REGION 7
LENEXA, KS 66219

November 22, 2023

MEMORANDUM

SUBJECT: Quality Assurance Project Plan EPA Brownfields Cleanup Grant-Region 7 City of Clinton, Iowa, 1000 Block of South 4th Street Project, Air Sampling During Building Demolition and Building Debris Removal and UST Removal, 1000, 1002, 1004, 1006-1008, and 1010-1012 South 4th Street, Clinton, Iowa – Approved with Conditions

FROM: Diane Harris, Regional Quality Assurance Manager
Laboratory Services and Applied Science Division

DIANE HARRIS
Digitally signed by DIANE HARRIS
Date: 2023.11.22 10:26:04 -06'00'

TO: Jennifer Morris, EPA Project Officer
Brownfields, Redevelopment and Reuse Branch
Land, Chemical and Redevelopment Division

The review of the subject document prepared by Blackstone Environmental, Inc. for City of Clinton, Iowa dated October 16, 2023, has been completed according to the "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations," EPA QA/R-5 March 2001.

Based on the comments below, the document is approved with conditions. The document was found to be incomplete in addressing key areas to the extent of potentially jeopardizing the quality of the data. The areas are fully described in this review memorandum as critical comments and can be adequately addressed by incorporation into the document but without resubmission. The document would not be approved without addressing these issues. General comments identify opportunities for strengthening the document, however, do not affect approval.

Critical Comments

1. Table 2.2, Summary of Field and QC Samples to be Collected: This table needs to be completed to include the QC samples for the UST removal groundwater sample or state zero QC samples not just blank, if applicable.

2. Tables 2.4 and 2.6, Analytical Method, Container, Preservation, and Holding Time Requirements: These tables specify preservation 4 degrees Celsius and holding times 14 business days for TEH and/or BTEX for liquid/sludge and groundwater samples, however, for aqueous samples analyzed by Method OA-2 states samples cooled need to be extracted within 7 days and Method OA-1 states

samples cooled but unpreserved analyzed within 7 days or if preserved with HCL within 14 days. Therefore, the holding times and preservation need to be verified and appropriately addressed.

General Comments

3. Section 1.13.2, Labels and Section 2.3, Sample Handling and Custody: These sections state "A copy of an example label is included in Appendix A," however, no example was found. Therefore, it would be helpful to include the example.

4. Section 2.6, Instrument/Equipment Testing, Inspection, and Maintenance: It would be helpful if this section addressed the availability and location of spare parts.

If you have any questions, please contact Rebecca Estep, Lead Reviewer, at x7598 or me at x7258.

R7QAO Document Number: 2024020

Quality Assurance Project Plan

EPA Brownfields Cleanup Grant – Region 7
City of Clinton, Iowa
Cooperative Agreement Number: 4B96705601

1000 Block of South 4th Street Project
Air Sampling During Building Demolition and Building Debris Removal and UST Removal

1000, 1002, 1004, 1006 – 1008, and 1010 – 1012 South 4th Street
Clinton, Iowa

Prepared for:
United States Environmental Protection Agency
Region 7
11201 Renner Boulevard
Lenexa, Kansas 66219

And

City of Clinton
611 South 3rd Street
Clinton, Iowa 52733

Prepared by:
BLACKSTONE
ENVIRONMENTAL
1465 41st Street, Suite 13
Moline, Illinois 61265

Revision No: 0
Date: October 16, 2023

Approvals Signature:

PROJECT DIRECTOR/MANAGER:

Date: 10-18-23

Tammy Johnson
City of Clinton, Iowa Project Manager

BLACKSTONE ENVIRONMENTAL, INC.

Date: October 16, 2023

Krista Brodersen
Project Manager

Lindsay E. James

Date: October 16, 2023

Lindsay E. James, R.G
QA/QC Reviewer

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY PROJECT MANAGER APPROVAL:

JENNIFER MORRIS

Digitally signed by JENNIFER MORRIS
Date: 2023.10.24 12:42:46 -05'00'

Date: ________________

Jennifer Morris
Brownfields Project Officer

DIANE HARRIS

Digitally signed by DIANE HARRIS
Date: 2023.11.22 10:17:32 -06'00'

Date: ________________

Diane Harris
Region 7 Quality Assurance Manager

approved w/condition

TABLE OF CONTENTS

Section Page

ACRONYMS

ABCA	Analysis of Brownfields Cleanup Alternatives
ACM	Asbestos Containing Materials
BS	blank spike
BSD	blank spike duplicate
COC	Chain of Custody
City	City of Clinton
CFR	Code of Federal Regulations
DQA	data quality assessment
DQO	data quality objectives
ESA	Environmental Site Assessment
eV	electron volts
IAC	Iowa Administrative Code
I.D.	identification
IDNR	Iowa Department of Natural Resources
f/cc	fiber per cubic centimeter
GPS	Global Positioning System
LCS	laboratory control samples
MCEF	mixed cellulose ester filter
MDL	method detection limit
mg/kg	milligrams per kilogram
ml	milliliter
mm	millimeter
MS	matrix spike
MSD	matrix spike duplicate
NIOSH	National Institute of Occupational Safety and Health
NVLAP	National Voluntary Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration
oz	ounce
PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
PCM	Phase Contrast Microscopy
PE	performance evaluation
PELs	permissible exposure limits
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million
RACM	Regulated Asbestos Containing Materials
RL	reporting limit
RPD	relative percent difference
RSD	relative standard deviation
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control

SOPs	Standard Operating Procedures
TWA	Time-weighted Average
U.S. EPA	United States Environmental Protection Agency
µg/L	microgram per liter
µm	micrometer
VOCs	volatile organic compounds

1.0 PROJECT MANAGEMENT

1.1 Title and Approval Page – See pages 1 and 2

1.2 Table of Contents – See pages 3 through 6

1.3 Distribution List

The following individuals and their respective organizations will receive a finalized and signed QAPP approved by the EPA.

U.S. EPA Region 7
Name: Jennifer Morris
Title: Brownfields Project Officer
Organization: U.S. EPA Region 7
Contact Information:
11201 Renner Boulevard
Lenexa, Kansas 66219
(913) 551-7341
Morris.Jennifer@epa.gov

City of Clinton
Name: Tammy Johnson
Title: Community Development Director, Project Manager
Organization: City of Clinton
Contact Information:
611 South 3rd Street
Clinton, Iowa 52733
(563) 594-6730
tammyjohnson@cityofclintoniowa.us

Project File
Name: Krista Brodersen
Title: Project Manager
Organization: Blackstone Environmental, Inc.
Contact Information:
1465 41st Street
Moline, Illinois 61265
(309) 581-5095
kbrodersen@blackstone-env.com

1.4 Project Organization

Representing the City of Clinton (City) is Ms. Tammy Johnson, Project Director/Manager. Ms. Johnson is charged with directing project activities, approving final documents, and coordinating efforts between the consultant, state, and federal reviewers.

The EPA Brownfields Project Officer, Ms. Jennifer Morris, is the point of contact for the Cleanup Grant. The Brownfields Project Officer is responsible for reviewing and providing comments on the QAPP, responding to questions regarding the grant process, and other project submittals.

The Project Manager for Blackstone is Ms. Krista Brodersen. Ms. Brodersen oversees the consultant activities for the Project including planning, monitoring, and evaluating project field activities; resolving technical issues and providing guidance; and reviewing reports and documents. Ms. Brodersen reports to the City's Project Director/Manager.

The Quality Assurance Reviewer for Blackstone is Ms. Lindsay James. Ms. James will perform QA/QC audits, check and assist in document and project reviews relative to the project plan, and review the QAPP annually for updates.

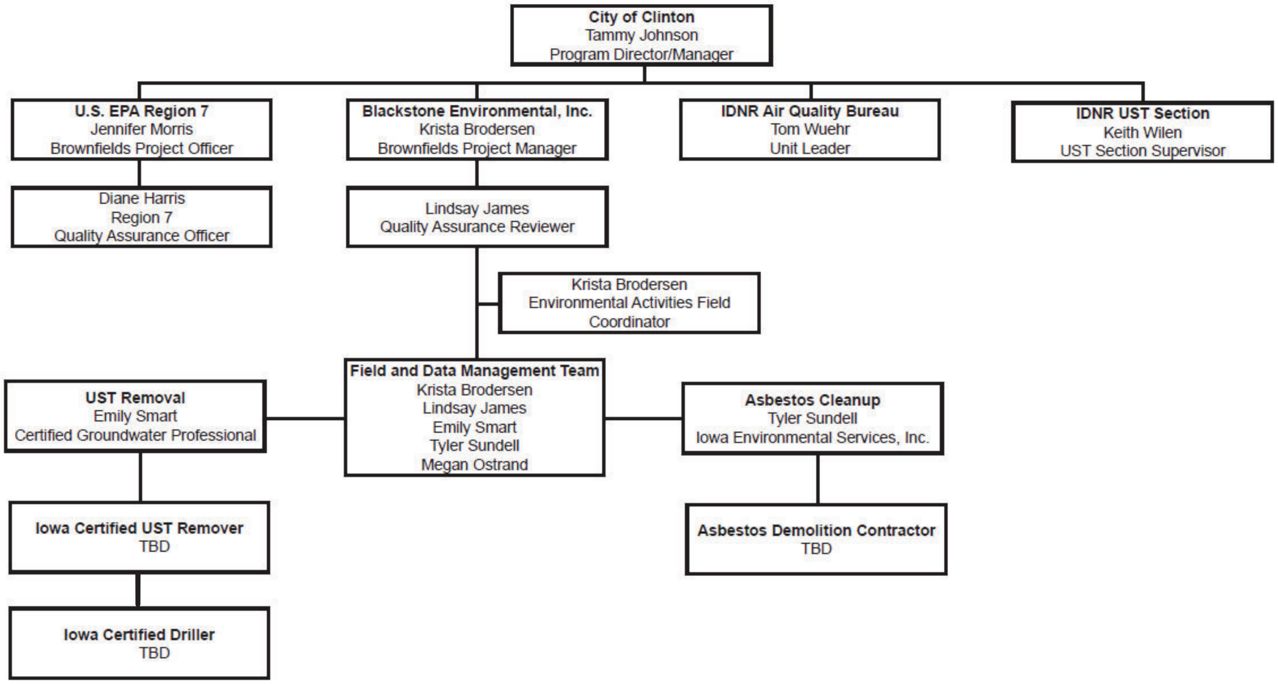
Cleanup activities and evaluation are overseen by the Blackstone Field Activities Coordinator, Ms. Brodersen. Ms. Brodersen will oversee cleanup activities, other Blackstone employees, and subcontractors who perform the cleanup activities on the Project. Ms. Brodersen will coordinate cleanup activities involving asbestos, UST removal, the analytical laboratory, and asbestos and UST removal contractors who hold necessary state and federal certifications and licenses to complete work planned on the Project. Cates Laboratory and Iowa Environmental Services, Inc. will perform the transmission electron microscopy analysis of the air samples collected. Teklab, Inc. will perform the analysis of soil and groundwater samples collected during the UST removal. An Iowa licensed UST Remover will perform the UST removal. The Iowa licensed UST Remover will be subcontracted by Blackstone. An Iowa certified asbestos demolition contractor will perform the demolition and debris removal. The Iowa certified asbestos demolition contractor will be obtained through proper procurement procedures and will be determined prior to the start of field activities.

The IDNR Air Quality Bureau oversees asbestos abatement and removal. Mr. Tom Wuehr, Unit Leader, will provide project oversight and guidance related to the asbestos cleanup portion of the project.

If an UST is identified on the Site, Ms. Emily Smart will act as the Iowa Certified Groundwater Professional and oversee the sampling of the soil and groundwater after the UST removal.

The IDNR UST Division will provide oversight if an UST is identified on the Site. Mr. Keith Wilken, UST Section Supervisor, will provide project oversight and guidance related to the UST removal portion of the project.

See Figure 1-1. Organization Chart



1.5 Problem Definition/Background

1.5.1 Problem Definition

The primary objective of the Project is to design and implement the cleanup of the 1000 Block of South 4th Street site. The project site is located at 1000, 1002, 1004, 1006 – 1008, and 1010 – 1012 South 4th Street (Site) in Clinton, Iowa (refer to figures in Section 7.0). To meet the primary objective, activities to be conducted include the demolition of a dilapidated building and removal of a debris pile comprised of materials associated with the collapsed and demolished buildings that contain asbestos in accordance with Federal and State requirements.

The secondary objective of the Project is to assess if an UST is present under the basement if the 1000 South 4th Street building. If an UST is present, activities to be conducted include the removal and disposal of the UST and impacted soil if found in accordance with Federal and State requirements.

This QAPP is intended to provide an overview of EPA Brownfields Cleanup activities to be performed in support of the City's effort to cleanup the Site and to help ensure the reliability of data generated from those activities.

1.5.2 Project Background

The Site consists of five 2- and 3-story brick buildings constructed between 1868 and 1912 that were used for retail purposes on the first floor and residential apartments on the second and third floors. Retail occupants have included a grocery, laundromat, hardware store, resale shop, upholstery store, furniture and antique store, used clothing store, offices, barber shop, drug store, restaurants, taverns, and a meeting hall. The buildings are currently vacant and have been for up to a decade. They are in disrepair, having been occupied by squatters for years, and are structurally unsafe with sagging roofs and unstable floors. The City has secured the buildings by boarding windows and doors.

Based on the age of the buildings, it is assumed ACM are present. An ACM inspection was conducted on the building located at 1010 – 1012 South 4th Street in 2022 that identified roofing materials, floor tile, and linoleum as ACM. The south and southwest portions of the second and third floors were not able to be inspected due to severe deterioration of the structure. Due to the state of the remaining buildings (severe disrepair and unsafe to enter), ACM inspection has not been conducted.

Evidence of a suspected UST was observed in the basement of the 1000 South 4th Street building in the form of a vent pipe. Based on the suspected location in the floor of the basement, the suspected UST is presumed to be a former heating oil UST. There was limited access to the basement and the UST and its presence has not been verified. It is possible that the UST is still located beneath the basement of the 1000 South 4th Street building.

The buildings addressed as 1000, 1002, 1004, and 1006 - 1008 South 4th Street comprise the North Building Block. The buildings are connected and share common walls between each. The property located at 1000 South 4th Street was quit claimed to the City in 2023 under proper due diligence practices. The property located at 1002 South 4th Street was acquired by the City in 2019 through tax sale. The City purchased the building located at 1004 South 4th Street in 2020 due to the dilapidated condition. Due diligence was not conducted prior to purchase. The 1006 - 1008 South 4th Street building was acquired in 2021 by the City under Iowa Code 657A – Abandoned or Unsafe Buildings. The property located at 1010 - 1012 South 4th Street was acquired by the City in 2019 through tax sale. The building addressed as 1010 - 1012 South 4th Street comprises the South Building Block and was acquired by the City in 2019 due to unpaid taxes. This building is severely deteriorated and has been deemed unsafe to enter and structurally unsound.

On August 11, 2023, the building located at 1006 – 1008 South 4th Street collapsed. Building materials (bricks) from the collapse were strewn into South 4th Street (Lincoln Highway). The same evening, Crandal Excavating, a contractor hired by the City of Clinton, removed the debris on South 4th Street and placed it in the collapsed area. The contractor also pushed in three of the remaining walls of the building to prevent further collapse. The wall connected to the 1004 South 4th Street building was left standing. In a letter dated August 15, 2023, a structural engineer from Willett Hofman & Associates Inc. indicated the collapsed building posed a significant threat to the structural integrity of the connected buildings located at 1000, 1002, and 1004 South 4th Street and recommended they be demolished to a level where a collapse would not allow debris to land on the roadway.

Based on the engineer's recommendation, the structures located at 1000, 1002, and 1004 South 4th Street were demolished to a level where a collapse would not allow debris to land on the roadway and possibly do harm to the public. The demolition was conducted from August 28 through 30, 2023 and was conducted by Lawson Rigging and Excavating, a contractor hired by the City of Clinton, that was overseen by a certified asbestos abatement contractor. The demolition was conducted under wet conditions. The building materials from the four buildings were stockpiled on Site and covered with plastic. Air monitoring for asbestos was conducted during the demolition and periodic air monitoring has been conducted since the demolition. Periodic air monitoring will be conducted until the debris pile can be removed. It is planned that the 1010 – 1012 South 4th Street building be demolished when the debris pile is removed.

1.6 Project/Task Description and Schedule

This QAPP covers activities associated with the cleanup of the Site performed by the City and its consultants pursuant to the Small Business Liability Relief and Brownfields Revitalization Act of 2002. The cleanup activities addressed in this QAPP will be pursuant to:

- Title 29, CFR, Sections 1910.120, 1910.1101, 1910.134, 1910.2, 1910.1200, and 1926.58. OSHA, U.S. Department of Labor.
- Title 40, CFR, Part 61, Subparts A and M, National Emission Standards for Hazardous Air Pollutants, U.S. EPA.
- Title 40, CFR, Part 763, Subparts E and G, Asbestos Abatement Project.
- Chapter 88B of the Code of Iowa, Removal or Encapsulation of Asbestos.
- Chapter 81 of the IAC, Asbestos Control Procedures, Iowa Bureau of Labor.
- Iowa Bureau of Labor Guidelines for removal of non-friable ACM, e.g., floor tile, roofing, etc.
- IAC 567, 455B, Jurisdiction of Department of Natural Resources.
- IAC 567, 455B, Chapter 133, Rules for Determining Cleanup Actions and Responsible Parties.
- IAC 567, 455B, Chapter 134, UST Licensing and Certification Programs.
- IAC 567, 455B, Chapter 135, Technical Standards and Corrective Action Requirements for Owners and Operators of USTs.

It is the purpose of the QAPP to provide a program of decision that produces data of sufficient quantity and quality to determine whether airborne concentrations of asbestos are present during storage of the stockpile and demolition of the buildings and determine if the possible UST has impacted soil and groundwater beneath the Site.

This QAPP is in effect for the duration of the Cleanup Grant project period as indicated on the signature page. The Blackstone QA Reviewer will review the QAPP periodically during this time for applicability.

1.6.1 Task Description

The project will consist of demolishing the building located at 1010 – 1012 South 4th Street as RACM and the removal of the stockpiled collapsed and demolished buildings formerly located at 1000, 1002, 1004, and 1006 – 1008 South 4th Street. Once the stockpile and concrete basement floor is removed, if an UST is identified, it will be removed along with identified impacted soil.

Prior to the start of field activities, caution signs will be posted on fencing surrounding the Site that meet the specifications of OSHA 29 CFR 1910.1101 where airborne concentrations of asbestos may exceed ambient background levels. Signs will be posted at a distance sufficiently far enough away from the work area to permit an employee to read the sign and take the necessary protective measures to avoid exposure.

The demolition of the 1010 – 1012 South 4th Street Building and removal of debris from the collapsed and demolished buildings located at 1000, 1002, 1004, and 1006 – 1008 South 4th Street will be conducted using heavy equipment only. The activities will include the following:

- Use of one or more excavators, front-end loaders, or similar heavy equipment and dump trucks to remove the debris.
- Thoroughly and adequately wetting the debris pile and structure using fire hydrant water applied with a variable rate nozzle prior to and during debris loading and building demolition. A water meter (or equivalent device) will be installed at the water hydrant to measure the volume of water used during the activities. The water will be delivered as a mist or concentrated stream. The demolition debris will be adequately wet at all times and kept wet during handling and loading into containers for transport to a licensed disposal site.
- Direct high-pressure water impact of ACM will be prohibited. A minimal to moderate amount of water runoff is expected. Best Management Practices will be used to control water runoff and collect storm water on the Site. Storm drain inlet protection will be used in conjunction with on-site controls (such as natural and manmade drainage channels), as necessary.
- All materials will be treated as asbestos-contaminated waste. The RACM debris will be transported to a licensed disposal site in lined and covered containers. Waste load out containers shall be lined with two layers of six mil polyethylene sheeting secured with tape for transport to the landfill.
- Grading of the Site for future use.

Air monitoring will be conducted during the field activities to assess concentrations of asbestos in the air. An initial exposure and negative exposure assessment will be conducted by a competent person (Iowa certified asbestos professional). The initial exposure assessment will be conducted by the competent person (abatement contractor) before or at the initiation of the field activities to ascertain expected exposures during debris removal and building demolition. The results of initial exposure monitoring from breathing zone air samples will be representative of the 8-hour TWA and 30-minute short-term exposures of each employee covering operations which are most likely during the performance of the entire asbestos job to result in exposures over the PELs.

A negative exposure assessment will also be conducted to demonstrate that employee exposure during an operation is consistently below the PEL. For any one specific asbestos job which will be performed by employees who have been trained in compliance with the standard, the employer may demonstrate that employee exposures will be below the PELs by data which conform to the following criteria.

Air monitoring will be conducted daily during removal activities. Air sampling monitors will be placed every approximately 200 feet along the fence line surrounding the Site. Exposure monitoring will also be conducted for each job classification in the work area for a full shift.

The air samples will be analyzed for PCM by NIOSH 7400 by Cates Laboratory and/or Iowa Environmental Services, Inc.

A report will be prepared documenting the emergency demolition, sampling during and after the emergency demolition, building demolition, debris removal, sampling during the demolition and debris removal, data/validation/evaluation, disposal (including waste tickets), and maps.

If an UST is discovered after the removal of the debris and concrete basement floor at the 1000 South 4th Street building, removal of the UST will be conducted. Testing of the contents of the UST will be conducted to identify the contents. If the UST is identified and is determined to contain petroleum products other than heating oil, the UST will need to be registered with the IDNR. Whether or not the UST is required to be registered, IDNR Form 542-1308, Notification of Tank Closure or Change-in-Service, will be completed and submitted to the IDNR UST Section. This form would need to be submitted at least 30 days prior to starting UST closure activities.

The field activities for the UST removal will include the following:
- Testing of contents of the UST.
- One or more excavators, front-end loaders, or similar heavy equipment and dump trucks will be used to uncover and remove the UST as well as collecting soil samples and disposing of the UST and identified impacted soil.
- The UST will be transported to a licensed disposal site.
- Liquids from the UST, sludge, and cleaning fluids will be transported to a licensed disposal site.
- Impacted soil, if identified, will be transported to a licensed disposal site. Waste loads will be covered or tarped for transport to the landfill.
- Geoprobe drilling to collect a groundwater sample.
- Grading of the Site for future use.

The UST removal will be conducted by an Iowa Certified UST Contractor. The removal and sampling associated with the removal will be provided by or directly supervised by an Iowa licensed Certified Groundwater Professional.

The soil and groundwater samples will be analyzed for BTEX and TEH by Iowa Methods OA-1 and OA-2, respectively by Teklab, Inc.

A report will be prepared documenting the UST removal, sampling conducted, data/validation/evaluation, disposal of UST and soils (including waste tickets), and maps.

1.6.2 Schedule

The tentative project schedule is presented below. The major activities are listed sequentially, and the expected duration of each activity is presented.

Task	October 2023	November 2023	December 2023	January 2024	February 2024
QAPP Development	■				
Building Demolition and Debris Removal		■	■		
Air Sampling		■	■		
Analytical Results/ Data Evaluation			■	■	
UST Removal		■	■		
Report				■	■

1.7 Quality Objectives and Criteria for Measurement Data

The quality objective of this project is to implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide data that will lead to the development of scientifically valid conclusions in the final report. Specific procedures for sampling, chain-of-custody, laboratory analysis, field and laboratory audits, preventive maintenance of field equipment, and corrective actions are described in other sections of this QAPP.

