code of Federal regulations Title 10, Part 20)

Category	Dose in mrem	Dose in mSv
Whole Body	5000	50
Pregnant Worker (during gestation period)	500	5
Eye Dose Equivalent	15,000	150
Shallow dose equivalent to the skin or any extremity or organ	50,000	500
Maximum allowable dose for the general public (annual)	100	1.0
For a Minor	500	5.0

Monitoring your radiation exposure

Individuals can be monitored for the radiation dose they receive by use of radiation dosimetry devices (dosimeters). Monitoring dose using a dosimeter can be a way of identifying improper use and at the same time demonstrating proper use. In some locations, dosimetry is required by regulations and in others it is optional. It is normally required when the user could reasonably be expected to receive in excess of 10% of the annual dose limit. Thermo Fisher Scientific recommends that you determine and obey the local regulatory requirements concerning radiation monitoring of occupational workers.

Two common types of dosimeters are whole-body badges and ring badges. Whole body badges are often attached to the user's torso (e.g., clipped to the collar, shirt pocket, or waist as appropriate). A ring badge is worn on the finger as a measure of maximum extremity dose. When worn, the specific location of the dosimeter should be that part of the body that is expected to receive the highest dose. This location will depend on how the analyzer is used and so it may not be the same for all users. Dosimetry services are offered by many companies. Two companies offering dosimetry services in the USA and much of the world are:

Global Dosimetry Solutions

2652 McGaw Avenue

Irvine, CA 92614

www.dosimetry.com

(800) 251-3331

Landauer, Inc.

2 Science Road

Glenwood, IL 60425-9979

www.landauerinc.com

(800) 323-8830

Note Wearing a dosimeter badge does not protect you against radiation exposure. A dosimeter badge only measures your exposure (at the dosimeter location). ♦

Pregnancy and Radiation Exposure

International guidance documents (e.g., ICRP Publication 60 and NCRP Publication 116*) recommend that the radiation dose to the embryo/fetus of a pregnant woman should not exceed a total of 500 mrem (10% of normal radiation worker limit) during the gestation period. While this dose limit exceeds the dose limit to a trained operator, pregnant workers may want to take special precautions to reduce their exposure to radiation. For more information see the U.S. NRC Regulatory Guide 8.13 "Instruction Concerning Prenatal Radiation Exposure" which can be found on the resource CD.

* The International Commission on Radiological Protection, ICRP, is an independent Registered Charity, established to advance for the public benefit the science of radiological protection, in particular by providing recommendations and guidance on all aspects of protection against ionizing radiation.

* The National Council on Radiation Protection and Measurements (NCRP) was chartered by the U.S. Congress in 1964 as the National Council on Radiation Protection and Measurements.

How to Use the NITON XL3t Analyzer Safely

The NITON XL3t analyzer is designed to be safe to operate provided that it is used in accordance with manufacturers' instructions. Under conditions of normal use, monitored operators seldom receive a measurable dose and have not been known to receive in excess of 10% of the annual occupational dose limits (a criteria that would require monitoring under regulation in the U.S.). In addition to proper use of the XL3t, it is recommended that you follow these precautions to ensure your safety and the safety of those around you.

Know where the beam is

The primary beam is a directed beam out of the front of the analyzer that can have high dose rates. The secondary beam, or scattered beam, has much lower dose rates.

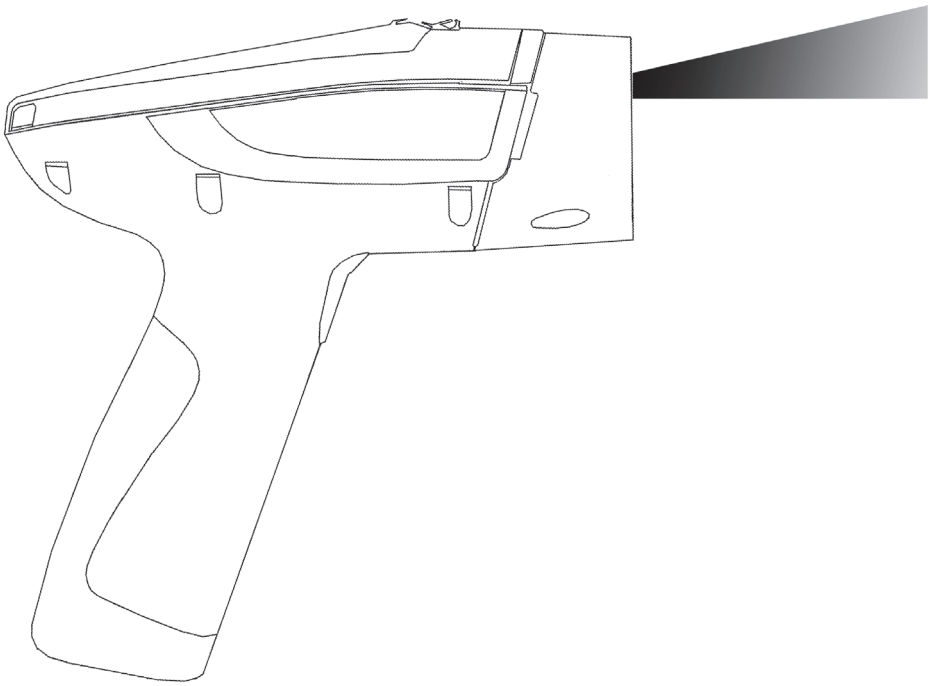


Figure 3-1. . Primary Beam

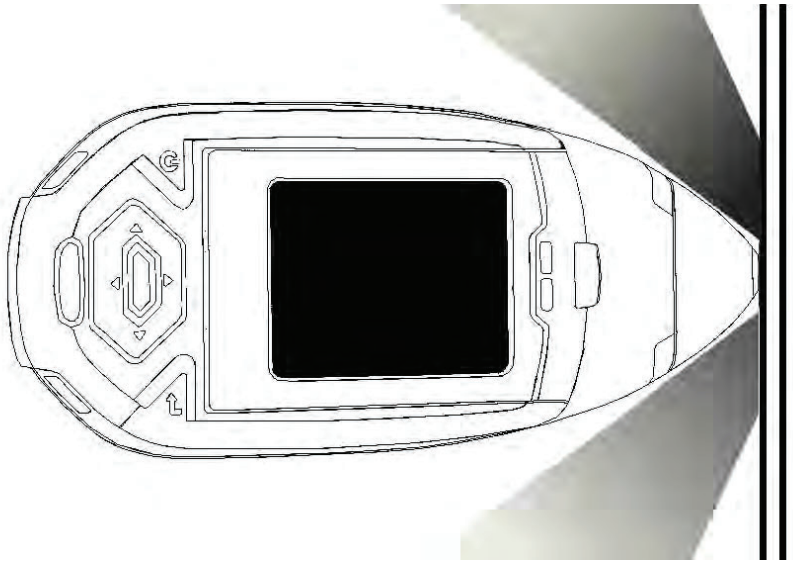


Figure 3-2. Secondary (Scattered) Beam

The Shutter-Open Indicator Lights

When the lights are flashing, the primary beam is on, the shutter is open, and radiation is being emitted from the front of the analyzer. (This does not include the brief flash of the lights when first turning the analyzer on.)

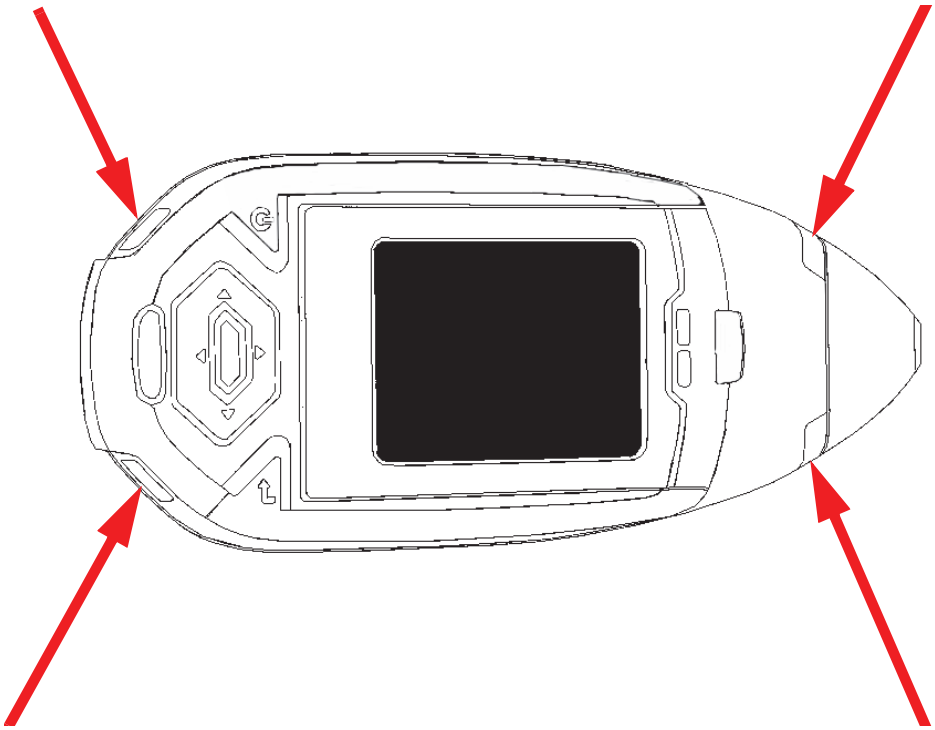


Figure 3-3. X-ray BeamThe Shutter Open Indicator Lights

Handle and Use with Respect

Avoid holding the front of the analyzer when the x-ray tube is energized and the shutter is open. Never point the instrument at yourself or anyone else when the shutter is open and the x-ray tube is energized. Never look into the path of the primary beam.

Follow a Radiation Protection Program

Your organization should establish, document, and follow a Radiation Protection Program. An example of such a program can be found on the resource CD (provided with the instrument).

Take Proper Care of your NITON XL3t Analyzer

Keeping your analyzer maintained in good condition will help minimize the risk of accidental exposure. Mechanical malfunction of the shutter can be avoided by maintaining the measurement window, as described in the User Guide. This prevents foreign objects from entering your XL3t.

Avoid Over-Exposures

Direct contact with the window could result in overexposures in the times indicated in Table 0-4 below.

Table 3-3. Potential Exposure Limit Times

Location of Dose	Limit	Time to Reach Limit
Deep Dose / Whole Body	5 rem (50 mSv)	2.1 minutes
Shallow Dose / Extremities	50 rem (500 mSv)	0.95 minutes
Member of Public (i.e. untrained operator)	0.1 to 5 rem (1 to 50 mSv)	2.5 to 9.5 seconds

Extremity is defined by the NRC as the hand, elbow, arm below the elbow, foot, knee, or leg below the knee. Whole Body is defined by the NRC as the head, trunk (including male gonads), arms above the elbow, or legs above the knee.

Safe Handling of Samples

As mentioned many times in this chapter, never place any part of your body in the path of the x-ray beam. There is always a safe way to handle samples whether they are small, irregularly shaped, or of low density. Never look into the path of the primary beam.

Small Samples

A small sample would be any sample that is smaller than the measurement window. Small samples present a unique risk because they don't block the entire beam path. The difficulty with placing small samples down on a work surface to analyze them is that you may get readings from the work surface that interfere with analytical results. A test stand is an effective way of analyzing small samples accurately and safely. Never hold samples during analysis or look into the path of the primary beam.

Irregularly Shaped Samples

Irregularly shaped samples may not allow the proximity button to be depressed, or they may not entirely cover the primary beam and cause additional scattering. A back scatter shield is a safe way of reducing your radiation exposure while effectively analyzing an irregularly shaped sample.

Low Density Materials (such as plastics)

X-rays are attenuated more through denser materials and less through low density materials such as plastic. This causes higher dose rates in the scattered radiation. If you are frequently handling low density samples, you should consider the use of test stands, backscatter shields, or the equivalent.

Radiation Profile

Table 3-4, Table 3-5, Table 3-6 and Table 3-7 below describes the external radiation dose rates that are present at various points in space around the NITON XL3t analyzer when it is being used. Figure 3-4 illustrates where these dose rate points are relative to the analyzer.

Table 3-4. Primary Beam Dose Rates in mSv/hr

Max Power Settings	Max Power Settings		Window Contact Deep	Window Contact Shallow	5 cm Deep	30 cm Deep
kVp	µA	Max in Following Modes* (Filter)	(mSv/hr)	(mSv/hr)	(mSv/hr)	(mSv/hr)
40	50	G, D, E, A, P, F, M, J (Main Filter)	1,410	1,410	50.00	6.3
40	50	B (Main Filter)	750	2,250	40.00	5.4
50	40	H (Main Filter), D, E, M, J (High Filter)	1,090	4,060	84.0	12.2
20	100	D, H, E, M, J (Low Filter)	1,450	31,717	5.2	0.5
15	100	A, B (Low Filter)	133	10,567	4.3	0.42

Table 3-5. Primary Beam Dose Rates in Rem/hr

Max Power Settings	Max Power Settings		Window Contact Deep	Window Contact Shallow	5 cm Deep	30 cm Deep
kVp	µA	Max in Following Modes* (Filter)	(Rem/hr)	(Rem/hr)	(Rem/hr)	(Rem/hr)
40	50	G, D, E, A, P, F, M, J (Main Filter)	141	141	5.00	0.63
40	50	B (Main Filter)	75	225	4.00	0.54
50	40	H (Main Filter), D, E, M, J (High Filter)	109	406	8.4	1.22
20	100	D, H, E, M, J (Low Filter)	145	3,171.7	0.52	0.05
15	100	A, B (Low Filter)	13.3	1,056.7	0.43	0.042

* G = Alloy, B = Alloy Electronics, F = Dental Alloy, P = Precious Metals, M = Mining, D = Soil, J = Exploration, A = Lead Paint, E = Thin Sample, H = Plastic

Table 3-6. Secondary (Scatter) Dose Rates (μSv/hr)

kVp	μA	Max in Following Modes* (Filter)	Substrate	Max @ 5cm (μSv/hr) Point A	Max @ 30 cm (μSv/hr) Point A′	Max @ Trigger (μSv/hr) Point B
40	50	G, D, E, A, P, F, M, J (Main Filter)	Aluminum	25	2	0.5
40	50	G, D, E, A, P, F, M, J (Main Filter)	Stainless	16	1.2	0.1
40	50	B (Main Filter)	Aluminum	4	0.4	0.1
40	50	B (Main Filter)	Stainless	1.4	0.1	0.1
50	40	H (Main Filter), D, E, M, J (High Filter)	Plastic	400	35	20
50	40	H (Main Filter), D, E, M, J (High Filter)	Soil	80	4	0.7
20	100	D, H, E, M, J (Low Filter)	Aluminum	0.15	0.1	0.1
20	100	D, H, E, M, J (Low Filter)	Stainless	0.15	0.1	0.1
20	100	D, H, E, M, J (Low Filter)	Plastic	1.3	0.15	0.15
20	100	D, H, E, M, J (Low Filter)	Soil	0.15	0.15	0.15
15	100	A, B (Low Filter)	Aluminum	0.15	0.15	0.15
15	100	A, B (Low Filter)	Stainless	0.15	0.15	0.15

* G = Alloy, B = Alloy Electronics, F = Dental Alloy, P = Precious Metals, M = Mining, D = Soil, J = Exploration, A = Lead Paint, E = Thin Sample, H = Plastic.

Table 3-7. Secondary (Scatter) Dose Rates (mRem/hr)

kVp	uA	Max in Following Modes* (Filter)	Substrate	Max @ 5cm (mRem/hr) Point A	Max @ 30 cm (mRem/hr) Point A'	Max @ Trigger (mRem/hr) Point B
40	50	G, D, E, H, A, P, F, M, J (Main Filter)	Aluminum	2.5	0.2	0.05
40	50	G, D, E, H, A, P, F, M, J (Main Filter)	Stainless	1.6	0.12	0.01
40	50	B (Main Filter)	Aluminum	0.4	0.04	0.01
40	50	B (Main Filter)	Stainless	0.14	0.01	0.01
50	40	H (Main Filter), D, E, M, S, J (High Filter)	Plastic	40	3.5	2
50	40	H (Main Filter), D, E, M, S, J (High Filter)	Soil	8	0.4	0.7
20	100	D, H, E, M, S, J (Low Filter)	Aluminum	0.015	0.01	0.01
20	100	D, H, E, M, S, J (Low Filter)	Stainless	0.015	0.01	0.01
20	100	D, H, E, M, S, J (Low Filter)	Plastic	0.13	0.015	0.015
20	100	D, H, E, M, S, J (Low Filter)	Soil	0.015	0.015	0.015
15	100	A, B (Low Filter)	Aluminum	0.015	0.015	0.015
15	100	A, B (Low Filter)	Stainless	0.015	0.015	0.015

* G = Alloy, B = Alloy Electronics, F = Dental Alloy, P = Precious Metals, M = Mining, D = Soil, J = Exploration, A = Lead Paint, E = Thin Sample, H = Plastic.

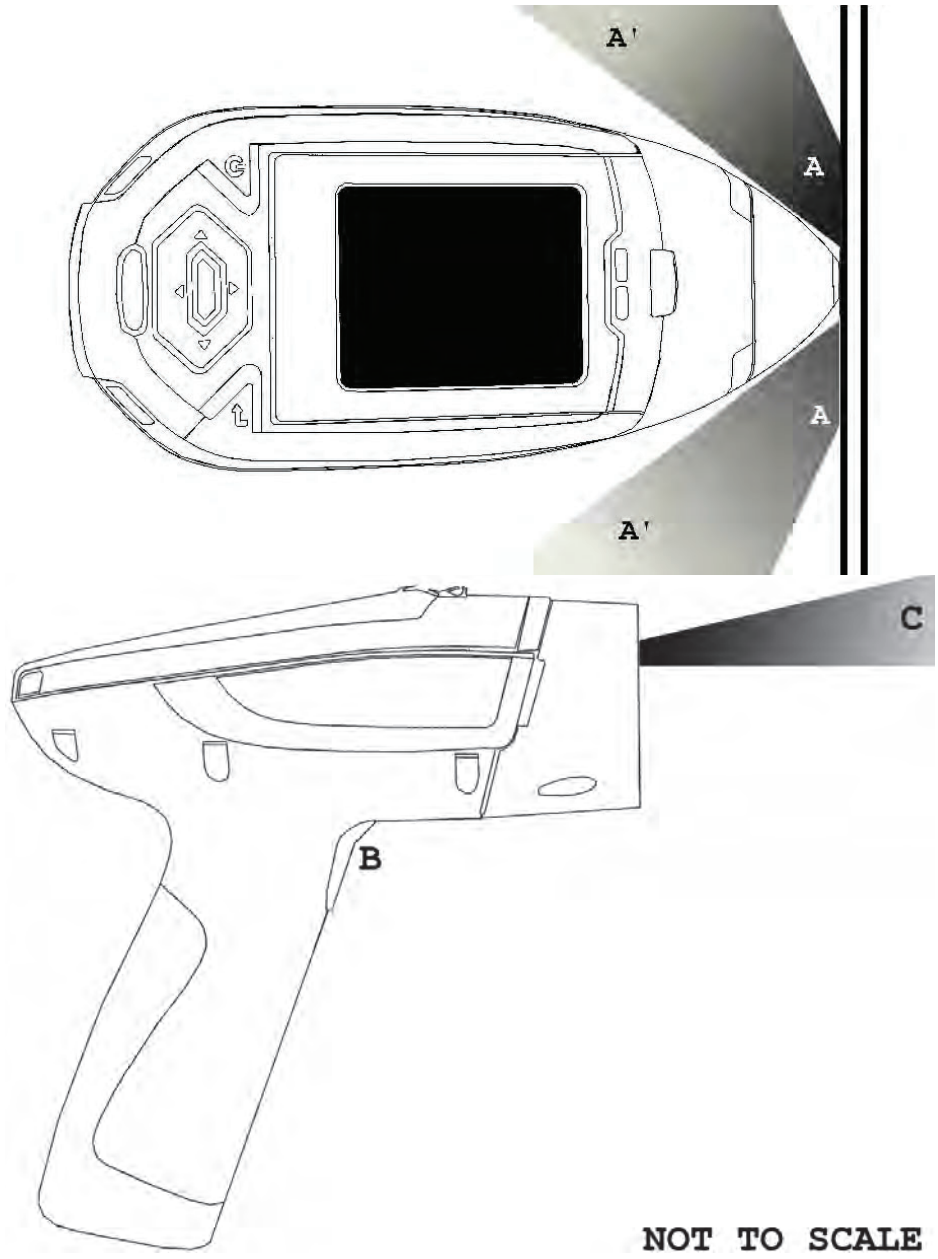


Figure 3-4. Primary & Secondary Dose Rate Locations

Primary Radiation

Primary radiation is radiation that is produced by the analyzer and emitted out through the kapton measurement window. Individuals should never place any part of their body in the primary beam path when the x-ray tube is on. There should always be a sample in contact with the measurement window when the x-ray tube is on. The sample will absorb most of the primary-beam radiation unless it is smaller than the instrument's

measurement window or of low density and/or thickness. Caution should be taken when analyzing samples that are small, thin, and/or low in density as they may allow much more of the primary beam to escape. In-beam primary radiation dose rates are listed in Table 3-4 and Table 3-5 and their location identified relative to the analyzer in Figure 3-4 as Dose Point C.

Secondary Radiation

Under conditions of normal and proper use, individuals can be exposed to secondary (or "scattered") radiation. Secondary radiation is low-level radiation that emanates from the sample being analyzed as a result of primary beam radiation scattering in the sample or primary beam radiation inducing fluorescent x-rays in the sample. Dose points A, A' and B in Figure 3-4 are examples of where you can encounter secondary radiation. The magnitude of this secondary radiation is sample dependent. Higher density samples such as steel will emit the lowest levels as they absorb most primary and secondary radiations. Lower density samples such as aluminum, wood, and especially plastic, will produce higher levels of secondary radiation. Secondary radiation dose rates are listed in Table 3-6 and Table 3-7 for a few common sample types over a wide range of densities.

The operator is reminded that one should never hold samples during analysis, doing so will result in higher than necessary exposure to secondary radiation and could expose the operator directly to the much higher primary-beam dose rates.

Deep and Shallow Dose

You will find in Table 3-4 and Table 3-5 that shallow dose rates are listed for some dose points. All dose rates listed in Table 3-4 and Table 3-5 are deep dose unless they are specifically identified as shallow dose. Deep dose is dose from penetrating radiation that is delivered to both skin and underlying tissues and organs and is the type most commonly referred to when describing external radiation hazards. Occupational deep dose is limited to a maximum of 5 rem (50 mSv) per year in the United States and most countries internationally. Deep dose is measured at 1.0 cm below the skin surface.

Shallow dose is often referred to as "skin dose" because it is a result of low penetrating radiation that only interacts with the skin. Shallow dose is limited to a maximum of 50 rem (500 mSv) per year in the United States and most countries internationally. Shallow dose is listed below for primary in-beam dose points only because the low penetrating radiation that causes shallow dose is nearly all absorbed by a sample and does not produce any significant secondary radiation. Shallow dose is measured at a point 0.007 cm below the surface.

Storage & Transportation

Storage

Regulations in nearly all locations will require that you store your analyzer locked in a secured area to prevent access, use, and/or removal by unauthorized individuals. Storage requirements will vary by location, particularly with regard to storage at temporary job sites or away from your primary storage location such as hotels and motels and in vehicles. You should contact your local Radiation Control Authority to identify the specific storage requirements in your jurisdiction.

Transportation

There are no specific US Department of Transportation (DOT) or International Air Transport Association (IATA) radiation regulations regarding shipping the NITON XL3t analyzer. It is recommended that you ship the XL3t in its carrying case and an over-pack to protect the sensitive measuring equipment inside the analyzer.

Do NOT ship the analyzer with the battery pack connected to the analyzer.

EMERGENCY PROCEDURES

THIS PAGE CONTAINS EMERGENCY CONTACT INFORMATION THAT SHOULD BE AVAILABLE TO THE OPERATOR AT ALL TIMES.

Lost or Stolen Instrument

If the NITON XL3t analyzer is lost or stolen, notify your Radiation Safety Officer (RSO) or the equivalent responsible individual at your company or institution immediately. Your company's RSO, as well as other important emergency contacts, are listed below. Your company RSO may need to notify the x-ray tube regulatory authority and the local police. It is also recommended that a notification is made to Thermo Fisher Scientific.

Damaged Instrument

Minor Damage

If the instrument is intact but there is indication of an unsafe condition such as a cracked case, a shutter mechanism failure, or the lights remain flashing after a measurement is terminated, follow these steps:

1. **Stop using the instrument**
2. **Remove the battery, the x-ray tube can not produce radiation when the battery is disconnected. The instrument is now safe to handle.**
3. **Place the instrument securely in the holster**
4. **Place the instrument in the carrying case that came with the instrument.**
5. **Notify your Radiation Safety Officer (RSO) or the equivalent responsible individual at your company or institution immediately.**
6. **You or your RSO should call Thermo Fisher Scientific at one of their contact numbers listed below for additional instructions and guidance.**

Major damage

If the instrument is severely damaged:

1. **Perform the same steps as described above for minor damage. There will be no radiation hazard as long as the battery is removed from the instrument.**

2. **Place all components in a plastic bag and contact Thermo Fisher Scientific.**

Emergency Response Information

Please Complete the Following Emergency Response Information and Keep with the Analyzer at All Times

NITON ANALYZER EMERGENCY CONTACT INFORMATION

The Company RSO is:_____

RSO Telephone Number:_____

Regulatory Agency Emergency Number:_____

Local Fire Department:_____

Local or State Police Department:_____

Thermo Fisher Scientific's NITON Analyzer Contact Numbers

Main Number (USA): (800) 875-1578

Additional Radiation Emergency #'s: (978) 790-8269 or (617) 901-3125

Outside the USA - Local NITON Service Center:_____

For assistance with your NITON XL3t analyzer outside the United States, please contact your nearest manufacturer's service center identified below:

Europe

NITON Analyzers Europe

Munich, Germany

Phone: +49 89 3681 380

Fax: +49 89 3681 3830

Email: niton.eur@thermo.com

Asia NITON Analyzers Asia

Hong Kong

Phone: +852 2869-6669

Fax: +852 2869-6665

Email: niton.asia@thermo.com

Registration and Licensing

As a user of a NITON XL3t analyzer, you may be required to register or obtain a license with your local radiation control authority. In the US, if you intend to do work with your XL3t in states other than your own, you may be required to register there as well. Below is a list of commonly asked questions that come up when filling out registration forms.

FAQ

What is the max mA, max kVp, and max power?

Maximum mA is 0.1 mA

Maximum kVp is 50 kVp

Maximum power: 2 watts

What is the accelerator voltage or MeV?

This should be filled out as not applicable N/A as it does not apply to XL3t analyzers.

What is the radioisotope?

There are no radioactive isotopes in XL3t analyzers.

What category is the XL3t?

States differ greatly in their categories; the following is a list of common categories:

- o X-Ray Fluorescence
- o Analytical or Analytical XRF
- o Open Beam or Open Beam Analytical
- o Portable Gauge or Portable XRF
- o Industrial Analytical or Non-Destructive Testing

When selecting the category make sure that you don't select medical or radiographic.

How many tubes are in the XL3t?

One.

What is the analyzer serial number?

The serial number is a 5 digit number located on the yellow sticker on the underside of your analyzer.

What is the tube serial number?

The serial number on the tube is different from the serial number on the analyzer itself. If your jurisdiction asks for this number please call us at 1-800-875-1578 and ask to speak with someone regarding X-Ray tube registrations and we can look this number up for you.

What is the type of X-Ray Processing?

None. XL3t analyzers do not use film.

How often do I need to perform leak tests on the XL3t?

Never. Leak tests are only required for analyzers with radioactive isotopes. XL3t analyzers do not have radioactive isotopes.