1.7.1 Objectives and Project Decisions

The primary objective is to remove the risk of exposure of asbestos to the public and the environment from the dilapidated buildings and debris from the collapsed and demolished buildings. The sampling will determine if concentrations of airborne asbestos are present during the building demolition and debris removal. If asbestos is identified in air samples, measurements will be taken to reduce the concentrations.

The secondary objective of the Project is to remove the risk of exposure from a leak from a suspected UST under the basement of the 1000 South 4th Street building. The sampling will determine if concentrations of chemicals of concern are present in soil and groundwater beneath the Site from the suspected UST. Decisions to be made with the data include:

- If the UST is regulated by the IDNR.
- If the data is found to exceed IDNR standards, the release will be reported to the IDNR.
- If the data is found to exceed IDNR standards, the impacted soil will be removed.

1.7.2 Action Limits/Levels

Data generated under this QAPP should be scientifically sound, defensible, and of known, acceptable, documented quality to support project decisions.

The data requirements for this project encompass field sampling, laboratory analysis, and database management to reduce sources of errors and uncertainty in the use of the data. Methods and procedures described in this document are intended to reduce the magnitude of measurement error sources and frequency of occurrence. DQOs include the following:

- Use of standardized, repeatable sample collection procedures.
- Use of trained scientists to perform the sample collection and analyses.
- Calibration of measurement equipment.
- Analysis of duplicate samples.
- Use of Chains-of-Custody when transferring samples or sample material between Blackstone and outside laboratories or experts.
- A QA/QC check on a percentage of samples.
- Maintenance of data.

For data collected under this QAPP to support the DQOs identified above, the DQI, identified below, must be of sufficient quality to provide a high level of confidence in the resulting decisions.

DQIs are qualitative and quantitative statements that clarify the intended use of the data, define the type of data needed to support the decision, identify the conditions under which the data should be collected, and specify tolerable limits on the probability of decision error because of uncertainty in the data. To ensure the collection of high-quality data, specific DQIs have been established for laboratory and field analytical procedures on a method basis for precision, accuracy, representativeness, comparability, completeness, and sensitivity.

The investigation will not be considered invalid if the criteria are not fully achieved, but variances will trigger QA/QC measures to evaluate, and correct, if necessary, identified problem areas.

1.7.1 Quantitative Data Quality Indicators and Determination Methodologies

1.7.1.1 Precision

Precision measures the agreement among a set of replicate measurements. Field precision is assessed through the collection and analysis of field duplicates. Laboratory analytical precision is estimated by comparing the results of split samples, duplicate samples, and duplicate spike samples. The most used estimates of precision are the RSD and, when only two samples are available, the relative percent difference (RPD).

The formula for calculating RPD is as follows:

$$RPD = \frac{|S - D|}{\frac{(S + D)}{2}} x100$$

where:
S = first sample value (original sample value); and
D = second sample value (duplicate sample value).

For field sampling, precision is increased by following SOPs and by collecting samples using the same sampling procedures. Field QC samples collected to measure precision include field duplicate samples (i.e., transport and field handling bias) and include collocated samples (i.e., sampling and measurement precision). Field measurement precision is monitored by taking duplicate measurements at a frequency of 10% of the samples collected and is increased through proper operation and maintenance of field equipment.

Precision for field work is evaluated by calculating the RPD between the results for the field duplicate samples. RPDs will only be calculated for results which are detected at a value greater than 5x the reporting limit. A RPD goal of +/- 50% for soils and +/- 35% for aqueous samples will be used for both field and lab analyses and will be included in the task assignment.

If RPDs greater than 50% for soil samples and 35% for aqueous samples are encountered, corrective action procedures will be implemented. Corrective actions would include evaluation of the sampling procedures, inspection of the sample matrix, and review of field screening results. Laboratory quality control statistics will be calculated per methods specified in Teklab, Inc.’s Quality Assurance/Quality Control Manual (Appendix A).

For the asbestos air samples, precision is dependent upon the total number of fibers counted and the uniformity of the fiber distribution on the filter. A general rule is to count at least 20 and not more than 100 fields. The count is discontinued when 100 fibers are counted, provided that 20 fields have already been counted. Counting more than 100 fibers results in only a small gain in precision. As the total count drops below 10 fibers, an accelerated loss of precision is noted.

1.7.1.2 Accuracy

Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. QC analyses used to measure accuracy include standard recoveries, laboratory control samples, spiked samples, and surrogates.

At this time, there is no known method to determine the absolute accuracy of the asbestos analysis.

For the soil and groundwater samples, overall analytical accuracy is assessed on a batch-specific basis by evaluating the percent recovery (%R) of known concentrations for each analyte in the LCS (and LCSD) against the QC limits. The formula for calculating percent recovery is as follows:

$$\% R = \frac{A - B}{C} x\ 100$$

where:
A = the analyte concentration determined experimentally from the spiked sample;
B = the background level determined by a separate analysis of the unspiked sample (for calibration standards, LCSs, and surrogate compounds, the value of this term is zero); and
C = the amount of the spike added.

Accuracy is also determined by the analysis of reference material and comparison of the resulting value to that of the accepted value. The difference between the accepted and reference value is the percent difference (%D). The percent difference is calculated as follows:

$$\% D = \frac{A - B}{A} x\ 100$$

where:
A = the original quantity measured, and
B = the comparison quantity measured.

Field blanks may be used to evaluate the purity of sample containers and chemical preservatives. In most cases, one field blank per sampling event will be sufficient. No other measures will be taken to evaluate accuracy that are directly associated with sampling and field procedures. For samples analyzed by an accredited analytical laboratory, accuracy will be assessed and evaluated by Teklab, Inc.'s personnel in accordance with their Quality Assurance Manual.

1.7.1.3 Completeness

Completeness is a measure of the amount of valid data collected compared to the amount planned. Measurements are considered to be valid if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. The formula for calculating sampling completeness is as follows:

$$Field\ Completeness = \frac{Number\ of\ Data\ Points\ Obtained}{Number\ of\ Planned\ Data\ Points} x\ 100$$

Analytical completeness is defined as the percentage of valid (nonrejected) analytical results obtained from measurement systems compared with the total number of analytical results requested. The formula for calculating analytical completeness is as follows:

$$Analytical\ Completeness = \frac{Number\ of\ Acceptable\ Laboratory\ Measurements}{Number\ of\ Laboratory\ Measurements\ Reported}\ x\ 100$$

For a set of data to be used with confidence, the data must be complete (i.e., there must be enough valid data from analyses to support the decision). An integral part of obtaining adequate valid data will be to design the sampling network in such a manner that enough data are obtained to enable Site decisions to be made, even if some of the data are determined to be invalid or cannot be collected due to unexpected field conditions. If an adequate degree of completeness is represented by the data set allowing Site decisions to be made, as determined by the Blackstone Project Manager, the data will be considered complete.

Sampling will be considered complete if an adequate degree of completeness is represented by the data set allowing site decisions to be made, as determined by the Blackstone Project Manager. Sampling will be considered accurate if ninety-five percent (95%) of sampling protocols stipulated were used and documentation supports proper use.

1.7.1.4 Sensitivity

Sensitivity is defined as the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest.

At this time, there is no known method to determine sensitivity of the asbestos analysis.

For the soil and groundwater samples, the MDL is the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99 percent level of confidence. At the MDL, the false positive rate (Type I error) is 1 percent. MDLs are specific to an individual determination performed at an individual laboratory.

The RL is the lowest concentration that produces a quantitative result within specified limits of precision and bias. Detected analytical results with quantitation at or above the MDL but below the RL will be reported as detections by the laboratory with the qualification “J.” Detected analytical results at or above the RL will be reported without qualification unless affected by a QC issue.

Detection and quantification limits for sample data must be below the action levels specified in the EPA and State methods. When the list contains more than one action level, the lowest level is chosen. Sensitivity can be affected by contamination as reflected in the method blank results. High method blank results are cause for reruns in sample preparation or sample analysis. Method detection limits for laboratory analyses are specified in the laboratory's Quality Assurance Manual (Appendix A).

1.7.2 Qualitative Data Quality Indicators and Determination Methodologies

1.7.2.1 Representativeness

Sample representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. It is dependent on the proper design of the sampling program and will be satisfied by ensuring the approved plans were followed during sampling and analysis.

Although representativeness is a qualitative measurement, it is evaluated through a multistep process beginning with evaluation of precision and accuracy data. Project design is one of the critical inputs that determine if the data collected is representative of the population sampled:

- Representativeness of individual samples will be controlled by sample collection and handling in accordance with the project requirements:
    - The sample containers and preservation methods will be used to ensure that samples arriving at the laboratory retain the appropriate degree of representativeness.
    - Meeting required holding times ensures that samples retain representativeness at the time of extraction and analysis.
- Representativeness will also be assessed using field and laboratory blank samples to help determine if compounds detected in the environmental samples are Site-related or have been introduced through shipping, storage, field procedures, or laboratory procedures.
    - A method blank will be analyzed with every analytical or preparation batch (as appropriate to the analytical method) to determine potential contamination introduced during routine laboratory procedures.
    - Initial calibration blanks and continuing calibration blanks will be analyzed, as required, by analytical methods.
    - Equipment blanks will be collected for soil and groundwater samples to assess potential contamination due to field conditions.

Samples will be collected in such a manner (and at suitable locations) to accurately reflect the concentrations in the media from which they were collected at the time of sampling. Sample or measurement locations may be biased (judgmental) or unbiased (random or systematic), depending on the desired data use. Representativeness of the data is partially ensured by avoiding cross-contamination, adherence to standard sample handling and analysis procedures, and use of proper chain-of-custody and documentation procedures. Representativeness may be assessed by comparing repeated analysis from the same sampling point over a period of time.

1.7.2.2 Comparability

Comparability expresses the degree of confidence with which one data set can be compared to another. Data is comparable if Site considerations; collection techniques; and measurement procedures, methods, and sensitivity limits are equivalent for the samples within a sample set.

For this project, comparability will be satisfied by ensuring that the approved plans are followed, and that proper sampling and analysis techniques are applied. The sampling plans that will be implemented for this project are based on approved and established protocols.

Summaries of the QA/QC objectives for the analysis and collection of samples for this project are provided in subsequent narrative and tables. The specific DQIs associated with each subtask (asbestos analysis, soil samples, and groundwater samples) are presented in the method-specific sections. For each DQI, the procedures to be followed to provide assurance that an analytical procedure is returning valid results are provided. Each DQI has a specific result that must be met before the data are considered acceptable. Maintenance and calibration procedures for equipment and instrumentation are also provided along with sample collection methods. Analyte-specific tables provide information on the number of QA/QC samples to be prepared (duplicates, etc.) and the expected result as well as the person(s) responsible for assessing any problems and determining the proper course of action, if necessary.

1.7.3 Action Limits

Action limits for the air samples to be collected for this project are the PELs. The IAC 875, Chapter 10 adopts the OSHA standard for construction described in in 29 CFR 1926.1101(c)(1). The standard requires that employee exposure to airborne asbestos fibers be maintained below the PEL which is 0.1 (f/cc) of air as an eight-hour TWA. Additionally, the standard requires that no employee is exposed to airborne asbestos in excess of 1.0 f/cc as averaged over a sampling period of 30 minutes. The method for detecting the asbestos fibers is fiber counting by PCM.

See Table 1-1. Analytical Parameters and Target Limits

Table 1-1. Analytical Parameters and Target Limits
Matrix/Media: Air

Analytical Parameter	Project Action Limit/Level (applicable units)	Laboratory Limits (applicable units)	
		Quantitation Limits	Detection Limits
PCM – 8 hour TWA	0.1 f/cc	Not Applicable	10 fibers per 100 fields
PCM – 30 minute Excursion Limit	1.0 f/cc	Not Applicable	10 fibers per 100 fields

Action limits for the soil and groundwater that may be collected for this project are the Tier 1 Levels as indicated in IAC 455B, Chapter 135.9.

See Tables 1-2 and 1-3. Analytical Parameters and Target Limits

Table 1-2. Analytical Parameters and Target Limits
Matrix/Media: Soil

Analytical Parameter	Project Action Limit/Level (µg/kg)	Laboratory Limits (applicable units)	
		Quantitation Limits	Detection Limits
Benzene	540	1	0.27
Toluene	3,200	2	0.35
Ethylbenzene	15,000	2	0.34
Xylene	52,000	8	1.38
Waste Oil	No Limit	500	168
Diesel	3,800,000	500	168

Table 1-3. Analytical Parameters and Target Limits
Matrix/Media: Groundwater

Analytical Parameter	Project Action Limit/Level (µg/L)	Laboratory Limits (applicable units)	
		Quantitation Limits	Detection Limits
Benzene	5,000	0.5	0.05
Toluene	1,000,000	2	0.1
Ethylbenzene	700,000	2	0.1
Xylene	10,000,000	4	0.28
Waste Oil	400,000	1,000	400
Diesel	1,200,000	1,000	400

1.8 Special Training Requirements/Certification

Proper training of field personnel represents a critical aspect of meeting the data quality objectives in order to fulfill the goals of this QAPP. Blackstone staff that collect environmental data under this QAPP will be experienced in performing the project tasks required or will be supervised in the field by an experienced team member.

Asbestos abatement workers must be licensed as required by the Iowa Bureau of Labor. IDNR maintains a list of Iowa-registered asbestos workers. These registered workers are required to successfully complete an initial training course and annual refresher courses. This project requires licensed asbestos workers and will use Iowa-registered asbestos workers. A list of all personnel who will be involved in the abatement activity, their Iowa license, and documentation of respirator fit testing will be provided to the Project Manager and stored with the project documents.

Individuals conducting work under this QAPP are required to read the applicable SOP's and sign acknowledgement forms prior to conducting data collection, management, or analysis activities. Applicable Blackstone SOPs are provided in Appendix B.

Subcontractors, including laboratories, are prequalified through evidence of experience performing similar projects and through references. Laboratories used for analyzing soil and groundwater environmental samples must meet one of the following criteria:

- Participation in EPA Contract Laboratory Program (CLP).
- Performance of periodic performance evaluation blind sample analyses and receipt of an acceptable or greater rating.
- Participation in accredited analytical laboratory certification program (international, state, military, or other agency, such as the National Environmental Laboratory Accreditation Conference):

The laboratory must also have a written quality assurance program that complies with EPA Requirements for Quality Management Plans.

Laboratories used for analyzing asbestos air samples must be accredited by NVLAP.

1.9 Documents and Records

Documentation of data generated from tasks covered by this QAPP must be of sufficient quality to withstand challenges to their validity, accuracy, and legibility. To meet this objective, data are recorded in standardized formats and in accordance with prescribed procedures. The documentation of environmental data collection activities must meet the following minimum requirements:

- Data and associated information must be documented directly, promptly, and legibly by the observer onto established forms or in designated field logbooks. Reported data must be uniquely traceable to the raw data. Data reduction, correction or transformation changes must be documented, dated, and initialed.
- Original data records include, as appropriate, a description of the data collected, units of measurement, station or location identification, name or initials of the person collecting the data, date and time of collection, and the unique sample identification number.
- Changes to the original (raw data) entry must not obscure the original entry. The reason for the change must be documented, the change must be initialed and dated by the person making the change and approved by the Blackstone Project Manager.

Document control procedures ensure that relevant project documents are accurate, up-to-date, and available when information is needed for technical or administrative reasons. During project performance, hard copy working files may be maintained by personnel in their work or field offices. Once the project is completed, relevant hard copy documents will be filed in the office project file or scanned and maintained as an electronic document in the project file on the network servers.

1.10 Project Files

The Field Team Leader is responsible for maintaining the field project file, including copies of chains-of-custody, receipts, bills of lading, printouts of instrument downloads, daily logs, and checklists, as applicable. Once the field work is completed these documents will be placed in the final project files, along with copies of field logbooks, instrument downloads, and project photographs. Both hard copy and electronic project files are maintained in the Blackstone office. Electronic files are maintained by a secure cloud storage and online backup company.

Field and analytical data will typically be reduced for presentation in a project report. Laboratory data and most field instrument downloads are provided in electronic formats that are compatible with spreadsheet software such as Microsoft Excel, which will be used for presentation in the report. The direct conversion into such software minimizes the potential for transcription errors. The person conducting the project quality assurance review is also responsible for cross checking report tables with the raw data.

Complete project files will be maintained for the length of time specified by contractual or regulatory requirements. However, Blackstone policy is to retain files for 10 years, unless client or regulatory agency requirements mandate a longer retention policy. Records retained indefinitely include:

- contracts/subcontractor agreements.
- insurance certificates.
- final reports (original and/or electronic versions).
- final plans, specifications, cost estimates or other documents signed and sealed by a Blackstone professional engineer or professional geologist.

1.11 Field Documentation

Project field logbooks or sampling forms provide a useful technical record of activities and observations. The field documentation should be complete, accurate, and legible. Documentation will consist of consecutively numbered pages, and each page will be signed and dated by the individual recording the information it contains. Entries will be in waterproof ink and there will be no blank lines. Times of entries will be noted.

Examples of the type of information that should be recorded in field logbooks or on field sampling forms should include:

- Date.

- Environmental conditions.
- Field team members and visitors.
- Photographs (number and subject).
- Samples (identification number).
- Field changes (sample location, type, etc.).
- Field observations and measurements.
- Log of sampling locations.
- Equipment calibration and maintenance.
- Sample shipment.
- Deviations from the QAPP and/or complications encountered during field activities.

The specific information is dependent on the project scope. However, the information should be sufficient to reconstruct sampling activities.

1.12 Photographs

Photographs provide valuable documentation of site investigation activities. They should be used to record specific observations relating to the Site, sample locations, sample types, and general Site conditions and activities.

1.13 Document Control

Document control procedures ensure that relevant project documents are accurate, up-to-date, and available when information is needed for technical or administrative reasons. The documents discussed in this section should ultimately be retained in the project files in either electronic or hard copy form.

QAPP and health and safety plan documents are maintained electronically on the Blackstone office network servers as a word (or equivalent) and electronic pdf document in the individual project file. This ensures that the latest version of the document is available to personnel. Documents are identified by date and version number. Document updates will be transmitted to other users on the project team as changes are made to the document.

The final project report will include at a minimum, background information, discussion of objectives and scope, a description of the field investigation activities including deviations from the QAPP, presentation and evaluation of analytical results, quality assurance/quality control, a discussion of findings, and conclusions. Field documentation, access agreements, photographs, and original analytical data and chain-of-custody paperwork will be included in appendices, as applicable.

During project performance, hard copy working files may be maintained by personnel in their work or field offices. Once the project is completed, all relevant hard copy documents will be filed in the office project file or scanned and maintained as an electronic document in the project file on the network servers. The types of documents to be retained are indicated by the file categories including:

- background information.
- contracts and invoices.
- working files (e.g., correspondence, data, etc.).
- submittals.

Electronic files will be stored under the project files on the Blackstone office network server. These files are organized by client and project number.

Blackstone's Project Manager will be responsible for supervising the administrative support personnel in maintaining the project files for the duration of the project and shall not exceed five years without resubmission of a QAPP and approval. The project files will be kept in Blackstone's Kansas City office while the project remains active.

1.13.1 Laboratory Documentation and Records

The Blackstone Project Manager, in conjunction with the Cates Laboratory, Iowa Environmental Services, and Teklab, Inc. QA Managers, has the primary responsibility for defining site-specific data reporting requirements and relating them to the Field Activities Coordinator. These requirements, the turnaround time for receipt of deliverables specified, and site-specific requirements for retention of samples and laboratory records, should be clearly defined in requests for analytical services. The laboratory QA Managers are responsible for ensuring that all laboratory data reporting requirements in the QAPP are met. It is also the responsibility of the Blackstone Project Manager to provide the Field Activities Coordinator with the most recent version of the EPA-approved QAPP.

The data generated by the laboratory for each sampling event will be compiled into individual data packages/reports. The data packages will include the sample results and copies of the chain-of-custody forms.

The data packages will be reviewed by the Laboratory QA Officer to ensure the accurate documentation of any deviations from sample preparation, analysis, and/or QA/QC procedures; highlights of any excursions from the QC acceptance limits; and pertinent sample data. Once finalized, the Laboratory QA Officer will provide the data packages/reports to the Laboratory Project Manager who will sign them and submit them to the Project Manager. Problems identified by the Laboratory QA Officer will be documented in the narrative part of the report. Information about the documentation to be provided by analytical laboratory is also contained in the laboratory's QA Manual (Appendix A).

1.13.2 Labels

The samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. The samples will have preassigned, identifiable, and unique numbers. At a minimum, the sample labels will contain the following information:

- Sampling location
- Unique sample number

- Date and time of collection
- Initials/signature of sampler

Each sample location will have a unique sample identification number. A copy of an example label is included in Appendix A.

1.13.3 Sample Chain-of-Custody Forms

Chain-of-custody forms will be provided by the laboratory. The forms will be used to document collection and shipment of samples for off-site laboratory analysis. Sample shipments will be accompanied by a chain-of-custody form. The forms will be completed and sent with each shipment of samples to the laboratory. Copies will be sent to the Project Manager/QA Officer. The chain-of-custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is considered to be in someone's custody if it is either in someone's physical possession, in someone's view, locked up, or kept in a secured area that is restricted to authorized personnel. Until the samples are shipped, the custody of the samples will be the responsibility of the field personnel, who will sign the chain-of-custody form in the "relinquished by" box and note the date and time. Procedures for completion and distribution of the chain-of-custody form is included in Appendix A.

2.0 DATA GENERATION AND ACQUISITION

This section specifies the methods to be used in collecting and analyzing environmental media for the project (i.e., air sampling for asbestos and soil and groundwater sampling). The purpose is to ensure that appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and quality control activities are employed and documented. Pertinent information will be recorded on field logs.

2.1 Sampling Design

Procedures for the sampling process design are part of an overall data quality objectives process completed during project planning. The factors to be considered in the design include possible sources, potential receptors, contaminants of concern, and state programs involved.

For EPA Brownfields Cleanup activities, a non-probabilistic sampling (judgmental) approach may be used to provide subjective information to assess for the presence of asbestos in the air during abatement activities. A brief definition of the basic sampling approaches is provided below.

Judgmental Sampling—Judgmental sampling is the subjective selection of sampling locations based on historical information, visual inspection, and the best professional judgment of the sampler.

While the stockpile of debris is on Site prior to removal, air sampling will be conducted weekly to verify the tarp covering the debris is containing the debris and suspected ACM. The approximate sample locations are presented as Figure 2.

During the demolition and removal of debris, samples will be collected approximately every 200 feet along the designated demolition work area fence. The approximate sample locations are presented as Figure 3. In addition, personal air samples will be collected representing a full shift including one sample for each job classification. One short term exposure sample will be collected which represents the 30-minute time period in which the highest fibers are expected.

If an UST is identified on Site, a sample of liquid or sludge (whichever is present) from the UST will be collected to assess the contents. A determination of whether or not the UST is a regulated tank will be based on the results. If the contents are waste oil, permitting of the UST will not be required by the IDNR. If other petroleum constituents are identified, the UST will need to be permitted through IDNR prior to removal. Once removed, soil sampling will be conducted beneath and around the UST. As the size of the UST is unknown at this time and the number and locations of the samples required by IDNR are dependent on the size of the UST, the sampling will be conducted in general accordance with IDNR UST Closure Guidance dated May 2021 (Appendix C). As required by IDNR, a temporary groundwater well will be installed within 20 feet of the presumed downgradient direction from the UST and a groundwater sample will be collected.

Table 2.1 Sampling Design and Rationale

Sampling Location	Matrix	Appropriate Units	Analytical Parameter	Rationale for Sampling Design
North and south of the debris pile	Air	f/cc	PCM	Assess if asbestos fibers have been released
Approximately every 200 feet along fence line	Air	f/cc	PCM	Assess if asbestos fibers have been released
Personal – eight hour TWA	Air	f/cc	PCM	Assess if personnel have been exposed to airborne asbestos
Personal – 30 minute excursion limit	Air	f/cc	PCM	Assess if personnel have been exposed to airborne asbestos
Inside UST	Liquid and/or sludge	ppm	Iowa Method OA-2	Assess contents of UST
Around and beneath the UST	Soil	ppm	Iowa Method OA-1 and OA-2	Assess if UST had leaked
Within 20 feet of the presumed downgradient direction of UST	Groundwater	ppm	Iowa Method OA-1 and OA-2	Assess if UST had leaked

Air samples for asbestos will be collected weekly prior to the debris being removed. During demolition and removal, sampling will be conducted daily.

Liquid and/or sludge sampling will be conducted of the UST contents if found. Soil and groundwater samples will be collected as required by IDNR once the removal is complete.

A summary of the samples to be collected is provided below.

Table 2.2 – Summary of Field and QC Samples to be Collected

Sampling	Matrix	Analytical Parameters	Number of Sampling Locations	Number of Field Duplicates	Number of Equipment Blanks	Number of MS/MSD Samples	Total Number of Samples
Debris Pile	Air	PCM	3	1 every approximate 10 samples	Not Applicable	Not Applicable	53
During Demolition and Debris Pile Removal	Air	PCM	8	1	Not Applicable	Not Applicable	90
Personal – eight-hour TWA	Air	PCM	2	0	Not Applicable	Not Applicable	20
Personal – 30-minute excursion limit	Air	PCM	1	0	Not Applicable	Not Applicable	10
UST Removal – Testing of contents	Liquid or Sludge	Iowa Method OA-2	1	0	0	0	1
UST Removal	Soil	Iowa Method OA-1 and OA-2	TBD	1	1	0	TBD
UST Removal	Groundwater	Iowa Method OA-1 and OA-2	1				

2.2 Sampling Methods

2.2.1 Asbestos Air Sampling

Samples will be collected and handled in accordance with the SOPs for Collection of Airborne Asbestos Fibers provided in Appendix B which were developed from state and national guidance.

2.2.1 Liquid/Sludge, Soil, and Groundwater Sampling

Samples will be collected and handled in accordance with the following SOPs provided in Appendix B which were developed from state and national guidance:

- Standard Operating Procedure for Groundwater Sampling
- Standard Operating Procedure for Soil Sampling
- Standard Operating Procedure for Soil Screening with a PID
- Standard Operating Procedure for Chain of Custody
- Standard Operating Procedure for Equipment Decontamination
- Standard Operating Procedure for Investigative Derived Waste

Additional SOPs that address specialized sample collection and screening techniques may also be incorporated, if approved by the EPA Brownfields Project Manager.

2.3 Sample Handling and Custody

The samples will be handled in accordance with the Blackstone COC SOP (Appendix B), which was developed following state and federal guidance. Deviations from COC procedures will be noted in the report.

A sample label will be placed on the cassette indicating a unique sampling number. The cassette will be placed in a manila-type envelope or other appropriate container that will not relay a static charge to the cassette. The samples will then be transported to the laboratory with the chain-of-custody by hand or via mail carrier.

Examples of sample labels, chain-of-custody forms, and sample custody logs are included in Appendix A.

2.3.1 Field Health and Safety Procedures

A Site-specific Health and Safety Plan has been prepared and is included as Appendix D. A safety meeting will be held the first day of the samplings event to discuss emergency procedures (e.g., location of the nearest hospital) and local contact information (e.g., names and telephone numbers of local personnel, fire department, police department). PPE to be worn is included in the Health and Safety Plan in Appendix D. At a minimum, safety glasses, nitrile gloves, and steel-toed boots will be worn.

2.4 Analytical Methods

Samples will be analyzed by Cates Laboratories, Iowa Environmental, Inc., and Teklab, Inc. They have provided QA Manuals which are provided in Appendix A.

The preparation and analysis of fixed-base laboratory samples is described in general in the manuals. Specific method protocols will be within recommended procedures of standard methods. The samples will be analyzed within standard turnaround time unless the Blackstone Project Manager deems “rush” analyses are necessary to meet project goals.

The following tables present the analytical method, container type, preservation, and holding time requirements for the samples to be collected.

Table 2.3 – Analytical Method, Container, Preservation, and Holding Time Requirements				
Matrix: Air				
Analytical Parameter	Analytical Method Number	Containers	Preservation	Maximum Holding Time
PCM	NIOSH 7400	MCEF filters	None	None

Table 2.4 – Analytical Method, Container, Preservation, and Holding Time Requirements				
Matrix: Liquid/Sludge				
Analytical Parameter	Analytical Method Number	Containers	Preservation	Maximum Holding Time
TEH	Iowa Method OA-2	4-oz glass jar	4° Celsius	14 business days

Table 2.5 – Analytical Method, Container, Preservation, and Holding Time Requirements				
Matrix: Soil				
Analytical Parameter	Analytical Method Number	Containers	Preservation	Maximum Holding Time
TEH	Iowa Method OA-2	4-oz glass jar	4° Celsius	14 business days
BTEX	Iowa Method OA-1	4-oz glass jar	4° Celsius	14 business days

Table 2.6 – Analytical Method, Container, Preservation, and Holding Time Requirements				
Matrix: Groundwater				
Analytical Parameter	Analytical Method Number	Containers	Preservation	Maximum Holding Time
TEH	Iowa Method OA-2	250 mL amber jar	4° Celsius	14 business days
BTEX	Iowa Method OA-1	250 mL amber jar	4° Celsius	14 business days

2.5 Quality Control Requirements

QC samples will be required to verify the validity of analytical results and, where QC issues arise, to assess whether samples were contaminated as a result of improper decontamination procedures, use of contaminated containers or preservatives, and/or introduction of contaminants during transportation of the samples to the laboratory. Field QC samples may include trip blanks, rinsate samples, and duplicates as appropriate. Duplicate samples may be collected to assess the reproducibility of the sampling procedures and analytical methods. Temperature blanks are included to verify sample preservation.

For the asbestos air samples, blanks will be prepared by the field sampler and will be taken into the field by the sampling team. Closed field blanks are filter cassettes that have been transported to the Site and then sent to the laboratory without being opened. The Blackstone Project Manager, in conjunction with the QA Reviewer, will evaluate the results of the blanks to determine if they are acceptable. If sample results indicate contamination of blank samples (detections above method reporting limits), sampling and analysis may be performed again for the associated target analytes. The Project Manager, in conjunction with the QA Reviewer, will make this decision.

For the soil and groundwater samples to be collected, trip blanks will be prepared by Teklab, Inc. and will be taken into the field by the sampling team to determine whether any field-related activities resulted in the introduction of VOCs that would jeopardize the validity of analytical results. Field blanks are samples prepared in the field to assess whether contaminants were introduced by sample containers and/or preservatives. Rinsate samples are used to determine if decontamination procedures are being performed adequately to prevent cross-contamination between samples. The Blackstone Project Manager, in conjunction with the QA Reviewer, will evaluate the results of the trip, rinsate, and field blanks to determine if they are acceptable. If sample results indicate contamination of blank samples (detections above method reporting limits), sampling and analysis may be performed again for the associated target analytes. The Project Manager, in conjunction with the QA Reviewer, will make this decision.

Laboratory QC samples include duplicates, spikes, laboratory blanks, and PE samples as appropriate. Pertinent SOPs and guidance documents referenced in this QAPP will be followed to ensure QA objectives are met. Fixed-base laboratory QC procedures will be performed in accordance with the SOPs for the applicable analytical methods (Appendix B).

The following QA/QC guidance documents will be implemented as appropriate to ensure QA/QC elements are adequately addressed:

- *Guidance for the Data Quality Objectives Process* - EPA QA/G-4, OSWER. USEPA, February 2006.
- *EPA Requirements for Quality Assurance Project Plans* - EPA QA/R-5, March 2001.
- *Guidance for Quality Assurance Project Plans* - EPA QA/G-5, OSWER, USEPA, December 2002

QC samples will be required to verify the validity of analytical results and, where QC issues arise, to assess whether samples were contaminated as a result of the use of contaminated containers and/or introduction of contaminants during transportation of the samples to the laboratory. Field QC samples may include blanks and duplicates as appropriate. Duplicate samples may be collected to assess the reproducibility of the sampling procedures and analytical methods.

2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Field equipment will be calibrated, tested, and inspected in accordance with the manufacturers' specifications. Calibration and maintenance documents will be stored in the case alongside the associated field equipment or in a field logbook as appropriate. Field equipment manuals are presented in Appendix E.

Laboratory equipment will also be calibrated and maintained in accordance with the manufacturers' specifications and applicable laboratory analytical SOPs (Appendix B).

Laboratory instruments are maintained in accordance with manufacturer's specifications and the requirements of the specific method employed. This maintenance is carried out on a regularly-scheduled basis and is documented in the laboratory instrument service logbook for each instrument.

Laboratory analytical equipment, inspection, testing, and maintenance procedures are detailed in the Teklab Quality Assurance Manual (Teklab, 2022).

2.7 Instrument/Equipment Calibration and Frequency

Field equipment will be calibrated, tested, and inspected in accordance with the manufacturers' specifications. Calibration and maintenance documents will be stored in the case alongside the associated field equipment or in a field logbook as appropriate.

Laboratory equipment will also be calibrated and maintained in accordance with the manufacturers' specifications and applicable analytical SOPs and applicable laboratory SOPs.

Maintenance logs, including calibration frequency, are kept at each participating laboratory. Laboratory analytical equipment, inspection, testing, and maintenance procedures are detailed in the Teklab Quality Assurance Manual (Teklab, 2022).

2.8 Inspection/Acceptance Requirements for Supplies and Consumables

Blackstone maintains centralized control of field sampling expendables, supplies, and materials for conducting environmental sampling through the position of Environmental Activities Field Coordinator. Supplies and consumables that are of adequate quality to sustain confidence in the sample collection, processing, and laboratory analysis will be used. Purchased supplies and consumables will not be used until they have been inspected, calibrated, or otherwise verified to be in compliance with standard specifications relevant to calibrations or tests being performed and will be dedicated to that project. When possible, certified contaminant free sampling supplies and consumables (e.g., nitrile gloves) will be used and dedicated for one use at one location.

Analytical Laboratories provide pre-cleaned sampling containers for use by field sampling personnel. Cleaning is verified by the companies' QA Managers. These containers are obtained from reputable container manufacturers and are cleaned to EPA specifications (Specifications and Guidance for Contaminant-Free Sample Containers OSWER Directive #9240.0- 05A Dec 92). In addition, the Blackstone Environmental Activities Field Coordinator will visually inspect containers for evidence of contamination, necessary preservatives, appropriate size, number, and material for the required analyses.

2.9 Data Acquisition Requirements

No data from other sources, except EPA Brownfields investigations and Phase I ESAs will be used for decision-making purposes. Any secondary (non-EPA Brownfields) information, including other analytical data, reports, photographs, maps, etc. from additional sources referenced in reports compiled by Blackstone, may not have been verified by Blackstone. This information is mentioned for informational purposes only and will be addressed as supplemental information. It is not to be used for decision-making purposes without verification by an independent professional who is qualified to verify such data or information.

2.10 Data Management

Blackstone's Project Manager will be responsible for supervising the administrative support personnel in maintaining the project files for the duration of the project and shall not exceed five years without resubmission of a QAPP and approval thereof by EPA. The project files will be kept in Blackstone's Moline office while the project remains active. Upon completion of the project, Blackstone will archive the project files until the completion of the project. After completion of the project, project files will be transferred to the City.

Blackstone will use portable laptop computers along with data loggers to record, process, and manage project data. The following software potentially will be used to process data: Access®, ArcGIS®, Aqtesolv®, AutoCad®, AutoDesk®, DQO/DEFT®, Excel®, Surfer®, VSP®, Word®,.

Laboratory data management will focus on a level requisite of EPA protocols and the standard methods. These procedures are set forth in Appendix A.

3.0 ASSESSMENT AND OVERSIGHT

3.1 Assessments/Oversight and Response Actions

Both internal performance and system audits may be conducted during field operations. Performance audits include verification that field sampling activities and laboratory analyses of performance evaluation samples are being conducted in accordance with the requirements of this QAPP and any QAPP Amendment. System audits involve a qualitative examination of an environmental data collection system including records, personnel, and QA management activities.

This section describes the selection of audit personnel, the scope of field and laboratory audits, audit frequencies, and typical audit reports for internal audits initiated by the Blackstone QA Reviewer.

The fixed-base laboratory performance and system audits will be as outlined in Teklab, Inc.'s Statement of Quality Assurance (Appendix A).

3.1.1 Audit Personnel

The QA/QC Reviewer has the lead role in directing and executing all internal audit activities during an investigation. The QA/QC Reviewer is responsible for preparing an audit plan; coordinating and scheduling the audit with the project team or subcontractor; participating in the audit; coordinating the preparation and issuance of audit reports and corrective action request forms; and evaluating audit responses and resulting corrective actions.

3.1.2 Audit Scope of Work

Performance audits of field activities will be conducted to evaluate compliance with the requirements of this QAPP and any QAPP Amendments. Field system audits may include an examination of the following items:

- Sample collection records.
- Sample collection, handling, packaging, shipping, and custody records.
- Equipment operation, maintenance, and calibration records.

The laboratory performance and system audits by Teklab, Inc. will be completed as outlined in their Quality Assurance Manual (Appendix A).

3.1.3 Audit Frequencies

As necessary, this QAPP will provide a schedule for all planned audits to be conducted during the investigation. These audits may be required by EPA or planned by QA/QC Reviewer. Audit frequency will depend on several factors. In selecting investigations for auditing, the QA/QC Reviewer will consider investigations with a large volume of work or those on which EPA has placed a high level of importance. The QA/QC Reviewer may also randomly select investigations for auditing.

Unscheduled follow-up audits may occur if any deficiencies are discovered during an audit or review. Follow-up audits serve to verify that necessary corrective actions have been properly implemented to address deficiencies.

3.1.4 Audit Reports

Audit reports will be prepared for performance and system audits of field and laboratory activities and laboratory evaluation studies conducted under this Cooperative Agreement. Reports will be prepared by the QA/QC Reviewer. Audit reports will identify participants, describe the activity audited, summarize audit findings, and detail any deficiencies or deviations from protocol discovered during the audits, as well any corrective actions proposed. Field or laboratory analytical data generated during performance evaluation must be validated. Validated dates will be included in the audit reports.

Audit reports are distributed to the Blackstone Project Manager or laboratory QA manager, as appropriate. The QA/QC Reviewer has primary responsibility for ensuring audits are conducted thoroughly and properly. The Blackstone Project Manager or laboratory QA Manager is responsible for implementing corrective actions resulting from the audit. The QA/QC Reviewer is responsible for verifying recommended corrective actions have been implemented.

3.1.5 Corrective Action

Corrective actions will be taken whenever problems appear to be adversely affecting data quality and/or when the resulting decisions may affect future response actions pertaining to the Site. When such conditions are identified, the following corrective actions will be taken:

- Document that suspect data have been obtained.
- Review the system in question to ensure procedures were properly performed.
    - If procedures were not carried out properly, then document errors and repeat the procedures in accordance with proper methodologies, including all applicable quality control checks.
    - If any control checks gave out-of-control results, advise the project supervisor, and do not continue until the problem has been resolved.
    - If all of the control checks gave satisfactory results after corrective actions have been taken, document the corrective actions and continue.

3.2 Reports to Management

Reports describing the project activities, status, results of audits, corrective actions, needs for resolution among participating parties, and schedule changes will be distributed electronically. Quality Assurance problems will be noted in the reports as needed. These are summarized below in the following table.

Table 4 - Routine Reports

Document	Party	Preparer	Frequency
Grant Reports	City	Project Manager	Quarterly throughout Grant and as determined by the City.
Daily Job Reports	Blackstone	Environmental Activities Field Coordinator	Daily when field work in progress with logbook copies.
Project Status Meetings	Blackstone	Project Manager	Weekly during field activities, otherwise monthly.
Website for Community Outreach	City	Communications Specialist	Updated at final report for project activities or as desired by the City.
Project Closeout Report	Blackstone / City	Project Manager	End of Project

4.0 DATA REVIEW AND USABILITY

This section addresses the quality assurance activities that occur after data collection or generation is completed. Subsections address how data will be reviewed, verified and validated as well as how data will be assessed and reconciled with the project objectives.

4.1 Data Review, Verification, and Validation Requirements

It will be the primary responsibility of the Blackstone Project Manager to review and, as far as possible, validate and verify all data collected by project activities meet QAPP objectives.

Blackstone will follow EPA's DQA process to verify that the type, quality, and quantity of data collected are appropriate for their intended use. The DQA process involves first verifying that the assumptions under which the data collection design and DQOs were developed have been met or taking appropriate corrective action if the assumptions have not been met. The DQA process then evaluates how well the data collected support the decision that must be made so scientifically valid and meaningful conclusions can be drawn from the data. To the extent possible, Blackstone will follow DQA methods and procedures outlined in EPA's Guidance for Data Quality Assessment: A Reviewer's Guide (EPA QA/G-9R) (February 2006) and Data Quality Assessment: Statistical Methods for Practitioners (EPA QA/G-9S) (February 2006).

4.2 Verification and Validation Methods

The Blackstone Project Manager will be responsible for validation of project implementation, conducting a direct comparison of the project records to the QAPP for the cleanup prior to writing the final report. This will be initiated immediately upon completion of the field activities on the Site. The final report will contain a section designated for data validation and verification. The data users will be provided with copies of the report.

Due to the limited nature of the validation, the QA Reviewer will conduct a minimum of one review per year, or as needed, of the Blackstone Project Manager's validation of project implementation. The QA Reviewer will evaluate the implementation of the following relative to field and management procedures as they apply to the Brownfields Cleanup. Data will be reviewed to evaluate conformance with the quality criteria set forth in the QAPP. These evaluations will include, but are not limited to:

- Conformance to the QAPP's data quality objectives.
- Conformance with sample handling protocols.
- Results of quality control checks as they relate to field influences on data quality.
- Results of calibration of instruments and field forms.

The Blackstone Project Manager will rely on standard methods conformance according to the laboratory SOPs and their system of flagging data in the laboratory data packages to support valid analytical data.

The review will specifically evaluate field and management procedures as they apply to the Site. The quality of the resultant data will be evaluated in accordance with of the following:

- Generic conformance to design parameters of the QAPP.
- Sampling design.
- Sample collection procedures as prescribed in protocols of Appendix B and compared to field documentation.
    - Sampling will be considered complete only if an adequate degree of completeness is represented by the data set allowing Site decisions to be made, as determined by the Blackstone Project Manager.
    - Sampling will be considered accurate if ninety-five percent (95%) of the sampling protocols stipulated were used and documentation supports proper use.

- Sample handling protocols and chain-of-custody will be reviewed.
- Quality control checks conducted as they relate to field influences on data quality.
- Calibration of instruments at mobilization and in the field from instrument records and field logbooks specific to the Site.

4.1.1 Laboratory Data Validation Methods

Data validation practices will be followed to ensure that raw data are not altered and that an audit trail is developed for those data which required reduction. Field data, such as those generated during field measurements, observations, and field instrument calibrations, will be entered directly into a bound field notebook, or onto project-specific data forms.

Analytical data generated during the project will undergo a rigorous laboratory data review. This review will be performed in accordance with the method requirements. A preliminary review will be performed to verify all necessary paperwork (chain-of-custodies, analytical reports, laboratory personnel signatures) and deliverables as stated in the requirements are present.

Upon receipt of the sample data packages, the laboratory data will be quantitatively and qualitatively validated by the laboratory's Quality Assurance Chemist to verify the qualitative and quantitative reliability of the data as it is presented. This review will include a detailed review and interpretation of data generated by the laboratory. The primary tools which will be used by experienced data review chemists will be guidance documents, established (contractual) criteria, and professional judgment.

It is anticipated that the laboratory's data reduction for this site assessment will be minimal and will consist primarily of tabulating laboratory analytical results onto summary tables through the use of computerized spreadsheet software. Analytical data will be provided in the form of electronic deliverables.

Based upon the review of the analytical data, a quality assurance report will be prepared by the laboratory which will state in a technical, yet "user friendly" fashion, the qualitative and quantitative reliability of the analytical data. The report will consist of a general introduction section, followed by qualifying statements that should be taken into consideration for the analytical results to best be utilized. Based upon the quality assurance review, qualifier codes will be placed next to specific sample results on the sample data tables. These qualifier codes will serve as an indication of the qualitative and quantitative reliability of the data. Laboratory procedures to address QA/QC issues are outlined in the Teklab Quality Assurance Manual.

4.1.2 Blackstone Data Validation methods

Using the documentation provided by the laboratory, detection limits, holding times, COC, surrogate recoveries, method blanks, LCS, MS/MSD, trip blanks, and field duplicates will be reviewed for conformance with project guidelines, outlined below: If quality control/quality assurance (QA/QC) issues are identified during the data validation process, the Blackstone Quality Assurance Manager or Project

Manager will contact the laboratory to resolve the issues. Information generated regarding the resolution of the QA/QC issues will be included in the final report.

Raw field data will be summarized, reduced, or tabulated for use in the site assessment reports by the Project Geologist or Technician, and reviewed by the Quality Assurance Manager. Laboratory analytical data will be summarized and tabulated upon receipt, validated and qualified, and the final data submitted to the project team for use in the investigation reports.

4.1.2.1 Completeness Check

A completeness check will be performed upon receipt of the data and shall include a review of:

- case narrative.
- COC documentation.
- sample condition upon receipt.

The completeness check shall ensure that:

- all compounds and environmental samples are present.
- QC is present for every environmental sample.
- the most technically valid result is reported for each compound. This may result in full validation for a sample.

4.1.2.2 Data Verification Criteria

Data verification shall include, but is not limited to, reviewing the:

- completeness, as defined above.
- case narrative, including but not limited to, a description of non-conformances and corrective actions that were taken, plus anomalies, deficiencies, and QC problems that have been identified.
- COC documentation and original COC forms with identification numbers and laboratory receipt signatures, dates, and times.
- sample condition upon receipt, including cooler temperature, and shipping documentation.
- timeliness and a check for errors, including requested deliverables, preservation and holding times.
- sample analysis results, with quantitation limits and checking reporting limits checked against the contract required limits, and verifying dry weights, and dilutions.
- QC summary including but not limited to, method blanks, continuing calibration blanks, and preparation blanks, surrogate percent recoveries, spike percent recoveries and relative percent differences, and laboratory QC check sample and LCS recoveries.
- field duplicates, if identified, for which reproducibility shall be evaluated.
- laboratory RLs.
- laboratory duplicates.