Regarding Safety Devices for the Open Beam Configuration:

In the US, you may be required to file for an exemption, "variance letter", with your state if there is a requirement for a safety device that would prevent entry of an extremity into the primary beam. If you need assistance with the exemption letter, you may contact the radiation safety group.

Contact Information

If you have additional questions, please feel free to contact the Radiation Safety Group. If you have questions about regulatory requirements, we recommend that you contact your local radiation control authority. Contact information is listed below.

Thermo Fisher Scientific Contact Information

Radiation Safety Group

By phone: +1 978-670-7460

By fax: +1 978-670-7430

By e-mail: Radsafety.Billerica@thermofisher.com

Radiation Emergency Numbers (Call only if there is a radiation emergency)

Phone: +1 617-901-3125

Phone: +1 978-790-8269

Service Departments

USA Phone:+1 800-875-1578

Fax: +1 978-215-6127

Germany Phone:+49 89 368138-0

Fax:+49 89 368138-30

Hong Kong Phone:+852 2869-6669

Fax:+852 2869-6665

United States Regulatory Authority Contact Information

A list of states and their contacts can be found at the following website:

http://www.hsrd.ornl.gov/nrc/asdirectr.htm

Appendices

Appendix A: X-ray Emission Energies Arranged by Element, by Increasing Atomic Number, in KeV

Table Appendices-1. X-ray Emission Energies Arranged by Element, by Increasing Atomic Number, in KeV

Element	Symbol	Atomic Number	Atomic Weight	Ka1	Kb1	La1	Lb1	Lg1	Ma
magnesium	Mg	12	24.30	1.254	1.30				
aluminum	Al	13	26.48	1.487	1.557				
silicon	Si	14	28.08	1.74	1.84				
phosphorus	P	15	30.97	2.01	2.14				
sulphur	S	16	32.07	2.31	2.46				
chlorine	Cl	17	35.45	2.62	2.82				
argon	Ar	18	39.95	2.96	3.19				
potassium	K	19	39.10	3.3	3.6				
calcium	Ca	20	40.08	3.7	4.0				
scandium	Sc	21	44.96	4.1	4.5				
titanium	Ti	22	47.87	4.5	4.9				
vanadium	V	23	50.94	4.9	5.4				
chromium	Cr	24	52.00	5.4	5.9				
manganese	Mn	25	54.94	5.9	6.5				
iron	Fe	26	55.85	6.4	7.1				
cobalt	Co	27	58.93	6.9	7.6				
nickel	Ni	28	58.69	7.5	8.3				
copper	Cu	29	63.55	8.0	8.9				
zinc	Zn	30	65.41	8.6	9.6				
gallium	Ga	31	69.72	9.2	10.3				
germanium	Ge	32	72.64	9.9	11.0				
arsenic	As	33	74.92	10.5	11.7				
selenium	Se	34	78.96	11.2	12.5				
bromine	Br	35	79.90	11.9	13.3				
krypton	Kr	36	83.80	12.6	14.1				
rubidium	Rb	37	85.47	13.4	15.0				

Table Appendices-1. X-ray Emission Energies Arranged by Element, by Increasing Atomic Number, in KeV

Element	Symbol	Atomic Number	Atomic Weight	Ka1	Kb1	La1	Lb1	Lg1	Ma
strontium	Sr	38	87.62	14.2	15.8				
yttrium	Y	39	88.91	15.0	16.7				
zirconium	Zr	40	91.22	15.8	17.7				
niobium	Nb	41	92.91	16.6	18.6				
molybdenum	Mo	42	95.94	17.5	19.6				
technetium	Tc	43	98.00	18.4	20.6	2.4	2.5	2.8	
ruthenium	Ru	44	101.07	19.3	21.7	2.6	2.6	3.0	
rhodium	Rh	45	102.91	20.2	22.7	2.7	2.8	3.1	
palladium	Pd	46	106.42	21.2	23.8	2.8	3.0	3.3	
silver	Ag	47	107.87	22.2	25.0	3.0	3.2	3.5	
cadmium	Cd	48	112.41	23.2	26.1	3.1	3.3	3.7	
indium	In	49	114.82	24.2	27.3	3.3	3.5	3.9	
tin	Sn	50	118.71	25.3	28.5	3.4	3.7	4.1	
antimony	Sb	51	121.76	26.4	29.7	3.6	3.8	4.3	
tellurium	Te	52	127.60	27.5	31.0	3.8	4.0	4.6	
iodine	I	53	126.90	28.6	32.3	3.9	4.2	4.8	
xenon	Xe	54	131.29	29.8	33.6	4.1	4.4	5.0	
cesium	Cs	55	132.91	31.0	35.0	4.3	4.6	5.3	
barium	Ba	56	137.33	32.2	36.4	4.5	4.8	5.5	
lanthanum	La	57	138.91	33.4	37.8	4.7	5.0	5.8	
cerium	Ce	58	140.12	34.7	39.3	4.8	5.3	6.0	
praseodymium	Pr	59	140.91	36.0	40.7	5.0	5.5	6.3	
neodymium	Nd	60	144.24	37.4	42.3	5.2	5.7	6.6	
promethium	Pm	61	145.00	38.6	44.0	5.4	6.0	6.9	
samarium	Sm	62	150.36	40.1	45.4	5.6	6.2	7.2	
europium	Eu	63	151.96	41.5	47.0	5.8	6.5	7.5	
gadolinium	Gd	64	157.25	43.0	48.7	6.1	6.7	7.8	1.18
terbium	Tb	65	158.92	44.5	50.4	6.3	7.0	8.1	1.24
dysprosium	Dy	66	162.50	46.0	52.2	6.5	7.3	8.4	1.29
holmium	Ho	67	164.93	47.5	53.9	6.7	7.5	8.7	1.34
erbium	Er	68	167.26	49.1	55.7	6.9	7.8	9.1	1.41
thulium	Tm	69	168.93	50.7	57.6	7.2	8.1	9.4	1.46
ytterbium	Yb	70	173.04	52.4	59.4	7.4	8.4	9.8	1.52

Table Appendices-1. X-ray Emission Energies Arranged by Element, by Increasing Atomic Number, in KeV

Element	Symbol	Atomic Number	Atomic Weight	Ka1	Kb1	La1	Lb1	Lg1	Ma
lutetium	Lu	71	174.97	54.1	61.3	7.7	8.7	10.1	1.58
hafnium	Hf	72	178.49	55.8	63.2	7.9	9.0	10.5	1.64
tantalum	Ta	73	180.95	57.5	65.2	8.1	9.3	10.9	1.71
tungsten	W	74	183.84	59.3	67.2	8.4	9.7	11.3	1.77
rhenium	Re	75	186.20	61.1	69.3	8.7	10.0	11.7	1.84
osmium	Os	76	190.23	63.0	71.4	8.9	10.4	12.1	1.91
iridium	Ir	77	192.22	64.9	73.6	9.2	10.7	12.5	1.98
platinum	Pt	78	195.09	66.8	75.7	9.4	11.1	12.9	2.05
gold	Au	79	196.97	68.8	78.0	9.7	11.4	13.4	2.12
mercury	Hg	80	200.59	70.8	80.3	10.0	11.8	13.8	2.19
thallium	Tl	81	204.38	72.9	82.6	10.3	12.2	14.3	2.27
lead	Pb	82	207.20	75.0	85.9	10.5	12.6	14.8	2.34
bismuth	Bi	83	208.98	77.1	87.3	10.8	13.0	15.2	2.42
polonium	Po	84	(209.0)	79.3	89.8	11.1	13.4	15.7	
astatine	At	85	(210.0)	81.5	92.3	11.4	13.9	16.2	
radon	Rn	86	(222.0)			11.7	14.3	16.8	
francium	Fr	87	(223.0)			12.0	14.8	17.3	
radium	Ra	88	(226.0)			12.3	15.2	17.8	
actinium	Ac	89	(227.0)			12.7	15.7	18.4	
thorium	Th	90	232.04			13.0	16.2	19.0	
protactinium	Pa	91	(231.0)			13.3	16.7	19.6	
uranium	U	92	238.03			13.6	17.2	20.2	
neptunium	Np	93	237.00			13.9	17.7	20.8	
plutonium	Pu	94	244.00			14.3	18.3	21.4	

Appendix B: X-ray Emission Energies Arranged Alphabetically by Element, by name

Table Appendices-2. X-ray Emission Energies Arranged Alphabetically by Element, by Name

Element	Symbol	Atomic Number	Atomic Weight	Ka1	Kb1	La1	Lb1	Lg1	Ma
actinium	Ac	89	(227.0)			12.7	15.7	18.4	
aluminum	Al	13	26.48	1.487	1.557				
antimony	Sb	51	121.76	26.4	29.7	3.6	3.8	4.3	
argon	Ar	18	39.95	2.96	3.19				
arsenic	As	33	74.92	10.5	11.7				
astatine	At	85	(210.0)	81.5	92.3	11.4	13.9	16.2	
barium	Ba	56	137.33	32.2	36.4	4.5	4.8	5.5	
bismuth	Bi	83	208.98	77.1	87.3	10.8	13.0	15.2	2.42
bromine	Br	35	79.90	11.9	13.3				
cadmium	Cd	48	112.41	23.2	26.1	3.1	3.3	3.7	
calcium	Ca	20	40.08	3.7	4.0				
cerium	Ce	58	140.12	34.7	39.3	4.8	5.3	6.0	
cesium	Cs	55	132.91	31.0	35.0	4.3	4.6	5.3	
chlorine	Cl	17	35.45	2.62	2.82				
chromium	Cr	24	52.00	5.4	5.9				
cobalt	Co	27	58.93	6.9	7.6				
copper	Cu	29	63.55	8.0	8.9				
dysprosium	Dy	66	162.50	46.0	52.2	6.5	7.3	8.4	1.29
erbium	Er	68	167.26	49.1	55.7	6.9	7.8	9.1	1.41
europium	Eu	63	151.96	41.5	47.0	5.8	6.5	7.5	
francium	Fr	87	(223.0)			12.0	14.8	17.3	
gadolinium	Gd	64	157.25	43.0	48.7	6.1	6.7	7.8	1.18
gallium	Ga	31	69.72	9.2	10.3				
germanium	Ge	32	72.64	9.9	11.0				
gold	Au	79	196.97	68.8	78.0	9.7	11.4	13.4	2.12
hafnium	Hf	72	178.49	55.8	63.2	7.9	9.0	10.5	1.64
holmium	Ho	67	164.93	47.5	53.9	6.7	7.5	8.7	1.34
indium	In	49	114.82	24.2	27.3	3.3	3.5	3.9	
iodine	I	53	126.90	28.6	32.3	3.9	4.2	4.8	
iridium	Ir	77	192.22	64.9	73.6	9.2	10.7	12.5	1.98
iron	Fe	26	55.85	6.4	7.1				
krypton	Kr	36	83.80	12.6	14.1				

Table Appendices-2. X-ray Emission Energies Arranged Alphabetically by Element, by Name

Element	Symbol	Atomic Number	Atomic Weight	Ka1	Kb1	La1	Lb1	Lg1	Ma
lanthanum	La	57	138.91	33.4	37.8	4.7	5.0	5.8	
lead	Pb	82	207.20	75.0	85.9	10.5	12.6	14.8	2.34
lutetium	Lu	71	174.97	54.1	61.3	7.7	8.7	10.1	1.58
magnesium	Mg	12	24.30	1.254	1.30				
manganese	Mn	25	54.94	5.9	6.5				
mercury	Hg	80	200.59	70.8	80.3	10.0	11.8	13.8	2.19
molybdenum	Mo	42	95.94	17.5	19.6				
neodymium	Nd	60	144.24	37.4	42.3	5.2	5.7	6.6	
neptunium	Np	93	237.00			13.9	17.7	20.8	
nickel	Ni	28	58.69	7.5	8.3				
niobium	Nb	41	92.91	16.6	18.6				
osmium	Os	76	190.23	63.0	71.4	8.9	10.4	12.1	1.91
palladium	Pd	46	106.42	21.2	23.8	2.8	3.0	3.3	
phosphorus	P	15	30.97	2.01	2.14				
platinum	Pt	78	195.09	66.8	75.7	9.4	11.1	12.9	2.05
plutonium	Pu	94	244.00			14.3	18.3	21.4	
polonium	Po	84	(209.0)	79.3	89.8	11.1	13.4	15.7	
potassium	K	19	39.10	3.3	3.6				
praseodymium	Pr	59	140.91	36.0	40.7	5.0	5.5	6.3	
promethium	Pm	61	145.00	38.6	44.0	5.4	6.0	6.9	
protactinium	Pa	91	(231.0)			13.3	16.7	19.6	
radium	Ra	88	(226.0)			12.3	15.2	17.8	
radon	Rn	86	(222.0)			11.7	14.3	16.8	
rhenium	Re	75	186.20	61.1	69.3	8.7	10.0	11.7	1.84
rhodium	Rh	45	102.91	20.2	22.7	2.7	2.8	3.1	
rubidium	Rb	37	85.47	13.4	15.0				
ruthenium	Ru	44	101.07	19.3	21.7	2.6	2.6	3.0	
samarium	Sm	62	150.36	40.1	45.4	5.6	6.2	7.2	
scandium	Sc	21	44.96	4.1	4.5				
selenium	Se	34	78.96	11.2	12.5				
silicon	Si	14	28.08	1.74	1.84				
silver	Ag	47	107.87	22.2	25.0	3.0	3.2	3.5	
strontium	Sr	38	87.62	14.2	15.8				

Table Appendices-2. X-ray Emission Energies Arranged Alphabetically by Element, by Name

Element	Symbol	Atomic Number	Atomic Weight	Ka1	Kb1	La1	Lb1	Lg1	Ma
sulphur	S	16	32.07	2.31	2.46				
tantalum	Ta	73	180.95	57.5	65.2	8.1	9.3	10.9	1.71
technetium	Tc	43	98.00	18.4	20.6	2.4	2.5	2.8	
tellurium	Te	52	127.60	27.5	31.0	3.8	4.0	4.6	
terbium	Tb	65	158.92	44.5	50.4	6.3	7.0	8.1	1.24
thallium	Tl	81	204.38	72.9	82.6	10.3	12.2	14.3	2.27
thorium	Th	90	232.04			13.0	16.2	19.0	
thulium	Tm	69	168.93	50.7	57.6	7.2	8.1	9.4	1.46
tin	Sn	50	118.71	25.3	28.5	3.4	3.7	4.1	
titanium	Ti	22	47.87	4.5	4.9				
tungsten	W	74	183.84	59.3	67.2	8.4	9.7	11.3	1.77
uranium	U	92	238.03			13.6	17.2	20.2	
vanadium	V	23	50.94	4.9	5.4				
xenon	Xe	54	131.29	29.8	33.6	4.1	4.4	5.0	
ytterbium	Yb	70	173.04	52.4	59.4	7.4	8.4	9.8	1.52
yttrium	Y	39	88.91	15.0	16.7				
zinc	Zn	30	65.41	8.6	9.6				
zirconium	Zr	40	91.22	15.8	17.7				

Appendix C: SpectraView

SpectraView enables you to qualitatively analyze the fluorescent x-rays of most of the elements in the periodic table from potassium (element 19) through plutonium (element 94) in a given sample. For a complete list of elements and their fluorescent x-rays see Appendix A. In SpectraView Mode, the spectrum is displayed in a linear scale, autoscaled logarithmically so that the highest peak on the screen reaches the top of the scale.

How to Use SpectraView

You can access the SpectraView screen after taking a measurement in any mode, or while viewing a previous measurement, by selecting Spectra from the NAV Menu. Once you are in SpectraView, you can use the up and down positions of the 4-way touch pad to scroll through the spectrum, or you can tap on the spectrum display with the stylus to place the cursor at the point you tapped. The vertical cursor line indicates the current position along the spectrum.

Viewing the Information in SpectraView Mode

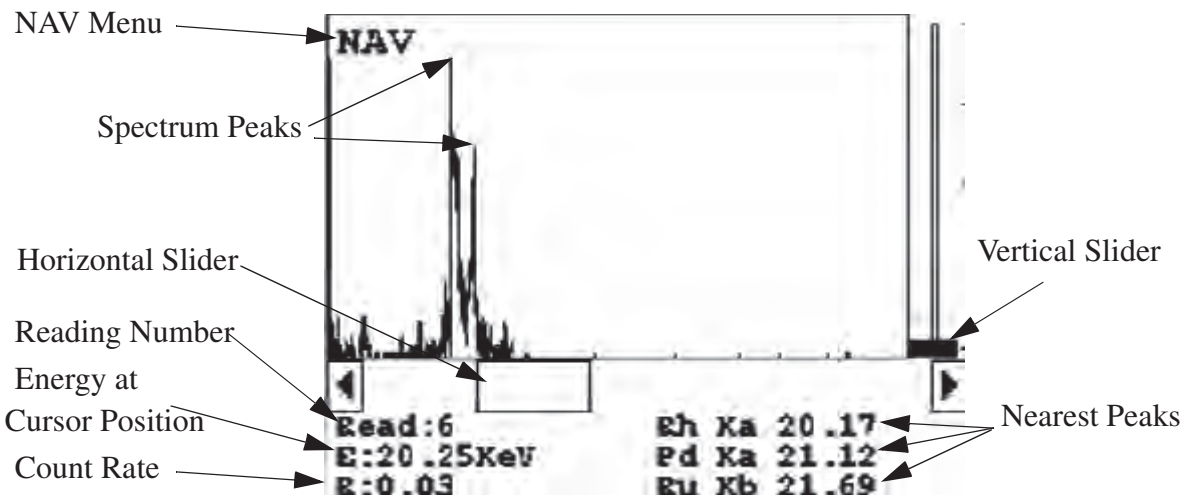


Figure Appendices-1. The SpectraView Screen

By default, the following information is shown along with the spectrum:

The Reading number (Bottom Left) in the form "Read:x", where x is the Reading number.

The position of the cursor on the energy scale (Bottom Left, under the Reading number), in the form "E: x.xx KeV", where KeV is thousands of electron volts.

The **count rate** (Bottom Left, under the energy position), in the form “R:x.xx”.

Ka, **Kb**, **La,** Lb, and/or Lg peaks of the three elements closest to where your cursor is positioned on the energy scale (Bottom Right). This information is written with the element symbol first, followed by either Ka (K shell alpha peak), Kb (K shell beta peak), La (L shell alpha peak), La (L shell beta peak), or Lg (L shell gamma peak). An example would be "Al Ka 1.5." To determine if a given element is present, look at the count rate at that cursor position.

SpectraView cannot be used to determine exact element percentages in a sample.

Multiple Spectra

SpectraView can display the reading spectra from multiple filter settings if your analysis uses more than one filter. Use the NAV Menu to select which spectrum to view.

The “Spectra1” choice will display the display the spectrum produced by excitation with the first filter setting.

The “Spectra2” choice will display the display the spectrum produced by excitation with the second filter setting.

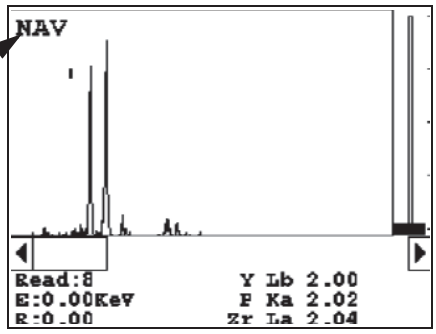
The “Spectra3” choice will display the display the spectrum produced by excitation with the third filter setting.

SpectraView Navigation

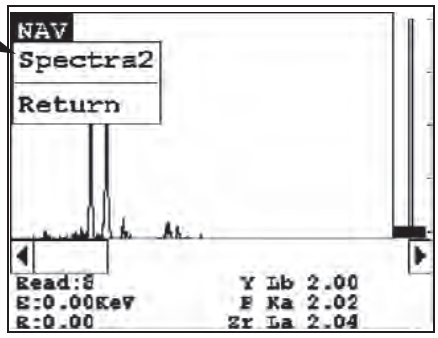
Use the left button on the 4-way touch pad to expand the spectrum, centered on the position of the cursor.

Use the right button on the 4-way touch pad to contract the spectrum, centered on the position of the cursor.

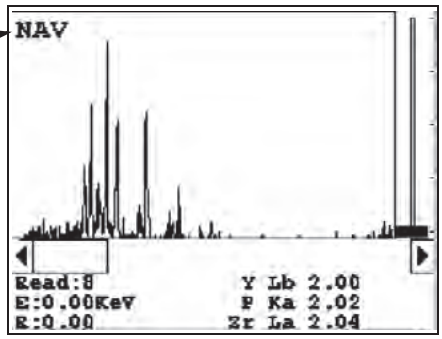
Select NAV to access the NAV Menu while viewing the first source spectrum.



Select Spectra2 to view the second source spectrum



Select NAV to access the NAV Menu.



Select Spectra1 to return to the first source spectrum.

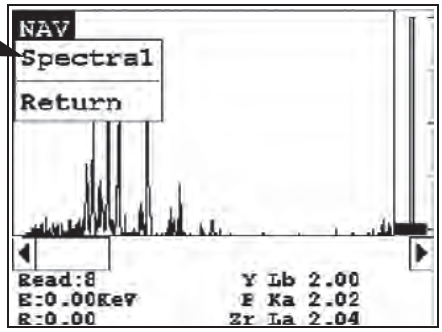


Figure Appendices-2. Viewing Multiple Spectra

Appendix D: Summary of Warnings

WARNING! Do not attempt to use this instrument without first reading and understanding the entire User's Guide! ♦

WARNING! Always treat radiation with respect. Do not hold your instrument near the Kapton window during testing. Never point your instrument at yourself or anyone else when the shutter is open. ♦

WARNING! The preconditions for operation must be continued for the duration of the reading. If the preconditions are violated, the x-ray tube will turn off, the calibration shutter will close, and the measurement will end. The four LED lights will stop blinking when the measurement is ended. The flashing of the LED lights is not synchronized to minimize power consumption. ♦

WARNING! When the four LED lights are blinking, the x-ray tube is on. This should only occur during a measurement, while the preconditions for operation are met. If the LED lights blink at any other time, disconnect the battery pack and call Thermo Scientific's Service Department in the United States, toll free, at (800) 875-1578, or outside the United States, at +1-978-670-7460, or your local Authorized NITON Service Center. ♦

WARNING! Tampering with the 5,500 ppm (lead high) lead-in-soil standard may cause exposure to lead dust. Keep all standards out of the reach of children. ♦

WARNING! Do not attempt to take measurements while downloading readings! This will generate an error requiring a system reset, and may corrupt your stored readings, requiring all stored readings to be erased. ♦

WARNING! Grinding and sifting dried samples produces dust. Even clean soil contains silica, which may be hazardous when airborne. Prepare all samples in a ventilated area; wear a mask, gloves, and an apron; and spread a drop cloth. ♦

WARNING! All Service, except exterior cleaning and Kapton window replacement, must be performed by Thermo Scientific or an Authorized NITON Analyzers Service Center. Do not attempt to make repairs yourself. Opening the case of your NITON will void the analyzer Warranty in its entirety. ♦

WARNING! In the highly unlikely event that the x-ray tube remains on when the trigger is not depressed, disconnect the battery pack immediately to turn off the x-ray tube, and call Thermo Fisher Scientific's Service Department in the United States, toll free, at (800) 875-1578, or outside the United States at +1-978-670-7460, or your local Authorized NITON Analyzers Service Center. ♦

Appendix E: Summary of Cautions

CAUTION NITON Analyzers are not intrinsically safe instruments in regard to sparking. All pertinent Hot Work procedures should be followed in areas of concern. ♦

CAUTION All test equipment must be kept clean to prevent contamination of samples. ♦

CAUTION Never tamper with Test Standards. They should not be used unless they are completely intact. ♦

CAUTION Never turn off the instrument while data is being erased! ♦

CAUTION Do not leave the battery pack connected to the charger for excessive periods of time. Overnight recharging is recommended. ♦

CAUTION Store the instrument and the spare battery packs in a cool place, away from direct sunlight. ♦

CAUTION Always obtain a Return Authorization (RA) number from Thermo Scientific's Service Department in the United States, toll free, at (800) 875-1578, or outside the United States, at +1-978-670-7460 before returning your instrument to the NITON Service Department or local Authorized NITON Analyzers Service Center. ♦

CAUTION Do not store battery packs or charger in direct sunlight. ♦

CAUTION Do not let the battery pack recharge for excessive periods of time. ♦

CAUTION Always transport the unit in its padded carrying case, and store the NITON Analyzer in its case whenever it is not being used. ♦

CAUTION In most cases, no notification is required if transporting within state boundaries. This may not be the case when entering federal properties. ♦

CAUTION Always follow all pertinent local and national regulations and guidelines, wherever your analyzer is transported or used. ♦

CAUTION If you return your NITON instrument without the carrying case, you will void your analyzer's warranty in its entirety. You will be billed for a replacement case plus any repairs resulting from improper shipping. ♦

CAUTION Always remove the battery pack when transporting or storing your instrument. ♦

CAUTION Avoid any vibration, loud noise, strong electronice fields, or other possible interference when your analyzer is calibrating its detector. ♦

CAUTION Within the United States, always keep a copy of the US DOT compliance statement in your NITON analyzer case at all times. A copy is included with your analyzer. ♦

CAUTION Whenever you turn on your NITON Analyzer after it has been off for more than 30 minutes, you should measure your check sample to assure proper operation. If the instrument is not reading properly, you should re-calibrate your NITON Analyzer's sample analysis electronics before you start to take readings. When the instrument is turned on after being off for more than 30 minutes, your NITON analyzer will require a 10 minute warm-up period before the instrument can be calibrated, unless this 10 minute warm-up period is manually overridden.

Appendix F Glossary

Calibration factors numbers, calculated from sample readings, that are used to adjust for consistently high or consistently low readings from the XRF Analyzer

Matrix a substance in which things are embedded or suspended.

In mining, the earthy or stony substance in which metallic ores or crystalized minerals are found (source: Webster's Revised Unabridged Dictionary, via dictionary.com)

Pearson correlation coefficient a dimensionless index that ranges from -1.0 to 1.0 inclusive and reflects the extent of a linear relationship between two data sets.

R^2 the square of the Pearson correlation coefficient.

RMS error root-mean-squared error, the square root of the arithmetic mean of squared deviations from the mean. This number ells you how good your approximation is. The lower the number, the better the approximation.

Appendix F: Warranty

Seller warrants that the Products will operate or perform substantially in conformance with Seller's published specifications and be free from defects in material and workmanship, when subjected to normal, proper and intended usage by properly trained personnel, for the period of time set forth in the product documentation, published specifications or package inserts. If a period of time is not specified in Seller's product documentation, published specifications or package inserts, the warranty period shall be **Two (2) years** from the date of shipment to Buyer in the country of purchase. Seller agrees during the Warranty Period, to repair or replace, at Seller's option, defective Products so as to cause the same to operate in substantial conformance with said published specifications; provided that Buyer shall (a) promptly notify Seller in writing upon the discovery of any defect, which notice shall include the product model and serial number (if applicable) and details of the warranty claim; and (b) after Seller's review, Seller will provide Buyer with service data and/or a Return Material Authorization ("RMA"), which may include biohazard or other Radiation safety decontamination procedures and other product-specific handling instructions, then, if applicable, Buyer may return and receive the defective Products to Seller with all costs of freight and insurance prepaid by Buyer. Replacement parts may be new or refurbished, at the election of Seller, the warranty of these parts expire with the instrument warranty. All replaced parts shall become the property of Seller. Shipment to Buyer of repaired or replacement Products shall be made in accordance with the Delivery provisions of the Seller's Terms and Conditions of Sale. Accessories and Consumables are expressly excluded from this warranty (see list A for details).