4.3 Reconciliation with User Requirements

Following completion of each year's effort, the precision, accuracy, and completeness measures will be assessed and compared with the criteria. If data collected meet the DQOs for the study, then the data are considered to meet the objectives of the study. Uncertainties and limitations in the use of these data and interpretation of results will be provided to MDNR and will be reconciled, as possible.

5.0 REFERENCES

- Title 40, Chapter I, Subchapter C, Part 61, Subpart M, § 61.145 Standard for demolition and renovation.
- *Guidance for the Data Quality Objectives Process* - EPA QA/G-4, OSWER. USEPA, February 2006.
- *EPA Requirements for Quality Assurance Project Plans* - EPA QA/R-5, March 2001.
- *Guidance for Quality Assurance Project Plans* - EPA QA/G-5, OSWER, USEPA, December 2002.
- Title 29, Code of Federal Regulations, Sections 1910.1001, 1910.134, 1910.2, 1910.1200 and 1926.58. OSHA, U.S. Department of Labor.
- Title 40, Code of Federal Regulations, Part 61, Subparts A and M, National Emission Standards for Hazardous Air Pollutants. U.S. EPA.
- Title 40, Code of Federal Regulations, Part 763, Subparts E and G, Asbestos Abatement Project.
- Chapter 88B of the Code of Iowa, Removal or Encapsulation of Asbestos.
- Chapter 81 of the Iowa Administrative Code, Asbestos Control Procedures, Iowa Bureau of Labor.
- Iowa Bureau of Labor Guidelines for removal of non-friable ACM.
- 40 CFR Part 763 Asbestos Worker Protection.
- National Institute for Occupational Safety and Health. 1977. Occupational Exposure Sampling Strategy Manual, Publication No. 77-173, January 1977.
- Teklab, Inc., Quality Assurance Manual, Revision 29. July 2022.
- U.S. Environmental Protection Agency (USEPA). Specifications and Guidance for Contaminant-Free Sample Containers OSWER Directive #9240.0- 05A, December 1992.
- U.S. Environmental Protection Agency (USEPA). Laboratory Methods Manual Volume 1 - Biological and Physical Analyses. U.S. Office of Research and Development, Narragansett, RI EPA/620/R-95/008. 1995.
- U.S. Environmental Protection Agency (USEPA). Guidance on Environmental Data Verification and Data Validation, EPA QA/G-8, EPA/240/R-02/004, November 2002.
- U.S. Environmental Protection Agency (USEPA). Requirements for Quality Assurance Project Plans, EPA QA/R-5, EPA/240/R-009, December 2002.
- U.S. Environmental Protection Agency (USEPA). Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing Quality Assurance Project Plans, EPA QA/G-5S, EPA/240/R-02/005, December 2002.
- U.S. Environmental Protection Agency (USEPA). Guidance on Systematic Planning using the Data Quality Objective Process, EPAQA/G-4, EPA/240/B-06/001, February 2006.
- U.S. Environmental Protection Agency (USEPA). Systematic Planning: A Case Study for Hazardous Waste Site Investigations, EPA/240/B-06/004, February 2006.

- U.S. Environmental Protection Agency (USEPA). Requirements for Quality Management Plans (QA/R-2), EPA/240/B-2/002, March 2001, reissued May 2006.
- U.S. Environmental Protection Agency (USEPA). Guidance for Preparing of Standard Operating Procedures, EPA QA/G-6, EPA/600/B-07/001, April 2007.
- Blackstone Environmental. SOPs, 2023.

6.0 LIMITATIONS

This report was prepared in accordance with that level of skill and care ordinarily exercised by other members of Blackstone's profession practicing in the same locality and under similar conditions when the services were provided. No warranties, express or implied, are intended or made.

7.0 FIGURES

🟥 Property Boundary

FIGURE 1	Project Mgr: KB	Date: 10-2023	CLIENT NAME City of Clinton
	Designed By: MO	Rev.:	SHEET NAME Site Map
	Drawn By: MO	Rev.:	PROJECT NAME AND LOCATION 1000 Block of South 4th Street QAPP
	Checked by: KB	Rev.:	
	Job No.:	Rev.:	

BLACKSTONE ENVIRONMENTAL

Path: C:\Users\Megan\OneDrive - blackstone-env.com\DATABASE\ESA Database\Env. Site Assessment Database.aprx

🟥 Property Boundary

🟦 Approximate Location of Fence

● Approximate Location of Air Sampling Locations

Sample ID

N

Feet

0 25 50 100

FIGURE 2	Project Mgr: KB	Date: 10-2023	CLIENT NAME City of Clinton
	Designed By: MO	Rev.:	SHEET NAME Proposed Air Sampling Locations During Demolition and Removal
	Drawn By: MO	Rev.:	
	Checked by: KB	Rev.:	PROJECT NAME AND LOCATION 1000 Block of South 4th Street QAPP
	Job No.:	Rev.:	

BLACKSTONE ENVIRONMENTAL

Path: C:\Users\Megan\OneDrive - blackstone-env.com\DATABASE\ESA Database\Env. Site Assessment Database.aprx

FIGURE 3	Project Mgr: KB	Date: 10-2023	BLACKSTONE ENVIRONMENTAL	CLIENT NAME City of Clinton
	Designed By: MO	Rev.:		SHEET NAME Approximate Air Sampling Locations of Debris Prior to Removal
	Drawn By: MO	Rev.:		
	Checked by: KB	Rev.:		PROJECT NAME AND LOCATION 1000 Block of South 4th Street QAPP
	Job No.:	Rev.:		

8.0 APPENDICES

APPENDIX A. LABORATORY DOCUMENTATION

APPENDIX B. SOPS

APPENDIX C. TANK CLOSURE GUIDANCE

APPENDIX D. HEALTH AND SAFETY PLAN

APPENDIX E. FIELD DOCUMENTATION AND EQUIPMENT

8.1 APPENDIX A - LABORATORY DOCUMENTATION

CATES LABORATORIES

CHAIN OF CUSTODY

CL Project No.____________________
(Lab Only)

Company:____

Contact/Results to:____ **Verbal** ☐ **Email** ☐ **Fax** ☐ (check all that apply)

Email(s):____

Telephone No.:________________________ **Fax No.:**____________________

Project Information

Project:____ **Project No.:**________________________

Address:____ **P.O. No.:**____________________

Turnaround (check one)

CLEARANCE (PCM) ☐ **ASAP (SAME DAY)** ☐ **(IMMEDIATE)** ☐ **RUSH (1-DAY)** ☐ **2-DAY** ☐ **STANDARD (3-4-DAY)** ☐ **5-DAY** ☐

Testing Services (check all that apply, use separate COC's for Asbestos & IAQ)

Asbestos

PLM-BULK
EPA 600/R-93/116 ☐
Point Count (400) ☐

PCM-AIR
NIOSH 7400 ☐
OSHA: TWA ☐

IAQ - Mold (Non-Viable)

AIR (spore trap) - Standard Profile (count/genus identification) ☐
AIR (spore trap) - Expanded Profile (w/insect parts/pollen/skin) ☐
BULK (tape lift, swab) - Standard Profile (genus identification) ☐

CatesLab No. Range (Lab Only):	**Sample Date**
—	

No. of Samples:________ Positive Stop: Yes ☐ No ☐

Sample No.	Sample Description/Location	Volume (air only)

Relinquished By:	**Date/Time:**	**Received By:**	**Date/Time:**

AF72017-10 - *issued 04/26/2023* Walk-In☐ Drop Box ☐ FedEx☐ UPS☐ Lonestar☐ USPS ☐

*1339 Motor Circle, Dallas, TX 75207 * (214) 920-5006, Fax 1-972-767-0167* ________ of________
NVLAP Lab Code 200569-0, TDSHS-Asbestos: 30-0287, TDLR-Mold: LAB1034, AZ Lab Cert. AZ0948

CATES LABORATORIES

Additional Sample Page

CHAIN OF CUSTODY

CL Project No.____________________
(Lab Only)

Project Name:____ Project No.:_____________________________

Sample No.	Sample Description/Location	Volume (air only)

Relinquished By:	**Date/Time:**	**Received By:**	**Date/Time:**

AF72017-10 *- issued 12/12/2022*

________ of________

IOWA **ENVIRONMENTAL**
SERVICES Inc.

11101 Aurora Avenue, Urbandale Iowa 50322
PHONE: 515-279-8042 FAX: 515-279-1853
WWW.IESIOWA.COM

CHAIN OF CUSTODY RECORD

Client Name: ______________________________
____

Address: ______________________________
____
____

Phone #: ______________________________

FAX #: ______________________________

Project: ______________________________
____

Date Samples: ______________________________

Date Submitted: ______________________________

P.O. #: ______________________________

Email: ______________________________

DATE	SAMPLE #	SAMPLE DESCRIPTION	BULK	AIR		
				TIME	FLOW	VOLUME

Relinquished by: ______________________________ Date/Time: ____________________

Received by: ______________________________ Date/Time: ____________________

Relinquished by: ______________________________ Date/Time: ____________________

Received by: ______________________________ Date/Time: ____________________

Print PDF

CHAIN OF CUSTODY

Pg __ of __ Workorder # ____________

TEKLAB INC, 5445 Horseshoe Lake Road, Collinsville, IL 62234 Phone (618) 344-1004 Fax (618) 344-1005

Client: ____________________
Address: ____________________
City/State/Zip: ____________________
Contact: ____________ Phone: ____________
Email: Fax:

Are these samples known to be involved in litigation? If yes, a surcharge will apply: ☐ Yes ☐ No
Are these samples known to be hazardous? ☐ Yes ☐ No
Are there any required reporting limits to be met on the requested analysis?. If yes, please provide limits in the comment section: ☐ Yes ☐ No

Samples on: ☐ **ICE** ☐ **BLUE ICE** ☐ **NO ICE** _______ **°C**
Preserved in: ☐ **LAB** ☐ **FIELD** **FOR LAB USE ONLY**
LAB NOTES:

Client Comments:

PROJECT NAME/NUMBER

SAMPLE COLLECTOR'S NAME

RESULTS REQUESTED

☐ Standard ☐ 1-2 Day (100% Surcharge)
☐ Other ________ ☐ 3 Day (50% Surcharge)

BILLING INSTRUCTIONS

				# and Type of Containers									**INDICATE ANALYSIS REQUESTED**													
Lab Use Only	**Sample ID**	**Date/Time Sampled**	**Matrix**	**UNP**	**HNO3**	**NaOH**	**H2SO4**	**HCL**	**MeOH**	**NaHSO4**	**TSP**	**Other**														
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							
			Aqueous																							

Relinquished By	Date/Time	Received By	Date/Time

*The individual signing this agreement on behalf of the client, acknowledges that he/she has read and understands the terms and conditions of this agreement, and that he/she has the authority to sign on behalf of the client. See www.teklabinc.com for terms and conditions

Terms and Conditions: When Client requests analytical or other services from Teklab, Inc. (hereafter referred to as Teklab) the terms and conditions set forth in this agreement shall prevail. Requests for services may be in the form of a purchase order, electronic order, telephonic order or verbal order. Client's act of sample delivery or shipment to Teklab accompanied by a properly signed Chain of Custody shall constitute acceptance by Client to do business with Teklab under the terms and conditions of this agreement. Any conflicting and/or preprinted terms and conditions of any Client request/purchase order are null and void. Any third party agreements between Client and another party are in no way to be incorporated into this agreement unless agreed to in writing by Teklab and Client. This agreement may be amended only by written agreement between Teklab and Client.

Pricing: Fees for analysis or other services requested by Client shall be the current Teklab listed pricing schedule unless otherwise agreed to by Teklab and Client. Other pricing agreements may be in the form of a Teklab pricing quote. Teklab reserves the right to charge additional fees for expedited analytical results when Client requests expedited results, as determined by Teklab. No discounted pricing shall be accepted for analytical results which take longer than the initially agreed upon time frame, unless specifically agreed to by Teklab and Client. Teklab reserves the right to change its listed pricing without notification.

Quality Assurance/Quality Control: Teklab shall perform its services in a manner consistent with the Teklab Quality Assurance/Quality Control (QA/QC) manual and Teklab's Standard Operating Procedures (SOP's) in effect at the time of the agreement. It is the responsibility of Client to ensure that Teklab's QA/QC manual and SOP's conform to Client's specific requirements. Teklab reserves the right to deviate from its QA/QC manual and/or SOP's provided that the deviations are consistent with generally accepted industry practices and are deemed necessary, by Teklab personnel. In the event that Client desires deviations from the Teklab QA/QC manual or SOP's Client must submit the request in writing prior to submission of samples to Teklab. It is the responsibility of Client to submit any project or permit specific required methodologies, reporting limits or other information prior to the submission of samples to Teklab.

Sample Acceptance: Teklab reserves the right to refuse acceptance of samples or return previously accepted samples to Client when such action is deemed warranted by the Teklab laboratory director or his/her representative. It is the responsibility of Client to inform Teklab, prior to sample submission, when samples are known to be involved with litigation or known to be hazardous. Client shall submit all samples either through personal delivery, via a courier (such as the U.S. Mail, UPS, Federal Express, etc.) or through submission to a Teklab employee at a location other than the facility located at 5445 Horseshoe Lake Road. A properly completed Chain of Custody must accompany all samples.

It is the responsibility of Client to ensure that all samples are collected in accordance with generally accepted sampling protocols or site specific sampling requirements. It is the responsibility of Client to ensure that all samples are shipped or transported in a manner consistent with all federal, state or local laws. The risk of loss or damage to any sample shall remain with Client until Teklab sample acceptance is complete. Sample acceptance shall be completed once Teklab personnel have signed the properly completed Chain of Custody that accompanied the samples. It is the responsibility of Client to ensure that all samples are received with an adequate amount of time for Teklab to perform analysis within the applicable holding times, as specified in the Teklab QA/QC manual. Samples with holding times of seven days or greater must be received with, at least, four days of holding time remaining. Samples with holding times less than seven days must be received with, at least, one half of the holding time still remaining. Teklab reserves the right to charge and Client agrees to pay additional fees for samples received with less than the above stated holding times remaining. Go here for a full description of our sample acceptance policy.

Resampling: In the event that resampling is required, for whatever reason, Teklab in no way accepts responsibility for fees associated with the resampling. Teklab may assume all or a portion of the resampling costs if agreed to in writing by Teklab and Client, such fees will be determined and agreement made prior to the initiation of the resampling event. The fees, which Teklab may agree to pay, shall be the lesser of the actual sampling fees or the total amount paid by Client for work covered under this agreement.

Re-analysis: In the event that re-analysis is requested by Client, Client agrees to pay Teklab fees equivalent to those already agreed upon or the Teklab list price, plus any applicable surcharge for expedited analytical results.

Sample Retention: Samples are routinely retained for 30 days after sample acceptance is complete. Samples may be returned to Client, at no cost to Teklab, if so requested or if deemed appropriate by the Teklab laboratory director or his/her representative. Longer sample retention times may be possible, if requested by Client and agreed to by Teklab. Client agrees to pay Teklab an additional fee of $40.00 per month per sample when samples are to be retained for a period longer than the time period indicated above. Sample retention times shall be calculated from the date of sample acceptance by Teklab and shall be rounded into whole months with sample storage during any one day of the month constituting a charge for storage during the entire month.

Subcontracting: Teklab reserves the right to subcontract any or all portions of the services it provides. Subcontracting will occur in a manner consistent with the Teklab QA/QC manual and/or SOP's.

Reports and Data: Teklab maintains copies of reports and data for the time period and in the manner specified in its QA/QC manual and/or applicable SOP's in effect at the time of sample acceptance. Additional copies of analytical reports and/or analytical data, including QA/QC data, pertaining to Client's samples may be obtained, prior to data destruction, for additional fees, as deemed appropriate by Teklab.

Indemnification: Client shall indemnify and hold harmless Teklab and its respective owners, officers, directors and employees individually and jointly from and against any and all causes of action, claims, injuries, lawsuits, demands, judgments, damages, losses, liabilities, fines, penalties, expenses and other charges directly or indirectly arising from or related to:
(a) the negligent actions, omissions or willful misconduct of Client;
(b) Client's breach of its warranties or obligations under this agreement;
(c) Teklab's performance of services, provided, however that the foregoing indemnification shall not apply to the extent any damages are caused solely by the gross negligence or willful misconduct of Teklab. In any event Teklab's liability will be limited to the lesser of (a) actual damages or (b) the amount of compensation paid to Teklab for services under this agreement.

Payment: Client agrees to remit payment to Teklab within 30 days of receipt of invoice. If Client defaults in punctual payment, all past due amounts will bear interest at the rate of eighteen percent (18%) per annum or the highest rate permitted by law, whichever is lesser, and customer shall reimburse Teklab for all costs of collection incurred, including (without limitation) reasonable attorney fees. Acceptance of payment by Teklab in no way constitutes a waiver of Teklab's rights or claims that Teklab may have against Client.

Termination: Either Client or Teklab may terminate this agreement by sending written Notice of Termination. Upon termination, Client shall be invoiced for services performed and charges incurred prior to termination.

Miscellaneous:
(a) Except for the obligation to make payments hereunder, neither party shall be in default for its failure to perform or delay in performance caused by events beyond its reasonable control, including, but not limited to, strikes, riots, imposition of laws or governmental orders, fires, acts of God, and inability to obtain acceptable Quality Control results, and the affected party shall be excused from performance during the occurrence of such events;
(b) This Agreement shall be binding on and shall inure to the benefit of the parties hereto and their respective successors and assigns;
(c) This Agreement represents the entire agreement between the parties and supersedes any and all other agreements, whether written or oral, that may exist between the parties;
(d) This Agreement shall be construed in accordance with the law of the state of Illinois; and
(e) All written notification required by this Agreement shall be by Certified Mail, Return Receipt Requested. If any provision of this Agreement is declared invalid or unenforceable, then such provision shall be severed from and shall not affect the remainder of this Agreement; however, the parties shall amend this Agreement to give effect, to the maximum extent allowed, to the intent and meaning of the severed provision. In the event Teklab successfully enforces its rights against Client hereunder, Client shall be required to pay Teklab's attorneys' fees and court costs.

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QA/QC MANUAL FOR ASBESTOS AIR ANALYSIS.

Written-March 1990
Reviewed January 2023
Written by
Michael A. Freese
Reviewed by
Robert L. Sigmund, Jr.

IOWA **ENVIRONMENTAL**
SERVICES Inc.

11101 Aurora Avenue, Urbandale, Iowa 50322
515-279-8042 WWW.IESIOWA.COM

Table of Contents

INTRODUCTION

LABORATORY CHARACTERIZATION:

Iowa Environmental Services, Inc (IES), operates as a commercial environmental consulting firm. The air sample laboratory is an addition to the many services offered by Iowa Environmental Services, Inc. Any personnel performing any laboratory activities will follow all laboratory policies and procedures that are written in this manual.

PURPOSE:

This air laboratory manual is written for all Iowa Environmental Services, Inc., personnel working in the air asbestos laboratory. The purpose of this manual is to insure safe, proper and accurate work procedures when handling, recording or analyzing air asbestos samples.

USE OF THE MANUAL:

All laboratory personnel will be provided a copy of this manual. They will be required to comprehend all phases of this program. The laboratory manual will be reviewed once a year to be sure that all analytical procedures are current with the NIOSH 7400 analytical method and AIHA quality assurance procedures.

QUALITY CONTROL PROGRAM:

This program has been designed to perform quality control testing on 10% or more of the total air samples that are analyzed by IES laboratory personnel. This program will also include control charts for precision and accuracy using samples with known concentrations of asbestos fibers, AAR and PAT proficiency testing programs, round robin testing and lab blank analysis. These quality control checks will be performed by in-house analysts, or a trained analyst employed by a laboratory outside IES. The quality control section will be discussed in the quality control section of this manual.

APPROVED SIGNATORY:

Richard E. Soyer, Owner of IES and Robert L. Sigmund, Jr. are the approved signatories. Approved signatories shall be persons with responsibility, authority and technical capability within the organization for the results produced.

AIR LABORATORY COORDINATOR\QUALITY SYSTEMS OFFICER:

Robert L. Sigmund, Jr. will be in charge of all air sample laboratory duties and updating the quality control manual. Other responsibilities will include quality control program, record keeping and documentation of this program. This person will have access to the highest level of management at which decisions are taken on laboratory policies and procedures.

In the event that no qualified analysts are available to do air sample analysis due to vacation, sickness or leave, samples will be submitted to an outside laboratory. At no time will PAT, AAR or any other proficiency testing samples be submitted to another laboratory for analysis.

Procedures for choosing a PCM laboratory:

- Look in directory for laboratories in our area. (updates of this directory will be kept in the laboratory at all times)
- Laboratories are chosen based on PAT, AAR proficiency and references.
- Ask laboratory to submit resumes that indicate education and experience for each analyst, and laboratory contact person.
- Require laboratory to submit references.
- Call references.
- A laboratory will not be chosen based solely on the lowest price.
- Consult with the president of Iowa Environmental (President has the final decision on the laboratory chosen)
- lf comfortable with the experience and reputation of the laboratory and if the President of Iowa Environmental Agrees, than fill out chain of custody forms and submit samples for analysis.

All Clients will be contacted and informed before the fact, that the sample analysis will be performed by an outside laboratory. All reports of samples submitted to an outside laboratory will list the name, address, contact person and the following statement:

LABORATORY PERSONNEL

Qualifications

All laboratory personnel will have a minimum of a college degree with a background in science or 2 years of laboratory experience.

Criteria for successful completion of in-house training will include at least two weeks of in-house training, successfully analyze 100 air samples and complete the McCrone Research Institutes or equivalent 582 Asbestos Fiber Counting course. All air samples analyzed during training will be reviewed by the laboratory coordinator until the above criteria is met. All training courses and in-house training will be documented in each analysts personnel file.

In-house training will consist of the following:

Sample custody, sample tracking, sample preparation, sample analysis (Including blanks and blind testing to determine competency. Results of all blanks and blind testing will be kept on file.), calibration of equipment, filing, data input, printing reports, sample storage, retention/disposal and the hazards of handling asbestos containing materials. All sample analysis performed by a trainee will be analyzed by a trained analyst until the trainee has proven competency in performing air sample analysis.

Laboratory personnel will complete a course that instructs the correct procedures for handling and disposing of asbestos containing materials. Recommended courses include: EPA approved AHERA Inspection Management Planning Course, or Practices and Procedures for Asbestos Control.

Employees area encouraged to take courses to improve themselves and their job skills. All courses that relate to the employees current job will be paid for by Iowa Environmental Services.

STAFF RESPONSIBILITIES

IES PRESIDENT

Supervision of all analysts to assure that all laboratory operations, including the quality control program, is running smoothly. Conducts yearly laboratory audits to verify that all policies and procedures are followed. The president is the signatory for all AIHA activities.

LABORATORY COORDINATOR/QUALITY SYSTEMS OFFICER

Responsible for updating the president on any problems, changes or additions in the air and bulk laboratory. Responsible for logging, record keeping, and updating all the laboratory tiles including, equipment services and repair, etc., Responsible for updating the laboratory manuals Responsible for participating in the quality control program including, inter-operator and intra operator testing.

Oversees all laboratory staff members using the PCM for air sample analysis.