Notwithstanding the foregoing, Products supplied by Seller that are obtained by Seller from an original manufacturer or third party supplier are not warranted by Seller, but Seller agrees to assign to Buyer any warranty rights in such Product that Seller may have from the original manufacturer or third party supplier, to the extent such assignment is allowed by such original manufacturer or third party supplier. In no event shall Seller have any obligation to make repairs, replacements or corrections required, in whole or in part, as the result of:

i. normal wear and tear,

ii. accident, disaster or event of force majeure,

iii. misuse, fault or negligence of or by Buyer,

iv. use of the Products in a manner for which they were not designed,

v. causes external to the Products such as, but not limited to, power failure or electrical power surges,

vi. improper storage and handling of the Products,

vii. use of the Products in combination with equipment or software not supplied by Seller,

viii. moderately heavy or excessive impact against any object, including but not limited to floors, walls, furniture, sample or other objects. A shock sensor is fitted inside of the instrumentation; warranty is void if this shock sensor is activated,

ix. excessive water, moisture or condensing humidity that breaches the instrument seals,

x. excessive or extreme ambient or direct temperature or

xi. Heavy vibrations directly to the instrument for extended periods of time.

If Seller determines that Products for which Buyer has requested warranty services are not covered by the warranty hereunder, Buyer shall pay or reimburse Seller for all costs of investigating and responding to such request at Seller's then prevailing time and materials rates. If Seller provides repair services or replacement parts that are not covered by this warranty, Buyer shall pay Seller therefore at Seller's then prevailing time and materials rates.

ANY INSTALLATION, MAINTENANCE, REPAIR, SERVICE, RELOCATION OR ALTERATION TO OR OF, OR OTHER TAMPERING WITH, THE PRODUCTS PERFORMED BY ANY PERSON OR ENTITY OTHER THAN SELLER WITHOUT SELLER'S PRIOR WRITTEN APPROVAL, OR ANY USE OF REPLACEMENT PARTS NOT SUPPLIED BY SELLER, SHALL IMMEDIATELY VOID AND CANCEL ALL WARRANTIES WITH RESPECT TO THE AFFECTED PRODUCTS.

THE OBLIGATIONS CREATED BY THIS WARRANTY STATEMENT TO REPAIR OR REPLACE A DEFECTIVE PRODUCT SHALL BE THE SOLE REMEDY OF BUYER IN THE EVENT OF A DEFECTIVE PRODUCT. EXCEPT AS EXPRESSLY PROVIDED IN THIS WARRANTY STATEMENT, SELLER DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR

IMPLIED, ORAL OR WRITTEN, WITH RESPECT TO THE PRODUCTS AND INCLUDING WITHOUT LIMITATION ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS

FOR ANY PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE PRODUCTS ARE ERROR-FREE OR WILL ACCOMPLISH ANY PARTICULAR RESULT.

Accessories, Spares and Consumables - exclusions

(List A)

Specific warranties of some common accessories:

- Battery Charger and batteries - 12 months
- Instrument accessories - 12 months
- Consumable - no warranty
- Soil Grinder - no warranty
- Single-stage or two stage helium tank regulator - 12 months
- Test stands, extend-a-poles and docking stations – 12 months
- Parts or spares sold, installed or supplied outside of the product warranty period and not listed above – 12 months

Thermo Fisher Scientific shall not be liable for delays, deprivation of use, or any other damages, direct or indirect, which may result to the purchaser because of defects in the product or because of the purchaser's inability to operate it or use it to his satisfaction. Thermo Fisher will not be liable to anyone for special or consequential damages of any kind. Thermo Fisher neither assumes nor authorizes any person to assume for it, any other obligation or liability with respect to Thermo Fisher products..

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GENERAL FIELD SAMPLING GUIDELINES

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The policies and procedures established in this document are intended solely for the guidance of OLEM employees of the U.S. Environmental Protection Agency (EPA). They are not intended and cannot be relied upon to create any rights, substantive or procedural, enforceable by any party in litigation with the United States. EPA reserves the right to act at variance with these policies and procedures, and to change them at any time without public notice. EPA strongly encourages all readers to verify the validity of the information contained in this document by consulting the most recent Code of Federal Regulations (CFR) and updated guidance documents.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to describe the general field sampling techniques and guidelines that will assist in planning, choosing sampling strategies and sampling locations, and frequency of Quality Control (QC) samples for proper assessment of site characteristics. The ultimate goal is to ensure data quality during field collection activities.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure the methods used are adequate to satisfy the data quality objectives (DQOs).

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

2.0 APPLICABILITY

This SOP applies to the collection of aqueous and non-aqueous samples for subsequent laboratory analysis to determine the presence, type, and extent of contamination at a site.

3.0 DESCRIPTION

Representative sampling ensures that a sample or a group of samples accurately reflect the target population from which the sample(s) are intended to draw conclusions about. Depending on the contaminant of concern and matrix, several environmental and logistical variables may contribute to uncertainty in sampling design, which may affect the representativeness of the samples and subsequent measurements. Environmental variability can occur due to non-uniform distribution of the pollutant due to topographic, meteorological and hydrogeological factors, changes in species, and dispersion of contaminants and flow rates. Logistical variables including restricted or limited access to areas for sampling due to health and safety concerns, physical obstructions, or inability to obtain access agreements may affect the spatial representativeness of the sampling design and/or preclude samples from being collected in areas of interest.

Determining the sampling approach depends on what is known about the site from prior sampling (if any) and the site history, variation of the contaminant concentrations throughout a site, potential migration pathways, and human and environmental receptors. The objectives of an investigation determine the appropriate sampling design.

The frequency of sampling and the specific sample locations that are required must be defined in the site-specific QAPP.

3.1 Planning Stage

The objectives of an investigation are established and documented in the site-specific QAPP. The technical approach including the media/matrix to be sampled, sampling equipment to be used, sampling design and rationale, and SOPs or descriptions of the procedure to be implemented are included in the QAPP. Refer to the matrix-specific SOPs for sampling techniques which include the equipment required for sampling.

During the planning stage, the DQOs will be determined. In turn, the project's DQOs will determine the need for screening data or definitive data. Screening data supports an intermediate or preliminary decision but eventually is supported by definitive data before the project is complete (i.e., placement

of monitor wells, estimation of extent of contamination). Definitive data is suitable for final decision making, has defined precision and accuracy requirements and is legally defensible (i.e., risk assessments, site closures).

3.2. Sampling Design

A sample design specifies the number of samples to be collected for each matrix of concern, the measurements which will be conducted on those samples, where the samples will be collected (downstream of the contaminant release, along a grid, etc.) and how the samples will be collected (discrete or composite samples, seasonally, etc.). The DQOs for a Site assist in selecting the appropriate sampling design for the population of concern (e.g., lead concentrations in residential soil, contaminant uptake in plants, polychlorinated biphenyl [PCB] levels in a specific reach of a river). Other factors may include logistical, measurement and budgetary constraints, such as accessibility to the sampling area, analytical instrument sensitivity or manpower availability. EPA QA/G-5S, *Guidance on Choosing a Sampling Design for Environmental Data Collection*, provides detailed guidance on the selection of a representative sampling design.

There are two main categories of environmental sampling designs:

1. Judgmental, also known as biased or targeted sampling; and
2. Probability-based sampling, which includes, but is not limited to, simple random, systematic, ranked set, stratified and cluster sampling.

Judgmental sampling is based on expert/technical knowledge of the site, known contaminant pathways and the chemical/physical processes associated with the contaminants of concern (COCs). It can be less expensive than probability-based sampling as it is typically quicker to implement. It is often used to target sampling in areas where there have been known chemical spills or visible staining of the matrix of concern. Because it is based on professional judgment, the reliability and precision of the results cannot be quantified using statistical assessments. The interpretation of the sampling results is dependent on personal interpretation.

Although probabilistic sampling is often more costly in time and implementation, this type of design allows for the assessment of the uncertainty associated with the sampling results and provides reproducible results, if performed accurately. Probability-based sampling includes a random/unbiased component for locating samples. Inferential statistics can be used to extend the measured results of the sampling efforts to the larger population of concern and statistical limits can be computed assessing the variability of the measurements. Probabilistic sampling is used when DQOs include the need to obtain the mean or median concentration across an area of concern, establish variability of the COC(s), perform trend analyses, determine the probability of exceeding an actionable level, locate hot spot(s) within a designated area, compare reference and on-site COCs, and establish background levels of COCs. There are many more applications of probabilistic-sampling. Simple random, systematic and stratified random sampling are the most commonly applied sampling designs in assessing environmental sites.

3.2.1 Judgmental Sampling

Judgmental sampling is the subjective selection of sampling locations based on the professional judgment of the field team. This method is useful to locate and to identify potential sources of contamination when there is reliable historical and physical knowledge about a relatively small feature or condition. It may not be representative of the full site and is used to document worst case scenarios. For example, groundwater sampling points

are typically chosen based on professional judgment, whether permanently installed wells or temporary well points. Judgmental sampling may also be implemented at a site when there are schedule and budget limitations, or to determine if there are contaminant "hotspots" that require further investigation using an extensive probability-based sampling design. For example, judgmental sampling may be used to identify multiple areas of contaminated soil, and a subsequent probability-based sampling design can be used to fully delineate the extent of the contaminated soil in each area within a specified level of uncertainty.

3.2.2 Simple Random Sampling

In simple random sampling, sample locations are selected randomly. For example, random pairs of coordinates could be selected from an area where soil sampling is planned. The simple random sampling approach is applied when there are many sample locations and the concentrations are assumed to be homogeneous across a site with respect to the parameter(s) that are going to be analyzed or monitored for. Simple random sampling can also be used to select an initial sample location in a systematic and stratified sampling design.

3.2.3 Systematic Sampling

Systematic grid sampling involves the collection of samples at fixed intervals when the contamination is assumed to be randomly distributed. A random point is chosen as the origin for the placement of the grid. A grid is constructed over a site and samples are collected from the nodes (where the grid lines intersect). Depending on the number of samples that are required to be collected, the distance between the sampling locations can be adjusted. The representativeness of the sampling may be improved by shortening the distance between sample locations.

Systematic random sampling is used for estimating contaminant concentrations within grid cells. Instead of sampling at each node, a random location is chosen within each grid cell. The systematic grid and random sampling approaches are useful for delineating the extent of contamination, documenting the attainment of clean-up goals, and evaluating and determining treatment and disposal options.

Transect sampling involves one or more transect lines established across the site. Samples are collected at systematic intervals along the transect lines. The number of samples to be collected and the length of the transect line determines the spacing between the sampling points. This type of sampling design is useful for delineating the extent of contamination at a particular site, for documenting the attainment of clean-up goals, and for evaluating and determining treatment and disposal options.

3.2.4 Stratified Sampling

Stratified sampling involves separating a site with heterogenous conditions into multiple homogenous strata. It is useful when a heterogeneous population or area can be broken down into regions with less variability within the boundaries of a stratum then between the strata. Professional judgement, historical information, site observations, exposure to ecological and human receptors, soil type, fate and transport mechanisms, and other site-specific factors can be used to separate a sampling area into multiple strata. Additionally, strata can be defined based on the decisions that will be made. Sampling locations can be

selected from each stratum using professional judgment, random sampling, or systematic sampling. Using a systematic sampling design within each stratum, with varying sample densities between different strata, ensures that areas of the site thought to have higher variability in contaminant concentrations and/or thought to be within the boundaries of uncertainty surrounding decision levels are sampled at a higher spatial resolution. This method still maintains a representative and unbiased sample design within each stratum.

3.3 Sampling Techniques

Sampling is the selection of a representative portion of a larger population or body (i.e. target population). The primary objective of all sampling activities is to characterize a site accurately in a way that the impact on human health and the environment can be evaluated appropriately.

3.3.1 Sample Collection Techniques

Sample collection techniques may be either grab or composite. A grab sample is a discrete aliquot representative of a specific location at a given time and collected all at once from one location. The representativeness of such samples is defined by the nature of the materials that are sampled. Samples collected for volatile organic compounds (VOCs) are always grab samples and are never homogenized. Composite samples are non-discrete samples composed of more than one specific aliquot collected at selected sampling locations. Composite samples must be homogenized by mixing prior to putting the sample into containers. Composite samples can, in certain instances, be used as an alternative to analyzing a number of individual grab samples and calculating an average value. Incremental sampling conducted over a grid is a special case of composite sampling and is detailed in U.S. EPA Environmental Response Team (ERT) SOP, *Incremental Soil Sampling.* Choice of collecting discrete or composite samples is based on project's DQOs.

3.3.2 Homogenization

Mixing of soil and sediment samples is critical to obtain a representative sample. An adequate volume/weight of sample is collected and placed in a stainless steel or Teflon® container, and is thoroughly mixed using a spatula or spoon made of an inert material. Once the sample is thoroughly mixed the sample is placed into sample containers specific for an analysis. Avoid the use of equipment made of plastic or polyvinyl chloride (PVC) when sampling for organic compounds when the reporting limit (RL) is in the parts per billion (ppb) or parts per trillion (ppt) ranges. Refer to ERT SOP, *Soil Sampling*, for more details on homogenization.

3.3.3 Filtration

In-line filters are used specifically for collecting groundwater samples for dissolved metals analysis and for filtering large volumes of turbid groundwater. Groundwater samples collected for VOCs are typically not filtered due to potential VOC losses. Filtering groundwater is performed to remove silt particulates from samples to prevent interference with the laboratory analysis. The filters used in groundwater sampling are either cartridge type filters inserted into a reusable housing, or are self-contained and disposable. Filter chambers are usually made of polypropylene housing an inert filtering material that removes particles larger than 0.45 micrometers (µm). Refer to ERT SOP, *Groundwater Well Sampling* and ERT SOP, *Surface Water Sampling*, for more details on filtration techniques.

3.4 Quality Assurance /Quality Control Samples

QA/QC samples provide an evaluation of both the laboratory's and the field sampling team's performance. Including QA/QC samples in a sampling design allows for identifying and measuring sources of error potentially introduced from the time of sample collection through analysis. The most common QA/QC samples collected in the field are collocated field duplicates, field replicates, equipment blanks and field blanks. Trip blanks are typically added for each matrix in each cooler used to ship VOC samples and are prepared prior to going into the field preferably by the laboratory that will be performing the analyses. Extra volume/mass is collected for a matrix spike/matrix spike duplicate (MS/MSD) at a frequency of 5 percent (%; one in 20 samples). Spiking is performed in the laboratory. For additional information or other QA/QC samples pertinent to sample analysis, refer to ERT SOP, *Quality Assurance/Quality Control Samples*.

Collocated field duplicates may be collected based on site objectives and used to measure variability and precision associated with the sampling process including sample heterogeneity, sampling methodology, and analytical procedures. Field replicates are field samples obtained from one location, homogenized, and divided into separate containers. This is useful for determining whether the sample has been homogenized properly. Equipment blanks (also known as rinsate blanks) are typically collected at a rate of one per day. The equipment blank is used to evaluate the relative cleanliness and the decontamination methods of non-dedicated equipment. Refer to ERT SOP, *Sampling Equipment Decontamination,* for more details regarding decontaminating non-dedicated equipment.

3.5 Sample Containers, Preservation, Storage and Holding Times

The amount of sample to be collected, the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix sampled and the analyses to be conducted. This information is provided in ERT SOP, *Sample Storage, Preservation, and Handling*. Field personnel need to be cognizant of any short holding times that warrant immediate shipment/transfer to the laboratory.

3.6 Documentation

Field conditions and site activities must be documented. Scribe will be used to document sample information and generate chain of custody records. Other field measurements not typically entered into Scribe will be documented in a site-specific logbook or in a personal logbook. All sample documentation will be maintained in accordance with ERT SOP, *Sample Documentation* and ERT SOP, *Chain of Custody Procedures.*

4.0 RESPONSIBILITIES

4.1 ERT Work Assignment Manager

The ERT WAM is responsible for providing technical expertise and technical direction to the contractor, preparing task orders/work assignments, reviewing deliverables, interacting with the Regional customers and monitoring the financial and administrative management of the project.

4.2 ERT Quality Control Coordinator

The ERT Quality Coordinator provides quality assurance oversight for all projects and implements/maintains the ERT Quality Assurance Program.

4.3 ERT Contractor Task Leaders

Task Leaders (TLs) are responsible for the overall management of the project. Task Leader responsibilities include ensuring that field personnel are well informed of the sampling requirements for a specific project and that SOP and QA/QC procedures stated in the site-specific QAPP are adhered to, issuing a Field Change Form that documents any changes to sampling activities after the QAPP has been approved and maintaining sample documentation.

4.4 ERT Contractor Field Personnel

Field personnel are responsible for reading the QAPP prior to site activities and performing sample collection activities as written. They are responsible for notifying the TL of deviations from sample collection protocols which occurred during the execution of sampling activities. Field staff will collect samples and prepare documentation in accordance with ERT SOP, *Sample Documentation*. In addition, field personnel are responsible for reading and conforming to the approved site-specific Health and Safety Plan (HASP).

4.5 ERT Contractor QA/QC Officer

The contractor's QA/QC Officer is responsible for reviewing this SOP and ensuring that the information in this SOP is updated on a timely basis. Compliance to this SOP may be monitored by either conducting a field audit or reviewing deliverables prepared by the contractor's TL.

4.6 ERT Contractor Health and Safety Officer

Based on OSHA requirements, a site-specific health and safety plan (HASP) must be prepared for response operations under the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, 29 CFR 1910.120. Field personnel working for EPA's ERT should consult the Emergency Responder Health and Safety Manual currently located at https://response.epa.gov/_HealthSafetyManual/manual-index.htm for the development of the HASP, required personal protective equipment (PPE) and respiratory protection.

The contractor's Health and Safety Officer (HSO) is responsible for ensuring that a HASP has been written and approved prior to field activities. Additionally, the contractor's HSO is responsible for ensuring that the contractor's site personnel H&S training and that their medical monitoring is current.

5.0 REFERENCES

U.S. EPA. 2006. Guidance on Systematic Planning using the Data Quality Objectives Process (QA/G-4), EPA/240/B-06/001, February 2006.

U.S. EPA. 2002. Guidance on Choosing a Sampling Design for Environmental Data Collection (QA/G-5S), EPA/240/R-02/005, December 2002.

6.0 APPENDICES

This section is not applicable to this SOP.

SAMPLE DOCUMENTATION

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SAMPLE DOCUMENTATION

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Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

1.0 OBJECTIVE

The objective of this Standard Operating Procedure (SOP) is to define the procedures required for preparing and maintaining documentation that provides the details of field sampling activities. The sample documentation discussed in this procedure includes Site Logbooks, Field Data Worksheets, Analytical Logbooks, Labels, Chain of Custody records and custody seals.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure that the methods used are adequate to satisfy the data quality objectives listed in the QAPP for a particular site.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

2.0 APPLICABILITY

This SOP is applicable to all field activities which involve the collection of samples and/or the generation of environmental measurements and data associated with sample collection. It is applicable to both traditional (handwritten) and electronic records as those acquired through equipment that denotes sample locations (e.g. global positioning system [GPS]) or equipment that measures conditions at the time of sample collection (e.g. data logger).

Scientific recordkeeping accurately records and preserves data, provides a usable and comprehensive reference for clients and coworkers, enables continuation or replication of work and preserves all data describing the work for scientific and legal purposes.

3.0 DESCRIPTION

3.1 General

Accurate sample documentation is essential for proper site evaluation. A clear traceable paper trail must follow each sample from its point of origin to the final client deliverable. It is important that specific procedures be adopted so that the desired degree of accuracy and completeness is achieved.

All sample documents must be completed accurately and completely. Each line, table or checkbox present on any field datasheet must be completed. If there is some reason why certain areas of portions of a field datasheet are not used, field personnel are required to cross out those sections and initial and date. Any hardcopy corrections or revisions must be made by crossing out the incorrect entry and initialing and dating the error.

3.2 Sample/Measurement Documentation

Field sample documentation must be sufficient so that an accurate account of field operations can be reconstructed in the writer's absence. Site activity may be documented in a site logbook or on field datasheets. There is the potential, especially on Superfund sites, for these records to be used as legal evidence. All site logbooks, field datasheets, data acquired electronically by U.S. EPA Environmental Response Team [ERT] and ERT contractor personnel and Scribe databases are official records. Upon completion of the sampling event, all sample information that can be imported must also be entered into the site-specific Scribe database.

3.2.1 Site Logbook

The site logbook is essentially a descriptive notebook detailing site activities and observations. All entries should be dated and signed by the individual(s) making the entries. Site logbooks should contain at a minimum, the following information:

- Site name and location on inside and outside cover
- Name of person to whom the logbook was assigned
- Date and location of field work
- Times (military times preferred, or reference AM or PM)
- Names and addresses of field contacts
- Site sketches and/or photographic references
- Weather conditions
- Sample descriptions, locations, times taken, identification numbers
- Chain of Custody information, shipping paper identification number, recipient address and phone number, etc.
- Field observations and discussion
- Field measurements (i.e. pH, temperature, surface water flow rates, etc.)
- Instructions issued by the Work Assignment Manager
- Field activities by all contractor personnel on site

Entries may be made in site logbooks by any ERT or ERT contractor personnel on site and should detail the activities of all personnel involved in the field operations. Each entry should be signed by the person making the entry and should relate to previous entries or have sufficient background detail. The sequence of site activities should be clear to a reader who was not at the site. Various types of logbooks available are shown in Figure 1, Appendix A.

When a site logbook is completed and no longer needed for site documentation, or after a project is finished, the site logbook must be returned to the ERT contractor's Central Files for archiving. If the site logbook is transmitted to ERT, documentation of the transmittal and a copy of the notes from the logbook must be prepared and maintained in the Central Files.

3.2.2 Field Data Worksheets

Field data worksheets, specific to a sampling or measurement/monitoring task, may be used to record all information pertinent to sampling efforts. Field data worksheets are pre-printed to document specific data related to sample collection or field measurement/monitoring data. Required fields typically include Site Name, Project Number (Work Assignment Number [#]), Sampler(s), ERT Work Assignment Manager (WAM), the ERT contractor's Task Leader, Date, Sample #, sample location information, collection information, measurement/monitoring data including type of device used for collection/measurement activities, any calibrations performed, flow rate, etc. and analytical requirements. Examples of Field Data Worksheets include: Air Sampling Worksheets, SUMMA Sampling Worksheets, Boring Logs, Slug Test Data Sheets, etc. All sample data documented on Field Data Worksheets will be transferred to the site-specific Scribe database, as fields allow. Field Datasheets/Worksheets will be archived in the ERT contractor's Central Files and are typically appended to the final client deliverable.

Examples of field datasheets/worksheets can be found in Figures 2 through 5, Appendix A.

3.3 Analytical Documentation

Analytical data, including sample analysis or field analytical measurements, must be documented so that the sequence of laboratory activities will be clear to a reader who was not involved in the analysis. These measurements are recorded in an analytical logbook. Analytical logbooks will be issued for, but are not limited to: documenting analysis by a particular lab (stationary, mobile, Trace Atmospheric Gas Analyzer [TAGA]) or instrument; recording sample preparation and extraction procedures; recording temperature readings, and; documenting bench-scale and treatability studies.

Entries must detail the analytical activities of laboratory personnel. Each entry must be signed and dated by the analyst making the entry and must relate to previous entries or have sufficient background detail. Upon completion of an analytical logbook, the logbook must be returned to the ERT contractor's Quality Assurance/Quality Control (QA/QC) Officer for archival or remain in the laboratory for reference.

3.4 Sample Labels

Sample labels are attached to environmental samples and are used to document sample information including the sample location, sample number, sample date/time, sample volume (air samples) and analyses. Sample labels may be generated by Scribe or pre-numbered sample labels may be used. If pre-numbered labels are used, the Scribe database must be updated to include all sample information. If a Contract Laboratory Program (CLP) laboratory will be analyzing the sample(s), the sample label(s) must include unique preassigned CLP number(s). ERT SOP, *Scribe Use in Field Operations* should be consulted for more detail on the use of Scribe.

3.4.1 Scribe Generated Sample Labels

Sample labels are generated by the Scribe software for inclusion on the sample containers. The label contents can be tailored to suit the needs of the project and the laboratory where the samples will be analyzed. Scribe generated labels (Figures 6 and 7, Appendix A) are used for all types of samples.

If duplicates or blanks are collected at a sampling location, the sample sets must be treated as being unique from the original sample and labeled with different and unique sample identification numbers. The Scribe database should be used to document sample duplicates and link to the original sample. When collecting samples for parameters which require extra volume for matrix spike/matrix spike duplicate (MS/MSD) analysis, the original sample container(s) and the MS/MSD containers are labeled with the same sample identification number. Required volumes for MS/MSD analysis for typical parameters are specified in each site specific QAPP.

3.4.2 Pre-Numbered Sample Labels

Logistically, there may be circumstances where Scribe cannot be used to effectively generate labels to fulfill the demands of a project. This may be due to lack of computing or printing resources, the need to pre-label sample containers (i.e. tracking high and low volume activity based sampling [ABS] cassettes), or time-sensitive constraints. At the

discretion of the Task Leader, pre-numbered sample labels may be used to meet sample documentation needs.

The pre-numbered sample label for SUMMA canister sampling (Figure 3, Appendix A) consists of three parts. The largest part includes the project name, the contract number, the sample identification number, and space for the following information: the site name, sample volume, date, time, requested analysis, and remarks. Other parts include two additional sample labels with only the sample identification number.

When a sample is collected, the largest part of the sample label is completed and affixed to the sample container in the manner described by the appropriate ERT air sampling SOP. The two remaining sample number labels can be used to label additional sample containers comprising that sample or to identify sample number on the Field Data Sheet or Logbook.

Although pre-numbered labels may be used to meet project demands, all data must be entered into the Scribe database.

3.5 Chain of Custody

A Chain of Custody (COC) record (Figure 9, Appendix A) must be maintained from the time a sample is collected to its final deposition so that the entire path and life of a sample can be tracked. Chain of Custody (COC) is a legal term that refers to the ability to guarantee the identity and the integrity of the sample (or data) from collection through reporting of the test results. A sample is under custody if: (1) it is in a person's actual possession; (2) it is in your view, after being in your possession; or (3) it was in your possession and is now custody sealed; or (4) it is stored in a controlled area.

In the case of litigation, the COC is evaluated to ensure that sample integrity was maintained from the time of sample collection to completion of analysis. The COC should be generated by the TL or their designee using Scribe software. Scribe is required for generating COC records. Refer to ERT SOP, *Chain of Custody Procedures.* In instances where a Scribe COC can't be generated in the field due situations such as emergency response, working remotely without power or computer problems, a preprinted blank COC record may be used as a last resort (Figure 10, Appendix A).

3.6 Custody Seals

Custody Seals (Figure 11, Appendix A) demonstrate that a sample container has not been opened or tampered with during transport or storage. Two seals should be affixed in such a manner that the shipping container cannot be opened without breaking the seal. The person in direct possession of the samples shall sign and date the seal at the time of its application. In some circumstances, usually for CLP procedures, it may also require that each individual sample container be sealed with a custody seal.

4.0 RESPONSIBILITIES

4.1 ERT Work Assignment Manager

The ERT Work Assignment Manager (WAM) is responsible for providing technical expertise and technical direction to the contractor, preparing task orders/work assignments, reviewing deliverables, interacting with the Regional customers and monitoring the financial and administrative management of the project.

4.2 ERT Quality Coordinator

The ERT Quality Coordinator provides QA oversight for all projects and implements/maintains the ERT Quality Assurance Program.

4.3 ERT Contractor Task Leaders and Field Staff

The ERT contractor TLs and field staff are responsible for preparing and maintaining sample documentation in accordance with this SOP.

4.4 ERT Contractor Management

The ERT contractor's management are responsible for ensuring implementation of the procedures outlined in this SOP.

4.5 ERT Contractor QA/QC Officer

The ERT contractor's QA/QC Officer is responsible for ensuring compliance with this SOP by auditing reports prepared by contractor personnel and notifying contractor management personnel on an annual basis to review and revise this SOP.

5.0 REFERENCES

U.S. EPA, *for Documenting Environmental Information in Logbooks*, accessed at https://www.epa.gov/quality/procedure-documenting-environmental-information-logbooks (July 2020).