Responsible for keeping the laboratory facility and equipment properly calibrated and in good working condition. Responsible for assigning all quality control samples to analysts and keeping records of all quality control data, and procedures. Responsible for noting discrepancies and action taken to correct them.

ANALYSTS

Responsible for the logging and record keeping of air samples. Responsible for participating in the quality control program, including, inter-operator, intra-operator and between laboratory testings. Responsible for updating the laboratory coordinator on any equipment failures and suspect sample contamination.

FACILITIES AND EQUIPMENT

Iowa Environmental Services, Inc. has the facilities that are necessary to prevent asbestos contamination and maintain sample identification. All asbestos air sample handling will be conducted in a safe manner at all times to prevent air sample or laboratory contamination. The laboratory coordinator will be in charge of the maintenance, calibration of all air sample laboratory equipment and assuring that all air laboratory equipment is contamination free and in good working condition. The damage of any equipment should be reported to the laboratory coordinator. The equipment which has been damaged will be taken out of commission until it is repaired. The repaired equipment will be calibrated before it is returned to service. All damage and repairs to any equipment will be documented and filed in the equipment service and repairs file in the laboratory by the laboratory coordinator. ·

The equipment and microscopes used in the air sample laboratory was purchased and put into service in March of 1990. All equipment was purchased from McCrone Accessories and Components, 850 Pasquinelli Drive, West Mont, Illinois.

All air sample analysis laboratory equipment is listed below:

- 3 Olympus CH2 Phase Contrast Microscopes with green filters, 10X eye pieces and 4OX phase objectives.
- 3 Walton Beckett Graticule
- HSE/NPL Phase Contrast Test Slide
- 3 Ocular Phase Ring Centering Telescope
- Stage Micrometer
- 3 Acetone Vaporizer
- Sampling Utensils (razor knives, forceps, probes, etc.)
- Acetone Compound Liquid
- Triacetin
- Slides (25X75mm)
- Cover slips (22X22mm, 1 1/2 thickness)
- Hypodermic Syringes
- Lens Tissue {
- Storage boxes for air sample storage.
- 6 mil poly asbestos burial bags for proper disposal of waste and sampling materials.

TEST METHODS AND PROCEDURES

Receiving:

All incoming samples are first inspected for damage to the shipping container(s) or to the sample(s) it contains. If damage to sample containers or samples are observed the damage is noted and the client will be informed. Acceptable containers in which clients may submit air asbestos samples taken on the correct type cassette with the end caps intact. If the sample(s) are accepted, they will be reviewed to determine if an adequate amount of sample information is present and if the information matches the transmittal forms. All transmittal forms and sample information will be kept with the sample(s) until sample analysis is complete and all results are input into computer files. At this time all sample information and transmittal forms will be tiled under the client name.

The following conditions will result in a rejected sample:

> The sample container is breached or improperly sealed, the sample is not conclusive to accurate analysis, the sample condition is otherwise such that, in the judgment of laboratory personnel, the analytical results would be highly suspect.

Sample Tracking

Upon receipt, all samples are immediately taken to the laboratory where the sample and chain of custody documents are reviewed. lf there are any discrepancies between chain of custody documents and samples that are submitted, the client will be contacted. The sample(s) will be logged in the incoming sample logbook as follows:

- The sample is given a laboratory identification number. This number will be used to identify the sample prior to, during, and after analysis. At no time will the sample be taken from the laboratory until the sample has been analyzed and recorded in the computer files.
- The laboratory identification number will be recorded on the slide and the box which the sample will be stored.
- Record client identification number.
- Record date the sample was received.
- Record date of sample collection.
- Record sample description.
- Record sample volume.
- Record limit of quantification.
- Record client name and name of project.
- Record the initials of the analyst.
- Record initials of employee who input and printed analytical results.
- Record fibers/mm^2. (Record after sample analysis)
- Record Fibers/cc. (Record after sample analysis) _

The incoming sample log notebook will be kept in the laboratory at all times and will be available to all personnel. This will eliminate sample custody errors such as mixing up or losing samples.

Sample Handling

Prior to handling asbestos containing materials the employee will be instructed in the hazards of asbestos and precautions for working with asbestos containing materials. The employee will complete a certified course that teaches the correct handling and disposal procedures when working with asbestos containing materials.
Sample Preparation, Analysis And Measurement
Asbestos fibers must fall under the labs working definition of asbestos. (Refer to EPA Method: NIOSH 7400 Method, A counting rules) These documents are kept in the laboratory at all times.

SAMPLE PREPARATION

- Plug MACVAP Acetone Vaporizer in and turn on. Let warm up for 2 to 3 minutes. When the unit is ready for operation, the red light will come on.
- Open cassette and cut a triangular wedge out of the filter with a sharp scalpel blade. When cutting the wedge, start from the perimeter of the circle, working towards the center to avoid tearing the filter. The wedge size should be approximately 25% of the total filter size to obtain a good representative sample.
- Place wedge, dust side up, on a clean glass slide free of dust and Fibers.
- Place the slide under the nose of the vaporizer. As long as the filter cannot be seen in the normal operating position, it will be centered well enough to clear.
- To clear the filter, inject with slow, steady pressure approximately 0.15 ml of acetone through the rubber system located at the top of the unit. (This amount may vary depending on the speed of the injection and the quality of the syringe.) Wait approximately 3-5 seconds and then remove the slide and inspect the filter for proper clearing. The object is to produce fully-cleared samples with smooth (non—grainy) backgrounds that are consistently flat, unwrinkled, and without air bubbles.

  CAUTION: WHILE USING THE MACVAP, MAKE SURE TO WORK
  IN A WELL VENTILATED AREA.
- • Using a 5 microliter micropipette, immediately place 3.0 to 3.5 microliters of triacetin on the wedge. Gently lower a clean cover slip onto the wedge at a slight angle to reduce bubble formation.
- • Glue the edges of the cover to the slide using lacquer or nail polish. Counting may proceed immediately after clearing and mounting are completed.

Note—For maintenance information see the MACVAP Warranty information page.

ANALYSIS AND MEASUREMENT

- Center the slide on the stage of the calibrated microscope under the objective lens.
- Focus the microscope on the plane of the filter and adjust the microscope
- Refer to the counting rules specified by NIOSH in the A rules of the 7400 method.
- Count only fibers longer than 5 microns.
- Count only fibers with a length-to-width ratio equal to or greater than 3:1.
- For fibers which cross the boundary of the graticule field:

(1) Count any fiber longer than 5 microns which lies entirely within the graticule area,
(2) Count as % fiber any fiber with only one end lying within the graticule area,
(3) Do not count any Hber which crosses the Graticule boundary more than once, and
(4) Reject and do not count all other fibers.

- Count bundles of fibers as one fiber unless individual fibers can be identified by obsen/ing both ends of a fiber.
- Count enough graticule fields to yield 100 fibers. Count a minimum of 20 fields. Stop at 100 graticule fields regardless of count.
- Start counting from the tip of the filter and progress along a radial line or zigzag to the outer edge. Shift up or down on the filter and continue in the reverse direction. (Keep in mind movement across the Held of view is in the opposite direction with respect to the actual movement of the slide on the stage.) Ensure that, as a minimum, each analysis covers one radial line from the filter center to the outer edge of the filter.
- Select graticule fields randomly by looking away from the eyepiece briefly while advancing the stage. When an agglomerate cover 1/6 or more of the graticule Held, reject the graticule Held. Do not report rejected graticule fields in the total number counted.
- it is important to continuously scan a range of focal planes slightly above and below the filter surface to detect raised or imbedded fibers. Avoid counting on the bottom of the filter. An increased grainy appearance and reduced number or particulate indicates the bottom of the filter.
- For calculations and reporting of results refer to the attached Asbestos Fiber Count form.
- All results should be rounded to two (2) significant figures down to a level of 0.0XXf/cc and as one significant figure at 0.00Xf/cc. When a result is below the reliable quantification or detection limit it should be reported as <0.00X where 0.00X is the calculated detection limit for the volume collected. It should not be reported as “not detected.

Written Air Sample Analysis form

The laboratory analyst will record all analytical data on air sample bench top/written analysis forms. Standard procedures for filling out the air sample bench top/written analytical form are as follows:

- Record current date of analysis.
- Record client name
- Record client Identification number
- Record assigned lab Identification number.
- Record each fiber counted in each field and record the total at the end of each row
- Add rows and fill in total fibers
- Record total fields of view counted
- Record fibers per field by taking total fibers divided by number of fields
- Record Blank count

- Record volume of air run for each sample
- Record fibers per cubic centimeter
- Record quantification limit
- Record fibers per millimeter squared.
- Record comments that relate to the sample
- Record initials of analyst
- Record date of analysis

Reporting

Analytical Results are reported on company letterhead and will include the following information: Client name and address, sample identification number, sample color, description and location of sample, sample results, a description of any problems encountered during analysis and departures from the current test method, signature of the analyst and the date of analysis. Note: Results relate only to the items submitted for analysis.

Record Keeping

All sample results will be recorded on the computer (with an adequate back—up system) under the clients file name. All written lab results will be stored in the laboratory file cabinet under each client's file name. All computer files and written files will be stored in the laboratory for as long as the company is in operation. These files are available to all personnel.

Storage of Asbestos Air Samples and Waste Materials:
After receiving the air samples and the logging procedures have been completed, each sample cassette and slide preparation is separately placed in a box with its correct laboratory and client identification numbers. After air sample analysis has taken place the slide preparation will be stored in these boxes until they are submitted back to the client, submitted to another laboratory for quality control or disposed of as asbestos waste. Each sample storage box is visually marked with the corresponding sample numbers in which it contains. Each air sample is retained for a .minimum of three months. At the end of the three month period the air samples are submitted back to the client or disposed of at an EPA accredited landfill.
Asbestos air samples, debris, tissues, used slides, sample containers and other waste materials will be stored and disposed of as follows:
Lab Waste:

- When bags are filled they are placed in 6 mil poly asbestos storage bags and stored in a sealed off cabinet until the are transported to an accredited land fill for disposal.

Disposal Procedures:

- When waste storage space is full a local licensed asbestos abatement contractor is notified.
- Contractor will pick up lab and sample waste.

- Documents will be filled out and kept in the laboratory waste and disposal Hle each time that asbestos waste is taken to a landfill. All waste documents will be kept in the laboratory for as long as the company is in existence. Procedures for filling out the document will be as follows:
- Write in the date the waste material is submitted to a license contractor
- List Transporter
- Check materials disposed (bulk samples, air samples, lab waste)
- lf bulk samples or air samples are disposed of list the corresponding sample numbers being disposed. For example, if air samples with numbers from 1000 to 1050 are being disposed. Write these numbers on the document next to bulk samples.
- Check beside lab waste if lab waste is disposed.
- If samples are submitted back to a client it should be noted on this form. A copy of the waste disposal document can be found in the appendix of this manual.
- Contractor will follow all State of Iowa and Department of Transportations regulations for the transportation and disposal of asbestos waste. P `

OLYMPUS MODEL CHS BIOLOGICAL MICROSCOPE CALIBRATION,

ADJUSTMENTS, AND MAINTENANCE

Phase contrast microscope

- Focus on the sample using coarse and fine adjustment knobs on 10x objective.
- Adjust inter-pupillary distance
- Adjust diopter—Look at image through right eyepiece with right eye and focus on specimen with focus adjustment knobs. Next, look at image throughileft eyepiece with left eye and rotate diopter adjustment ring (eyepiece) to focus on specimen (without using focus adjustment knobs).
- Adjust the field iris—An image of the field iris should be in focus at the specimen plane and its adjusted edges adjusted and nicely centered on the edge of the field of view.
- Rotate the diaphragm ring counterclockwise so that the iris diaphragm is at its minimum.
- Rotate the condenser height adjustment knob in either direction until the image of the field diaphragm is visible sharply in the field of view.
- Bring the image of the field diaphragm into the center of the field by means of the two attachment lenses centering screws.
- Open the diaphragm until the small ring of the diaphragm inscribes the field of view. If the polygonal ring is not concentric with the field of view, repeat the centering procedure mentioned above.
- After centration is complete, re-open the diaphragm until it becomes a larger polygonal ring around (or circumscribes) the circular edge of the field.
- Center the phase rings using Olympus CH-2 Phase Annulus—Phase contrast is a form of illumination which is used to see objects which are close, in refractive index, tothe medium. For phase contrast to work properly, the rings must be as concentric as possible.
- Snap phase annulus into bottom of condenser with centering screws facing the front of the microscope.
- Focus on specimen.
- Rack condenser all the way up and back down slightly (approximately 1/8 of a turn).
- To ensure proper condenser height, a flat opaque straight edge (such as a ruler) can be laid on top of the light source. Then focus condenser on straight edge.
- Remove one of the oculars and insert centering telescope.
- Unscrew the top portion of the centering telescope ONLY-HALF WAY AT MOST (Do not fully unscrew the centering telescope or focusing eye- piece or permanent damage to the treads may occur.) until the phase annulus ring comes into focus.
- Center the phase annulus (bright circle) inside the phase ring (dark circle) using the centering screws.

- Open the iris diaphragm past the field of view.
- Remove the centering telescope and replace the ocular. F
- Center the HSE/NPL phase-contrast test slide under the phase objective.
- Locate block 1 (the coarsest set) ofthe test objects and move the slide to observe adjacent blocks.
- Determine the block of the finest groves that can be seen. (For asbestos counting the micro- scope optics must completely resolve the grooved lines in block 3, blocks 4 and 5 must be partially visible, and grooved lines in blocks 6 and 7 must be invisible.) At least once/day.

Maintenance of the Microscope

• The microscope should be checked each time it is used to ensure the lens surfaces are free from dust and fingerprints. Oil and fingerprints should be wiped off with gauze moistened with a small amount of xylene, alcohol, or ether. Microscopes shall receive professional cleaning and checking once per year for field microscopes and once every two years for laboratory microscopes.
• Check the field diameter with a stage micrometer upon receipt of the Walton—Beckett Graticule from the manufacturer (acceptable range 100 microns 1 2 microns). Determine the field area (mm^2) from the equation A=¤r’. The field area should be 0.00785 mm^2. The following equation will be used to determine the correct graticule for each specific microscope.

$$dc = \frac{Lg \times D}{Lc}$$

where dc = circle diameter (mm)
D = magnified diameter = 100 microns
Lq = actual grid length (mm) `
Lc = magnified circle length (microns) D

QUALITY CONTROL

IES quality control program will include intra-laboratory and Inter-laboratory testing. Intra-laboratory testing will include blank analysis and replicated and duplicate sample analysis. Inter -laboratory testing will include QC analysis with an independent laboratory and proficiency testing.

SAMPLING QUALITY ASSURANCE PRACTICES

Measuring airborne asbestos is a sophisticated and exacting process. Errors may be introduced at any one of the many data collection steps. To guard against this possibility and assure reliable results, the following equipment setup, operation, and calibration procedures are followed by Iowa Environmental Services.

- SAMPLING MEDIUM -- 0.8 to 1.2 pore micron mixed cellulose ester membrane filter
- COLLECTION DEVICE -- 25mm cassette with open-faced 50mm electrically conductive extension cowl
- AIR FLOW -- 0.5 liter/min to 2.5 liter/min for excursion sampling; 0.5 liter/min to 3.0 liters/min for personal sampling; 0.5 liter/min to 10 liters/min for area sampling
- AIR VOLUME—Adjust sampling rate and time to produce a fiber density of 100 and 1300 fibers/mm^2, or for the required limit of reliable quantification or detection limit for clearance or background sampling.
- DETECTION LIMIT/LIMIT OF RELIABLE QUANTIFICATION—

For certain types of area sampling in relation to abatement monitoring it is necessary to sample a sufficient volume of air to reach a given "detection Limit" or "limit of reliable quantification" that is required in the specifications. These terms are sometimes used interchangeably which is incorrect.

The foregoing limits are generally accepted as:

Detection limit = 7 fibers/ mm^{2}of field area (equivalent to 5.5 fibers per 100 fields with a Walton- Beckett Graticule.

Limit of Reliable Quantification = 10 fibers/100 fields with a Walton-Beckett Graticule.

The equation below shows how to calculate the volume of air needed for a specified detection or reliable quantification limit.

Volume of = (0.055 or 0.10 fibers/field)(385 mm)

- Air (7.85)(Detection or R.Q. limit in f/cc)
- CALIBRATION—Refer to the calibration check list and the calibration notebook (for recording data).
- The soap bubble meter and the electronic Gilian Minibuck are used for primary flow calibrations. Calibrate each sampling pump before and after use with a representative filter cassette installed between the pump and the calibration devices.
- The rotometer is used for secondary flow calibrations. The rotometer is calibrated against the soap bubble meter at least quarterly and recorded in the calibration notebook. The rotometer is used to monitor the sample flow rate and check for leaks through the sampling apparatus. For field calibration of pumps, use the rotometer before sampling and after sampling (before removing cassette).

SAMPLING PROCEDURE

- Personal samples shall be taken in the "breathing zone" of the employee. Remove top cover from end of cowl extension (open face) and orient face down. Wrap the joint between the extender and the monitor’s body with shrink tape to prevent leaks.
- Area samples should be located so they are not influence by unusual air circulation patters and away from where air flow may be restricted (room, corners, under shelves, etc.).
- Aggressive sampling is used if or post abatement air testing. The aggressive sampling will be done in accordance with the EPA publication "Measuring Airborne Asbestos Following an Abatement Action” - November 1985.
- The number of samples are determined by the specifications for the project. (The number of samples recommended for reliably determining compliance with release criterion following an abatement action is in accordance with EPA’s publication "Measuring Airborne Asbestos Following an Abatement Action" — November 1985).
- At least 2 field blanks (or 10% of the total samples, whichever is greater) are to be submitted for each set of samples. Remove the caps from the Held blank cassettes in a clean area (bag or box) during the sampling period. Replace caps when sampling is completed.
- Once sampling equipment is in place, the location, time, filter# (from pre-numbered form to avoid possible bias by lab analysts), pump #, and other pertinent information is recorded on the field log sheets.
- After the pump is started, the flow rate is recorded and verified after 15-30 minutes of operation to guard against leaks or constrictions of the sampling train. Intermediate flow rate checks are recorded. When the pump needs to be shut off for any reason, the cassette should first be oriented in an upright position to preclude the chance of collected fibers falling from the filter when the vacuum is released.
- Do not exceed 1 mg total dust loading on the filter. lf a filter darkens in appearance or if loose dust is seen on the filter, a second one shall be started.
- When the required sampling volume has been reached, the time and final flow rate are recorded.
- Remove field monitor at the end of the sampling, replace the top cover and small end caps, and store the monitor.
- Cassettes should be wiped with a moistened cloth or paper towel before being returned to the container or box where they are being carried. F .
- lf samples are not hand carried to the lab, ship the samples in a rigid container with sufficient packing material to prevent dislodging collected fibers. Do not use polystyrene foam (which create electrostatic forces which may cause fiber loss from filter).

INTRALABORATORY QUALITY CONTROL

QUALITY ASSURANCE Officer—The Quality Assurance Officer for Iowa Environmental Services is . Robert L. Sigmund, Jr. The Quality Assurance Officer is responsible for:

- Relabeling slides for the performance of blind recounts.
- Maintaining a set of reference slides (Held and PAT samples).
- Ensuring each counter counts 1 reference slide a day.
- Changing labels on reference slides, so that the counter does not become familiar with the samples.
- Maintaining control charts for the blind recounts on reference samples.
- Posting results of the quality assurance programs (intra- and inter-laboratory data) on the bulleting board.

BLANKS

- Laboratory Blank—Prepare and count a blank laboratory control filter with each batch of samples to check for fiber contamination. lf the blank yields greater than 5.5 fibers/100 fields, identify the source of the contamination (filter, equipment, reagent) and take corrective measures.
- Field Blank— The identity of blank filters should be unknown to the counter until all counts have been completed. lf a field blank yields greater than 7 fibers/100 fields report possible contamination of the samples. The mean field blank count per graticule field is subtracted from the total fiber count per field and divided by the graticule field area (0.00785 mm^2) to yield fiber density on the filter (fibers/ mm^2).

BLIND RECOUNTS BY THE SAME COUNTER (to confirm individual's precision by performing recounts against samples individual counted previously) -- on 10% of the filters counted or at least one per group of samples.

- The QA Officer will re-label a slide (tape over Lab# on ground glass portion of slide) for purposes of a blind recount by the same counter. After the recount is completed, the tape is removed and the count corresponding to the Lab# on the ground glass is compared to the recount. Record results on the Blind Recounts By Same Counter form.
- If the difference between the counts [C1 -C2| exceeds (2.77)((C1 + C2) + 2)(relative standard deviation) then the analytical data associated with the sample should be discarded.
- If a pair of counts is rejected because of this test, recount the remaining samples in the set and test the new counts against the first counts. Discard the analytical data associated with all _ rejected paired counts. .

BLIND RECOUNTS ON REFERENCE SLIDES (to determine Laboratory’s precision by calculating intra-counter and inter-counter relative standard deviations)

- • The QA Ofncer will relabel 4 slides taken from a variety of sources, including both field and PAT samples, to be used as reference slides. The QA Officer will change the labels on the slides once a month so that the counter does not become familiar with the samples.

- • Each analyst will count 1 reference slide per day and record his results on the Blind Recounts on Reference Slides form.
- • The QA Ofhcer will estimate the laboratory intra- and inter-counter releative standard deviation (separate relative standard deviation values for each of 4 sample matrices) using the following control chart forms:
- Blind Recounts on Reference Slides, ln-House Intra-Counter Statistics, and Blind Recounts on Reference Slides, in-house inter-Counter Statistics.

INTERLABORATORY QUALITY CONTROL

- NIOSH 582 Course—AII analysts at Iowa Environmental Senrices, performing asbestos fiber counts have taken the NIOSH 582 course, Sampling and Evaluating Airborne Asbestos Dust. The NIOSH 582 course explains the equipment, procedures, and calculations required and recommended by the NIOSH method 7400. Course completion certificates are enclosed as Appendix 11.
- PATlPr0gram—Iowa Environmental Services participates in the Proficiency Analytical Testing (PAT) Program. The PAT program provides quality audit samples to occupational health laboratories. The objectives of the PAT program is to assist the participating labs in improving analytical performance. Sample kits are mailed quarterly. Results are evaluated, laboratories are screened for those with questionable performance, and each laboratory is notified of their status prior to the next official round of samples.
- Asbestos Analysts Registry—The American Industrial Hygiene Association (AIHA) operates an Asbestos Analysts Registry which specifies, among other things, that analysts must adhere to a written quality assurance program.
- Round Robin—The purpose of the round robin is to compare the performance in counting between laboratories. Iowa Environmental Services will participate in round robin testing with the following independent laboratories.
- The round robin testing will be conducted as follows:
- An exchange of mounted asbestos sample slides will take place every six months, specifically, January and July. Each lab will take turns sewing as coordinator for these round robins. Each laboratory will submit three mounted slides, typical of their workload, to the coordinating lab for each round. The slides should be prepared with the acetone, triacetin method and sealed with clear nail polish. The coordinating lab will be responsible for collecting slides from each participating lab for a total of nine slides. The coordinating lab will re-label these slides with quality control numbers, analyze them, and then send the nine slides to each participating laboratory for analysis. All labs must use the method 7400 counting rules “A”, and report their results in units of fibers/ mm^2
- The coordinating lab will be responsible for compiling data received from the participating labs and providing each lab with the results found. The form, Round Robin Testing, will be used to compile the data from the round robin testing. The data will be mailed to participating laboratory no later than the 30th day of the following month. All results will be kept in a permanent laboratory record. lf there is an outlier (2-sided 95% confidence limits) among the participating labs, the reason for the outlier will be investigated. The outlying lab will be notified

and asked to reanalyze all slides. The Coordinating lab will be responsible for assuring that this is done.