6.0 APPENDIX

A - Figures

APPENDIX A
Figures
SOP: ERT-PROC-2002-20
October 2020

FIGURE 1. Example Site Logbooks

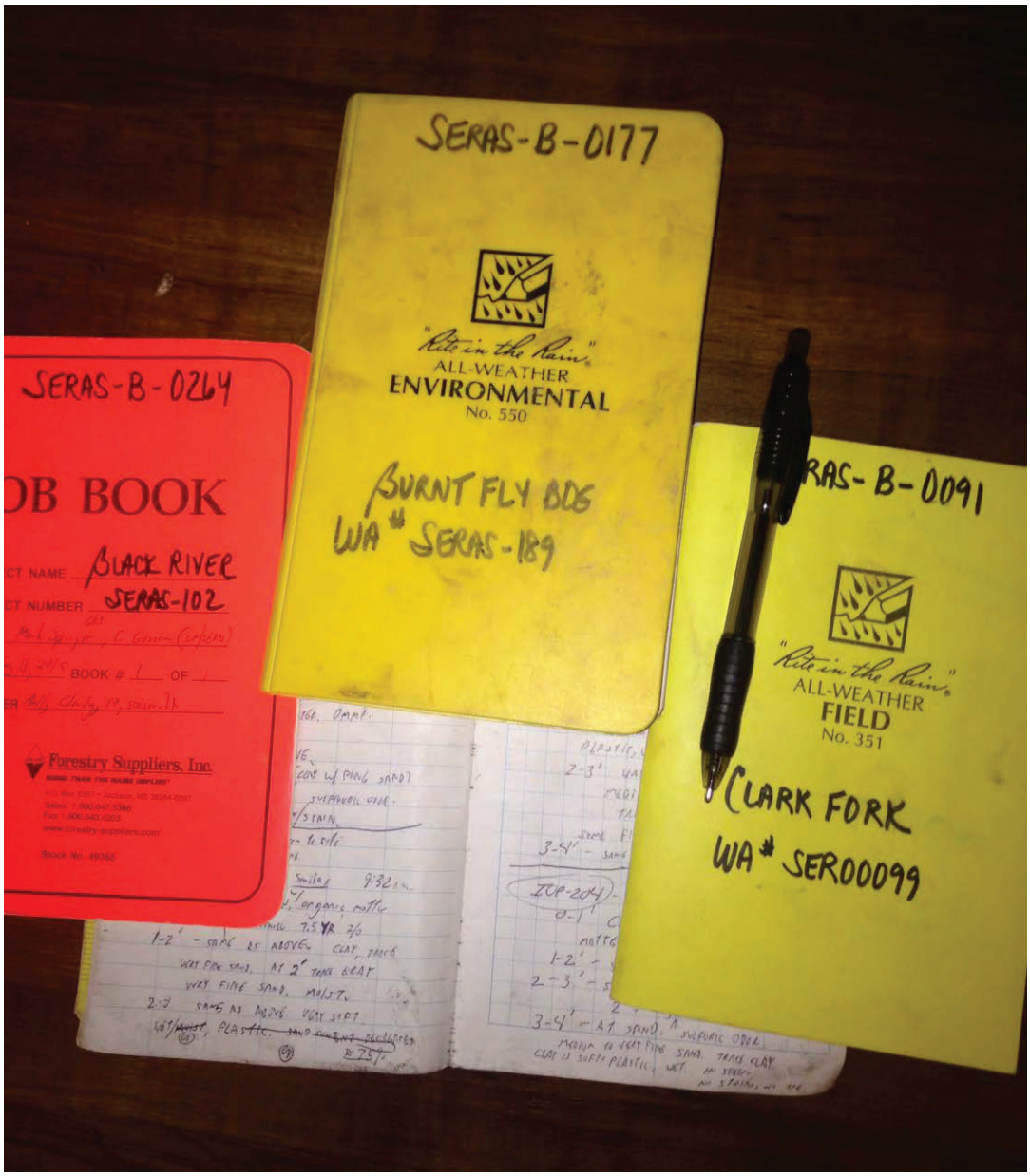

FIGURE 2. Air Sampling Worksheet

Page _____ of

EPA/Environmental Response Team
Scientific, Engineering Response and Analytical Services Contract
Air Sampling Work Sheet
Leidos, Edison, NJ
U.S. EPA Contract No. EP-W-09-031

Site: _____ WA#: _____

Sampler: _____ U.S. EPA/ERT WAM _____

Date: _____ SERAS Task Leader: _____

Sample #					
Location					
Pump #					
Media					
Analysis/Method					
Rotameter/ Calibration Device					
Time/Counter (Start)					
Time/Counter (Stop)					
Total Time					
Pump Fault	Y / N	Y / N	Y / N	Y / N	Y / N
Flow Rate (Start)					
Flow Rate (End)					
Flow Rate Average					
Sample Volume					
MET Station on Site?: Y / N					

FIGURE 3. SUMMA Sampling Work Sheet

Page ____of____

EPA/Environmental Response Team
Scientific, Engineering, Response and Analytical Services
Leidos, Inc., Edison, NJ
U.S. EPA Contract No. EP-W-09-031

Air Sampling Work Sheet - SUMMA

Site: _____ WA# _____

Sampler: _____ U.S. EPA/ERT WAM:_____

Date: _____ SERAS Task Leader:_____

Sample #					
Location					
Sub-Location					
Summa #					
Orifice ID					
Start Pressure					
NIST Gauge S/N					
Flow Rate (Start)					
Flow meter					
Analysis/Method					
Time/Counter (Start)					
Time/Counter (Stop)					
Total Time					
End Pressure					
NIST Gauge S/N					

MET Station on Site?: Y / N

FIGURE 4. Tedlar Bag Sampling Worksheet

Page ____of____

EPA/Environmental Response Team
Scientific, Engineering, Response and Analytical Services
Leidos, Inc., Edison, NJ
U.S. EPA Contract No. EP-W-09-031

Air Sampling Work Sheet – Tedlar Bag

Site: _____ WA# _____

Sampler: _____ U.S. EPA/ERT WAM:_____

Date: _____ SERAS Task Leader:_____

Sample #	Location	Sub Location	Time	Tedlar Bag Analysis/Method	Volume (Liters)

Sampler (Print Name)_____ Sampler (Signature) _____

Received by (Signature)_____ Date _____ Time _____

Comments:

FIGURE 5. Air Monitoring Worksheet

Page ____of____

EPA/Environmental Response Team
Scientific, Engineering, Response and Analytical Services
Leidos, Edison, NJ
U.S. EPA Contract No. EP-W-09-031

Air Monitoring Work Sheet

Site: _____ WA# _____

Sampler: _____ U.S. EPA/ERT WAM:_____

Date: _____ SERAS Task Leader:_____

Instrument	EPA #	Location/Description	Reading	Time

General Comments:

FIGURE 6. Example Scribe-Generated Sample Labels

Sample # B8B51
Date: 5/17/2010 Time: 15:50
Analyses: CLP TCL Pesticide/PCBs Preservation: 4 C
MS/MSD: N

Sample # B8B51
Date: 5/17/2010 Time: 15:50
Analyses: CLP TCL Volatiles Preservation: 4 C
MS/MSD: N

Sample # B8B51
Date: 5/17/2010 Time: 15:50
Analyses: CLP TCL Volatiles Preservation: 4 C
MS/MSD: N

Sample # B8B51
Date: 5/17/2010 Time: 15:50
Analyses: CLP TCL Volatiles Preservation: 4 C
MS/MSD: N

Sample # B8B51
Date: 5/17/2010 Time: 15:50
Analyses: CLP % Moisture Preservation: 4 C
MS/MSD: N

Sample # MB8B51
Date: 5/17/2010 Time: 15:50
Analyses: CLP TAL Total Metals Preservation: 4 C
MS/MSD: N

Sample # B8B51
Date: 5/17/2010 Time: 15:50
Analyses: CLP TCL Semivolatiles Preservation: 4 C
MS/MSD: N

Sample # B8B52
Date: 5/17/2010 Time: 16:45
Analyses: CLP TCL Volatiles Preservation: 4 C
MS/MSD: N

Sample # B8B52
Date: 5/17/2010 Time: 16:45
Analyses: CLP TCL Volatiles Preservation: 4 C
MS/MSD: N

Sample # B8B52
Date: 5/17/2010 Time: 16:45
Analyses: CLP TCL Volatiles Preservation: 4 C
MS/MSD: N

FIGURE 7. Example Scribe-Generated Sample Labels

Sample # 059-2001
Date: 5/17/2010 Time: 15:50
Location: GCMW-43 Sub Location 5
Analyses: CLP TCL Pesticide/PCBs Preservation: 4 C
MS/MSD: N

Sample # 059-2001
Date: 5/17/2010 Time: 15:50
Location: GCMW-43 Sub Location 5
Analyses: CLP TCL Volatiles Preservation: 4 C
MS/MSD: N

Sample # 059-2001
Date: 5/17/2010 Time: 15:50
Location: GCMW-43 Sub Location 5
Analyses: CLP TCL Volatiles Preservation: 4 C
MS/MSD: N

Sample # 059-2001
Date: 5/17/2010 Time: 15:50
Location: GCMW-43 Sub Location 5
Analyses: CLP TCL Volatiles Preservation: 4 C
MS/MSD: N

Sample # 059-2001
Date: 5/17/2010 Time: 15:50
Location: GCMW-43 Sub Location 5
Analyses: CLP % Moisture Preservation: 4 C
MS/MSD: N

Sample # 059-2001
Date: 5/17/2010 Time: 15:50
Location: GCMW-43 Sub Location 5
Analyses: CLP TAL Total Metals Preservation: 4 C
MS/MSD: N

Sample # 059-2001
Date: 5/17/2010 Time: 15:50
Location: GCMW-43 Sub Location 5
Analyses: CLP TCL Semivolatiles Preservation: 4 C
MS/MSD: N

Sample # 059-2002
Date: 5/17/2010 Time: 16:45
Location: GCMW-43 Sub Location 7
Analyses: CLP TCL Volatiles Preservation: 4 C
MS/MSD: N

Sample # 059-2002
Date: 5/17/2010 Time: 16:45
Location: GCMW-43 Sub Location 7
Analyses: CLP TCL Volatiles Preservation: 4 C
MS/MSD: N

Sample # 059-2002
Date: 5/17/2010 Time: 16:45
Location: GCMW-43 Sub Location 7
Analyses: CLP TCL Volatiles Preservation: 4 C
MS/MSD: N

FIGURE 8. Pre-Numbered SUMMA Label

SERAS, EDISON NJ
(732) 321-4200 SAMPLE NO. 00351
EPA CONTRACT EP-W-09-031
SITE NAME | DATE
VOL OF AIR | TIME
ANALYSIS REQUEST: | REMARKS:

SERAS, EDISON NJ
(732) 321-4200 SAMPLE NO. 00352
EPA CONTRACT EP-W-09-031
SITE NAME | DATE
VOL OF AIR | TIME
ANALYSIS REQUEST: | REMARKS:

00351
00351
00352
00352

SERAS, EDISON NJ
(732) 321-4200 SAMPLE NO. 00353
EPA CONTRACT EP-W-09-031
SITE NAME | DATE
VOL OF AIR | TIME
ANALYSIS REQUEST: | REMARKS:

SERAS, EDISON NJ
(732) 321-4200 SAMPLE NO. 00354
EPA CONTRACT EP-W-09-031
SITE NAME | DATE
VOL OF AIR | TIME
ANALYSIS REQUEST: | REMARKS:

00353
00353
00354
00354

SERAS, EDISON NJ
(732) 321-4200 SAMPLE NO. 00355
EPA CONTRACT EP-W-09-031
SITE NAME | DATE
VOL OF AIR | TIME
ANALYSIS REQUEST: | REMARKS:

SERAS, EDISON NJ
(732) 321-4200 SAMPLE NO. 00356
EPA CONTRACT EP-W-09-031
SITE NAME | DATE
VOL OF AIR | TIME
ANALYSIS REQUEST: | REMARKS:

00355
00355
00356
00356

SERAS, EDISON NJ
(732) 321-4200 SAMPLE NO. 00357
EPA CONTRACT EP-W-09-031
SITE NAME | DATE
VOL OF AIR | TIME
ANALYSIS REQUEST: | REMARKS:

SERAS, EDISON NJ
(732) 321-4200 SAMPLE NO. 00358
EPA CONTRACT EP-W-09-031
SITE NAME | DATE
VOL OF AIR | TIME
ANALYSIS REQUEST: | REMARKS:

00357
00357
00358
00358

SERAS, EDISON NJ
(732) 321-4200 SAMPLE NO. 00359
EPA CONTRACT EP-W-09-031
SITE NAME | DATE
VOL OF AIR | TIME
ANALYSIS REQUEST: | REMARKS:

SERAS, EDISON NJ
(732) 321-4200 SAMPLE NO. 00360
EPA CONTRACT EP-W-09-031
SITE NAME | DATE
VOL OF AIR | TIME
ANALYSIS REQUEST: | REMARKS:

00359
00359
00360
00360

SAMPLE DOCUMENTATION

Lockheed Martin / SERAS
EPA Contract Number EP-W-09-031

CHAIN OF CUSTODY RECORD
SERAS <Site Name>
SERAS Task Leader <Name>
Phone Number <xxx-xxx-xxxx>

No: SERAS-XXX-MM/DD/YY-00XX
Cooler #
Lab Name <Name>
Lab Phone <xxx-xxx-xxxx>

Lab #	Sample #	Location	Analyses	Matrix	Collected	Sample Time	Numb Cont	Container	Preservative	MS/MSD
	02001-0124	SWO-001	Semivolatiles (SVOAs)	Water	11/19/2009	16 00	2	1L Amber	None	
	02001-0124	SWO-001	Volatiles (VOAs)	Water	11/19/2009	16 00	3	40 ml VOA	None	
	DAM111909	Underflow Dam	Semivolatiles (SVOAs)	Surface Water	11/19/2009	15 50	3	1 liter amber	None	Y
	DAM111909	Underflow Dam	Volatiles (VOAs)	Surface Water	11/19/2009	15 50	6	40 ml VOA	None	Y
	DAM111909	Underflow Dam	Metals (Unfiltered and filtered)	Surface Water	11/19/2009	15 50	1	1 L poly	HNO3 pH<2	Y

Special Instructions

SAMPLES TRANSFERRED FROM
CHAIN OF CUSTODY #

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished By	Date	Received by	Date	Time

FIGURE 9. Chain of Custody Record (SCRIBE)

FIGURE 10. Generic Chain of Custody Record

SERAS, Edison, NJ
(732) 321-4200
EPA Contract No. EP-W-09-031

CHAIN OF CUSTODY RECORD

Project Name:
Project Number:
LM Contact: Phone:

No: 01294
Sheet 01 of 01 (Do not copy)
(for addnl. samples use new form)

Sample Identification

REAC#	Sample No	Sampling Location	Matrix	Date Collected	# of Bottles	Container/Preservative	Analyses Requested						

Special Instructions:

SAMPLES TRANSFERRED FROM CHAIN OF CUSTODY #:

Matrix:

A- Air
AT-Animal Tissue
DL- Drum Liquids
DS- Drum Solids
GW- Groundwater
O- Oil
PR-Product
PT-Plant Tissue
PW- Potable Water
S- Soil
SD- Sediment
SL- Sludge
SW- Surface Water
TX-TCLP Extract
W- Water
X- Other

Items/Reason	Relinquished by	Date	Received by	Date	Time	Items/Reason	Relinquished by	Date	Received by	Date	Time

☆ U.S. GPO: 2000-521-181

SAMPLE DOCUMENTATION

FIGURE 11. Custody Seals

SERAS, Edison, NJ
US EPA Contract No. EP-W-09-031
(732) 321-4200
CUSTODY SEAL
SERAS
DATE
SIGNATURE

SERAS, Edison, NJ
US EPA Contract No. EP-W-09-031
(732) 321-4200
CUSTODY SEAL
SERAS
DATE
SIGNATURE

SERAS, Edison, NJ
US EPA Contract No. EP-W-09-031
(732) 321-4200
CUSTODY SEAL
SERAS
DATE
SIGNATURE

SERAS, Edison, NJ
US EPA Contract No. EP-W-09-031
(732) 321-4200
CUSTODY SEAL
SERAS
DATE
SIGNATURE

SERAS, Edison, NJ
US EPA Contract No. EP-W-09-031
(732) 321-4200
CUSTODY SEAL
SERAS
DATE
SIGNATURE

SERAS, Edison, NJ
US EPA Contract No. EP-W-09-031
(732) 321-4200
CUSTODY SEAL
SERAS
DATE
SIGNATURE

STANDARD OPERATING PROCEDURE APPROVAL AND CHANGE FORM

Scientific, Engineering, Response and Analytical Services 2890 Woodbridge Avenue Building 209 Annex Edison New Jersey 08837-3679	
STANDARD OPERATING PROCEDURE	
Title: Surface Water Sampling	
Approval Date: 07/31/2016	
Effective Date: 07/31/2016	SERAS SOP Number: 2013, Rev 1.0
Authors	
Name Scott Grossman Title Environmental Scientist Signature	Date 7/31/16
Name Christopher Gussman Title SERAS Environmental Scientist (Biologist) Signature	Date 7/31/16
Approvals	
Name Richard Leuser Title Deputy Program Manager Signature	Date 7/31/16
Name Deborah Killeen Title SERAS QA/QC Officer Signature	Date 7/31/16
Name Kevin Taylor Title SERAS Program Manager Signature	Date 7/31/16

The top row of this table shows the most recent changes to the controlled document. For previous revision history information, archived versions of this document are maintained by the SERAS QA/QC Officer on the SERAS local area network (LAN).

History	Effective Date
Editorial changes	07/31/16
Added UFP QAPP preparation language to Section 1.0; training records for documenting competency to Section 9.0; data verification text to Section 10.0	07/31/16
Rewrite of Section 3.0	07/31/16
Added text discussing selection of samplers based on composition; and the impact of floating debris on dip samplers and of currents when using Kemmerer bottles, to Section 4.0	07/31/16
Added field rinsing discussion to Section 7.1	07/31/16
Rewrite of Section 7.2	07/31/16
Deleted discussion of Van Doren and Bacon Bomb samplers from SOP	07/31/16
Rewrite of sections 7.3.2 Dip Sampler and 7.3.3 Direct Method	07/31/16

SURFACE WATER SAMPLING

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2.0 METHOD SUMMARY

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SUPERSEDES: SOP #2013; Revision 0.0; 02/15/02; U.S. EPA Contract 68-C99-223

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1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) is applicable to the collection of representative surface water samples from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth, as well as samples collected from the surface.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure that the methods used are adequate to satisfy the data quality objectives listed in the QAPP for a particular site.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

2.0 METHOD SUMMARY

Sampling situations vary widely due to varying water depths, velocity, sampling intervals, etc.; therefore, no universal sampling procedure can be recommended. However, surface water sampling is generally accomplished through the use of one of the following samplers or techniques:

- Kemmerer bottle
- Dip sampler
- Direct method (collecting water samples directly into the sample container)

These samplers and sampling techniques will result in the collection of representative samples from the majority of surface waters and impoundments encountered.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample collected, along with the proper sample container type (i.e. glass, plastic), chemical preservation, and storage requirements are dependent upon the matrix sampled and analysis performed. For further information, refer to the Scientific Engineering Response and Analytical Services (SERAS) SOP #2003, *Sample Storage, Preservation and Handling*.

Whenever possible, dedicated sampling devices should be used. However, if sampling with re-usable (non-dedicated) equipment, equipment will need to be decontaminated. Refer to SERAS SOP #2006, *Sampling Equipment Decontamination*, for proper procedures.

Once samples have been collected, the following procedures should be followed:

1. Transfer the sample(s) into suitable, labeled sample containers specific for the analyses to be performed.
2. If appropriate, preserve the sample, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.
3. Cap the container securely, place in a resealable plastic bag, and cool to less than or equal to (≤) 6 degrees Centigrade (°C).
4. Record all pertinent data in the site logbook and/or on field data sheets.
5. Complete the Chain of Custody (COC) record.

6. Attach custody seals to cooler prior to shipment.
7. Decontaminate all non-dedicated sampling equipment prior to the collection of additional samples.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Cross contamination problems can be eliminated or minimized through the use of dedicated or disposable sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to SERAS SOP #2006, *Sampling Equipment Decontamination*, for proper procedures.

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, polyvinyl chloride (PVC) or polytetrafluoroethylene (PTFE) commonly referred to as Teflon®, should be based upon the suspected contaminants and the analyses to be performed

Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed or non-representative area.

Following proper decontamination procedures, minimizing disturbance of the sample site, and careful selection of sampling locations will eliminate these problems. Proper timing for the collection of samples must be taken into consideration due to tidal influences and low or fast-flowing streams or rivers.

Dip samplers may collect floating debris which may skew sample results.

Collection at a non-representative depth may result when using a Kemmerer bottle in a current, due to inaccurate depth measurements.

5.0 EQUIPMENT/APPARATUS

Equipment needed for collection, preservation and handling of surface water samples may include (depending on technique chosen):

- Kemmerer bottles
- Line and messengers
- Dip sampler
- Peristalic pump
- Tygon tubing
- Polyethylene (PE) or PTFE tubing
- 0.45 micron (µm) filters
- Sample bottles
- Preservation reagents
- pH paper
- Resealable plastic bags
- Ice
- Coolers
- Inert packing material
- Sample labels
- Printer
- Chain of Custody records
- Custody seals

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- Field data sheets
- Decontamination equipment/supplies
- Maps/plot plan
- Personal protective equipment (PPE)
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Vessel
- Global Positioning System (GPS) unit
- Camera
- Logbook/waterproof pen
- Paper towels
- Water quality meter

6.0 REAGENTS

Reagents are utilized for preservation of samples and for decontamination of sampling equipment. The preservatives depend on the analysis to be performed and are summarized in SERAS SOP #2003, *Sample Storage, Preservation and Handling.* Decontamination solutions are specified in SERAS SOP #2006, *Sampling Equipment Decontamination.*

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the type and amount of equipment and supplies needed.
2. Obtain the necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5. Use stakes, flags, or buoys to identify and mark all sampling locations identified by GPS data. If required, the proposed locations may be adjusted based on site access, property boundaries, and obstructions.
6. Field Rinsing - Once field work has begun, and before samples are collected, the sample-wetted portions of most of the collection and processing equipment require a field rinse with native water. Field rinsing helps to condition, or equilibrate, sampling equipment to the sample environment. Rinsing also serves to ensure that all cleaning-solution residues have been removed. **Note –** Do not field rinse pre-preserved bottles or when collecting volatile organic compounds (VOCs).

7.2 Representative Sampling Considerations

In order to collect a representative sample, the hydrology and characteristics of a stream, river, pond, lake or impoundment should be determined prior to sampling. This will aid in determining the presence of separate phases or layers in lagoons or impoundments, flow patterns in streams, and appropriate sample locations and depths. Location of sampling will depend on project goals and conditions. For example, in a stream or river the sample should be collected at a location where the velocity is sufficient to prevent deposition of solids and should have relatively uniform flow. In

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moving water, the sampler must always stand downstream of the collected sample. Care must be taken to avoid introducing re-suspended sediment into the sample, particularly in small stagnant ponds. Recent storm events may dilute contamination or bring contaminants from upstream sources and should be taken into consideration when collecting samples. In addition, present or recent storm events will alter water quality data. Storm event data should be recorded in logbooks to help evaluate the data.

7.2.1 Water Quality Data

Water quality data, including pH, conductivity, oxygen reductions potential (ORP), and dissolved oxygen (DO) may be collected in ponds, lakes and impoundments to determine if stratification is present. Measurement intervals will depend on many factors (i.e. total depth, location access, site conditions, etc). A determination will be made prior to collecting any water quality data as to depth(s) and frequency of measurements. These measurement intervals should be as consistent as possible throughout the sampling event. Depth intervals should be documented in the QAPP, any changes should be documented in a field logbook. Refer to SERAS SOP # 2041, *Operation of the Water Quality Multi-Parameter Meters,* for more information on how to collect the necessary water quality data.

7.2.2 Sampling Methods

Factors that contribute to the selection of a sampling method are:

- Width, depth, flow and accessibility of the location being sampled
- Whether the sample will be collected onshore or offshore

Kemmerer bottles (Figure 1, Appendix A) may be used in most situations where site access is from a boat or structure, such as a bridge or pier, and where samples at specific depths are required.

Dip samplers (Figure 2, Appendix A) are useful in situations where a sample is to be recovered from an outfall pipe or along a lagoon bank where direct access to the sample point is not feasible.

The direct method may be utilized to collect water samples from streams, rivers, lakes, and other surface waters directly into the sample container(s).

7.3 Sample Collection

7.3.1 Kemmerer Bottle

Sampling procedures for a Kemmerer Bottle are as follows:

1. Use a properly decontaminated Kemmerer bottle. Set the sampling device so that the upper and lower stoppers are pulled away from the body, allowing the surface water to enter tube.
2. Lower the pre-set sampling device to the predetermined depth. Avoid disturbance of the bottom.
3. When the Kemmerer bottle is at the required depth, send the weighted messenger

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down the suspension line to close the sampling device.

4. Retrieve the sampler and discharge the first 10-20 milliliters (mL) from the drain to clear potential contamination from the valve. Fill sample containers for VOC samples first as these samples should not be composited. This procedure may be repeated if additional sample volume is needed to fulfill analytical requirements. Subsequent grabs may be composited or transferred directly to appropriate sample containers.

7.3.2 Dip Sampler

Sampling procedures for a Dip Sampler are as follows:

1. If necessary, assemble the device in accordance with the manufacturer's instructions.
2. Extend the device to the sample location and collect the sample by dipping the sampler into the water.
3. Retrieve the sampler and transfer the sample to the appropriate sample container(s).

7.3.3 Direct Method

For streams, rivers, lakes, and other surface waters, the direct method may be utilized to collect water samples directly into the sample container(s). Health and safety considerations must be addressed when sampling lagoons or other impoundments where specific conditions may exist that warrant the use of additional safety equipment. These issues must be addressed in the site-specific Health and Safety Plan (HASP).

Using adequate protective clothing for wading or boats, access the sampling station from a downstream location, walking upstream so as to not disturb sediments and suspending them into the water column. Collect water quality information for the sampling location and record in the site log book or field data sheets. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Avoid disturbing the substrate. For lakes and other impoundments, collect the sample under the water surface while avoiding surface debris and boat wake. Pre-preserved sample bottles cannot be used for this sampling method.

Surface water samples may also be collected directly by using a peristaltic pump with PE or PTFE lined tubing. This method is also used when collecting filtered samples.

8.0 CALCULATIONS

This section is not applicable to this SOP.

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9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or in site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Calibration of equipment must occur prior to sampling/operation and must be documented in the site log book or field data sheets.
3. To avoid the incidental inclusion of disturbed sediment in the sample, multiple surface water samples should be collected from a downstream to upstream direction and upstream of any activity that may disturb the sediment (i.e., wading).
4. While collecting surface water using the direct method, the sample container should be opened below the surface to avoid the collection of floating debris.
5. Water quality data (pH, specific conductivity, ORP, temperature, and DO) may be collected to detect the presence of stratified layers or other site-specific characteristics that would affect the sample.
6. The competency of field personnel must be demonstrated and documented.

Additional Quality Assurance/Quality Control (QA/QC) Samples should be collected as outlined in the QAPP for each specific site. Further information on QA/QC Samples can be located in SERAS SOP #3001, *Quality Assurance/Quality Control Samples*.

10.0 DATA VALIDATION

Data verification/completeness checks must be conducted to ensure project-specific quality objectives have been met as defined in the corresponding UFP-QAPP. The SERAS Task Leader is responsible for completing the UFP-QAPP verification checklist for each project.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, Occupational Health and Safety Administration (OSHA) and/or corporate health and safety procedures.

When sampling lagoons or surface impoundments containing known or suspected hazardous substances, adequate health and safety and boating precautions must be taken to ensure the safety of sampling personnel. Refer to SERAS SOP #3023, *Boat Safety* and SERAS SOP #3016, *Personal Protective Equipment Program.*

12.0 REFERENCES

Wilde, F.D., D.B. Radtke, J. Gibs and R.T. Iwatsubo. 1998. National Field Manual for the Collection of Water-Quality Data - Selection of Equipment for Water Sampling. U.S. Geological Survey Techniques of Water - Resources Investigations, Book 9, Chap. A2, variously paged.