- When the use of different microscopes contributes to differences between counters, the effect of the different microscope shall be rejected, as necessary.

FIELD COUNTING AND QUALITY CONTROUASSURANCE

• Selecting—A set-up area of a lab performing analyses at a remote site will be negotiated between the building or site owner and Iowa Environmental Services. The area of the on—site lab will be located at a distance from the work area to prevent cross contamination. It will be located in an area that is unoccupied and clean.

- FILTER CONTAMINATION CHECK—Iowa Environmental Services will use only MCE filters that are carefully quality controlled by the manufacturer. A limit is stated on the box for each lot. Approximately 5-7 samples per box of 50 are also normally checked by serving as field blanks.
- Iowa Environmental Services will use clearing solution that has not been on a shelf for more than 3 months. The on-site analyst will randomly select a filter from the box, clear and count. If the result is greater than 3 fibers/100 fields the analyst will check the clearing solution on the slide with a cover glass but no filter. If the solution is clear he will check two more filters. lf either one exceeds 3 fibers/100 fields the box will be discarded.
- FIELD BLANKS—Prepare and count the field blanks along with the field samples. Report the counts on each blank. Calculate the mean of the field blank counts and subtract this value from each sample count for the entire set of samples. The identity of the field blanks will be unknown. If the field blank yields fiber counts greater than 7 fibers/100 fields report sample as possibly contaminated.
- BLIND RECOUNTS BY SAME COUNTER—Recounts by the same counter will be performed on one sample per set or 10%, whichever is greater, of the slides making up the set of samples. Recounts are to be performed during routine analysis. Slides will be selected randomly and relabeled to keep the identity hidden from the counter. The following 95% confidence level test will be used to determine whether a pair of counts on the same filter should be rejected.

  (COUNT1-COUNT2) > 2.77 x AVG x CV = REJECT
  and
  (COUNT1-COUNT2) < 2.77 x AVG X CV = ACCEPT
  where: AVG = average of the two counts
  CV = coefficient of variance = 0.45
- Each analyst will maintain a personal quality control log for purpose of recording the results of blind recounts.
- RECOUNTS BY A SECOND COUNTER—This is intended to provide additional quality assurance for counts made under field conditions. One out of every 10 filters counted by a Held counter should be selected randomly and submitted to another qualified Held counter if available. If a field counter is not available, recounts will be performed by the in-house laboratory or another certified laboratory.

Corrective Action Policies For Detected Test Discrepancies

A letter explaining all discrepancies will be presented to the client. This will be followed by a meeting or a telephone call to explain these discrepancies. Corrective action include retesting the original sample by all staff members and the analysis of a new sample of the same material submitted by the client. This sample will be analyzed free of charge. Details explaining all discrepancies and all corrective action taken will be tiled in the appropriate quality control tiles in the laboratory.

Dealing with Testing Complaints

An explanatory letter will be presented to a client who is inquiring about test results of any of that clients sample results. This should be followed by a meeting or a telephone call explaining the test procedures, results and quality control checks. A statement of corrective action, if any, will be dated, signed and tiled. Suggested action includes the retesting of the original sample by all laboratory members or the analysis of a new sample of the same material submitted by the client which will be analyzed free of charge. Any test discrepancies found will be presented to the client in writing. All 4 written corrective information will be filed in the correct laboratory files.

Emergency Procedures for Contamination

These procedures that are listed below will be follow closely in the event of major or minor fiber release outside the HEPA hood area. This will include the spilling of untested bulk samples or previously analyzed samples that have tested positive for asbestos fibers.

- Wet the material
- Care must be used to prevent the material from being stirred up
- Shut down HVAC system
- Notify staff members working in the laboratory ·
- Evacuate the laboratory, Permitting only trained cleanup personnel in the spill area
- Use wet cleaning methods and a hepa vacuum to pick up the spilled material or debris
- Trained cleanup personnel are to wear the proper respiratory protection and protective clothing during cleanup
- Material that has been cleaned up, waste and protective clothing will be double bagged in labeled 6 mil poly bags and disposed of as asbestos waste
- Clearance air sampling to determine if fiber levels are at 0.01f/cc or lower.

LABORATORY SAFETY

ACTIVITIES PROHIBITED IN THE LABORATORY

Smoking, food, drink and horseplay are prohibited in the laboratory.

Proper Handling Of Equipment -All laboratory samples, chemicals and tools should be handled with care to avoid injury or exposure to dangerous substances. Equipment, such as microscopes, chemicals and oils should be handled with care do to their expense and fragility. The above items should be handled with both hands. Never try to carry more than one of these items at a time.

AIR MONITORING PROCEDURE

Laboratory air monitoring will be conducted twice a year to help detect faulty filter of hoods as well as guarding against potential contamination of the laboratory from unknown sources. It will also help ensure the safety of all laboratory personnel. Air monitoring will consist of two samples. One placed at the entrance to the laboratory and one near the HEPA filtration hood. In the event that PCM levels exceed 0.010 f/cc a laboratory decontamination will be performed. Laboratory decontamination will consist of wet wiping the inside and outside of the HEPA filtration hood, microscopes table surfaces and vacuuming the floors will a HEPA vac. At the completion of laboratory decontamination more PCM air monitoring will be conducted until levels are below 0.010f/cc. The results of air monitoring in the laboratory will be posted for all personnel.

EMERGENCY PROCEDURES FOR CONTAMINATION

Emergency procedures should be posted in the laboratory where it can be easily read by each analyst at his/her station. The procedures listed below will be follow closely in the event of major or minor fiber release outside the HEPA hood area. This will include the spilling of untested bulk samples or previously analyzed samples that have tested positive for asbestos fibers.

- Put on half face respirator.
- Wet the material.
- Isolate the spill by gently covering it with a wet paper towel.
- Shut down HVAC system.
- Remove any contaminated clothing (if bulk sample came into direct contact with clothing) and put on disposable coveralls.
- Turn on all HEPA filtered hoods.
- Perfomed decontamination cleaning. in the laboratory.
- All activity will cease in the laboratory until a PCM air sample indicates the air is clean (<0.010f/cc).
- A sign will be posted in the laboratory area with specific procedures. For injury of personnel in the laboratory, call 911 if the injury is serious and the administer the appropriate fist aid.

Emergency Equipment Required ln The Laboratory.

- Half faced respirator
- First Aid kit
- Fire extinguisher that can handle class A, B, and C fires
- Tyvek disposable coveralls
- HEPA Vacuum must be on the premises.

Procedures For Changing The HEPA Filter.

- Wet wipe the interior of the hood and HEPA vac any exposed areas of the filter.
- Put on HEPA filter respirator and disposable coveralls.
- Take hood outside away from any areas where people are likely to pass close by. Remove old filter and place into an asbestos waste bag.
- Seal the waste bag.
- Install new filter and return hood to the laboratory.
- Remove respirator and coveralls and dispose coveralls as asbestos waste.

Handling Of Asbestos Waste And Waste Disposal

Any laboratory waste generated by the laboratory must be sealed in a zip lock bag or another air tight container and pleased in a garbage container designated for asbestos waste. When the garbage can has become full the asbestos waste must be double bagged and taken to an area designated for the storage of asbestos waste. When the waste or asbestos containing samples are ready to be disposed of tall applicable federal, state, and local ordinances regarding the disposal of asbestos containing hazardous waste must be followed.

Teklab, Inc.
Quality Assurance Manual

Corporate HQ Collinsville
5445 Horseshoe lake Road
Collinsville, IL 62234
Phone (618) 344 1004
Fax: (618) 344 1005
Fax (217) 698-1005

Corporate	**Signature**	**Date**
John H. Riley - *Chief Executive /Marketing Officer - Ext.30*		7/6/2022
James S. Riley – *President /CFO– Ext. 15*		7/6/2022
Robert Henson –*Technical Director (Corporate)– Ext. 13*		7/6/2022
Elizabeth Hurley – *Director of Customer Service Ext. 33*		7/11/22
Stacy A. Mathis – *Quality Manager-Ext.13*	Stacy A Mathis	7/6/2022
Claire T. Bogner – *Quality Assurance Officer-Ext.13*	Claire Bogner	7/5/2022

Teklab Air Laboratory
1355 N. Bluff road
Collinsville, IL 62234
Phone (618) 344 7697

Heather Riley – Director of Operations/Analyst	Heather Riley	7/6/2022
Kori Kizer - Technical Director/Analyst		7/27/22

See Table of Contents for major organizational units covered by this quality manual.

Table of Contents

Section 1 - INTRODUCTION AND SCOPE

(TNI V1:M2 – Sections 1,2,3)

Teklab is an Environmental/Chemical testing laboratory. Consultants, landfills, municipalities, industry and state and federal government routinely use Teklab's services. A wide variety of analyses are performed on air, drinking water, aqueous samples, solid samples, and non-aqueous liquids in accordance with environmental regulations such as drinking water standards, NPDES permits, pre and post treatment standards, RCRA, UST/LUST standards and TCLP. Air Testing is a new service added in 2009.

This manual dictates Teklab's Quality Assurance Program. It is designed to ensure the precision, accuracy and completeness of all data generated for every client. This document describes the specific protocols which will be followed for sampling, sample handling and storage, chain of custody, and laboratory (and field) analysis. All Teklab, Inc. organizational units are subject to this manual.

Teklab, Inc. will protect Clients' confidential information and proprietary rights, as directed by local, state or federal laws. All confidential information and/or proprietary rights claimed by any Client and/or Vendor must be clearly identified in writing, prior to initiation of any business activity. Teklab, Inc. will voluntarily treat information generated by Teklab, Inc. (analytical results, sampling information, associated quality control results, etc.) as confidential in nature only without the fear of retribution. That is, Teklab, Inc. will not accept any liability for the inappropriate or accidental release of information, unless specifically agreed to under mutually binding contractual obligations. See Teklab, Inc. NELAP Policy Client Confidential Information for additional information and procedures.

All QA/QC procedures are in accordance with applicable professional technical standards, U.S. Environmental Protection Agency and Illinois Environmental Protection Agency requirements. Teklab uses only methods mandated by legal requirements, recognized published methods or methods developed and validated by Teklab. Methods are not used for reporting results unless competence for each particular matrix is demonstrated.

	7/6/22		7/6/22
Chief Executive Officer	Date	President	Date

Teklab, Inc.
5445 Horseshoe Lake Road
Collinsville, IL 62234-7425
(618) 344-1004

SIC Code 8734
Tax ID 37-1208950
CAGE Code OZZ46
CEC Number 02-695-3349

1.1 Teklab Inc

Teklab prominently displays its most recent TNI accreditation certificate in the customer service/sample reception area of the laboratory. The most recent NELAP accredited fields of testing are also available in Appendix D of this manual, on the Teklab server and on the company website (www.teklabinc.com). Any reports or general literature such as catalogs, advertising, business solicitations, proposals, quotations, or other materials that use the accrediting authorities name or the TNI/NELAP logo, do not imply endorsement by the accrediting authority and must be accompanied by at least the phrase “NELAP Accredited” and the laboratory accreditation number.

Teklab is a full service environmental/chemical-testing laboratory. Seven basic analytical departments exist: air (volatile and semi-volatile), volatile organic, semi-volatile organic, automated inorganic, wet chemistry, metals, and microbiology analysis. Semi-volatile and metals departments are further divided into instrumental and sample preparation. Volatile air analysis is performed at the Teklab Air Laboratory. See Quality Manual Appendix B for Teklab’s Organizational Charts.

Technicians prepare samples for analysis and analysts perform the analysis. Due to personnel and fiscal restraints, Teklab personnel may operate as both technician and analyst.

The purpose of this Quality Manual is to outline the management system for Teklab Inc. The Teklab Inc Quality Manual defines the policies, procedures, and documentation that assure analytical services continually meet a defined standard of quality that is designed to provide clients with data of known and documented quality and, where applicable, demonstrate regulatory compliance.

This Quality Manual also sets the standard under which all laboratory operations are performed, including the laboratory's organization, objectives, and operating philosophy. It has been prepared to assure compliance with the TNI Environmental Laboratory Sector Standard; Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis (Modules 1, 2 and 4). This Standard is consistent with ISO/IEC 17025:2005 requirements that are relevant to the scope of environmental testing services and thus, the laboratory operates a quality system in conformance with ISO/IEC 17025:2005(E). In addition, the policies and procedures outlined are compliant with the various accreditation and certification programs listed in Appendix D.

1.2 Scope of Testing

The laboratory’s scope of analytical testing services includes those listed in Appendix D – Laboratory Certifications.

1.3 Table of Contents, References and Appendices

The Table of Contents starts on Page 2 of this Quality Manual and the Appendices start after Section 29.

The Teklab Inc Quality Manual uses the references included in the 2016 TNI Environmental Laboratory Sector Standard; Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis.

1.4 Acronyms

Quality control terms are generally defined within the Section that describes the activity.

A list of acronyms used in this document and their definitions are:
AB - Accreditation Body
ADOC - Annual Demonstration of Capability
CCB - continuing calibration blank
CCV – Continuing calibration verification
COC – Chain of custody
EPA – Environmental Protection Agency
FoPT - Fields of Proficiency Testing
g/L – grams per liter
GC/MS – gas chromatography/mass spectrometry
ICB - initial calibration blank
ICP – inductively coupled plasma
ICV – Initial calibration verification
IDOC – Initial Demonstration of Capability
LCS – Laboratory control sample
MBLK - Method Blank
MDL – method detection limit
MSP - Managed Service Provider
mg/Kg – milligrams per kilogram
mg/L – milligrams per liter
MS – matrix spike
MSD – matrix spike duplicate
NELAP – National Environmental Laboratory Accreditation Program
NIST – National Institute of Standards and Technology
PQL – Practical Quantitation Limit
PT – Proficiency Test(ing)
PTP - Proficiency Testing Provider
QA – Quality Assurance
QC – Quality Control
RL – Reporting limit
RPD – Relative percent difference
RSD – Relative standard deviation
SOPs – Standard operating procedures
SQL - - Structured Query Language
std – standard
TNI - The NELAC Institute
ug/L – micrograms per liter

1.5 Management of the Quality Manual

The Quality Department is responsible for maintaining the currency of the Quality Manual.

The Quality Manual is reviewed at least annually by the Quality Department to ensure it reflects current practices and meets the requirements of any applicable regulations or client specifications. When sections of the manual are updated, the revision number is increased by one and the effective date is updated. The cover sheet, the first page of Section 1 and Page 91 (Report Signatures) of the Quality Manual must also be re-signed. To ensure consistency, the table of contents is updated whenever a Section is updated.

The Quality Manual is considered confidential within Teklab Inc and may not be altered in anyway except by approval of the Quality Department. If it is distributed to external users, it is for the purpose of reviewing Teklab Inc's management system and may not be used for any other purpose without written permission.

Section 2 - ORGANIZATION

(TNI V1:M2 – Section 4.1)

The laboratory is a legally identifiable organization. Teklab Inc's Tax ID number is noted in section 1 of this Quality Manual. The laboratory is responsible for carrying out testing activities that meet the requirements of the TNI Standard, the ISO/EIC 17025 Standard, and that meet the needs of the client. Through application of the policies and procedures outlined in this Section and throughout the Quality Manual:

- The laboratory ensures that it is impartial and that personnel are free from undue commercial, financial, or other undue pressures that might influence their technical judgment.

- Management and technical personnel have the authority and resources to carry out their duties and have procedures to identify and correct departures from the laboratory's management system.

- Personnel understand the relevance and importance of their duties as related to the maintenance of the laboratory's management system.

- Ethics and data integrity procedures ensure personnel do not engage in activities that diminish confidence in the laboratory's capabilities (see Appendix A, Section 3 "Management" and Section 17 "Data Integrity Investigations" for more information on data integrity).

- Confidentiality is maintained.

- The laboratory will report changes in ownership, significant personnel, laboratory name, or location to the accreditation authority within 30 days of occurrence.

2.1 Organization

Teklab Inc. is a full-service environmental commercial laboratory established in 1982. A variety of laboratory services are provided to serve industries specializing in air, drinking water, wastewater, sludge, soil, oil, and special waste testing. The following listed service centers are owned and operated by Teklab, Inc. Teklab operates in Collinsville, Illinois (Corporate Headquarters and Air Laboratory), Springfield, Illinois (Service center), Downers Grove, Illinois (Service center) and Lenexa, Kansas (Service Center).

<u>Service Centers:</u>

1. Springfield Service Center
   3920 Pintail Suite A
   Springfield, IL 62711
   (217)698-1004

The Springfield Service Center (SFSC) opened February 9th, 2009. The Springfield Service Center serves as a bottle order collection and sample drop off point for our clients in Central Illinois. This service center also has a sample courier service for bottle or air canister delivery and sample pick-up.

2. Kansas City Service Center
   8421 Nieman Road
   Lenexa, KS 66214
   (913)541-1998

The Kansas City/Lenexa Service Center opened its doors in the summer of 2007. The Kansas City Service Center serves as a bottle order collection and sample drop off point for our clients in Western Missouri and Eastern Kansas. This service center also has a sample courier service for bottle delivery and sample pick-up.

3. Downers Grove Service Center
   1319 Butterfield Road, Suite 502
   Downer's Grove, IL 60515
   (630)800-8639

The Chicago Area Service Center opened in July of 2015 and serves as a bottle order collection and sample drop off point for our clients throughout the Chicago Metropolitan Area

We are committed to providing the services our customers require, and as customer needs change, so will the analysis we perform.

The laboratory's organizational charts can be found in Appendix B of this Quality Manual. Additional information regarding responsibilities, authority and interrelationship of personnel who manage, perform or verify testing is included in Section 3 – "Management Roles and Responsibilities" and Section 18 – "Personnel and Training". These Sections also include information on supervision, training, technical management, job descriptions, quality personnel, and appointment of deputies for key managerial personnel.

The laboratory has the resources and authority to operate a management system that is capable of identifying departures from that system and from procedures during testing, and initiates actions to minimize or prevent departures.

2.2 Conflict of Interest and Undue Pressure

Teklab is organized so that confidence in its independence of judgment and integrity are maintained at all times. It has processes to ensure that its personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work. Teklab has a proactive program for prevention and detection of improper, unethical or illegal actions.

All new employees are trained during orientation and all personnel are trained, at least annually, on data integrity, ethical behavior, legal responsibilities and conflict of interest. Each Teklab job description includes an agreement with the employee that they are aware of their ethical responsibilities and will avoid any conflict of interest. See Teklab Inc. NELAP Policy Ethics, Legal Responsibility, & Conflict of Interest for topics discussed during training.

Section 3 - MANAGEMENT

(TNI V1:M2 – Section 4.2)

The laboratory maintains a management system that is appropriate to the scope of its activities.

3.1 Management Requirements

Top management includes the CEO, President, Chief Financial Officer, Chief Marketing Officer, Technical Director (however named), Quality Manager, Quality Officer(s) and Supervisors.

Management’s commitment to good professional practice and to the quality of its products is defined in the Quality Policy statement in Section 3.3.

Management has overall responsibility for the technical operations and the authority needed to generate the required quality of laboratory operations. Management ensures communication within the organization to maintain an effective management system and to communicate the importance of meeting customer, statutory, and regulatory requirements. Management assures that the system documentation is known and available so that appropriate personnel can implement their part. When changes to the management system occur or are planned, managers ensure that the integrity of the system is maintained.

Management is responsible for carrying out testing activities that meet the requirements of the TNI Standard, the ISO/IEC 17025 Standard and the needs of the client.

Management implements, maintains, and improves the management system, and identifies noncompliance with the management system of procedures. Managers initiate actions to prevent or minimize noncompliance (See Section 12 “Improvement, Section 13 “Corrective Action and Section14 “Preventive Action”).

Management ensures technical competence of personnel operating equipment, performing tests, evaluating results, or signing reports, and limits authority to perform laboratory functions to those appropriately trained and/or supervised. See Section 18 “Personnel” for details on personnel requirements.

Management is responsible for defining the minimal level of education, qualifications, experience, and skills necessary for all positions in the laboratory and assuring that technical staff have demonstrated capability in their assigned tasks.

Training is kept up to date as described in Section 18 – “Personnel” by periodic review of training records and through employee performance review.

Management has specific responsibility for maintenance of the management system. This includes defining roles and responsibilities of personnel, approving documents, providing required training, providing a procedure for confidential reporting of data integrity issues, and periodically reviewing data, procedures, and documentation. The assignment of responsibilities, authorities, and interrelationships of the personnel who manage, perform, or verify work affecting the quality of environmental tests is documented in employee job descriptions and section 18 of this Quality Manual.

Management ensures that audit findings and corrective actions are completed within required time frames.

Designated deputies are appointed by management during the absence of the Technical Director if the absence is for more than 15 days.

3.2 Management Roles and Responsibilities

3.2.1 Corporate: Chief Executive Officer / Chief Marketing Officer

3.2.1.1 Responsibilities

- Establishes current and long range goals, objectives, plans and policies.
- Plans, coordinates and controls the daily operation of the organization through organization’s managers.
- Dispenses advice, guidance, direction and authorization to carry out major plans, standards and procedures, consistent with established policies.
- Meets with organization’s other executives to ensure that operations are being executed in accordance with the organization’s policies.
- Oversees the adequacy and soundness of the organization’s financial structure.
- Plans and directs all investigations and negotiations pertaining to mergers, joint ventures, acquisition of businesses or the sale of major assets.

- Establishes and maintains an effective system of communication throughout the organization.
- Represents the organization with major customers, shareholders, the financial community and the public.
- Establishes strategic marketing plans to achieve corporate objectives for products and services.
- Develops, executes and directs comprehensive marketing plans and programs, both short and long range, to support sales and revenue objectives of the organization.
- Plans and oversees advertising and promotions activities.
- Designates, directs, advises and evaluates Teklab's sales staff.
- Works with Teklab's Project Management and Customer Service Departments to be a liaison for the customers, communicate customer needs and to develop and promote outstanding customer service.
- Establishes and maintains relationships with industry influencers and key community and strategic partners.

3.2.2 Corporate: Technical Director (however named)

The Laboratory Director provides the resources necessary to implement and maintain an effective quality and data integrity program.

- Responsible for standards of performance in quality control/quality assurance, the validity of the methodologies and technologies of the analyses performed and the data generated in the laboratory to assure reliable data
- Provides technical assistance to laboratory personnel
- Oversees Teklab's QA/QC program to maintain quality assurance following TNI quality systems requirements. Some of these functions include, but are not limited to, quality control, document control, accreditations, audits, data integrity, data validation and report review.
- Oversees Teklab's Training program.
- Responsible for in depth understanding of methodology and regulatory requirements.
- Oversees method research, development, reviews, implementation and updates. Responsible for implementing and approving standard operating procedures as related to methods.
- Involved with instrument optimization and maintenance.
- When absent for a period of time exceeding 15 consecutive calendar days, the President will temporarily perform this function.
- If this absence exceeds 35 consecutive calendar days, the primary accreditation body shall be notified in writing.

The Technical Director (however named) or designee:

1. is not the Technical Director of more than one accredited environmental laboratory; unless authorized to do so by the primary accreditation authority.
2. is a full-time laboratory staff member and supervises laboratory operations and data reporting.
3. meets the general and education requirements and qualifications found in Sections 4.1.7.2 and 5.2.6.1 of the TNI Standard - EL-V1M2.

The Technical Director's proof of experience in the fields of accreditation may be found on the Teklab Server in Employees Electronic Training File.

3.2.3 Corporate: President/Chief Financial Officer

3.2.3.1 Responsibilities

- Establishes current and long range goals, objectives, plans and policies, subject to approval by the Board of Directors.
- Manages the operations of the laboratory through subordinate managers to ensure that the current and long range goals, objectives, plans and policies are met in a financially responsible manner.
- Dispenses advice, guidance, direction, and authorization to carry out major plans, standards and procedures, consistent with established policies and Board approval.
- Oversees the adequacy and soundness of the organization's financial structure.
- Determines agencies and suppliers of record, and negotiates contract terms and conditions for major services and suppliers.
- Directs company finance and purchasing.
- Represents the organization with major customers, shareholders, the financial community and the public.
- Designates, directs, advises and evaluates the laboratory Supervisors to achieve timely data reporting, while maintaining high safety and quality standards.
- Assists in the planning and implantation of safety policies and procedures in compliance with local, state and federal Occupational Safety and Health Administration (OSHA) rules and regulations.
- Directs, advises and coordinates personnel in their role in the analytical and operational activities of the laboratory to safely produce high quality data as quickly as possible.
- Identifies, analyzes and resolves, and/or assists personnel in solving operational problems.
- Ensures that laboratory resources are available.
- Handles difficult or highly technical situations with clients as needed.
- When absent for a period of time exceeding 15 consecutive calendar days, the Laboratory Director will temporarily perform this function.
- If this absence exceeds 35 consecutive calendar days, the primary accreditation body shall be notified in writing.

3.2.4 Corporate: Quality Manager

The Quality Manager (or designee) is responsible for the oversight and review of quality control data, and is independent from laboratory operations. The Quality Manager's training and proof of experience in QA/QC procedures, knowledge of analytical methods, and the laboratory's management system are available in employee training record files, which are stored on the Teklab Inc server.

3.2.4.1 Responsibilities

- Oversees or maintains Certificate/Accreditation functions
- Provide QA/QC expertise to staff and supervisors
- Oversee and/or maintain performance testing program
- Oversee and /or prepare and maintain Quality Manual
- Notify laboratory supervisors of quality system deficiencies and monitor Corrective actions
- Supervise and/or perform test data validation and data entry
- Supervise and/or perform Level 2, 3 and Level 4 quality control data review
- Responsible for in depth understanding of methodology and regulatory requirements
- Approve and/or prepare laboratory Standard Operating Procedures
- Perform internal QA/QC audits
- Respond to corrective actions from both internal and external audits
- Oversee and/or maintain method related QA/QC documentation according to the TNI standard - EL-V1M2.

3.2.5 Corporate: Director of Customer Service

3.2.5.1 Responsibilities

- Responsible for designating and supervising project managers and customer service specialists
- Provides initial and ongoing orientation, safety and quality training of direct reports
- Analyzes and resolves, or assists workers in resolving customer service problems
- Establishes or adjusts department work procedures to meeting testing schedules
- Identifies and either provides on the job training or seeks training opportunities to ensure that project management and customer service quality meets TNI standards
- Confers with Laboratory Supervisors to achieve timely data reporting to clients, while maintaining the high safety and quality standards
- Confers with the Chief Marketing Officer on customer service and project related needs or issues and to keep abreast of the status of future and potential workload

3.2.6 Collinsville Air laboratory: Director of Operations/Analyst

3.2.6.1 Responsibilities

- Responsible for standards of performance in quality control/quality assurance, the validity of the methodologies and technologies of the analyses performed and the data generated in the laboratory to assure reliable data.
- Designates, directs, advises and evaluates Teklab’s QA/QC program to maintain quality assurance following TNI quality systems requirements.

Some of these functions include, but are not limited to, quality control, data integrity, data validation and report review.

- Responsible for in depth understanding of methodology and regulatory requirements.
- Oversees method research, development, reviews, implementation and updates. Responsible for implementing and approving standard operating procedures as related to methods.
- Involved with instrument optimization and maintenance.
- Provide QA/QC expertise to staff
- Maintain method related QA/QC documentation according to the TNI standard - EL-V1M2.
- Identifies, analyzes and resolves, and/or assists personnel in solving operational problems.
- Ensures that laboratory resources are available.
- Handles difficult or highly technical situations with clients as needed.
- When absent for a period of time exceeding 15 consecutive calendar days, the Corporate Laboratory Director or the President will temporarily perform this function.
- If this absence exceeds 35 consecutive calendar days, the primary accreditation body shall be notified in writing.

3.2.7 Collinsville Air laboratory: Technical Director

3.2.7.1 Responsibilities

- Responsible for standards of performance in quality control/quality assurance, the validity of the methodologies and technologies of the analyses performed and the data generated in the laboratory to assure reliable data
- Provides technical assistance to laboratory personnel
- Responsible for in depth understanding of methodology and regulatory requirements.
- Involved with instrument optimization and maintenance.
- When absent for a period of time exceeding 15 consecutive calendar days, the Director of Operations (Air facility) will temporarily perform this function.
- If this absence exceeds 35 consecutive calendar days, the primary accreditation body shall be notified in writing.

The Technical Director (however named) or designee:

4. is not the technical director of more than one accredited environmental laboratory; unless authorized to do so by the primary accreditation authority.
5. is a full-time laboratory staff member and supervises laboratory operations and data reporting.
6. meets the general and education requirements and qualifications found in Sections 4.1.7.2 and 5.2.6.1 of the TNI Standard - EL-V1M2.

The Technical Director’s proof of experience in the fields of accreditation may be found on the Teklab Server in Employees Electronic Training File.

3.3 Quality Policy

Management's commitment to quality and to the management system is stated in the Quality Policy below, which is upheld through the application of related policies and procedures described in the laboratory's Quality Manual, SOPs and policies.

Teklab's Management is committed to ensuring compliance with the TNI Standard and shall strive to continually improve the effectiveness of the Management System. Teklab's overall Quality objective is to adhere to good professional practices and to develop and implement procedures for field sampling, chain of custody, laboratory analysis and reporting, that will provide results that are legally defensible in a court of law. Specific procedures for sampling, chain of custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal quality control, audits, preventive maintenance of equipment and corrective actions are described in the applicable 1000 series SOPs and other sections of this manual. The purpose of this section is to address the overall objectives that produce accurate, precise, complete, representative and comparable data. The Teklab QA/QC program is communicated and monitored by Teklab's Quality Department.

The Teklab QA/QC program must provide technicians, analysts, and managers with the direction and information necessary to consistently produce reliable and valid analytical data. These results are best attained by rigorously following the validated standard operating procedures and this Quality Manual. This Quality Manual has been developed by Teklab and is available to each Department in an electronic format.

SOP reading is completed at least annually. New laboratory employees are required to read method SOPs once per quarter for six quarters. SOP reading is tracked using controlled reading forms or in controlled Department databases. Employees note the revision and date read for each SOP. Documentation of reading provides evidence that employees have read, understood, and are using the latest version of Teklab Inc. SOPs.

New employees will read the Teklab Quality Manual in their first year of employment. Other laboratory personnel will read the Quality manual when a revision is made.

Teklab provides all employees with on-the-job training specific to their job assignment. Safety, Quality and Ethics training are provided upon hiring and in ongoing programs. Every Teklab employee must ensure that the generation and reporting of quality analytical data is a fundamental priority. All employees are trained annually on ethical principles and procedures surrounding the data that is generated. The laboratory maintains a strict policy of client confidentiality. Offsite training is provided on an as needed basis. The following is a partial listing of the types of training provided by Teklab:

- Safety
- Technical training specific to job assignment
- Data Integrity, Ethics and Conflict of Interest
- NELAP quality systems

3.4 Ethics and Data Integrity System

The laboratory has an Ethics and Data Integrity policy that is included in Appendix A. The laboratory's Ethics and Data Integrity program, training and investigations are discussed in Section 17 – "Data Integrity Investigations". Slides of Teklab's Data Integrity Training can be found in the Quality Documents folder on the Teklab Server.

3.5 Documentation of Management/Quality System

The management system is defined through the policies and procedures provided in this Quality Manual and written laboratory Standard Operating Procedures (SOPs) and policies.

3.5.1 Quality Manual

The Quality Manual contains the following required items:

3.5.1.1 document title;

3.5.1.2 laboratory's full name and address;

3.5.1.3 name, address (if different from above), and telephone number of individual(s) responsible for the laboratory;

3.5.1.4 identification of all major organizational units which are to be covered by this quality manual and the effective date of the version;

3.5.1.5 identification of the laboratory's approved signatories;

3.5.1.6 the signed and dated concurrence (with appropriate names and titles), of all responsible parties including upper management, Quality Officer(s), the Quality Manager, and Technical Director(s);

3.5.1.7 the objectives of the management system and contain or reference the laboratory's policies and procedures;

3.5.1.8 the laboratory's official quality policy statement, which shall include management system objectives and management's commitment to ethical laboratory practices and to upholding the requirements of this Standard; and

3.5.1.9 a table of contents, and applicable lists of references, glossaries and appendices.

This Quality Manual contains or references all required elements as defined by the TNI Standard - V1:M2, Section 4.2.8.4.

3.5.2 Standard Operating Procedures (SOPs)

The laboratory has documented procedures for making and controlling revisions to SOPs. The following information is included on each page of the SOPs:

- SOP number;
- Revision date;

- Revision letter;
- Current page number and total pages of a section.

The effective date of the SOP is the date the SOP is signed by an approving authority. Standard operating procedures (SOPs) represent all phases of current laboratory operations and are available to all personnel. They contain sufficient detail to allow someone with similar qualifications to perform the procedures. There are two types of SOPs used in the laboratory:

1) test method SOPs, which have specific requirements as outlined below
2) general use SOPs which document general procedures.

See SOP1010 for more information on SOPs.

Each accredited analyte or method has an SOP. Sometimes an SOP is a copy of a method, and any additions are clearly described. The laboratory's test method SOPs are listed in SOP1010. SOPs should contain or reference the following information where applicable.

i. identification of the method;
ii. applicable matrix or matrices;
iii. limits of detection and quantitation;
iv. scope and application, including parameters to be analyzed;
v. summary of the method;
vi. definitions;
vii. interferences;
viii. safety;
ix. equipment and supplies;
x. reagents and standards;
xi. sample collection, preservation, shipment and storage;
xii. quality control;
xiii. calibration and standardization;
xiv. procedure;
xv. data analysis and calculations;
xvi. method performance;
xvii. pollution prevention;
xviii. data assessment and acceptance criteria for quality control measures;
xix. corrective actions for out-of-control data;
xx. contingencies for handling out-of-control or unacceptable data;
xxi. waste management;
xxii. references; and
xxiii. any tables, diagrams, flowcharts and validation data.

3.5.3 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is based upon whichever policy is the strictest (where applicable); otherwise the order is as follows:

- Quality Manual

- SOPS
- Reference Methods
- Policies

Section 4 - DOCUMENT CONTROL

(TNI V1:M2 – Section 4.3)

A controlled document is one that is uniquely identified, issued, tracked, and kept current as part of the management system.

An approved document is one that has been reviewed, and either signed and dated, or acknowledged in writing or by secure electronic means by the issuing authority(ies).

Retired documents are documents that have been superseded by more recent versions or are no longer required.

Documents can be “SOPs, policy statements, specifications, calibration tables, charts, textbooks, posters, notices, memoranda, software, etc. These may be on various media, whether hard copy or electronic, and they may be digital, analog, photographic or written.” (TNI V1M2 4.3.1). See section 5 for information on control of records.

Procedures for document control and management include controlling, distributing, reviewing, and accepting modifications. The purpose of document control is to preclude the use of invalid and/or obsolete documents.

4.1 Controlled Documents

Documents are reviewed at least annually to ensure their contents are suitable and in compliance with the current management system requirements, and accurately describe current procedures.

Approved copies of documents are available to staff at all locations where operations are essential to the effective functions of the laboratory. Superseded or obsolete paper and electronic documents must be promptly removed from all points of issue and archived following the procedures in SOP 1291. SOPs are located on the Teklab Inc server in the Quality Documents folder. A copy of the current SOP for any analysis is in the appropriate laboratory section performing that analysis. The Quality Department maintains the original Microsoft Word copy of the most current SOP revision and retired revisions of all SOPs.

Controlled internal documents are uniquely identified with:
1) revision date
2) revision letter

And also the following for SOPs and the Teklab Quality Manual*:
3) unique identification (text or number)
4) page number
5) the total number of pages (or a mark to indicate the end of the document)

6) the signature/s of the approving authority
* Teklab Quality Manual revisions are designated by a revision number and date

SOPs and the Teklab QAM are reviewed annually.

SOPs may be prepared by anyone at Teklab, Inc. All SOPs are prepared in a standard layout containing the same sections (See SOP1010). Documents must be reviewed, revised (as appropriate) and approved for use prior to issue by an "approving authority" which is one of the following staff - Quality Manager, Quality Officer, Laboratory Management or Laboratory Supervisor. See SOP 1010 "SOPs and Controlled Documents" for guidelines. Where a laboratory's quality manual contains the necessary requirements, a separate SOP or policy is not required.

A master list of SOPs, which includes SOP number, SOP title, revision and review dates is maintained by the Quality Department and is updated each time a revision is made to an SOP or an SOP is reviewed. The master list is stored in the Quality Department's Training Database, located on the Teklab Inc server. The Controlled Document database, located on the Teklab server, tracks QA manual and other controlled document revisions and can be modified to track any controlled document when required.

The current QA manual is accessible to laboratory personnel via the Quality Documents folder on the Teklab Inc. server.

Copies of controlled documents, whether hard copy or electronic, made without permission from the QA Department, are not controlled. As such, it is the responsibility of the document holder to ensure that they have the most current revision.

4.1.1 Changes to Controlled Documents

4.1.1.1 Paper Document Changes

Document changes are approved by an 'approving authority' (Section 4.1 lists approving authorities). Modifications to paper documents that require a revision change shall be clearly written on the document and given to the Quality Department for review. Once the review is complete, the document can be approved and signed by an approving authority. The document will then be processed by the Quality Department and issued to the relevant departments.

Changes that are not process modifications but clarifications (also called minor revisions) may be performed without changing the revision letter of the document. The Quality department shall be notified of any minor revisions. The modified document shall then be copied and distributed to the applicable department/s, and obsolete documents shall be removed from all points off use and noted as such in the master list of controlled documents. Minor amendments/modifications to documents are incorporated into a new revision and reissued when the document is reviewed and updated.

The reason for the minor modification or change is written on the document and is provided as historical information. This is not required if the reason for the modification is evident (e.g. to correct a spelling error).

4.1.1.2 Electronic Document Changes

A Microsoft Word copy of the document (if available) may be requested from the Quality Department. The document will be emailed to the reviewer and should be downloaded to the C Drive of their personal computer before making any changes. All editing must be tracked following the guidelines in SOP 1010. The final document must then be emailed back to the Quality Department. Revised 1000 series SOPs are reviewed by the Quality Department and Method SOPs are reviewed by technical reviewers; such as the Technical Director or the Quality Training Officer. Once the document has passed review, it can be approved and signed by an approving authority. When signed, the document will then be processed by the Quality Department and issued to the relevant areas of the laboratory.

Intermediate revisions can be made directly into PDF copies of SOPs or the Quality Manual located in the Quality Documents folder. These revisions must be approved by either the Department Supervisor (or designee) or a member of the Quality Department. Changes to documents are processed following the guidelines in SOP 1010.

4.2 Obsolete Documents

All invalid or obsolete documents are removed from general distribution, or otherwise prevented from unintended use. The master copy of an obsolete document is marked with a retired date and is archived in accordance with SOP 1291 "Record Retention and Access". Hard copies are also marked with the word "retired". Archived documents may be in paper or electronic format. All copies of obsolete documents must be removed from point of use and destroyed. Documents must be securely stored for at least five years before being destroyed. If documents have been scanned and stored on the Teklab Inc Server, related hard copies can be destroyed at the discretion of the applicable department.

Storage boxes are maintained in the Teklab storage area until archived to an off-site storage facility. Both the on-site and off-site storage areas have all access documented in an access log maintained at the respective sites. Both storage facilities are protected against fire, theft, loss, environmental deterioration, and vermin. Electronic records are protected from electronic or magnetic sources in a fire proof safe. Details of all stored (and labeled) storage boxes (current and destroyed) are recorded in a Microsoft Access Database by the Quality Department for tracking purposes.

Controlled electronic documents are stored on the Teklab server indefinitely (where applicable). The Teklab server is backed up on a daily basis. Two Iomega storage units, that can be accessed via the Teklab Inc network, are also available to archive documentation. Each has a built in raid configuration to provide data redundancy.

Note: See section 5 of this QA manual for specific guidelines on the control and archival of laboratory records.

In the event that the laboratory goes out of business, documents will be maintained at the off-site storage facility until they can be securely destroyed. If the laboratory transfers ownership, records and documentation shall be transferred to the new ownership. In the event the laboratory transfers geographic location, records and documentation shall be maintained at the off-site storage facility until the records can be securely destroyed.

Section 5 - CONTROL OF RECORDS

(TNI V1:M2 – Section 4.13)

Records may be on any form of media, including electronic and hard copy. Records allow for the historical reconstruction of laboratory activities related to sample-handling and analysis. See Section 4 for information on control of documents.

5.1 Records Maintained

The laboratory maintains a record keeping system that facilitates the retrieval of working files and archived records for inspection and verification purposes by the NELAP accrediting authority.

The laboratory documents and maintains records related to all procedures and activities to which a sample is subjected, including (See SOP 1010 for a full list)

a) Identity of personnel involved in sampling, preparation and testing;

b) sample preservation, including but not limited to: sample container and compliance with holding times;

c) sample identification code, receipt, log-in, acceptance or rejection;

d) sample storage and tracking, including: shipping receipts, transmittal form, and internal routing and assignment records;

e) sample preparation including: cleanup and separation procedures, extract or digestate identification codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;

f) sample analysis;

g) records for all standards, reagents, reference materials, and media, including the manufacturer/vendor, the manufacturer's Certificate of Analysis or purity (if available), the date of receipt, and recommended storage conditions;

h) equipment receipt, use specification, operating conditions and preventative maintenance

i) calibration criteria, frequency and acceptance criteria;

j) method performance criteria including quality control requirements;

k) quality control protocols and assessment;

l) all automated sample handling systems;

m) calculations and statistical formulae used by the laboratory;

n) written procedures for all calculations are available for review;

o) representative calculations are available and indicate that routine calculations are consistent with the written procedures;

p) all raw data and supporting information needed to recreate calculations are available for review;

q) the appropriate number of significant figures are carried out through all recorded data and calculations; and

r) the least precise step is identified in the calculations and the number of significant figures is an accurate reflection of the actual tolerances of the instrument or equipment used in this step.

s) Procedures to verify that the reported data is free from transcription and calculation errors;

t) data handling, including but not limited to: reduction, review, confirmation, interpretation, assessment or validation, and reporting;

u) QC measurements, including procedures to select samples on which to perform QC measurements, and assessment of method performance;

v) requirements specified in sample acceptance and receipt section of this manual;

w) electronic records, including but not limited to; copies of final reports, PT studies, bench sheets, instrument strip charts or printouts, data calculations, and data reports for five years or for as long as is required by the applicable regulatory program, whichever is greater. These records include an input summary and copy of the PT study final reports from the PT vendor used by the laboratory;

x) data review and cross-checking forms;

y) all information necessary to produce unequivocal, accurate records that document the laboratory activities associated with the sample receipt, preparation, analysis and reporting; and

z) procedures that maintain an unequivocal link with the unique field identification and the laboratory identification code assigned each sample.

5.2 Records Management and Storage

The laboratory maintains a record management system for control of laboratory records. See SOP# 1010, 1060, 1290 and 1291 for more information on tracking, reporting and storage.

Data is recorded immediately and legibly in permanent ink (data generated by automated data collections systems is recorded electronically.) Corrections are initialed and dated with the reason noted for corrections other than transcription errors. A single line strikeout is used to make corrections so that the original record is not obliterated.

Excel data sheets used for data entry in the laboratory are coded to allow tracking and automatic documentation of all changes made within that file. The worksheet containing the tracking information is stored within the workbook for the life of the file.

Electronic corrections in LIMS are tracked via SQL files which log all changes made; including the user making the change and reason for the change where applicable. SQL files are retained securely on the Teklab server for at least 5 years.

See SOP#1534 for Teklab server/SQL back-up schedules.

Where computers or automated equipment is used for the capture, processing, manipulation, recording, reporting, storage or retrieval of test data, the laboratory:

- Maintains computer and automated equipment to ensure proper functioning and provide environmental and operating conditions necessary to maintain the integrity of calibration and test data
- Performs software and hardware testing
- Establishes and implements procedures for the maintenance of security of data, including the prevention of unauthorized access to, and the unauthorized amendment of, computer records and
- Maintains hard copy or write protected backup copies of records that are stored or generated by computers.

The laboratory controls access to all programs that are used to acquire, process, record or report data. All programs have limited access and are dependent on the security permissions that are assigned to each employee. An employee is granted access depending on his/her responsibilities and job description.

Records, including electronic records, are easy to retrieve, legible, and protected from deterioration or damage; held secure and in confidence; and are available to accrediting bodies for a minimum of five years or as required by regulation or contract. Records that are stored only on electronic media are supported by the hardware and software necessary for their retrieval. Access to protected records is limited to applicable department personnel. Procedures for identification, access, filing, storage, maintenance and disposal of quality and technical records can be found in SOPs 1010, 1060 and 1291. Quality records shall include reports from internal audits as well as records of corrective and preventive actions.

The laboratory maintains the record management system for control of all applicable information, in an organized, chronological order. Hard copy records are segregated by type (i.e. laboratory data packets, Teklab Reports etc.), in chronological order, and placed in storage boxes. The exterior of the storage box indicates the contents. Storage boxes are maintained in the Teklab storage area until archived to an off-site storage facility. Additional information regarding control of data is included in Section 21.5 – “Control of Data”.

Paper records must be safely stored, held secure, and in confidence to the client. All information necessary for the historical reconstruction of the data must be maintained. Non-drinking water records must be retained for 5 years from generation of last entry in records. Drinking water chemical analysis records from public water systems serving at least 25 persons or having at least 15 service connections must be maintained for 10 years from the generation of the last entry in the records. Lead and copper drinking water records must be maintained for 12 years from generation of last entry. Per Louisiana regulations all air analysis records must be kept for at least 10 years. Records may be stored longer at client request.

Metals and Inorganics data is scanned and kept on the server per the regulation retention times noted above. Hard copies of scanned Metals and Inorganics data are kept for one year. VOA and Organics data is electronically generated and is stored on the Teklab Server for at least five years.

Data for all other environmental analyses that are associated with the laboratory’s accreditation is stored for a minimum of five years, unless otherwise specified in another regulation. And for all suppliers from whom it obtains support services or supplies required for testing, for a minimum of five years.