U.S. Environmental Protection Agency. 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA/600/4-84-076.

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13.0 APPENDICES

A - Figures

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APPENDIX A
Figures
SOP #2013
July 2016

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FIGURE 1. Kemmerer Bottle

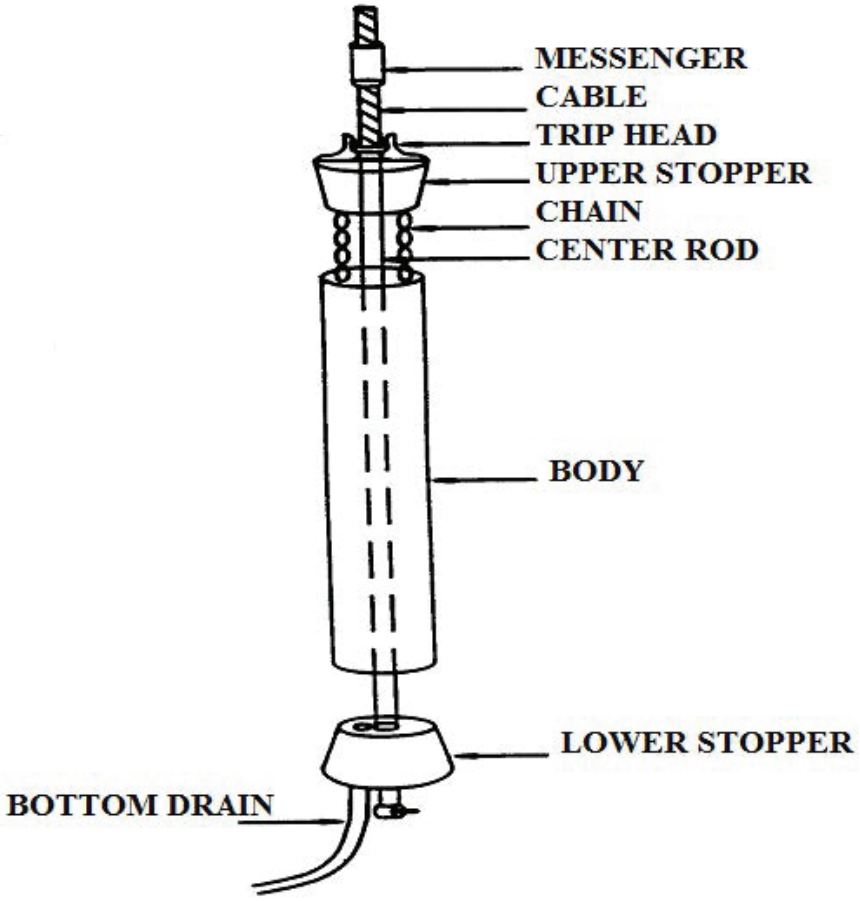

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FIGURE 2. Dip Sampler

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STANDARD OPERATING PROCEDURE APPROVAL AND CHANGE FORM

Scientific, Engineering, Response and Analytical Services 2890 Woodbridge Avenue Building 209 Annex Edison New Jersey 08837-3679	
STANDARD OPERATING PROCEDURE	
Title: Waste Pile Sampling	
Approval Date: 07/31/16	
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The top row of this table shows the most recent changes to the controlled document. For previous revision history information, archived versions of this document are maintained by the SERAS QA/QC Officer on the SERAS local area network (LAN).

History	Effective Date
Editorial changes	07/31/16
Added UFP QAPP preparation language to Section 1.0; training records text to Section 9.0; added data verification text to Section 10.0	07/31/16
Added bulleted list including: storing samples at 4 ^{0}C, concerns regarding VOC samples, discussion of composite samples and dedicated sampling devices to Section 3.0.	07/31/16
Added discussion of representative sampling to Section 4.0	07/31/16
Added decontamination and sample preservation reagents to Section 6.0.	07/31/16
Replaced text in Sections 7.2.1 and 7.2.2 to reflect current practices	07/31/16

WASTE PILE SAMPLING

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SUPERSEDES: SOP #2017; Revision 0.0; 11/16/01; U.S. EPA Contract 68-C99-223

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1.0 SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to outline the equipment and methods used in collecting representative samples from waste piles, sludge, or other solid/liquid waste mixed with soil.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The analyst needs to ensure that the methods used are adequate to satisfy the data quality objectives listed in the QAPP for a particular site.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

2.0 METHOD SUMMARY

Shovels, trowels, or scoops constructed of appropriate materials should be used to clear away surface material and debris before samples are collected. For depth samples, a decontaminated auger may be used to advance the hole, and then another decontaminated auger is used for sample collection. For sample cores, thin wall tube samplers are used. Near-surface samples can be collected with clean spoons or trowels.

All samples collected, except those for volatile organic compounds (VOCs), must be placed into inert containers that will not react with the contaminants, or interfere with the analyses (e.g., Teflon®-lined or stainless steel) and mixed thoroughly before sample aliquots are transferred to appropriate sample container(s). Samples collected for VOC analysis should be placed intact directly into the specified sampling container without homogenization and minimal disturbance.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

- The sample container and sample volume are dependent on the analytical analyses and are specified in the site specific QAPP. Generally wide-mouth glass containers or vials with Teflon® (PTFE) lined caps are used for most types of waste pile samples/analyses.

- Environmental samples are routinely stored at 4 degrees Centigrade (°C). The site specific QAPP will specify storage conditions for all samples being collected on the specific project.

- When collecting samples for VOC analyses, they are to be collected first before any other samples and transferred directly from the collection device to the specified sample container to prevent loss of VOCs. **VOC samples are never to be homogenized.**

- Composite samples require multiple grabs. The grabs are required to contain the same amount of soil from each location and are placed in a container. The samples are then homogenized to obtain a representative sample.

- Whenever possible, dedicated sampling devices should be used. However, if sampling with reusable equipment, decontaminate them prior to and after use as described in the Scientific, Engineering, Response and Analytical Services (SERAS) SOP #2006, *Sampling Equipment Decontamination*.

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4.0 INTERFERENCES AND POTENTIAL PROBLEMS

One of the main difficulties encountered with waste sampling is obtaining a "representative sample" that has the properties and composition of the waste pile area from which it was collected. There are several variables involved in collecting a representative waste sample, including shape and size of piles, compactness, and structure of the waste material. Waste material or waste piles vary greatly in areal extent and height. Since Federal and State regulations or protocols often require a specified number of samples per volume of waste, the size and shape must be used to calculate volume and to plan for the correct number of samples. Shape must also be accounted for when planning physical access to the sampling point and the equipment necessary to successfully collect the sample at that location.

Material to be sampled will be homogeneous or heterogeneous or a combination of the two. Homogeneous material resulting from known situations may not require an extensive sampling protocol. Heterogeneous and unknown wastes require more extensive sampling and analysis to ensure the different components (i.e. layers, strata) are being represented.

The usual options for obtaining the most "representative sample" from waste piles are simple random sampling or stratified random sampling. Simple random sampling is the method of choice unless: (1) there are known distinct strata; (2) one wants to prove or disprove there are distinct strata; or (3) one is limited in the number of samples and wants to statistically minimize the size of a "hot spot" that could go un-sampled. If any of these conditions exist, stratified random sampling would be chosen.

Stratified random sampling can be employed only if all points within the pile can be accessed. In such cases, the pile should be divided into a three-dimensional grid system. The grid cubes should be numbered and the grid cubes to be sampled should be chosen by random number tables or generators. The only exceptions to this are situations in which representative samples cannot be collected safely or where the investigative team is trying to determine worst case conditions.

If sampling is limited to certain portions of the waste pile, a statistically-based sample will be representative only of that portion, unless the waste is homogenous.

Single point (discrete) or composite sampling may be utilized as specified in the site-specific QAPP. Discrete sampling will provide greater information regarding contaminant variability within the waste piles, but will also have greater analytical costs.

5.0 EQUIPMENT/APPARATUS

Waste pile solids may include powdered, granular, or block materials of various sizes, shapes, structure, and compactness. The type of sampler chosen and the construction of the sampler should be compatible with the waste characteristics. Samplers commonly used for waste piles include: scoops, shovels, trowels, spoons, and hand augers, typically constructed of stainless steel, plastic or Teflon®.

Equipment needed for collection, preservation and handling of waste samples may include (depending on the technique chosen):

- QAPP
- Maps/plot plan

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- Safety equipment, as specified in the Health and Safety Plan (HASP)
- Global Position System (GPS) receiver
- Tape measure
- Survey stakes or flags
- Camera and film, or suitable recording media
- Homogenization bucket or bowl, constructed of appropriate material
- Appropriate size sample jars
- Canvas or plastic sheet
- Spade or shovel
- Spatulas, scoops, etc.
- Plastic or stainless steel spoons
- Trowel
- Continuous flight (screw) augers
- Bucket auger
- Posthole auger
- Extension rods
- T-Handle
- Thin-wall tube sampler with cutting tips
- Sampling trier
- Grain sampler
- Re-sealable plastic bags (e.g., Ziploc)
- Logbook
- Labels
- Chain of Custody records and seals
- Field data sheets
- Cooler(s)
- Ice
- Paper towels
- Decontamination supplies/equipment

6.0 REAGENTS

The only reagents that may be required for waste pile samples are for decontamination or sample preservation. Refer to the site-specific QAPP and/or SERAS SOP #2006, *Sampling Equipment Decontamination* for a list of necessary decontamination solutions or sample preservation reagents.

7.0 PROCEDURES

7.1 Preparation

1. Review all information available on expected or unknown contaminants.

2. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required. All of this information is specified in the site-specific QAPP.

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3. Obtain necessary sampling and monitoring equipment.

4. Decontaminate any non-dedicated sampling equipment as per the site-specific QAPP and/or SERAS SOP #2006, *Sampling Equipment Decontamination*.

5. Ensure all sampling equipment is present and in working order.

6. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.

7. Perform a general site survey prior to site entry in accordance with the site-specific Health and Safety Plan (HASP).

8. Use stakes or flagging to identify and mark all sampling locations. Specific site factors, including extent and nature of contaminant(s) should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

9. GPS all sample locations (SERAS DRAFT SOP #2047, *Operation of a Global Positioning System*). The circumference of the base of the waste pile or bottom area should also be located and documented with the GPS so a volume maybe estimated at a later time, if necessary.

7.2 Sample Collection

7.2.1 Surficial Sampling with Trowels, Shovels, or Scoops

Surficial waste pile samples can be collected with tools such as; shovels, trowels, and scoops depending on the type of material in the waste pile and the volume of sample required. Sampling tools should be constructed of materials suitable for environmental sampling (typically stainless steel, plastic or aluminum). Devices plated with chrome or other materials should not be used as they may introduce contaminants to the sample. All equipment used for sampling should be either dedicated or decontaminated prior to use.

The over-burden or overlying surface material (i.e. leaves, grass, etc.) is first removed. The sampling tool (shovel, trowel or scoop) is advanced to the required depth and the sample is collected. Depending on the sampling depth and volume, it may take one or more scoops to get to the specified depth or obtain sufficient sample volume for all analyses. The use of a flat, pointed mason trowel to cut a block of the desired material can be helpful when undisturbed profiles are required. This methodology can be used in most soil types, but is limited to sampling at or near the ground surface.

If samples are going to be analyzed for VOCs, waste material for this analysis are subsampled immediately prior to any mixing or homogenization. The sample can be transferred into an appropriately labeled sample container with a clean spoon, or equivalent or collected using EnCore or Terra Core samplers. Samples should immediately be labeled, capped and placed in storage at 4^0 C.

The remaining sample is placed into a dedicated or decontaminated bowl or pan and thoroughly homogenized. If a single point (discrete) sample is being collected, after the

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sample has been homogenized, aliquots of the sample are transferred to the appropriate labelled glassware with a clean spoon, or equivalent, capped and placed in storage at 4°C.

In some cases, if samples are only being analyzed for one analyte and the waste material is known to be homogeneous it may be collected directly into the sampling container.

If a composite sample is being collected, all sub-locations (increments) are sampled and composited in a single dedicated or decontaminated bowl or pan. Once all the sub-locations have been sampled, the material is thoroughly homogenized and aliquots of the sample are transferred to the appropriate labelled glassware with a clean spoon or equivalent, and placed in storage at 4°C.

7.2.2 Sampling with Bucket Augers or Thin-Wall Tube Augers

Bucket or tube hand augers can collect a soil sample from a discrete interval in a short period of time (Figure 1, Appendix A). Typically hand augers are used when the soils are close to the surface, as collecting deeper soils will become increasingly more difficult, time consuming and, depending on the material, the borehole may start to collapse.

The following procedures are used for collecting soil samples with augers:

1. Place plastic sheeting around the sampling area.

2. Attach the decontaminated auger head to an extension rod and attach the "T" handle.

3. Insert the auger into the soil at a 90° angle. Apply downward pressure while rotating in a clockwise motion continually. Each time the auger is filled with material or once the top of the sampling interval has been reached, remove the auger from the hole, discard the waste material on the plastic sheeting and continue to auger downward.

4. After reaching the top of the sample interval insert a clean auger into the borehole and auger downward to the bottom of the sampling interval. Remove the auger from the borehole and discard the top of the sample (approximately one-inch), as this represents material that may have fallen into the auger from the sides of the borehole.

5. If sampling for VOC analyses, collect the sample directly from the bucket/tube auger and transfer to the properly labeled sample container.

6. For all other analyses, collect the sample from the auger by using a dedicated or decontaminated spoon or laboratory scoop.

7. Place the soil into a dedicated or decontaminated bowl or pan and homogenize the sample. Once homogenized, transfer the sample into a properly labeled sample container(s), tightly seal the lid and store at 4° C until analysis.

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8. Decontaminate all non-dedicated sampling equipment according to SERAS SOP #2006, *Sampling Equipment Decontamination*.

9. If another sample is to be collected from the same hole, but at a greater depth, re-attach the bucket auger to the extension and "T" handle assembly, and follow Steps 3 through 11, making sure to decontaminate the bucket auger and thin-wall tube sampler between samples.

10. When sampling is completed, abandon the borehole following all local, state, and federal regulations.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All equipment must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the site-specific QAPP.

3. Equipment checkout activities must occur prior to sampling/use, and they must be documented.

4. Documentation of personnel's competency with the equipment and methodology will be maintained.

10.0 DATA VALIDATION

Data verification/completeness checks must be conducted to ensure project-specific quality objectives have been met as defined in the corresponding UFP-QAPP. The SERAS Task Leader is responsible for completing the UFP-QAPP verification checklist for each project.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, Occupational Safety and Health Administration (OSHA) and/or corporate health and safety procedures.

12.0 REFERENCES

New Jersey Department of Environmental Protection (NJDEP). 1992. *Field Sampling Procedures Manual.*

United States Environmental Protection Agency (U.S. EPA). Office of Solid Waste and Emergency Response. 1986. *Test Methods for Evaluating Solids Waste (SW-846)*, 3rd ed., Vol. II. Field Manual.

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United States Environmental Protection Agency (U.S. EPA), Engineering Support Branch, Region 4. 1986. *Standard Operating Procedures and Quality Assurance Manual.*

13.0 APPENDIX

A – Bucket Auger

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APPENDIX A
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FIGURE 1. Bucket Auger

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INVESTIGATION-DERIVED WASTE MANAGEMENT

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The policies and procedures established in this document are intended solely for the guidance of OLEM employees of the U.S. Environmental Protection Agency (EPA). They are not intended and cannot be relied upon to create any rights, substantive or procedural, enforceable by any party in litigation with the United States. EPA reserves the right to act at variance with these policies and procedures, and to change them at any time without public notice. EPA strongly encourages all readers to verify the validity of the information contained in this document by consulting the most recent Code of Federal Regulations (CFR) and updated guidance documents.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

1.0 OBJECTIVE

The objective of this standard operating procedure (SOP) is to provide general reference information on the management of investigation-derived waste (IDW) generated during Environmental response Team (ERT) site investigations.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The anticipated approach and procedures for IDW management will be detailed in the approved QAPP for the site investigation.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

2.0 APPLICABILITY

This SOP is applicable only if the U.S.EPA On-Scene Coordinator (OSC), Remedial Project Manager (RPM), or other Regional Manager does not have procedures in place for IDW management. Prior to site activities, the ERT contractor's Task Leader (TL) determines if the OSC, RPM, or other Regional Manager has procedures in place for IDW management. This should be done by contacting the ERT Work Assignment Manager (WAM). If it is determined that procedures are not in place, then the contractor's TL should evaluate IDW handling and management options based on:

- Site contaminants and their concentrations, and total projected volume of IDW
- Media potentially affected (e.g., groundwater, soil) by management options
- Location of the nearest population(s) and likelihood and/or degree of site access
- Potential exposure to workers
- Potential environmental impacts

Every effort must be made to ensure the selection of investigation method(s) minimizes the generation of IDW, contact with contaminants, and cost of disposal. It is important that the TL share information about site contaminants and expected IDW with the contractor's Health and Safety Officer (HSO) and Hazardous Waste Coordinator well in advance of site startup. This will better ensure that the upfront work can be done to minimize and dispose of IDW efficiently and in compliance with applicable regulations. Efforts made to characterize IDW will be consistent with the scope and purpose of the site investigation.

3.0 DESCRIPTION

3.1 Regulatory Background and Options for Managing IDW

3.1.1 Regulatory References

This SOP provides information that is based on the rules, regulations, and guidance documents summarized in Table 1 of Appendix A.

3.1.2 IDW Management Options

The National Oil and Hazardous Substances Contingency Plan (NCP) requires that management of IDW generated during site investigations complies with all applicable or relevant and appropriate requirements (ARARs) to the extent practicable unless a waiver

is granted. Potentially applicable provisions for IDW management at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites are listed in the following ARARs: the Resource Conservation and Recovery Act (RCRA), Safe Drinking Water Act (SDWA), Clean Air Act (CAA), Toxic Substances Control Act (TSCA), Clean Water Act (CWA), and other state laws.

Typical options for handling IDW include immediate disposal or interim management at the end of which the IDW is either: (1) returned to its source or (2) treated, disposed, or stored elsewhere. The contractor's TL in conjunction with the ERT WAM is required to select options for IDW management that are protective of human health and the environment and comply with or waive the ARARs. The most important general elements of managing IDW are as follows:

- Leaving a site in no worse condition than existed prior to the investigation
- Removing those wastes that pose an immediate threat to human health or the environment
- Leaving on site those wastes that do not require off-site disposal or long-term above-ground containerization
- Complying with federal and state ARARs to the extent practicable (OERR, 1991)
- Planning and coordination for IDW management
- Minimizing the quantity of wastes generated

The specific elements of the approach are as follows:

- Characterizing IDW through the use of existing information (manifests, Safety Data Sheets (SDSs), previous test results, knowledge of the waste generation process, and other relevant records) and best professional judgment.
- Delineating an area of concern (AOC) unit for leaving RCRA hazardous soil cuttings within the unit.
- Containerizing RCRA hazardous groundwater, decontamination fluids, personal protective equipment (PPE), and disposable sampling equipment (if generated in excess of 100 kilograms [kg]/month) and disposing of it at RCRA Subtitle C facilities.
- Leaving on site RCRA nonhazardous soil cuttings, groundwater, and decontamination fluids preferably without containerization and testing.

The U.S. EPA does not recommend the removal of wastes from all sites and, in particular, from those sites where IDW does not pose any immediate threat to human health or the environment.

Based on this information and the guidelines included in the following sections, the ERT contractor's TL should include a plan for handling IDW in the QAPP. Any deviations from or modifications to the plan due to unexpected or unforeseen field conditions must be documented using a field change form and noted in the site logbook.

3.2 Characterization of IDW

3.2.1 Types of IDW

IDW can be divided into investigation-derived environmental media, debris, and other materials. The U.S. EPA uses the term environmental media to describe soil, sediment, surface water, and groundwater or a mixture of such materials (61 Federal Register 18780, 18783; April 29, 1996). Environmental media are not inherently waste but contaminated environmental media becomes a waste if it cannot be returned to its source. The definition of environmental debris found in 40 Code of Federal Regulations (CFR) 268.2(g) and includes: solid material, particles that exceed 60 millimeters (mm), and materials intended for disposal. IDW may therefore include, but is not limited to, the following items:

Media

- Soil
- Sediment
- Bedrock
- Surface water
- Drill cuttings
- Purge water
- Development water

Debris

- Concrete, asphalt, building materials, etc.
- Slag
- Used glassware
- Clean trash
- PPE
- Decontamination equipment (buckets, brushes, clothing, tools, etc.)
- Field analytics waste (immunoassay, chlor-n-oil, chlor-n-soil, HACH kits, sample extracts, etc.)
- Dedicated/expendable equipment (bailers, fitters, hose, buckets, x-ray fluorescence [XRF] cups, etc.)

Other Materials

- Sludge
- Drum solids
- Biological tissue
- Drilling fluids
- Fluid and sludge from the dewatering of drilling mud
- Decontamination fluids

3.2.2 Hazardous IDW

To handle IDW properly, the ERT contractor's TL must know whether it contains CERCLA hazardous substances as defined under Section 101(14) and whether those

substances are RCRA hazardous wastes or contaminants regulated under other statutes such as TSCA, CWA, CAA, and SDWA. The complete list of CERCLA hazardous substances is found at 40 CFR 302.4. To handle IDW in compliance with regulations, reasonable efforts should be made to characterize it. However, these efforts should be consistent with the scope and purpose of the site investigation.

Contaminated environmental media is not solid waste (i.e. because it was in place and not discarded), cannot be considered RCRA hazardous waste (i.e., because it is not solid waste), but is subject to regulation under RCRA Subtitle C when it contains hazardous waste. The "contained-in" policy requires environmental media to be managed as hazardous waste when it is mixed with listed hazardous constituents (F-, K-, P-, or U-codes identified under 40 CFR 261.31 to 261.33) at concentrations above health-based levels or is mixed with enough hazardous constituents that it exhibits one of four hazardous characteristics (ignitability, corrosivity, reactivity, or toxicity) based on comparison of analytical results to limits established in 40 CFR 261.21 to 261.24. Once the characteristic is eliminated (i.e., through treatment), the environmental media is no longer considered to contain hazardous waste and be subject to RCRA regulations. A formal "contained-out determination" is not required because the determination can be easily made through analytical testing. However, in the case of environmental media that are no longer contaminated by high concentrations of a listed hazardous waste, EPA recommends that the Regions or authorized states make the "contained-out determination" using site-specific health-based standards. Environmental media that contained listed hazardous waste when first generated (i.e., removed from the ground) remain subject to Land Disposal Restriction (LDR) regulations known as Universal Treatment Standards (UTS) following an approved "contained out determination", except under certain circumstances.

The "contained-in" policy also applies to debris contaminated with RCRA-listed hazardous waste (51 Federal Register 37225, August 18, 1992), which must be handled as hazardous material until it no longer contains hazardous waste at concentrations above health-based levels [40 CFR 261.3(f)(2)]. Hazardous contaminated debris are also subject to LDR standards. Hazardous debris treated to comply with those standards would no longer be subject to RCRA regulation if the debris does not exhibit any hazardous waste characteristics. Agency action is not required; a "contained-out determination" is automatic.

A combination of solid IDW, such as sludge or drum solids, and listed or characteristic waste is considered a mixture under the "mixture rule". Mixtures of solid IDW and listed wastes are RCRA hazardous wastes under 40 CFR 261.3(a)2(iv).

3.2.3 Polychlorinated Biphenyl-Containing IDW

Management of IDW contaminated with polychlorinated biphenyls (PCBs) involves compliance with the requirements for PCB remediation waste as specified in the TSCA PCB regulations at 40 CFR 761.50(b)(3) and 761.61. However, PCBs mixed with RCRA hazardous waste become RCRA regulated material. Waste materials containing PCBs as the result of a spill, an intentional or accidental release or uncontrolled discharges of PCBs or other unauthorized disposal of PCBs is called PCB remediation waste which is managed at its "as-found" PCB concentration. Most of the PCB remediation waste encountered during site investigations consists of "bulk PCB remediation waste" (including, but not limited to, existing piles of soil, in-situ soil, sediments, dredged materials, muds, PCB

sewage sludge, and industrial sludge) or "liquid PCBs" (homogeneous, flowable material containing PCBs and no more than 0.5 percent (%) by weight non-dissolved material).

3.2.4 Asbestos-Containing IDW

Asbestos-containing IDW is most likely to be derived from building, landfill, or fill materials during Superfund site investigations. However, soil and rock may also contain naturally-occurring asbestos (NOA) at some sites. Asbestos-containing material (ACM) as defined in the National Emission Standards for Asbestos, found in Subpart M of the National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR Part 61, consists of: Category I and Category II nonfriable ACM containing greater than 1% asbestos as analyzed using polarizing light microscopy (PLM). Office of Solid Waste and Emergency Response (OSWER) Directive 9345.4-05 (Clarifying Cleanup Goals and Identification of New Assessment Tools for Evaluating Asbestos at Superfund Cleanups, EPA, August 2004) indicated that the 1% definition may not be reliable for assessing potential human health hazards from asbestos-contaminated soils at Superfund sites and that a risk-based, site-specific action level is generally more appropriate. Furthermore, OSWER Directive 9200.0-68 (Framework for Investigating Asbestos-Contaminated Superfund Sites, EPA, September 2008) indicated that accurate quantification is very difficult when the asbestos content of soil is less than 1% PLM and that the results should be interpreted semi-quantitatively.

U.S. EPA does not classify ACM as hazardous waste under RCRA; however, it can be designated a hazardous waste if it is located in a state that regulates asbestos (e.g., California classifies ACM as hazardous waste if it is friable [i.e., can be reduced to powder or dust under hand pressure when dry] and contains 1% or more asbestos). State solid waste regulations generally have asbestos handling and disposal requirements and the states determine which landfills can accept ACM. If the landfills accept regulated ACM (i.e., friable ACM; Category I nonfriable ACM that have become or will become friable or have been subject to grinding, cutting, abrading or burning; or Category II nonfriable ACM that have a high probability of becoming or that have become crumbled, pulverized, or reduced to powder due to work practices used during the course of demolition or renovation), they must comply with Asbestos NESHAP requirements.

3.2.5 Non-Hazardous IDW

Non-hazardous IDW is waste that does not meet the EPA's definition of hazardous waste.

Even if the IDW does not contain RCRA hazardous waste, the ERT contractor's TL should determine whether the IDW contains other CERCLA hazardous substances. CERCLA hazardous substances include, in addition to RCRA hazardous wastes, substances, elements, compounds, solutions, or mixtures designated as hazardous or toxic under CERCLA itself or under the authority of other laws such as TSCA, CWA, CAA, and SDWA. Therefore, even if RCRA is not applicable, one of these statutes may be.

3.3 Management of IDW

3.3.1 Waste Minimization

The ERT contractor's TL will obtain input from their HSO and Hazardous Waste Coordinator to support selection of site investigation methods that minimize the generation of IDW, particularly TSCA or RCRA hazardous wastes. The site investigation team should limit contact with contaminants and use drilling and decontamination methods (such as steam cleaning) that minimize PPE, disposable equipment, decontamination fluids, and soil cuttings. In particular, the inspection team should minimize the amounts of solvents used for decontamination or eliminate solvents altogether. Minimizing the amount of wastes generated reduces the number of IDW handling problems and costs of disposal.

3.3.2 Types, Hazards, and Quantities of IDW

Extensive testing of the IDW is not warranted in most cases; instead, the nature of the wastes should be assessed by applying professional judgment, using readily available information about the site (such as Safety Data Sheets, manifests, storage reports, process descriptions, preliminary assessments, and results of earlier studies), as well as direct observation of the wastes for discoloration, odor, or other indicators of contamination. Similarly, RCRA procedures for determining whether a waste exhibits RCRA hazardous characteristics do not require testing if the decision can be made by applying knowledge of the characteristic in light of the materials or process used. In most instances, a determination may be made based on available information and professional judgment. This does not mean that IDW can be assumed to be nonhazardous unless clearly proven otherwise. Given the limited information available, the ERT contractor's TL, in conjunction with the ERT WAM, must determine whether it more likely than not that the wastes are hazardous.

To handle IDW properly, the contractor's TL must determine the types (such as soil cuttings, groundwater, decontamination fluids, PPE, or disposable equipment), characteristics (whether RCRA hazardous or containing other CERCLA hazardous substances), and quantities of anticipated wastes. As discussed previously, testing will generally not be required to characterize IDW if available information indicates that it does not likely contain hazardous waste or hazardous constituents.

Upon determining the types of anticipated IDW, the contractor's TL should determine IDW characteristics, in particular whether it is expected to be RCRA hazardous or to contain high concentrations of PCBs. For RCRA hazardous IDW (listed or characteristic), the contractor's TL should determine whether it poses an increased hazard to human health and the environment relative to conditions that existed prior to the site investigation. Field analytical screening results, if available, may be helpful indicators of IDW characteristics. However, the contractor's TL must remember that these are not RCRA tests and that the test results usually do not identify RCRA hazardous wastes. The contractor's TL must also determine the exact properties of RCRA nonhazardous IDW to select an appropriate disposal facility when the off-site disposal is required.

Upon determining the type and characteristics of IDW to be generated, the ERT contractor's TL must assess the anticipated quantities of waste. This should be done based on past experience with site investigations of similar scope.

3.3.3 On-Site IDW Handling Options

In planning the scope of work, the ERT contractor's TL must decide if IDW can be left on site or if it must be disposed off-site. Handling of RCRA hazardous IDW and IDW with high PCB concentrations (greater than 50 parts per million [ppm]) may involve either moving the IDW within an AOC unit, or containerization, storage, testing, treatment, and off-site disposal. It is preferable to leave both RCRA hazardous and nonhazardous IDW on site within an AOC unit whenever it complies with regulations, does not pose any immediate threat to human health and the environment, or there is not a high probability of serious community concerns. The contractor's TL must determine procedures for handling IDW on site in conjunction with the WAM.

RCRA Nonhazardous IDW

If IDW are RCRA nonhazardous soil or water, they should be left on site unless other circumstances, such as state ARARs or a high probability of serious community concerns, require off-site disposal. RCRA hazardous soil also may be left on site. The on-site handling options available when IDW are RCRA nonhazardous are listed below.

For soil cuttings:

1. Spread around the well.
2. Put back into the boring.
3. Put into a pit within the AOC.
4. Dispose of at the site's operating treatment/disposal unit (TDU).

For groundwater:

1. Pour onto ground next to well to allow infiltration.
2. Dispose of at the site's TDU.

For decontamination fluids:

1. Pour onto ground (from containers) to allow infiltration
2. Dispose of at the site's TDU.

For decontaminated PPE and disposable equipment:

1. Double bag and deposit the bags on the site or in a U.S. EPA dumpster, or in any municipal landfill.
2. Dispose at the site's TDU if available.

RCRA Hazardous IDW

If IDW are considered RCRA nonhazardous due to lack of information on the waste hazard, the ERT contractor's TL should have an alternate plan for handling IDW if field conditions indicate that these wastes are hazardous. In such a case, there should be an adequate number of containers available for collecting groundwater, decontamination water, soil cuttings, etc.

If IDW consists of RCRA hazardous soils that pose no immediate threat to human health and the environment, plan on leaving it on site within a delineated AOC unit. However, one must also consider the proximity of residents and workers in the surrounding area and use best professional judgment to make these decisions. Planning for leaving RCRA hazardous waste on site involves:

- Delineating the AOC unit.
- Determining pit locations close to the borings within the AOC unit for waste burial.
- Covering hazardous IDW in the pits with surficial soil.
- Not containerizing and testing wastes designated to be left on site.

Another alternative for handling RCRA hazardous soil is disposal in a TDU located on the same property as the AOC under investigation. If the TDU is outside the AOC, it must comply with the off-site policy. If any decontamination fluids are generated which are RCRA hazardous wastes, they should be disposed off-site in compliance with the off-site policy or in compliance with the conditionally exempt small quantity generator exemption. Small quantities (i.e., no more than 100 kg/month) of decontamination fluids may be containerized prior to delivery to a hazardous waste facility.

3.3.4 Options Available for Off-Site Disposal of IDW

IDW should be disposed of off-site in the following situations:

- When identified as RCRA hazardous water
- When identified as RCRA hazardous soil that may pose a substantial risk if left at the site
- When identified as RCRA hazardous PPE and disposable equipment
- If leaving them on site would create increased risks at the site

RCRA nonhazardous wastes could be disposed off-site at appropriate RCRA nonhazardous facilities that are in compliance with CERCLA section 121(d)(3) and off-site policy when it is necessary to comply with legally enforceable requirements such as state ARARs that preclude on-site disposal. IDW designated for off-site disposal must be properly containerized, tested, and stored before pick up and disposal. Decontaminated PPE and disposable equipment should be double-bagged if sent to an off-site dumpster or municipal landfill.

Planning for off-site disposal should include the following guidelines:

- Informing the WAM that containerized IDW may be temporarily stored on site while awaiting pick up for off-site disposal
- Initiating the procurement process for IDW testing, pick up and disposal
- Coordinating IDW testing and pick-up activities
- Preparing adequate numbers and types of containers. Drums should be used for collecting small amounts of IDW. Larger amounts of soil and water can be contained in Baker tanks, poly tanks, and bins. PPE and disposable equipment should be double-bagged for disposal at a municipal landfill or collected in drums for disposal at a hazardous waste facility.
- Designating a storage area (either within the site's existing storage facility, existing

fenced area, or within a temporary fence constructed for the site investigation). No humans, children in particular, may have access to the storage area.

All IDW shipped off site, whether RCRA hazardous or not, must go to facilities that comply with the RCRA disposal policy, and the ERT contractor's TL, in conjunction with their Purchasing Department, must verify that the facilities operate in accordance with this policy.

3.4 Equipment/Apparatus

Equipment, materials, and supplies needed for containerizing IDW are generally selected based on waste characteristics or constituents. Other considerations include the case of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, 5-gallon buckets, plastic bags, etc. can help segregate contaminated materials. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

3.4.1 Waste Disposal

- Trash bags
- Trash containers
- 55-gallon drums or 5-gallon pails
- Metal/plastic buckets/containers for storage and disposal of decontamination solutions

3.4.2 Decontamination Equipment

- Drop cloths of plastic or other suitable materials
- Large galvanized tubs
- Wash solutions
- Rinse solutions
- Long-handled, soft-bristled brushes
- Paper or cloth towels
- Metal or plastic cans or drums
- Soap or wash solution

4.0 RESPONSIBILITIES

4.1 ERT Work Assignment Manager

The ERT WAM is responsible for providing technical expertise and technical direction to the contractor, preparing task orders/work assignments, reviewing deliverables, interacting with the Regional customers and monitoring the financial and administrative management of the project.

4.2 ERT Contractor's Task Leader

The contractor's TL becomes familiar with the available site history, sampling process and the waste(s) generated before and during field activities. Ensures proper storage/containerization of IDW so it is protected from the elements, covered except for when waste is added, and accessible by equipment needed to remove it. Takes samples of waste(s) for analysis if needed. Provides a physical description of the waste(s) and works closely with the hazardous waste coordinator to

complete waste profiles. They share site history, known contaminants, information about likely IDWs with their HSO and Hazardous Waste Coordinator well in advance of site mobilization. This would not apply to emergency responses with rapid start-up.

4.3 ERT Contractor's Health and Safety Officer

The contractor's HSO works with the contractor's TL and Hazardous Waste Coordinator to ensure that IDW management is compliant with applicable regulations. The HSO works with the TL to convene meetings as necessary to ensure necessary parties participate and that necessary investigation and planning are conducted in advance of field work to determine proper disposition of IDWs.

4.4 ERT Contractor's Hazardous Waste Coordinator

Obtains the federal hazardous waste generator identification number from the ERT WAM if needed. Contracts a reputable waste disposal service, completes waste profiles, and schedules waste removal. Requests additional analysis if required. Complies with Off-Site Rule 40 CFR 300.440. Reviews all paperwork for accuracy prior to signature by the ERT WAM. Maintains documentation in an organized file for all IDW removed. Provides ERT WAM with copies of manifests, Off-Site Rule communications and waste profiles.

5.0 REFERENCES

U.S. EPA, Management of Investigation-Derived Wastes During Site Inspections, Office of Emergency and Remedial Response Directive 9345.3-02, May 1991.

U.S. EPA, Guide to Management of Investigation Derived Wastes, Office of Solid Waste and Emergency Response Memorandum 9345.3.03FS, January 1992.

Code of Federal Regulations, Title 40, Part 261, Section 23, Section 11 (a) (3), and Section 24 (a) (b).

CFR Proposed Criteria: 51 FR 21685, June 30, 1986 and 51 FR 21450, May 20, 1992.

6.0 APPENDICES

This section is not applicable to this SOP.

OPERATION OF THE NITON XLt792YW FIELD PORTABLE X-RAY FLUORESCENCE INSTRUMENT

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14.0 BIBLIOGRAPHY

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1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to outline the steps required for the start-up, check out, operation, calibration, and routine use of the NITON Xlt 792YW field-portable x-ray fluorescence (XRF) instrument. The data generated using this SOP meets the Screening Data objective for a quick, preliminary assessment of site contamination, and provides preliminary analyte identification and quantification. Screening data without associated confirmation data are generally not considered to be data of known quality. This SOP supplements the NITON Xlt 700 Series Environmental Analyzer User's Guide (NITON 2004) that contains detailed information for optimizing instrument performance and for utilizing different applications. The principles of operation are detailed in Appendix A.

Solid and liquid samples may be analyzed with the NITON XLt792YW for elements potassium (K) through uranium (U) with proper X-ray tube/filter selection, application setup, measurement conditions, and instrument calibration. Typical environmental applications include:

- Heavy metals in soil (in-situ or samples collected from the surface or from bore whole drillings), sediments, and sludges.
- Heavy metal air particulates collected on membrane filters, either from personnel samplers or from high volume samplers.

The manufacturer recommends operating within a temperature range of 20 to 120 degrees Fahrenheit (°F).

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure the methods used are adequate to satisfy the data quality objectives listed in the site-specific QAPP.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

2.0 METHOD SUMMARY

Miniaturized X-ray tube technology is used by the NITON XLt792YW XRF instrument for the production of primary X-rays. This technology combined with multiple programmable primary excitation filters, eliminates the need for multiple radioisotope sources. Each filter transmits a specific range of primary X-rays, which excite a corresponding range of elements in a sample.

A sample is positioned in front of the X-ray tube/detector window and sample measurement is initiated. This exposes the sample to filtered primary radiation. Fluorescent and backscattered X-rays from the sample enter through the detector window and are counted by the high-performance, solid-state detector.

Elemental concentrations are computed based on ratios of analyte X-ray intensity to backscatter. The raw ratios are corrected for spectral overlap and inter-element effects. The NITON XLt792YW is factory calibrated, and the menu-driven software supports multiple calibrations called "test modes." Each test mode is a complete analysis configuration including elements to be measured, interfering elements in the sample, and a set of calibration coefficients. The manufacturer states that the "Standard Soil Mode" for the NITON

XLt792YW may be used when: 1) the percentage of the elements of interest are less than (<) 1.0%, 2) the material is of a light matrix (for example, aluminum silicate), and 3) elements with atomic number greater than iron do not exceed several percent.

Measurement time is user controlled. Shorter measurement times (30 - 60 seconds [s]) are generally used for initial screening and hot spot delineation, while longer measurement times (60 - 300s) are typically used for higher precision and accuracy requirements.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

Refer to Section 7.5, Sample Handling and Presentation.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Total method error for XRF analysis is a combination of both instrument precision and user- or application-related error. Instrument precision is typically the least significant source of error in XRF analysis. User- or application-related error is generally more significant and will vary with each site and method used. The following are examples of user or application-related errors:

- Sample Placement - This is a potential source of error because the X-ray signal decreases as the distance from the X-ray source is increased. This error may be minimized by maintaining the same distance for each sample. Sample geometry with respect to the X-ray tube/detector is also important. A tilted sample may cause analytical error. The NITON Xlt792YW ratios analyte X-ray lines to backscatter, which minimizes this type of error.

- Sample Representivity - To accurately characterize site conditions, samples collected must be representative of the site or area under investigation. Representative soil sampling ensures that a sample or group of samples accurately reflects the concentration of the contaminant(s) of concern at a given time and location. Analytical results from representative samples reflect the variation in pollutant presence and concentration range throughout a site. Variables affecting sample representativeness include: (1) geologic variability, (2) contaminant concentration variability, (3) collection and preparation variability, and (4) analytical variability. Attempts should be made to minimize these sources of variability. For additional information on representative sampling, refer to "Removal Program Representative Sampling Guidance, Volume 1 - Soil." (U.S. EPA/ERT 1991).

- Reference Analysis - Soil chemical and physical matrix effects may be corrected (to some extent) by adjusting XRF results (via regression) using site-specific soil samples which have been analyzed by Inductively-Coupled Plasma (ICP) or Atomic Absorption (AA) spectroscopy methods. A major source of error can result if these samples are not representative of the site and/or if the analytical error is large. Additionally, when comparing XRF results with reference analyses results, the efficiency of the sample digestion reference analysis should be considered. Some digestion methods may breakdown different sample matrices more efficiently than others.

- Chemical Matrix Effects - Chemical matrix effects result from differences in concentrations of interfering elements. These effects appear as either spectral interferences (peak overlaps) or as X-ray absorption/enhancement phenomena. Both effects are common in soils contaminated with heavy metals. For example, iron (Fe) tends to absorb copper (Cu) X-rays, reducing the intensity of Cu measured by the

detector. This effect can be corrected mathematically through the use of inter-element correction coefficients.

- Physical Matrix Effects - Physical matrix effects are the result of variations in the physical character of the sample and include parameters such as particle size, uniformity, homogeneity, and surface condition. For example, consider a sample in which the analyte exists in the form of very fine particles within a matrix composed of much coarser material. If two separate aliquots of the sample are prepared in such a way that the matrix particles in one are much larger than in the other, then the relative volume of analyte occupied by the analyte-containing particles will be different in each. When measured, a larger amount of the analyte will be exposed to the source X-rays in the sample containing finer matrix particles, resulting in a higher intensity reading for that sample and, consequently, an apparently higher measured concentration for that element.

- Application Error - Generally, the error in the application calibration model is insignificant (relative to the other sources of error) **PROVIDED** the instrument's operating instructions are followed correctly. However, if the sample matrix varies significantly from the design of the application, the error may become significant (e.g., using the Standard Soil Mode application to analyze a 50% iron mine tailing sample).

- Moisture Content - Sample moisture content affects the analytical accuracy of soil or sludge. The overall error may be secondary when the moisture range is small (5 to 20%), or it may be a major source of error when measuring the surface of soils that are saturated with water. NOTE: Attempting an in-situ measurement on a saturated soil may damage the instrument.

- Cases of Severe X-ray Spectrum Overlaps - When present in the sample, certain X-ray lines from different elements can be very close in energy and therefore, can interfere by producing a severely overlapped spectrum.

  Typical spectral overlaps are caused by the K-beta (K_β) line of element Z-1 (or as with heavier elements, Z-2 or Z-3) overlapping with the K-alpha (K_α) line of element Z. This is the so-called K_α/K_β interference. Since the K_α:K_β intensity ratio for the given element usually varies from 5:1 to 7:1, the interfering element, Z-1, must be present in large concentrations in order to affect the measurement of analyte Z. For example, the presence of large Fe concentrations could affect the measurement of cobalt (Co). The Fe K_α and K_β energies are 6.40 and 7.06 kiloelectron volts (KeV), respectively, and the Co K_α energy is 6.93 KeV. The resolution of the XLT792YW detector is approximately 250 electron volts (eve). Therefore, large amounts of Fe in a sample will result in spectral overlap of the Fe K_β with the Co K_α peak (Figure 1, Appendix B) and the resultant X-ray spectrum will include TOTAL counts for Fe plus Co lines.

  Other interferences arise from K/L, K/M, and L/M line overlaps. While these are less common, the following are examples of severe overlap: Arsenic (As) K-alpha (K_α)/Lead (Pb) L-alpha (L_α) and Titanium (Ti) K_α/Barium (Ba) L_α

  In the As/Pb case, Pb can be measured from the Pb L-beta (L_β) line, and As from either the As K_α or the As K_β line; this way the unwanted interference can be corrected. However, due to the limits of mathematical corrections, measurement sensitivity is reduced. Typically, As concentrations cannot be efficiently calculated in samples with Pb: As ratios of 10:1 or more. This may result in As being reported

as a non-detect, regardless of what the actual concentration is.

The NITON Xlt792YW uses overlap factors to correct for X-ray spectral overlaps for the elements of interest for a given application.

5.0 EQUIPMENT/APPARATUS

5.1 Description of the NITON XLt792YW System

The NITON XLt792YW is a complete, hand-held, portable X-ray tube based XRF analyzer that is powered from a four to six (4-6) hour capacity battery. The instrument utilizes the method of Energy Dispersive X-Ray Fluorescence (EDXRF) spectroscopy to determine the elemental composition of soil, sludge, particulate, and other waste materials.

The NITON XLt792YW analyzer includes a miniaturized X-ray tube plus multiple primary filters. The user enables the filters and the analyzer software reports concentrations based on stored information for each test mode. Measurement time is user determined. The NITON XLt792YW utilizes a high performance, electrically-cooled, solid-state detector optimized for L-shell and K-shell X-ray detection.

The unit provides internal non-volatile memory for storage of up to 3000 readings (multi-element analysis reports) including X-ray spectra. A RS-232 serial port is provided for downloading results and spectra to a PC. The multi-element analysis reports and spectra can be displayed on the instrument's display screen. The replaceable and rechargeable lithium-ion battery pack provides for field-portable operation.

The NITON XLt792YW is supplied with one or more test modes (applications). The “Standard Soil Mode” application is for analysis of up to 25 metals, where the balance of the sample (that portion not directly measured by the instrument) is essentially silica (SiO_2). The "Thin Sample" application is for analysis of thin films such as air monitoring filters or wipes. Consult the manufacturer to develop new applications to meet user-specific requirements (e.g., adding elements to the "Standard Soil Mode" application).

5.2 Equipment and Apparatus List

5.2.1 NITON XLt792YW Analyzer System

- Hand-held analyzer unit for data acquisition and processing, integrated touch-screen, and display, including a high-performance, solid-state detector, miniaturized X-ray tube/primary filters for excitation, remote control and data processing software, and control panel/results display
- RS-232C Serial Input/Output (I/O) Interface cable
- Battery charger
- Two battery packs, rechargeable lithium-ion

- System carrying/shipping case and field carrying case/holster
- Soil sample analysis/preparation accessories in separate carrying/shipping case
- NITON Xlt 700 Series Environmental Analyzer User's Guide, NITON Data Transfer (NDT) software, and remote control (NDTR) software

5.2.2 Optional Items

- 31-millimeter (mm) diameter sample cups
- XRF polypropylene film, 0.2 mil thick
- Windows-based Personal Computer (PC)
- Spare battery packs and spare charger
- Sample preparation accessories (such as drying ovens, grinders, sieves, etc.) for mobile or stationery laboratory use

See the NITON XLt792YW Accessories List for additional options.

5.3 Peripheral Devices

The NITON XLt792YW may be used with a PC to download results/spectra, for customized reports, and to remotely control the analyzer.

5.3.1 Communication Cable Connection - Plug the micro stereo connector end of the RS-232 Serial I/O cable into the NITON XLt792YW connector port in the handle of the analyzer (the connection on the battery pack) and the nine-pin connector of the cable into the serial port of the PC (May require a RS-232 to USB adaptor. Recently manufactured computers do not have RS-232 inlet).

5.3.2 NITON XLT 700 Series Software - The PC must be running the NITON NDTR software to remotely control the NITON XLt792YW. The NDT software allows the user to select various configurations for downloading, exporting, displaying, and reporting results/spectra. Refer to the NITON Data Transfer (NDT) User's Guide and NITON Guide to NDTR for details.

6.0 REAGENTS

- SiO_2 check sample or acid washed sand sample, used as a negative control or blank check
- National Institute of Standards and Technology (NIST) soil standard reference materials (SRMs) #2709A, 2710A, and 2711A, target element response check used for accuracy. Refer to Appendix C for certified values.

- Resource, Conservation, and Recovery Act (RCRA) check sample, 500 parts per million (ppm) nominal concentration (NOT certified), used for precision (supplied by NITON).

- Other NIST and/or precision standards depending on site requirements.

7.0 PROCEDURES

7.1 Instrument Operation

7.1.1 Startup

Attach the battery pack to the unit; fully insert the pack ensuring that it seats properly and the battery housing latch resets. Depress and hold the on/off/escape button on the control panel for approximately 3 seconds until you hear a beep On startup, the **Restart** screen will be displayed and will automatically count down from 9 to 0 in one second increments. When **Restart** is complete, the **Logon** screen will be displayed. Tap anywhere on this screen to access the virtual touch pad. Logon as a user by entering the password 1-2-3-4 followed by the "E" key. After you have completed the logon procedure, the word "SUCCESS" displays on the bottom of the screen, then the **Main Menu** is displayed.

Allow the NITON XLt792YW to warm up for a minimum of 20 minutes before performing analysis.

7.1.2 Precautions

The NITON XLt792YW should be handled in accordance with the following radiological control practices.

Refer to the NITON Xlt 700 Series Environmental Analyzer User's Guide for detailed discussion of Radiation Safety practices.

1. Keep your hands and all body parts away from the front end of the instrument when the shutter is open. When the shutter is open, under no circumstances should the analyzer be pointed at the operator or surrounding personnel.

2. Open the shutter only to do a test. The shutter can only be opened after the user has logged on to the instrument using the password.

3. The NITON XLt792YW should always be in contact with the surface of the material being analyzed and the material should completely cover the aperture when the X-ray tube is on (shutter is open). Do not remove a sample or move the unit while the X-ray tube is on.

4. Under no circumstances should the X-ray tube be on when the instrument is not in use. NOTE: The 3 warning lights on the instrument will blink on and off whenever the X-ray tube is on, and will continue to blink as long as the X-ray tube

is on. In the unlikely event that the X-ray tube remains on when a sample is not being measured, disconnect the battery pack and immediately notify the manufacturer (NITON).

5. The manufacturer (NITON) must be notified immediately of any condition or concern relative to the NITON XLt792YW's structural integrity, X-ray tube shielding, or operability.

6. Labels or instructions on the NITON XLt792YW must not be altered or removed.

7. The user must not attempt to open the unit.

8. The bulk test platform or equivalent sample stage provided by NITON LLC must be used whenever the NITON XLt792YW is used for measuring samples contained in XRF cups.

9. The NITON XLt792YW should not be dropped or exposed to conditions of excessive shock or vibration.

Additional precautions include:

1. The NITON XLt792YW should always be stored in its waterproof, drop-proof carrying case.

2. The battery charging unit should only be used in dry conditions.

3. Battery packs should be changed only in dry conditions.

7.2 Control Panel and Menu Software

This section outlines the control panel buttons and basic menu software. Detailed illustrations of the control panel, menus, and screen displays are in the NITON Xlt 700 Series Environmental Analyzer User's Guide.

7.2.1 The Control Panel

The NITON control panel is located on the instrument's top housing, directly below the LCD touch screen. The control panel consists of a 4-way touch pad and two control buttons, one on each side of the touch pad. Using either the control panel or the touch screen, allows the operator to navigate all the NITON screens and menus. The 4-way control pad moves the screen cursor to highlight each menu option. The enter button on the right side of the 4-way touch pad is used to select highlighted menu options. The on/off/escape button both controls the power to the instrument and serves as an "escape" button. When this button is depressed and immediately released, it functions as "escape" and returns from the current screen to the Main Menu.

7.2.2 The Menu System

Menus are presented as icons which, when selected, will do one of three things:

1. **Toggle** between two different functions or views.
2. Display a **sub-menu**, which allows the users to access more choices.
3. Display a **screen** allowing the user to view data, edit data, or control the unit.

Icons that are displayed in light gray represent features that are not enabled and, therefore, cannot be selected. Icons that are displayed with a diagonal line through them represent features that are currently turned off. Selecting an icon with a diagonal line erases the line and enables that feature.

7.2.3 The Main Menu

The Main Menu and subsidiary menus are used to access all NITON Xlt instrument functions. The instrument functions represented by icons on the Main Menu are: Test, Mode, Utilities, Data, and Common Setup. The Logoff icon returns to the Logon screen. Refer to the NITON Xlt 700 Series Environmental Analyzer User's Guide for detailed instructions on using the Main Menu.

7.2.4 The Mode Menu

The Mode Menu allows the operator to select any one of the sample test modes that have been installed on the particular NITON XLt analyzer. The Standard Soil Mode is used for soil/sediment analysis with the XLT792YW.

7.2.5 The Utilities Menu

The Utilities icon on the Main Menu accesses the Utilities Menu. This menu allows the operator to view instrument settings, set date and time, auto-calibrate the NITON detector or touch screen display, rotate the display on the LCD screen, or change communication rate for the RS-232 port.

Select the Date & Time icon to set the date and time as needed. The Date & Time screen displays date/time information in the format: mm/dd/yy hh:mm. Initially, the first character of the month is highlighted in reverse video. To change a character, select the digit from the virtual numeric keypad displayed on the screen, then select the Enter (E) character. The unit accepts the entry and advances to the next digit. To skip a digit; select the Enter (E) character. When Enter (E) is selected to confirm the last digit, the word "SUCCESS" is displayed below the Date field, and the Utilities Menu is displayed.

Select the Return icon to return to the Main Menu.

7.2.6 The Calibrate Menu

Select the Calibrate icon from the Utilities Menu to access the Calibrate Menu, which allows the operator to calibrate the detector or calibrate the touch screen. Select the Calibrate Detector icon to re-calibrate the instrument's electronics. This process calibrates detector energy gain/zero so that analyte X-rays are in their proper spectral location. Self-calibration takes about two to four minutes. When it is complete, the calibration results will be displayed. Note and record the "Res" value and the time for detector calibration. The self-calibration process should be performed every 4 to 6 hours during sample analysis to maintain proper detector calibration. Select the Return icon to return to the Utilities menu.

7.2.7 The Data Menu

The Data icon on the Main Menu accesses the Data Menu. This menu allows the operator to access readings and libraries for viewing or manipulation. Select the View Data icon to view previous test result readings. Select the Erase icon to access the Erase Menu.

7.2.8 The Erase Menu

The Erase Menu allows the operator to delete data from analyzer memory. Data should only be erased after it has been transferred (downloaded) to permanent storage. Select the Erase Readings icon to erase all accumulated test readings from analyzer memory. Select the Return icon to return to the Data menu.

7.2.9 The Common Setup Menu

Select the Common Setup icon from the Main menu to access the Common Setup Menu. This menu allows the operator to setup hardware, setup serial output, and set measurement protocol. Select the Set Protocol icon to access the Set Protocol Menu.

7.2.10 The Set Protocol Menu and Sub Menus

The Set Protocol Menu allows the operator to enable or disable any X-ray source and control measurement protocol. Select the Enable Sources icon to access the Filter Menu. The Filter Menu allows the operator to choose which of the primary filters contained in the NITON Xlt analyzer will be used for sample analysis. Select the Source Auto-Switch Time icon to access the Filter Time Menu, which allows the operator to set the measurement time for each enabled filter prior to auto-switching to the next filter.

7.2.10.1 The Filter Menu. Select the Enable Cd109 or Tube icon to toggle the X-ray tube between the enabled and disabled states. Select the Enable Filter icon to toggle the tube output filtering system between the enabled and disabled states. A black diagonal line will be displayed for disabled icons.

7.2.10.2 The Filter Time Menu. Select the Configure Filter 1 icon to set measurement time

for Filter 1 prior to auto-switching to the next filter. Select the Configure Filter icon to set measurement time for Filter 2 prior to auto-switching to the next filter.

7.2.11 Standard Soil Mode

Select the Test icon from the Main Menu to access the Standard Soil Mode on the NITON XLt792YW. This mode is used to analyze for contaminants in soil/sediment samples and uses Compton Normalization to automatically adjust for matrix effects. This mode is optimum for samples with elements of interest less than 1%.

Select the Data Entry icon to enter sample data prior to measurement. Type the parameters for the sample directly into the instrument using the Virtual Keyboard. The parameters that you enter will be attached to the next test that you perform.

7.2.12 The Results Screen

The Results Screen is displayed and updated regularly throughout the duration of each reading. When the reading is completed, a final update is done and final results are displayed. The concentration (ppm) and confidence (2-sigma, 95%) are displayed for each detected element. Results are divided into two groups: detected elements, and elements that were not detected. Press the up and down buttons on the 4-way touch pad to scroll through the element list. An element is classified as detected when the measured concentration (ppm) is at least 1.5-times the confidence level (i.e., 3-sigma). Non-detected elements are shown as "< xx", where xx is the 3-sigma instrument detection limit for that sample. The instrument detection limit (3-sigma) for each element is calculated for each sample.

7.3 Preoperational Checks

7.3.1 Energy Calibration

An energy calibration must be performed each time the analyzer is used or as required (e.g., after an instrument is shipped) to ensure proper energy calibration. The Detector Calibration function is located in the Calibrate Menu (see section 7.2.6). If the instrument does not calibrate properly, power down, power up, logon, wait 10 minutes, and re-calibrate.

NOTE: When sudden large changes in ambient temperature occur, the instrument may require re-calibration.

7.3.2 Resolution Check

The resolution check examines the detector's ability to resolve X-ray energies (Figure 2, Appendix B). This must be performed once at the beginning of the day. Record/document the Resolution and time in the Calibrate Detector Results screen (after Detector Calibration is completed). The value should not vary significantly from day to day and should typically be less than 300 eV. If the unit fails to meet this specification, call NITON for assistance. NOTE: The lower the number, the better the instrument will perform.

7.3.3 Blank (Zero) Sample Check

The blank (Zero) sample check is performed to monitor the instrument's zero drift in the selected application. The blank sample check only applies to the application (test mode) currently selected. This should be done once at the beginning of the day after Detector Calibration, after selecting a test mode, and whenever the instrument exhibits a persistent drift on a blank or low-level sample.

Load the SiO_2 Blank or acid washed sand sample in the NITON Bulk Sample Test Platform. Analyze for 120 seconds with each filter in the unit. Review results. All elemental results should be reported as non-detected (<xx, where xx is the 3-sigma instrument detection limit). Repeat the measurement if the unit fails to meet these specifications. If several elements continue to be significantly out of these specifications, check the plastic window and the blank sample for contamination. Perform the blank (Zero) sample check again. Save the results/spectra for documentation. Note: some elements may exceed the +/- 3-sigma limits with acid washed sand. If this happens, check the SiO_2 Blank sample.

7.3.4 Target Element Response Check

The purpose of the target element response check is to ensure that the instrument and the selected application are working properly prior to performing sample analysis. This check should be performed at the beginning and at the end of the working day. Use NIST SRMs 2709A, 2710A, and 2711A standards to check the Standard Soil Mode application. These samples should be measured using the same acquisition times that will be used for sample analysis. Save the sample check results/spectra for documentation.

7.4 Filter Measuring Time

The filter measuring time is user controlled. Generally, the element detection limit is reduced by 50 percent for every four-fold (x4) increase in measuring time. Although counting statistics improve as measurement time increases, the practical upper limit for typical applications is about 300 seconds.

A minimum measuring time of 120 seconds for each filter is recommended when using the Standard Soil Mode application. Measuring time for a filter that excites a specific target element can be increased if lower detection limits are required.

7.5 Sample Handling and Presentation

When making XRF measurements, be sure to maintain constant measurement geometry in order to minimize variations in analysis results. Document any anomalies in measurement geometry, sample surface morphology, moisture content, sample grain size, and matrix (see Section 4.0).

7.5.1 Soil Samples

Soil samples may be analyzed either in-situ or in XRF sample cups (after preparation). Appendix D summarizes sample preparation methods for field portable x-ray fluorescence (FPXRF) analysis. The Standard Soil Mode application assumes the sample to be infinitely thick. For in-situ measurements this is the case, however, for sample cup measurements it is advisable to fill the cup nearly full. This ensures that the sample is as uniformly thick as possible from analysis to analysis. The NITON XLt792YW bulk sample test platform or equivalent bulk sample platform provided by NITON must be used when analyzing sample cups.

An area for in-situ analysis should be prepared by removing large rocks, vegetation, and debris. The soil surface should be flat and compact prior to analysis. The NITON XLt792YW should be placed in the in-situ adaptor and held firmly on the ground to maximize contact with the ground. The unit should not be moved during analysis. Analysis of water-saturated soils should be avoided.

Coarse-grained soil conditions or nuggets of contaminated material may preclude a truly representative sample and adversely affect the analysis results. Such samples should be prepared before analysis. Preparation consistency is important to minimize variation in analytical results.

This application is designed for soil with the assumption that the balance of the material is essentially silica. If samples with a much lighter (lower atomic number) balance are analyzed, the results may be elevated. Contact NITON for help with the analysis of different matrices.

7.5.2 Thin (Filter) Samples

The Thin Samples application is for analysis of thin samples such as particulates on filters or wipes. The detection limits are affected by the thickness of the substrate. Best results are obtained on the thinnest substrates. Always use the Dust wipe and Filter Test platform when measuring thin samples. This is not only for user safety, but also ensures a controlled environment to facilitate testing thin samples. Contaminated material captured on filters or wipes is not usually deposited uniformly. Therefore, to produce meaningful results, several readings must be taken for each thin sample measurement. The average or sum of these readings is the reported value for the measurement. Refer to the NITON User's Guide for details on analyzing Thin Samples.

7.6 Downloading Stored Results and Spectra

Results (analytical reports) and spectra that have been stored in the NITON XLt792YW internal memory should be downloaded and captured in disk files on a PC (see section 5). NITON LLC provides software (NDT) for this purpose. Additionally, results or spectra may be exported to text files for importing into a spreadsheet. Refer to the operators manuals provided with this program for operation details.

After capturing results to a file, print a copy and save both the disk files and the printout for future reference and documentation purposes.

7.7 Instrument Maintenance

NOTE: All service except exterior cleaning must be performed by NITON LLC. Do not attempt to make repairs yourself. Opening the case of the NITON XRF instrument will void the Warranty.

7.7.1 Exterior Cleaning

When the Kapton plastic window on the front of the instrument becomes dirty, the performance of the NITON XLt792YW unit will be affected. Clean the window gently with cotton swabs. Clean the body of the instrument with a soft cloth. Never use water, detergents, or solvents. These may damage the instrument.

7.7.2 Further Information and Troubleshooting

Refer to the NITON XLt792YW 700 Series Environmental Analyzer User's Guide for additional detailed operational and/or maintenance and troubleshooting instructions. If no solution is found in the manual, contact NITON LLC for assistance.

An instrument log should be maintained to document specific corrective actions taken to alleviate any instrumental problems, or for recording any service that has been performed.

7.8 Reporting Results

All raw XRF data should be recorded including the individual results of multiple analyses of samples and sampling points. The average and concentration range of each multiple analysis should also be reported.

A "reported" value for each analysis or average of multiple analyses should be processed in the following manner.

1. Round the value to the same degree of significance contained in the calibration or check standard sample assay values (usually two). Round to two significant figures for sample results. DO NOT round results for standards used to determine method detection limit (MDL) or relative standard deviation (RSD) values (use raw data).

2. Report all values less than the reporting limit (RL) as not detected (U).

3. OPTIONAL: Flag and note all values greater than or equal to (≥) the MDL and less than the RL (usually with a "J" next to the reported value).

4. Report all values equal to or greater than the RL. The linear range for the NITON XLt792YW generally extends to 10,000 to 15,000 ppm. While the unit may be used for

higher concentrations, these results should be verified by laboratory analyses.

8.0 CALCULATIONS

The NITON XLt792YW is a direct readout instrument that does not require any external calculations.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

Data verification (completeness checks) must be conducted to ensure that all data inputs are present for ensuring the availability of sufficient information. These data are essential to providing an accurate and complete final deliverable. The Contractor's Task Leader (TL) is responsible for completing the UFP-QAPP verification checklist for each project. In addition to the specific quality assurance (QA) activities listed below, the following general QA procedures apply:

- All sample data, pre-operational and operational checks must be documented in the instrument run or analysis log;
- The instrument must be operated in accordance with this SOP and the manufacturer's recommendations;
- Preventive maintenance is conducted at the intervals recommended by the manufacturer;
- Records must be maintained, documenting the level of competency for the Contractor's personnel who will operate the instrument; and
- Results may also be recorded electronically on a hard drive or floppy disk.

9.1 Calibration Check

The self-calibration or energy calibration (Section 7.2.6) must be performed each time the instrument is used and may be performed every 4 to 6 hours during sample analysis to maintain proper detector calibration.

9.2 Resolution Check

A detector resolution check must be performed and documented at the beginning of each day or eight-hour shift.

9.3 Blank Check

The blank check must be performed and documented at the beginning of each day or eight-hour shift, after calibration, after selecting a test mode, or whenever the instrument drifts on the blank or a low-level sample.

9.4 Precision

The precision of the method is monitored by reading a low- or mid-level sample (e.g., SRM or RCRA sample) at the beginning and end of sample analysis and after approximately every tenth sample. Determining the precision around the site action level can be extremely important if the XRF results are to be used in an enforcement action. Therefore, selection of a sample with a target element concentration at or near the site action level or level of concern is recommended. The sample is analyzed by the instrument for the normal field analysis time, and the results are recorded.

A minimum of seven measurements should be made during field activities. The standard deviation for each target element is calculated. The RSD of the sample mean can be used to calculate precision. The percent relative standard deviation (%RSD) should be within ± 20 percent (U.S. EPA/ERT 1991).

9.5 Method Detection Limit and Reporting Limit

The MDL and RL are dependent upon site conditions and data quality objectives and, therefore, are site/project specific. They must be calculated from the measurement of either a low or blank sample (or a SRM) at the start and end of sample analysis, and after approximately every tenth sample during field activities. Alternatively, the SiO_2 blank or "clean" acid washed sand may be used if a blank soil or sediment sample is unavailable.

Determine the MDL using the same application and measuring time used for site samples. A minimum of seven measurements should be made during field activities. Calculate the sample standard deviation of the mean (σs) for each target element, and round up to the next whole number prior to calculating the MDL and RL.

The definition of the MDL is defined as follows:

$$MDL = t\,(n - 1, 99) * \sigma s$$

Where:

t (n – 1,99) = student's t-value for a 99% confidence level and
a standard deviation estimate with n – 1 degrees of freedom

σs = sample standard deviation (n – 1 degrees of freedom)

Since FPXRF is a screening technique, the definition of the RL is 1 to 5 times the MDL depending on element, soil type, site data quality objectives, and operator professional judgment.

NOTE: Although the ERT/SERAS Laboratory recognizes that the MDL procedure has been updated to conduct MDLs in three separate batches on three separate calendar days and analyzed on three separate calendar dates, this method does not lend itself to being able to prepare low-level spiked samples at two to ten times the estimated MDL. This method uses certified standard reference materials from NIST that may not fall into the range specified in Revision 2 of 40 CFR Part 136.

Appendix E lists typical MDL values for the NITON Xlt 792YW FPXRF analyzer.

9.6 Accuracy

The results obtained using NIST SRMs #2709A, 2710A or 2711A should fall within ± 20% of the true value for contaminant concentrations at least five times the XRF RL. Certified concentrations are listed in Appendix C.

9.7 Confirmation Analysis

The comparability of the data, relative to a specific digestion method and elemental analysis procedure, is determined by submitting a sample analyzed by XRF methods (prepared sample cups may be submitted) for AA or ICP analysis at a laboratory.

The on-site analysis of soils by field-portable XRF instrumentation should be considered screening data only [data category (SD)]. Data derived from the instrument should be used with discretion. Confirmatory analyses on a subset of the screening samples (minimum 10%) can be used to determine if the XRF data meets the Screening Data with Definitive Confirmation (SD/DC) data objective. The confirmation samples should ideally be selected randomly from the sample set. A random selection of samples at or near the critical level may also be selected for confirmation in addition to the original random selection. The results of the laboratory analysis (dependent) and the XRF analysis (independent) are evaluated with a regression analysis. The coefficient of determination (r^2) should be 0.7 or greater (U.S. EPA/ERT 1991).

Correcting the XRF results based on confirmatory analyses should only be undertaken after careful consideration. The laboratory analysis (AA or ICP) is an estimate of the extractable concentration of metal contamination and is dependent upon the digestion method and sampling methodology used. Since XRF is a total elemental technique, any comparison with referee results must account for the possibility of variable extraction efficiency, dependent upon the digestion method used and its ability to dissolve the waste or mineral form in question (see Appendix C, refer to the addendum attached to the NIST Certificates of Analysis for SRMs 2709A, 2710A, 2711A available at the NIST web site https://www.nist.gov).

9.8 Matrix Considerations

Other types of quality assurance/quality control (QA/QC) verification should include verification that the instrument calibration is appropriate for the specific site to be assessed. This includes verification of potential multiple soil matrix types that may exist at a site. Matrix differences that affect the XRF measurement include large variations in calcium content, which may be encountered when going from siliceous to calcareous soils, as well as large variations in Fe content.

9.9 Demonstration of Capability

Prior to running a method or any time there is a change in instrument type, personnel or test method or any time a method or analyst has not performed a method in a twelve-month period, an analyst must demonstrate acceptable performance for that method. This is known as the initial demonstration of capability (DOC). Four aliquots of a QC standard must be prepared and analyzed according to the method over one or a period of days. For this particular method, NIST or other vendor certified QC samples will be used. Using Excel, the analyst must provide a table containing the following: Results of the 4 replicates, Mean Concentration, Mean Recovery, Standard Deviation and %RSD. Results obtained using NIST SRMs 2709a, 2710a and 2711a should fall within ±20& of the true value of the analyte if the result is at least five times the RL.

10.0 DATA VALIDATION

10.1 Screening Data

The Contractor's XRF analyst reviews the data prior to submittal to the ERT Work Assignment Manager (WAM) ensuring that the instrument has been operated in accordance with this SOP and manufacturer's recommendations and that all QA/QC checks have been performed. Screening data is evaluated for calibration and detection limits criterion only.

10.2 Screening with Definitive Confirmation

Confirmation samples are recommended at a minimum rate of 10% and are required if SD/DC data objectives have been established for site activities (U.S. EPA/ERT 1991). Ideally, the sample cup that was analyzed by XRF should be the same sample that is submitted for AA/ICP analysis. When confirming an in-situ analysis, collect a sample from a 12-inch by 12-inch area for both an XRF measurement and confirmation analysis.

The XRF and confirmatory AA/ICP results are analyzed with a regression analysis using a statistical program (such as SAS®) or a spreadsheet with the intercept calculated in the regression. The r-square value (r^2) between XRF and AA/ICP data must be ≥ 0.7 for the SD/DC data objective (U.S. EPA/ERT 1991).

11.0 HEALTH AND SAFETY

Based on Occupational Safety and Health Administration (OSHA) requirements, a site-specific health and safety plan (HASP) must be prepared for response operations under the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, 29 CFR 1910.120. Field personnel working for EPA's Environmental Response Team (ERT) should consult the Emergency Responder Health and Safety Manual currently located at https://response.epa.gov/_HealthSafetyManual/manual-index.htm for the development of the HASP, required personal protective equipment (PPE) and respiratory protection.

12.0 REFERENCES

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13.0 APPENDICES

A - Principles of Operation
B - Figures
C - Certified Standard Values
D - Sample Preparation for FPXRF Analysis
E - Typical MDL Values for the NITON XL722S FPXRF Analyzer

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APPENDIX A
Principles of Operation
SOP: ERT-PROC-1720-20
June 2020

Principles of Operation

X-ray Fluorescence spectroscopy is a non-destructive, qualitative and quantitative analytical technique used to determine the chemical composition of samples. In an X-ray tube excited XRF analysis, primary X-rays emitted from an X-ray tube are utilized to irradiate samples. A primary filter may also be used to modify the distribution of incident X-rays irradiating the sample. During interaction with samples, tube X-rays may either undergo scattering (dominating process) or absorption by sample atoms in a process known as the photoelectric effect (absorption coefficient). This phenomenon originates when incident radiation knocks out an electron from the innermost shell of an atom creating a vacancy. The atom is excited and releases its surplus energy almost instantly by filling the vacancy with an electron from one of the higher energy shells. This rearrangement of electrons is associated with the emission of X-rays characteristic (in terms of energy) of the given atom and this process is referred to as emission of fluorescent X-rays (fluorescent yield). The overall efficiency of the fluorescence process is referred to as excitation efficiency and is proportional to the product of the absorption coefficient and the fluorescent yield.

Characteristic X-rays

The NITON XLt792YW analyzes characteristic X-ray lines originating from the innermost shells of the atoms: K, L, and occasionally M. The characteristic X-ray lines of the K series are the most energetic lines for any element and, therefore, are the preferred analytical lines. The K lines are always accompanied by the L and M lines of the same element. The energies of the L and M lines are much lower than the K lines and can usually be neglected for those elements for which the K lines are analytically useful. For heavy elements such as cerium (Ce) (atomic number, Z=58) to uranium (U, Z=92), the L lines are the preferred lines for analysis. The L-alpha (L_{α}) and L-beta (L_{β}) lines have almost equal intensities, and the choice of one or the other depends on what interfering lines might be present. An X-ray source just energetic enough to excite the L lines will not excite the K lines of the same element. The M lines will appear together with the L lines.

An X-ray source can excite characteristic X-rays from an element only if the source energy is greater than the absorption edge energy for the particular line group of the element (e.g., K absorption edge, L absorption edge, M absorption edge). The absorption edge energy is somewhat greater than the corresponding line energy. The K absorption edge energy is approximately the sum of the K, L, and M line energies, and the L absorption edge energy is approximately the sum of the L and M line energies of the particular element.

Energies of the characteristic fluorescent X-rays are converted (within the detector) into a train of electric pulses, the amplitudes of which are linearly proportional to the energy. An electronic multichannel analyzer measures the pulse amplitudes, which is the basis of a qualitative X-ray analysis. The number of counts at a given energy is representative of element concentration in a sample and is the basis for quantitative analysis.

Scattered X-rays

The X-ray source radiation is scattered from the sample by two physical processes: coherent or elastic scattering (no energy loss), and Compton or inelastic scattering (small energy loss). Thus, the X-ray source backscatter (background signal) consists of two components; the higher energy component is equal to the source energy. Since the whole sample takes part in scattering, the scattered X-rays usually yield the most intense features in the spectrum, and - therefore, contribute most of the total measured intensity signal. The NITON XLt792YW utilizes filtered primary X-ray tube radiation where the filter absorption edge is typically the most prominent feature in the spectrum.

APPENDIX B
Figures
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FIGURE 1. X-Ray Spectral Plot Showing Overlap of Iron K_β X-Rays in the Cobalt K_α Measurement Region.

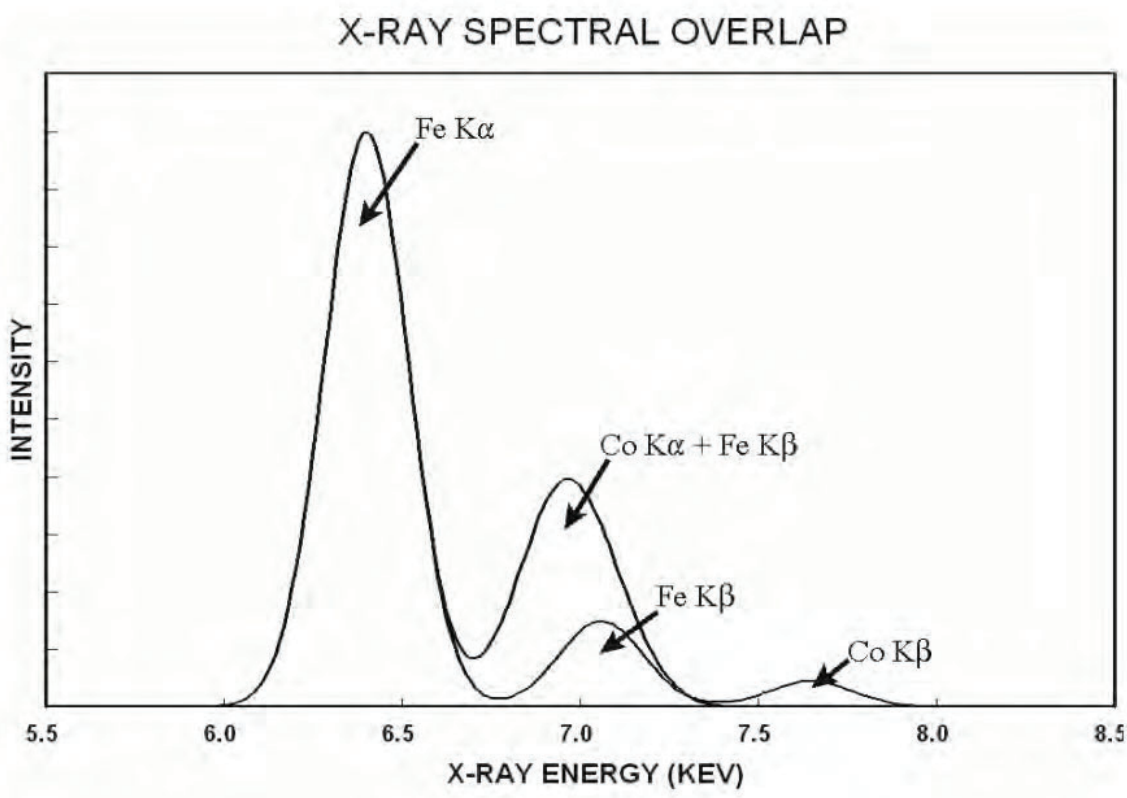
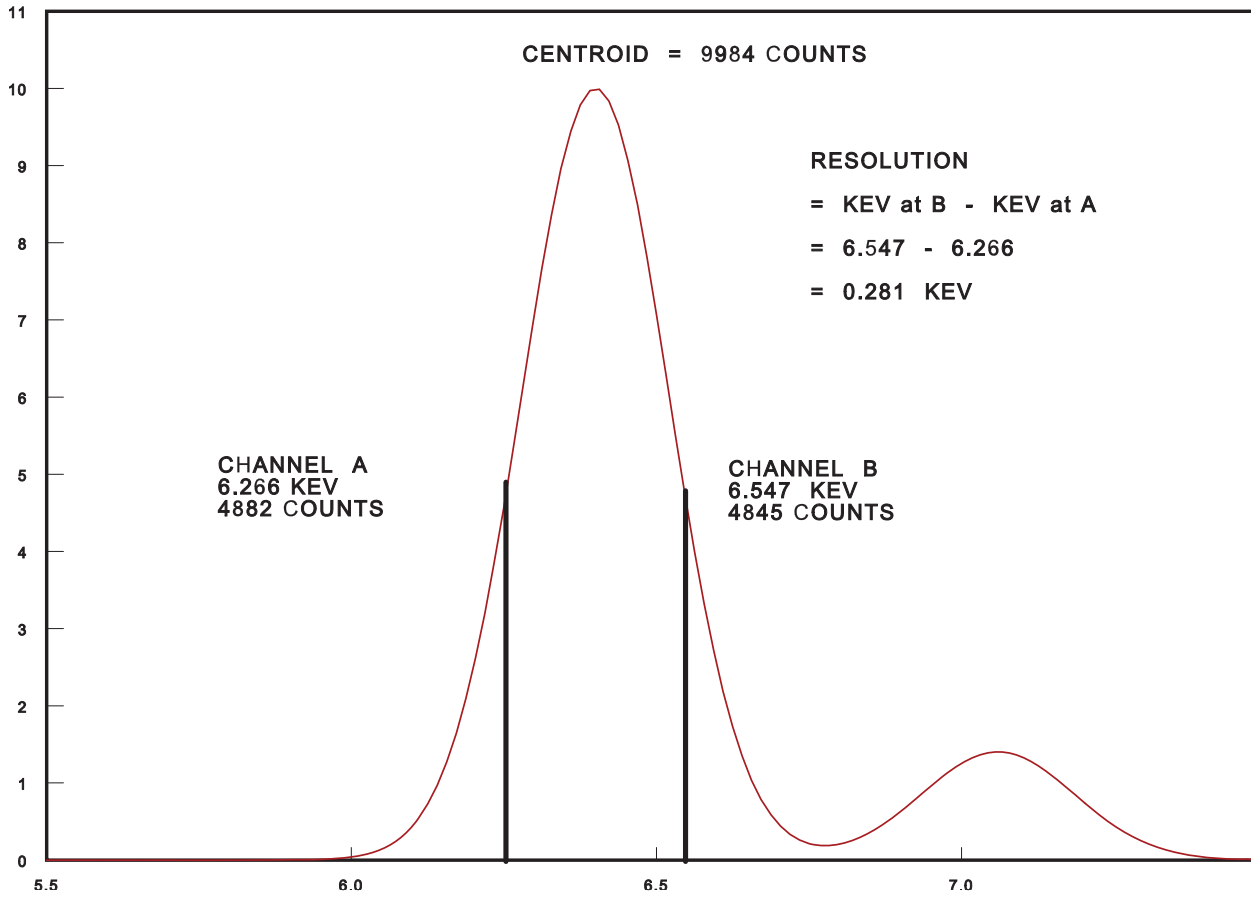


FIGURE 2. Iron X-Ray Spectrum Illustrating Detector Resolution



APPENDIX C
Certified SRM Values
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Certified SRM Values, mg/kg*

Element	#2709A (Low Standard)	#2711A (Medium Standard)	#2710A (High Standard)
Antimony	1.55 +/- 0.06	23.8 +/- 1.4	52.5 +/- 1.6
Arsenic	(10.5 +/- 0.3)	107 +/- 5	1540 +/- 100
Barium	979 +/- 28	730 +/- 15	792 +/- 36
Cadmium	0.371 +/- 0.002	54.1 +/- 0.5	12.3 +/- 0.3
Chromium	130 +/- 9	52.3 +/- 2.9	(23 +/- 6)
Cobalt	12.8 +/- 0.2	9.89 +/- 0.18	5.99 +/- 0.14
Copper	(33.9 +/- 0.5)	140 +/- 2	3420 +/- 50
Lead	17.3 +/- 0.1	1400 +/- 10	5520 +/- 30
Manganese	529 +/- 18	675 +/- 18	2140 +/- 60
Mercury	(0.9 +/- 0.2)	7.42 +/- 0.18	9.88 +/- 0.21
Nickel	(85 +/- 2)	21.7 +/- 0.7	(8 +/- 1)
Selenium	(1.5)	(2)	(1)
Silver	NA	(6)	(40)
Strontium	239 +/- 6	242 +/- 10	255 +/- 7
Thallium	(0.58 +/- 0.01)	(3)	(1.52 +/- 0.02)
Vanadium	110 +/- 11	80.7 +/- 5.7	(82 +/- 9)
Zinc	(103 +/- 4)	414 +/- 11	4180 +/- 150

* - NIST Certificates of Analysis available on NIST web site https://www.nist.gov

( ) – Reference or information value (not certified)

NA - Not Applicable, SRM - Standard Reference Material

Certified SRM Values, Weight %*

Element	#2709A (Low Standard)	#2711A (Medium Standard)	#2710A (High Standard)
Aluminum	7.37 +/- 0.16	6.72 +/- 0.06	5.95 +/- 0.05
Calcium	1.91 +/- 0.09	2.42 +/- 0.06	0.964 +/- 0.045
Iron	3.36 +/- 0.07	2.82 +/- 0.04	4.32 +/- 0.08
Magnesium	1.46 +/- 0.02	1.07 +/- 0.06	0.734 +/- 0.038
Phosphorus	0.0688 +/- 0.0013	0.0842 +/- 0.0011	0.105 +/- 0.004
Potassium	2.11 +/- 0.06	2.53 +/- 0.10	2.17 +/- 0.13
Silicon	30.3 +/- 0.4	31.4 +/- 0.7	31.1 +/- 0.4
Sodium	1.22 +/- 0.03	1.20 +/- 0.01	0.894 +/- 0.019
Titanium	0.336 +/- 0.007	0.317 +/- 0.008	0.311 +/- 0.007

* - NIST Certificates of Analysis available on NIST web site https://www.nist.gov

NA - Not Applicable, SRM - Standard Reference Material

APPENDIX D
Sample Preparation for FPXRF Analysis
SOP: ERT-PROC-1720-20
June 2020

SUMMARY OF SAMPLE PREPARATION FOR FPXRF ANALYSIS

A. In-Situ vs Prepared Samples

The choice to use in-situ or prepared samples for Field Portable X-Ray Fluorescence (FPXRF) analysis of metals in soil/sediment depends on FPXRF detection limit capabilities, sample wetness, sample homogeneity, and site data quality objectives. In-situ analysis is faster and, therefore, suitable for screening purposes and to guide excavation activities. If the soil/sediment is wet (greater than 20 percent moisture) or the concentration approaches the FPXRF detection limit (e.g., 3 - 5 times the detection limit), the samples should be prepared prior to analysis. Procedures for in-situ and prepared samples are summarized below.

B. In-situ Analysis

Prepare an area (12 x 12 inches) for in-situ analysis:

1. Remove large rocks, vegetation, and debris.
2. Ensure that the soil surface is flat and compact prior to analysis.
3. Place the FPXRF unit firmly in contact with the soil surface.
4. Initiate analysis; DO NOT move the unit during analysis.

NOTE: Avoid analysis of water saturated soils/sediments.

C. Prepared Samples

Samples are generally received in labeled plastic bags or glass jars and should be prepared as follows:

1. Thoroughly mix each sample.
2. Remove stones, vegetation, and other debris.
3. Place 10 - 20 grams of sample into a labeled aluminum weighing dish.
4. Dry the samples in a convection oven for 1 - 2 hours or until dry.
5. Allow the sample to cool and pass it through a clean 10-mesh stainless steel sieve.
6. Fill a labeled polyethylene X-ray sample cup to the snap ring with a portion of the sample that passed through the sieve.
7. Seal the XRF cup with 0.2-mil (5 micrometer) thick polypropylene X-ray window film.
8. Pack the sample evenly against the window film by tapping the XRF cup against a tabletop or other clean, flat surface.
9. Place the sample cup in the test stand (window side down), close the safety shield, and initiate the analysis.

APPENDIX E
Typical MDL Values for the NITON XLt792YW FPXRF Analyzer
SOP: ERT-PROC-1720-20
June 2020

Typical MDL Values for the NITON XLt792YW FPXRF Analyzer (SRM Matrix)	
Element	**MDL (mg/kg) for 120 Second Analysis**
Potassium (K)	500
Calcium (Ca)	500
Scandium (Sc)	150
Titanium (Ti)	75
Vanadium (V)	50
Chromium (Cr)	45
Manganese (Mn)	175
Iron (Fe)	175
Cobalt (Co)	250
Nickel (Ni)	90
Copper (Cu)	50
Zinc (Zn)	40
Arsenic (As)	15
Selenium (Se)	15
Lead (Pb)	15
Mercury (Hg)	12
Rubidium (Rb)	15
Strontium (Sr)	30
Cadmium (Cd)	50
Silver (Ag)	50
Tin (Sn)	100
Antimony (Sb)	100

APPENDIX E

EPA Residential RSLs Compared to Example Lab Reporting Limits

Volatile Organic Compounds – Soil

Analyte	CAS Number	Residential Summay RSL (ug/kg) THQ=1	Residential Summay RSL (ug/kg) THQ=0.1	Achievable Laboratory Limits[2,3]				
				Houston Lab 1			Houston Lab 2	
				MDL	LOD	QL	MDL	QL
1,1,1-Trichloroethane	71-55-6	8,100,000 ns	810,000 ns	0.503	1	5	0.5	5
1,1,2,2-Tetrachloroethane	79-34-5	600 c	600 c	0.470	1	5	0.8	5
1,1,2-Trichloro-1,1,2- trifluoroethane	76-13-1	6,700,000 ns	670,000 n	0.426	1	10	0.7	5
1,1,2-Trichloroethane	79-00-5	1,100 c**	150 n	0.392	1	5	0.5	5
1,1-Dichloroethane	75-34-3	3,600 c	3,600 c	0.376	1	5	0.5	5
1,1-Dichloroethene	75-35-4	230,000 n	23,000 n	0.277	1	5	0.5	5
1,2,3-Trichlorobenzene	87-61-6	63,000 n	6,300 n					
1,2,4-Trichlorobenzene	120-82-1	24,000 c**	5,800 n				1.0	5
1,2-Dibromo-3- Chloropropane	96-12-8	5.3 c	5.3 c*	0.704	1	5	1.0	5
1,2-Dibromoethane	106-93-4	36 c	36 c	1.04	5	5	0.5	5
1,2-Dichlorobenzene	95-50-1	1,800,000 ns	180,000 n	0.943	1	5	1.0	5
1,2-Dichloroethane	107-06-2	460 c*	460 c**	0.304	1	5	0.6	5
1,2-Dichloropropane	78-87-5	2,500 c**	1,600 n	0.198	1	5	0.8	5
1,3-Dichlorobenzene	*541-73-1*	*NS*	*NS*				*1.0*	*5*
1,4 Dichlorobenzene	106-46-7	2,600 c	2,600 c				1.0	5
2-Butanone (Methyl Ethyl Ketone)	78-93-3	27,000,000 n	2,700,000 n	3.65	5	20	1.3	10
2-Hexanone	591-78-6	200,000 n	20,000 n	2.13	5	10	1.4	10
4-Methyl-2-pentanone (Methyl Isobutyl Ketone)	108-10-1	33,000,000 ns	3,300,000 n	2.61	5	50	2.0	10
Acetone	67-64-1	61,000,000 n	6,100,000 n	11.1	25	100	2.0	20
Benzene	71-43-2	1,200 c*	1,200 c**	0.207	1	1	0.5	5
Bromochloromethane	74-97-5	150,000 n	15,000 n	0.526	1	5		
Bromodichloromethane	75-27-4	290 c	290 c	0.251	1	5	0.5	5
Bromoform	75-25-2	19,000 c*	19,000 c**	1.03	5	5	0.6	5
Bromomethane	74-83-9	6,800 n	680 n				1.0	10
Carbon disulfide	75-15-0	770,000 ns	77,000 n	0.292	1	5	0.6	10
Carbon tetrachloride	56-23-5	650 c	650 c*	1.64	5	5	0.6	5
Chlorobenzene	108-90-7	280,000 n	28,000 n	0.237	1	5	0.6	5
Chloroethane (Ethyl Chloride)	75-00-3	14,000,000 ns	1,400,000 n	0.444	1	10	0.8	10
Chloroform	67-66-3	320 c	320 c*	0.173	1	5	0.5	5
Chloromethane	74-87-3	110,000 n	11,000 n	0.431	1	5	0.5	10
cis-1,2-Dichloroethene	156-59-2	160,000 n	16,000 n				0.8	5
cis-1,3-Dichloropropene (542-75-6)	10061-01-5	1,800 c*	*NS*				0.5	5
Cyclohexane5	110-82-7	6,500,000 ns	650,000 ns	1.44	5	5	1.0	5
Dibromochloromethane	124-48-1	8,300 c	8,300 c*	0.895	1	5	0.5	5
Dichlorodifluoromethane	75-71-8	87,000 n	8,700 n	1.11	5	5	0.7	5
Ethylbenzene	100-41-4	5,800 c	5,800 c*	0.336	1	1	0.7	5
Isopropylbenzene (cumene)	98-82-8	1,900,000 ns	190,000 n	0.174	1	5	0.9	5

Volatile Organic Compounds – Soil

Analyte	CAS Number	Residential Summay RSL (ug/kg) THQ=1	Residential Summay RSL (ug/kg) THQ=0.1	Achievable Laboratory Limits[2,3]				
				Houston Lab 1			Houston Lab 2	
				MDL	LOD	QL	MDL	QL
m&p-Xylene	*179601-23-1*	*NS*	*NS*	*0.800*	*2*	*2*	*1.6*	*10.0*
xylenes	1330-20-7	580,000 ns	58,000 n				1.0	5.0
Methyl acetate	79-20-9	78,000,000 ns	7,800,000 n				0.7	5
Methyl t-butyl ether	1634-04-4	47,000 c	47,000 c*	0.409	1	5	0.5	5
Methylcyclohexane	*108-87-2*	*NS*	*NS*				*1.0*	*5*
Methylene Chloride (Dichloromethane)	75-09-2	57,000 c**	35,000 n	4.22	5	20	1.0	10
o-Xylene	95-47-6	650,000 ns	65,000 n	0.985	1	1	1.0	5.0
Styrene	100-42-5	6,000,000 ns	600,000 n	0.205	1	5	0.7	5
Tetrachloroethene	127-18-4	24,000 c**	8,100 n	0.370	1	5	0.7	5
Toluene	108-88-3	4,900,000 ns	490,000 n	1.00	1	5	0.6	5
trans-1,2-Dichloroethene	156-60-5	1,600,000 n	7,000 n	0.434	1	5	0.5	5
trans-1,3-Dichloropropene (542-75-6)	10061-02-6	1,800 c*	1,800 c**	*0.909*	*1*	*5*	0.6	5
Trichloroethene	79-01-6	940 c**	410 n	0.494	1	5	0.6	5
Trichlorofluoromethane	75-69-4	23,000,000 ns	2,300,000 ns				0.5	5
Vinyl chloride	75-01-4	59 c	59 c	0.441	1	5	0.8	2

Semivolatile Organic Compounds – Soil

Analyte	CAS Number	Summay RSL (ug/kg) THQ=1	Residential Summay RSL (ug/kg) THQ=0.1	Achievable Laboratory Limits[2,3] (ug/kg)				
				Houston Lab 1			Houston Lab 2	
				MDL	LOD	QL	MDL	QL
1,1'-Biphenyl[5]	92-52-4	47,000 n	4,700 n	14.7	66.7	167	1.7	6.6
1,2,4,5-Tetrachlorobenzene	95-94-3	23,000 n	2,300 n	16.5	66.7	167		
1,4-Dioxane[5]	123-91-1	5,300 c	5,300 c*					
2,4,5-Trichlorophenol	95-95-4	6,300,000 n	630,000 n	19.1	66.7	167	2.5	6.6
2,4,6-Trichlorophenol	88-06-2	49,000 c**	6,300 n	15.8	66.7	167	1.7	6.6
2,4-Dichlorophenol	120-83-2	190,000 n	19,000 n	17.4	66.7	167	1.3	6.6
2,4-Dimethylphenol	105-67-9	1,300,000 n	130,000 n	16.5	167	167	3.3	6.6
2,4-Dinitrophenol	51-28-5	130,000 n	13,000 n	24.2	66.7	333	4.5	13.2
2,4-Dinitrotoluene	121-14-2	1,700 c*	1,700 c**	12.7	66.7	167	0.9	6.6
2,6-Dinitrotoluene	606-20-2	360 c*	360 c**	23.3	66.7	167	3.3	6.6
2-Chloronaphthalene	91-58-7	4,800,000 n	480,000 n	29.0	66.7	167	1.3	6.6
2-Chlorophenol	95-57-8	390,000 n	39,000 n	15.8	66.7	167	1.3	6.6
2-Methylnaphthalene	91-57-6	240,000 n	24,000 n	45.2	66.7	167	0.5	3.3
2-Methylphenol (o-Cresol)	95-48-7	3,200,000 n	320,000 n	18.5	66.7	167	1.1	6.6
2-Nitroaniline	88-74-4	630,000 n	63,000 n	15.6	66.7	333	1.9	6.6
2-Nitrophenol	*88-75-5*	*NS*	*NS*	*14.6*	*66.7*	*167*	*2.5*	*6.6*
2,3,4,6-Tetrachlorophenol	58-90-2	1,900,000 n	190,000 n	12.3	66.7	167	1	6.6
3,3'-Dichlorobenzidine	91-94-1	1,200 c	1,200 c	15.4	66.7	333	2.5	6.6
3-Nitroaniline5	*99-09-2*	*NS*	*NS*	13.9	66.7	333	1.9	6.6
3&4-Methylphenol (m/p-cresol)	*15831-10-4*	*NS*	*NS*	15.4	66.7	167		
3 methylphenol (m-cresol)	*108-39-4*	*3,200,000 n*	*320,000 n*					
4 methylphenol (p-cresol)	*106-44-5*	6,300,000 n	*630,000 n*					
4,6-Dinitro-2-methylphenol	534-52-1	5,100 n	510 n	12.7	66.7	333	2.1	6.6
4-Bromophenyl phenyl ether	*101-55-3*	*NS*	*NS*	*13.3*	*66.7*	*167*	*1.6*	*6.6*
4-Chloro-3-methylphenol	59-50-7	6,300,000 n	630,000 n	18.4	66.7	167	0.7	6.6
4-Chloroaniline	106-47-8	2,700 c*	2,700 c**	12.6	66.7	333	1.1	6.6
4-Chlorophenyl phenyl ether	*7005-72-3*	*NS*	*NS*	*16.2*	*66.7*	*167*	*1.5*	*6.6*
4-Nitroaniline	100-01-6	27,000 c**	25,000 n	13.9	66.7	333	2.2	6.6
4-Nitrophenol	*100-02-7*	*NS*	*NS*	*25.8*	*66.7*	*333*	*1.9*	*13.2*
Acenaphthene	83-32-9	3,600,000 n	360,000 n	15.5	66.7	167	0.5	3.3
Acenaphthylene	*208-96-8*	*NS*	*NS*	*14.8*	*66.7*	*167*	*1*	*3.3*
Acetophenone	98-86-2	7,800,000 ns	780,000 n	14.3	66.7	167	0.8	6.6
Anthracene	120-12-7	18,000,000 n	1,800,000 n	13.8	66.7	167	0.5	3.3
Atrazine	1912-24-9	2,400 c	2,400 c*	16.5	66.7	333	2	6.6
Benzaldehyde	100-52-7	170,000 c*	170,000 c**	17.0	66.7	333	1.2	6.6
Benzo[a]anthracene	56-55-3	1,100 c	1,100 c	14.1	66.7	167	1.6	3.3
Benzo[a]pyrene	50-32-8	110 c	110 c*	17.2	66.7	167	1	3.3
Benzo[b]fluoranthene	205-99-2	1,100 c	1,100 c	12.6	66.7	167	1.2	3.3
Benzo[g,h,i]perylene	*191-24-2*	*NS*	*NS*	*15.4*	*66.7*	*167*	*0.7*	*3.3*
Benzo[k]fluoranthene	207-08-9	11,000 c	11,000 c	19.4	66.7	167	0.9	3.3

Semivolatile Organic Compounds – Soil

Analyte	CAS Number	Summay RSL (ug/kg) THQ=1	Residential Summay RSL (ug/kg) THQ=0.1	Achievable Laboratory Limits[2,3] (ug/kg)				
				Houston Lab 1			Houston Lab 2	
				MDL	LOD	QL	MDL	QL
bis (2-chloroisopropyl) ether	108-60-1	3,100,000 ns	310,000 n	17.8	66.7	167	0.9	6.6
Bis(2-chloroethoxy)methane	111-91-1	190,000 n	19,000 n	16.8	66.7	167	1.1	6.6
Bis(2-chloroethyl)ether	111-44-4	230 c	230 c	15.2	66.7	167	1.4	6.6
Bis(2-ethylhexyl) phthalate	117-81-7	39,000 c*	39,000 c**	167.0	167.0	333	1.7	6.6
Butyl benzyl phthalate	85-68-7	290,000 c*	29,000 c**	18.2	66.7	167	1.3	6.6
Caprolactam	105-60-2	31,000,000 n	3,100,000 n	20.3	66.7	167	1.2	6.6
Carbazole	*86-74-8*	*NS*	*NS*	*16.6*	*66.7*	*167*	*1.2*	*6.6*
Chrysene	218-01-9	110,000 c	110,000 c	16.5	66.7	167	0.8	3.3
Dibenz(a,h)anthracene	53-70-3	110 c	110 c	12.7	66.7	167	1.6	3.3
Dibenzofuran	132-64-9	73,000 n	7,800 n	15.4	66.7	167	0.7	3.3
Diethyl phthalate	84-66-2	51,000,000 n	5,100,000 n	15.3	66.7	167	1	6.6
Dimethyl phthalate	131-11-3	*NS*	*NS*	*15.9*	*66.7*	*167*	*0.8*	*6.6*
Di-n-butyl phthalate	84-74-2	6,300,000 n	630,000 n	16.0	66.7	167	1.2	6.6
Di-n-octyl phthalate	117-84-0	630,000 n	63,000 n	13.3	66.7	167	0.9	6.6
Fluoranthene	206-44-0	2,400,000 n	240,000 n	14.7	66.7	167	1.1	3.3
Fluorene	86-73-7	2,400,000 n	240,000 n	13.8	66.7	167	1.1	3.3
Hexachlorobenzene	118-74-1	210 c	210 c*	16.2	66.7	167	0.9	6.6
Hexachlorobutadiene	87-68-3	1,200 c*	1,200 c**	13.8	66.7	167	1.2	6.6
Hexachlorocyclopentadiene	77-47-4	1,800 n	180 n	15.2	66.7	167	0.8	6.6
Hexachloroethane	67-72-1	1,800 c*	1,800 c**	17.3	66.7	167	1.5	6.6
Indeno[1,2,3-cd]pyrene	193-39-5	1,100 c	1,100 c	13.4	66.7	167	0.8	3.3
Isophorone	78-59-1	570,000 c*	570,000 c**	14.5	66.7	167	0.8	6.6
Naphthalene	91-20-3	3,800 c*	2,000 c**	15.6	66.7	167	0.6	3.3
Nitrobenzene	98-95-3	5,100 c*	5,100 c**	18.5	66.7	167	0.9	6.6
N-Nitrosodi-n-propylamine	621-64-7	78 c	78 c	17.4	66.7	167	1.1	6.6
N-Nitrosodiphenylamine	86-30-6	110,000 c	110,000 c	18.6	66.7	167	0.7	6.6
Pentachlorophenol	87-86-5	1,000 c	1,000 c*	12.1	66.7	333	3.3	6.6
Phenanthrene	*85-01-8*	*NS*	*180,000*	*16.6*	*66.7*	*167*	*1.5*	*3.3*
Phenol	108-95-2	19,000,000 n	1,900,000 n	15.0	66.7	333	1.1	6.6
Pyrene	129-00-0	1,800,000 n	180,000 n	14.6	66.7	167	0.6	3.3

Inorganics – Soil

Analyte	CAS Number	Summay RSL (mg/kg) THQ=1	Residential Summay RSL (mg/kg) THQ=0.1	Achievable Laboratory Limits (mg/kg)				
				Houston Lab 1			Houston Lab 2	
				MDL	LOD	QL	MDL	QL
Aluminum	7429-90-5	77,000 n	7,700 n	1.21	2	20		
Antimony	7440-36-0	31 n	3.1 n	0.432	0.5	2	0.065	0.5
Arsenic	7440-38-2	0.680 c*R	0.68 c**R	0.424	0.5	2	0.07	0.5
Barium	7440-39-3	15,000 n	1,500 n	0.127	0.25	1	0.03	0.5
Beryllium	7440-41-7	160 n	16 n	0.0706	0.1	0.4	0.021	0.5
Cadmium	7440-43-9	71 n	7.1 n	0.239	0.25	1	0.027	0.5
Calcium	*7440-70-2*	*NS*	*NS*	*4.95*	*5*	*20*		
Chromium	*7440-47-3*	*NS*	*NS*	*0.0704*	*0.125*	*1*	*0.023*	*0.5*
Cobalt	7440-48-4	23 n	23 n	0.298	0.5	1		
Copper	7440-50-8	3,100 n	310 n	0.443	0.5	2		
Iron	7439-89-6	55,000 n	5,500 n	2.7	5	20		
Lead	7439-92-1	400	400 G	0.476	0.5	2	0.013	0.5
Magnesium	*7439-95-4*	*NS*	*NS*	*4.8*	*5*	*40*		
Manganese	*7439-96-5*	*1,800* n	180 n	0.278	0.5	2		
Mercury	7439-97-6	11 ns	1.1 n	0.0038		0.02	0.47	3.325
Nickel	7440-02-0	1,500 n	150 n	0.248	0.25	1	0.048	0.5
Potassium	*7440-22-4*	*NS*	*NS*	*15.8*	*25*	*50*		
Selenium	7782-49-2	390 n	39 n	0.498	0.75	3	0.015	0.5
Silver	7782-49-2	390 n	39 n	0.565	1	3	0.015	0.5
Sodium	*7440-23-5*	*NS*	*NS*	*7.22*	*12.5*	*50*		
Thallium	7440-28-0	0.780 n	0.078 n	0.427	1	2		
Vanadium	7440-62-2	390 n	39 n	0.553	1	9		
Zinc	7440-66-6	23,000 n	2,300 n	0.556	0.75	3		

Pesticides – Soil

Analyte	CAS Number	Summay RSL (ug/kg) THQ=1		Residential Summay RSL (ug/kg) THQ=0.1		Achievable Laboratory Limits[2,3] (ug/kg)				
						Houston Lab 1			Houston Lab 2	
						MDL	LOD	QL	MDL	QL
4,4'-DDD	72-54-8	1,900	c	190	n	0.266	1.7	3.3	0.5	3.3
4,4'-DDE	72-55-9	2,000	c	2,000	c**	0.160	0.8	3.3	0.5	3.3
4,4'-DDT	50-29-3	1,900	c*	1,900	c**	0.386	1.7	3.3	0.5	3.3
Aldrin	309-00-2	39	c*	39	c**	0.166	1.7	3.3	0.3	1.67
alpha-BHC	319-84-6	86	c	86	c	0.128	1.7	3.3	0.3	1.67
alpha-Chlordane	*5103-71-9*	*NS*		*NS*		*0.184*	*1.7*	*3.3*	0.2	1.67
beta-BHC	319-85-7	300	c	300	c	0.282	1.7	3.3	0.3	1.67
delta-BHC	*319-86-8*	*NS*		*NS*		*0.216*	*0.8*	*3.3*	*0.2*	*1.67*
Dieldrin	60-57-1	34	c*	34	c**	0.229	1.7	3.3	0.5	3.3
Endosulfan I (115-29-7)	959-98-8	470,000	n	47,000	n	*0.165*	*1.7*	*3.3*	0.3	1.67
Endosulfan II (115-29-7)	33213-65-9	470,000	n	47,000	n	*0.225*	*1.7*	*3.3*	0.6	3.3
Endosulfan sulfate	*1031-07-8*	*380,000*	n	38,000	n	*0.157*	*1.7*	*3.3*	0.6	3.3
Endrin	72-20-8	19,000	n	1,900	n	*0.219*	*1.7*	*3.3*	0.6	3.3
Endrin aldehyde	*7421-93-4*	*NS*		*NS*		*0.149*	*1.7*	*3.3*	*0.6*	*3.3*
Endrin ketone	*53494-70-5*	*NS*		*NS*		*0.477*	*1.7*	*3.3*	*0.6*	*3.3*
gamma-BHC (Lindane)	58-89-9	570	c*	570	c**	0.346	1.7	3.3	0.2	1.67
gamma-Chlordane	*5103-74-2*	*NS*		*NS*		*0.158*	*1.7*	*3.3*	*0.2*	*1.67*
Heptachlor	76-44-8	130	c	130	c*	0.156	1.7	3.3	0.3	1.67
Heptachlor epoxide	1024-57-3	70	c*	70	c**	0.198	1.7	3.3	0.3	1.67
Methoxychlor	72-43-5	320,000	n	32,000	n	0.529	1.7	3.3	3.4	16.7
Toxaphene	8001-35-2	490	c	490	c**	11.3	41.7	83.3	4.8	16.7

Polychlorinated Biphenyls – Soil

Analyte	CAS Number	Summay RSL (ug/kg) THQ=1	Residential Summay RSL (ug/kg) THQ=0.1	Achievable Laboratory Limits[2,3] (ug/kg)				
				Houston Lab 1			Houston Lab 2	
				MDL	LOD	QL	MDL	QL
PCB-1016	12674-11-2	4,100 n	410 n	7.90	8.33	33.3	4.2	16.7
PCB-1221	11104-28-2	200 c	200 c	7.90	8.33	33.3	5.6	16.7
PCB-1232	11141-16-5	170 c	170 c	7.90	8.33	33.3	4.5	16.7
PCB-1242	53469-21-9	230 c	230 c	7.90	8.33	33.3	5.9	16.7
PCB-1248	12672-29-6	230 c	230 c	7.90	8.33	33.3	5.9	16.7
PCB-1254	11097-69-1	240 c *	120 n	5.21	8.33	33.3	4.7	16.7
PCB-1260	11096-82-5	240 c	240 c	5.21	8.33	33.3	4	16.7

Herbicides – Soil

Analyte	CAS Number	Summay RSL (ug/kg) THQ=1		Residential Summay RSL (ug/kg) THQ=0.1		Achievable Laboratory Limits[2,3] (ug/kg)				
						Houston Lab 1			Houston Lab 2	
						MDL	LOD	QL	MDL	QL
2,4,5-T	93-76-5	630,000	n	63,000	n	1.07	8.33	8.33	1.90	5.00
2,4-D	94-75-7	700,000	n	70,000	n	2.21	8.33	8.33	14.0	33.3
2,4-DB	94-82-6	1,900,000	n	190,000	n	3.25	8.33	8.33	21.0	50.0
Dalapon	75-99-0	1,900,000	n	190,000	n	6.41	8.33	8.33	61.0	133
Dicamba	1918-00-9	1,900,000	n	190,000	n	3.39	3.33	8.33	3.20	6.67
Dichlorprop	*120-36-5*	*NS*		*NS*		*2.94*	*8.33*	*8.33*	*20.0*	*50.0*
MCPA	94-74-6	32,000	n	3,200	n	296	833	833	3600	6670
Picloram	1918-02-1	4,400,000	n	440,000	n					
Silvex (2,4,5-TP)	93-72-1	510,000	n	51,000	n				1.70	3.33
MCPP	93-65-2	63,000	n	6,300	n	210	833	833	2900	6670
Dinoseb	88-85-7	63,000	n	6,300	n	2.55	3.33	8.33	14.0	33.3

Notes:

1)Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites, Residential Soil. Carcinogenic
Located at http://www.epa.gov/region9/superfund/prg/ In cases where the RSL is below the laboratory QL, all
2)MDLs and QLs are based on laboratory QC limits for analysis of soil samples following SW846 8151. The
criteria using the procedures in its laboratory quality assurance manual.
3)MDLs and QLs presented are unadjusted for solid content and dilution factors. Actual MDLs and QLs for samples
4)The accuracy limits represent the minimum acceptance criteria for matrix spike samples and laboratory control
it is expected that individual laboratory limits will vary. The control criteria for laboratory control samples are expected
5)NS = Screening level not available
6)NA = Not applicable

orange - Lab MDL or RL is greater than EPA RSL
green - Lab QC
yellow - analyte is typically reported under different method (VOC/ SVC
gray - no data (Lab did not provide or does not analyze)
Gray text/ italics - no EPA RSL

APPENDIX F

Chemical Laboratory Quality Manual and SOPs

(These documents will be attached once the Laboratory is Selected)