The laboratory shall retain all records necessary to facilitate reconstruction of the preparation, processing, and reporting of analytical results for PT samples for a minimum of five years and make them available for review upon request by the Primary AB.

In the event that the laboratory transfers ownership or goes out of business, records are maintained or transferred according to client instructions. Appropriate regulatory and state legal requirements concerning laboratory records shall be followed.

5.3 Legal Chain of Custody Records

Evidentiary sample data are used as legal evidence. Procedures for evidentiary samples are outlined below and can also be found in SOP1065.

The laboratory establishes and maintains the following basic requirements for evidentiary chain-of-custody:

- The evidentiary chain-of-custody records accounting for an unbroken possession of the sample while it is in the laboratory's custody.
- The evidentiary chain-of-custody records include signatures of all individuals who were involved with physically handling the samples and the time of day and calendar date that the sample was physically transferred from one individual to the next individual or to and from a controlled access storage area. A sample is considered to be in someone's custody only if it is in one's actual physical possession, if it is in one's view, after being in one's physical possession, or if it is kept in a secured area restricted to authorized personnel only.
- A minimum number of persons shall be involved in sample handling.
- The laboratory limits the number of documents that are required to establish evidentiary chain-of-custody.
- The evidentiary chain-of-custody forms remain with the samples during transport or shipment.
- The laboratory controls access to all evidentiary samples and sub-samples, and documents this control as described in the Sample Acceptance and Receipt section of this manual.
- Transfer of samples, sub-samples, digestates or extracts to another laboratory is subject to all of the requirements for evidentiary chain-of-custody.
- The laboratory ensures that sample containers that are shipped, are sealed in such a manner so that tampering by unauthorized personnel is immediately evident. If any seals are not intact, the laboratory notes this on the chain-of custody.
- The laboratory ensures that, if required, individual sample containers are sealed in such a way as to prevent tampering.
- The laboratory maintains records of sample disposal practices including, where appropriate, the date of sample or sub-sample disposal and the name of the responsible person.
- The disposal of the physical sample occurs only with the concurrence of the affected legal authority, sample data user and submitter of the sample.
- The laboratory documents and retains a record of all conditions of disposal and all correspondence between all parties concerning the final disposition of the physical sample.
- The sample records indicate the date of disposal, the nature of disposal (such as depleted, sample manifested to a hazardous waste facility, sample returned to client), and the identity of the individual who performed the task.
- The laboratory has waste collection, storage, recycling, and disposal procedures and policies as part of their SOPs. Where disposal practices are included as part of an approved test method, the laboratory strictly follows the approved test method's disposal practices. While more specific disposal criteria are not an aspect of this manual, the laboratory applies appropriate Federal, state, and local disposal practices as a part of good laboratory practices.

Section 6 – REVIEW OF REQUESTS, TENDERS AND CONTRACTS

(TNI V1:M2 – Section 4.4)

The review of all new work assures that requirements are clearly defined, the laboratory has adequate resources and capability, and the test method is applicable to the customer's needs. This process ensures that all work will be given adequate attention and avoid shortcuts that may compromise data quality.

Contracts for new work may be formal bids, signed documents; verbal, or electronic. The client's requirements, including the methods to be used, must be clearly defined, documented and understood. The review must also cover any work that will be subcontracted by the laboratory.

See SOP1015 for details on Review of Requests, Tenders and Contracts and SOP 1100 for Subcontracting guidelines.

Section 7 - PURCHASING SERVICES AND SUPPLIES

(TNI V1:M2 – Section 4.6)

The laboratory ensures that purchased supplies and services that affect the quality of environmental tests are of the required quality by using approved suppliers and products.

7.1 Procedure for Purchasing

Supplies and Services that affect the quality of environmental tests are purchased by the Chief Financial Officer, who also reviews and approves the suppliers of services and supplies.

Purchase orders are automatically assigned unique order numbers and are generated from the LIMS. The Vendor section of the LIMS contains information that adequately describes the services and supplies ordered. Order details are stored under each vendor/supplier and allows for tracking and evaluation of past purchases.

Clipboards with Supply Order Forms are available in all departments of the laboratory. The form contains information such as the department, date (the date the item was added to the form), a description of the item and a priority code. Priority codes run from 1 (need immediately) to 3 (order within the next 2 weeks). Priority code 4 is reserved for special request/new items. When an item is ordered, the order date is noted beside the applicable item. A copy of the form is then given to the Customer Service department. When the goods are delivered to Teklab, the Customer Service department can use the Supply Order Form to expedite the distribution of supplies to the relevant departments. The laboratory strives to maintain an adequate supply of critical items to ensure continued analysis without interruption.

Purchased supplies that affect the quality of tests are inspected for breakage, leaks or any other damage when received. The supplies are stored according to manufacturer's recommendations, laboratory SOPs or test method specifications. See SOP1260 for information on supply receipt procedures.

Copies of calibration documentation (e.g. weight calibrations, reference thermometer calibrations, balance maintenance/calibrations) are kept on file by the Quality Department. Certificate of Analysis details are logged into the LIMS. A copy of the certificate is scanned and linked to information in the LIMS by the relevant department or a member of the Quality Department. See Section 23 “Reagents and Standards” and SOP1250 for more information.

7.2 Approval of Suppliers

The Chief Financial Officer maintains a list of approved suppliers in the Teklab LIMS. Vendors that are no longer used are inactivated through the same system.

<u>Evaluation Procedure</u>
Evaluation and selection of suppliers/ vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products/services, the quality of their service, their past history and competitive pricing. To ensure that critical consumables and equipment conform to specified requirements, all purchases from specific vendors are approved by a member of the management staff.

If problems with supplies (or services) arise after the product has entered the laboratory, the deficiency information can be relayed by the relevant department directly to the Chief Financial Officer. Critical deficiencies (that impact safety or the quality of data) must be relayed to the Chief Financial Officer as soon as possible. All returns are dealt with on a case by case basis.

Section 8 - SUBCONTRACTING OF ENVIRONMENTAL TESTS

(TNI V1:M2 – Section 4.5)

8.1 Procedure

When Teklab must subcontract analysis due to workload, need for further expertise, temporary incapacity, or on a continuing basis, work is placed with a laboratory accredited under NELAP for the test to be performed or with a laboratory that meets the applicable statutory and regulatory requirements for performing the tests and submitting the results of test performed. All subcontracted analyses and the name of the subcontracted laboratory are documented in the case narrative of the final report. Any non-NELAP accredited work does not have the letters “NELAP” in the qualifier column. The intent to subcontract analysis is specified in the project quote when Teklab intends to subcontract any part of a project. When possible, Teklab will advise the client in writing of any subcontracted analysis. Teklab maintains a register of all subcontractors that it uses for environmental tests and a record of the evidence of compliance for each. A record of subcontracted analysis is retained at Teklab and is archived in accordance with this manual. Teklab will ensure that the subcontract laboratory is provided all necessary information to meet the same commitments made to the client by the primary laboratory.

See SOP1100 for Subcontracting procedures and guidelines and SOP 1015 for review of requests, tenders and contracts.

Section 9 - SERVICE TO THE CLIENT

(TNI V1:M2 – Section 4.7)

The laboratory collaborates with clients and/or their representatives in clarifying their requests and in monitoring laboratory performance related to their work. Each request is reviewed to determine the nature of the request and the laboratory's ability to comply with the request within the confines of prevailing statutes and/or regulations without risk to the confidentiality of other clients.

9.1 Client Confidentiality

Teklab Inc’s confidentiality policy is to not divulge or release any information to a third party without proper authorization. Third party requests for data and information are referred to the client. Data and records identified as proprietary, privileged, or confidential are exempt from disclosure.

All electronic data (storage or transmissions) are kept confidential, based on technology and laboratory limitations, as required by client or regulation.

Teklab, Inc. will protect Clients’ confidential information and proprietary rights, as directed by local, state or federal laws. All confidential information and/or proprietary rights claimed by any Client and/or Vendor must be clearly identified in writing, prior to initiation of any business activity. Teklab, Inc. will voluntarily treat information generated by Teklab, Inc. (analytical results, sampling information, associated quality control results, etc.) as confidential in nature only without the fear of retribution. That is, Teklab, Inc. will not accept any liability for the inappropriate or accidental release of information, unless specifically agreed to under mutually binding contractual obligations. See Teklab, Inc. NELAP Policy Client Confidential Information for additional information and procedures.

Teklab quality training includes training on procedures for protecting clients’ confidential information. Clients’ names or client’s sample identifications are not listed in any laboratory data packets. Information in the laboratory data packets is identified with Teklab generated laboratory identifications only. Printed records containing client information are shredded before disposal. See Teklab Inc. NELAP Policy Client Confidential Information for policy and procedural details discussed during training.

9.2 Client Support

Communication with the client, or their representative, is maintained to provide proper instruction and modification for testing. Technical staff are available to discuss any technical questions or concerns the client may have.

The client, or their representative, may be provided reasonable access to laboratory areas to witness testing.

Delays or major deviations to testing are communicated to the client immediately, where possible, by email or phone by the applicable Project Manager, a member of the Customer Service Team or the Chief Marketing Officer.

Teklab will provide the client with all requested information pertaining to the analysis of their samples.

9.3 Client Feedback

The laboratory seeks both negative and positive feedback following the completion of projects and/or periodically for ongoing projects. Feedback provides acknowledgement, corrective actions where necessary, and opportunities for continuous improvement. Methods of receiving feedback may include conversations with customers (phone or email), website and email questionnaires.

Negative customer feedback is documented as a customer complaint (see Section 10 – "Complaints").

Section 10 - COMPLAINTS

(TNI V1:M2 – Section 4.8)

The purpose of this section is to ensure that customer complaints are addressed and corrected, and done so in a timely manner. This includes requests to verify results or analytical data. Complaints provide the laboratory an opportunity to not only improve client satisfaction but also laboratory operations.

Customer complaints are dealt with on a case by case basis. All customer complaints are documented by the person receiving the complaint and addressed to the responsible manager. Complaints concerning areas such as turnaround time or pricing, are handled solely at the discretion of Teklab management. The Technical Director, Quality Manager/Officer or Teklab Management handle all QA/QC complaints. An investigation determines the validity of the complaint. If it is determined that the complaint has merit, the procedures outlined in Section 13 – Corrective Action are utilized. If it is determined that a complaint is without merit, it is documented, and the client is contacted by the appropriate Project Manager.

A complaint such as a concern that data is repeatedly late should be reviewed for preventive action (see Section 14 – "Preventive Action") to minimize a future occurrence.

The laboratory has a documented policy and procedures for the resolution of complaints received from clients or other parties about the laboratory's activities.
The laboratory audits the laboratory activities as required in this manual resulting from a complaint, or any other circumstance that impacts the laboratory's compliance with:

1. The laboratory's policies and procedures;
2. The requirements of this manual; and
3. The quality of the laboratory's tests.

The laboratory documents and maintain records of the complaint/s, the laboratory's subsequent actions, and any corrective actions and/or revised reports.

Section 11 - CONTROL OF NON-CONFORMING ENVIRONMENTAL TESTING WORK

(TNI V1:M2 – Section 4.9)

Non-conforming work is work that does not meet acceptance criteria or requirements. Non-conformances can include departures from standard operating procedures, test methods or unacceptable quality control results (see Section 26 – "Quality Assurance for Environmental Testing"). Identification of non-conforming work can come via customer complaints, quality control, instrument calibration, evaluating consumable materials, staff observation, final report review, management reviews and internal and external audits.

11.1 Exceptionally Permitting Departures from Documented Policies and Procedures

Requests for departures from laboratory procedures are approved by the Technical Director or his/her designee and documented on a case by case basis with the applicable analytical data or final report. Planned departures from procedures or policies do not require audits or investigations.

If a client requests a departure from laboratory procedures, the laboratory does not have to consider that departure as a nonconformance that requires corrective action. However, that nonconformance must be documented as a nonconformance (or however named) that was approved by management.

11.2 Non-Conforming Work

The laboratory policy for control of non-conforming work is to identify the non-conformance and take appropriate action. All employees have the authority to stop work on samples when any aspect of the process does not conform to laboratory requirements.

The responsibilities and authorities for the management of non-conforming work are detailed in SOP#1280 and Section 13 "Corrective Actions". The procedure for investigating and taking appropriate corrective actions for non-conforming work are also described in Section 13. Section 13.3 outlines the procedures for Technical Corrective Actions. Formal corrective action procedures must be followed for non-conforming work that could reoccur (beyond expected random QC failures) or where there is doubt about the laboratory's compliance to its own policies and procedures.

The investigation and associated corrective actions for non-conforming work involving alleged violations of the company's Ethics and Data Integrity policies must follow the procedures outlined in Section 17 – "Data Integrity Investigations".

The reporting of non-conforming work involving alleged violations of the company's Ethics and Data Integrity policies must be reported to a member of the Management Team. Procedures described in Section 17 – "Data Integrity Investigations" are followed.
The laboratory evaluates the significance of the non-conforming work, and takes corrective action immediately. The customer is notified if their data has been impacted. The laboratory allows the release of non-conforming data only with approval of the

Technical Director or their designate on a case-by-case basis. Non-conforming data is clearly identified in the final report (see Section 27 – "Reporting the Results").

The discovery of a nonconformance for results that have already been reported to the customer must be immediately evaluated for significance of the nonconformance, its acceptability to the customer, and determination of the appropriate corrective action.

See Section 13 "Corrective Action" and SOP1280 for details on managing non-conforming work.

11.3 Stop Work Procedures

Laboratory supervisors, the Quality Department, and the Management team have authorization to halt non-conforming work at any time. Samples are not analyzed until the problem causing the deviation is corrected. If applicable, the system is monitored until 10 consecutive data points are within control chart limits. After corrective actions successfully eliminate the problem, the corrective actions taken, individual(s) involved, samples affected, and date are noted on corrective action forms and in the appropriate logbooks. Only the Technical Director (or their designee) can authorize the resumption of affected tests. See section 13 for more information on Corrective Actions.

Section 12- IMPROVEMENT

(TNI V1:M2 – Section 4.10)

Improvement in the overall effectiveness of the laboratory management system is a result of the implementation of the various aspects of the laboratory's management system: quality policy and objectives (Section 3 – "Management"); internal auditing practices (Section 15 – "Internal Audits"); the review and analysis of data (Section 26 – "Quality Assurance for Environmental Testing"); the corrective action (Section 13 – "Corrective Action") and preventive action (Section 14 – "Preventive Action") process; and the annual management review of the quality management system (Section 16 – "Management Reviews") where the various aspects of the management/quality system are summarized, and evaluated and plans for improvement are developed.

Section 13 - CORRECTIVE ACTION

(TNI V1:M2 – Section 4.11)

Corrective action is the action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation in order to prevent recurrence. Deficiencies cited in external assessments, internal quality audits, data reviews, customer feedback/complaints, control of nonconforming work or managerial reviews are documented and require corrective action. Corrective actions taken are appropriate for the magnitude of the problem and the degree of risk.

The following section dictates the decision process, procedures and initiation process for corrective actions. It identifies the data used to determine if a problem exists and the actions to be taken.

13.1 General Procedure

The laboratory uses the LIMS database to document and track corrective actions. See SOP#1280 for more information on Corrective Actions.

All deficiencies are first investigated to identify root cause and a corrective action plan is then developed and implemented if deemed necessary. The implementation is also monitored for effectiveness. Teklab technicians, analysts, and supervisors are responsible for initiating corrective actions on routine data reviews where a nonconformance is found that could reoccur (beyond expected random QC failures) or where there is doubt about the compliance of the laboratory to its own policies and procedures. Project Management and the QA Department must be informed immediately if the problem will or may affect client sample results.

Department supervisors are responsible for implementing the corrective action and tracking analysis until the system is in control again. Corrective actions may be entered into the LIMS by any Teklab Personnel. The final corrective action is reviewed by the Quality Department for completeness. The Technical Director and Quality Manager must approve and close out the completed corrective action in LIMS.

13.1.1 Cause Analysis

When failures due to systematic errors have been identified, the first step is an investigation to determination of the root cause(s) of the problem. When there are non-systematic errors, where the initial cause is readily identifiable or an expected random failure (e.g. failed quality control), a formal root cause investigation is not required.

13.1.2 Selection and Implementation of Corrective Actions

After the root cause(s) has been defined (where applicable), a corrective action plan is then selected and implemented (see Section 13.3 “Technical Corrective Actions” and SOP1280 “Corrective Actions and Root Cause Analysis”).

Where uncertainty arises regarding the best approach for analysis of issues that require corrective action, applicable personnel will recommend corrective actions that are appropriate to the magnitude and risk of the problem and that will most likely eliminate the problem and prevent recurrence

Teklab Management and the Quality Department shall ensure that corrective actions are discharged within the agreed upon time frame. Corrective Action records are maintained in the LIMS database. The records contain details of both the root cause(s) investigation and the corrective action plan. PDF copies of all signed corrective action reports are stored on the Teklab server.

13.1.3 Monitoring of Corrective Action

The Quality Department and Department supervisors (where applicable) will monitor implementation and documentation of the corrective action to assure that the corrective actions were effective. Internal audits may also be used to verify the effectiveness of corrective actions. See SOP 1280 for more information on monitoring corrective actions.

13.2 Additional Audits

Where the identification of non-conformances or departures from normal lab procedures cast doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with the TNI Standard, the laboratory ensures that the appropriate areas of activity are audited in accordance with Section 15 – "Internal Audits" as soon as possible.

13.3 Technical Corrective Action

Sample data associated with a failed quality control are evaluated for the need to be reanalyzed or qualified. Unacceptable quality control results are documented, and if the evaluation requires root cause analysis, the cause and solution are recorded (see Section 11 "Control of Nonconforming Environmental Testing Work"*).*

Analysts routinely implement corrective actions for data with unacceptable QC measures. First level correction may include re-analysis without further assessment. If the test method SOP addresses the specific actions to take, they are followed. Otherwise, corrective actions start with assessment of the cause of the problem.

Corrective action procedures for non-systematic errors or expected random failures are detailed in SOP#1280. All corrective actions are stored in the LIMS and on completion are stored in PDF format on the Teklab server. Corrective actions for non-conformances that may reoccur (beyond expected random QC failures) or where there is concern that the laboratory is not in compliance with its own policies and procedures require that a Corrective Action to be completed (see Section 13.1).

Whenever possible, samples are only reported if all quality control measures are acceptable. If a sample associated with unacceptable quality control measures must be reported, the deviation is clearly documented in the case or sample narrative of the final report. Whenever possible, corrective actions are undertaken to bring the system back in control.

Supervisors, the Quality Department and/or Management may review Corrective Action responses and suggest improvements, alternative approaches, and procedures where needed.

13.4 Data Evaluation

Teklab tracks the precision and accuracy of each analysis through the use of control charts. These control charts are based on the Relative Percent Difference (RPD), Laboratory Control Sample recoveries (LCS) and Matrix Spike recoveries (MSR). The RPD, LCS and MSR are calculated for each run of analysis. Independently verified Quality Control Samples (QC samples) also are used to determine if the analysis is in control. If the data exceeds the control chart or manufacturer specified limits, the analysis is checked for calibration, standard quality and analytical technique, and the analysis is stopped and corrective action taken.

Section 14 - PREVENTIVE ACTION

(TNI V1:M2 – Section 4.12)

The preventive action plan establishes the process to investigate and track potential non-conformances in Teklab Inc's Quality Management System. The foundation of preventive action is written and accessible documentation of actions taken and subsequent monitoring to determine that preventive actions have been implemented and documented.

Preventive Action Plan

Preventive action plans are part of a proactive process for improvement rather than a reaction to problems or complaints. Preventive action includes the utilization of measurable quality objectives and requirements such as validation and review processes, audits (internal and external), management review, feedback and complaints, and quality system requirements to detect, analyze and remove potential causes of non-conformance. All personnel have the authority to offer suggestions for improvements and to recommend preventive actions, however management is responsible for the actual implementation of preventive action.

The preventive action proactive process consists of:

- reviewing potential problems; deciding the potential cause of the problems;
- deciding the course of action to eliminate the problem from occurring;
- implementing the plan; and then ensuring or verifying the action solved the problem and/or is effective over time.
- Once identified, Preventive action plans are initiated by starting a corrective action in the LIMS.

Monitoring the effectiveness of the preventive action includes, but not limited to, the following:

- control charts;
- performance studies;
- training;
- customer input;
- employee suggestions and input;
- audits;
- management reviews;
- staff meetings
- Scheduled instrument maintenance

Needed improvements and/or potential sources of non-conformance (either technical or Quality related) are identified. If preventive action is required, action plans shall be developed, implemented and monitored to reduce the likelihood of the occurrence of such non-conformances and to take advantage of the opportunities for improvement. A corrective action shall be initiated in the LIMS once a potential nonconformity is identified. Preventive actions shall be monitored by the supervisor of the relevant department (or their designee); the Quality Department and management. Corrective action status reports (via email), will also aid in monitoring the status of preventive action plans. The Quality Manager (or designee) is responsible for follow-up and ensuring the action plans are completed.

A preventative maintenance program is maintained for each instrument. Any equipment found to be out of calibration or indicating problems is taken out of service until the problems are corrected. Records are maintained which document preventive maintenance and repairs to instrumentation and general laboratory equipment. Equipment failures or problems are noted as follows: the nature of the problem, corrective actions taken, the person performing corrective actions and the date. See Section 22 and SOP 1210 for additional information on equipment maintenance.

LIMS Preventive Action
Teklab has a preventive system to plan and test deployments of LIMS modifications to avoid or minimize the potential disruption associated with a LIMS failure.

- Production database: the live LIMS database used throughout the laboratory
- Development database: allows the application programmer to evaluate modifications to the LIMS without affecting live data. These changes are then re-evaluated through test databases.
- Test database: Test databases do not use real time data. They are distributed, by the applications programmer, to designated members of staff. These databases allow modifications to be assessed for potential conflicts and/or errors before updates are finally integrated into the production LIMS.

Section 15 - AUDITS

(TNI V1:M2 – Section 4.14)

15.1 Internal Audits

Audits measure laboratory performance and verify compliance with the TNI Standard, certification requirements, and management system requirements; including analytical methods, SOPs, the Quality Manual, ethics policies, data integrity, and other laboratory policies.

Audits provide management with an on-going assessment of the management system. They are also instrumental in identifying areas where improvement in the management system will increase the reliability of data. Results of the audits (and any associated corrective actions) are reported to the Teklab Board of Directors at least annually.

It is the responsibility of the Quality Manager (or designee) to plan and organize audits as required by the schedule and requested by management. These audits are carried out by trained and qualified personnel who are, wherever resources permit, independent of the activity to be audited.

These annual audits examine the above stated items as well as the following:

- Personnel training
- SOPs
- Log-In and chain of custody procedures
- Housekeeping
- Balance and micropipette calibrations
- Refrigerator, oven and incubator temperatures
- Fume hood operation and face velocity determinations
- Reagent, solvent and standard documentation
- Instrument maintenance logs
- Corrective action procedures and reports
- Data collection, reduction, validation and reporting
- Waste disposal

The Quality Manager, or their representative, is also responsible for incorporation and/or documentation of changes, including but not limited to, changes in the approved test methods, changes in laboratory equipment, or changes in laboratory personnel. The area audited, the audit findings, and corrective actions are recorded. Audits are reviewed after completion to assure that corrective actions were implemented and effective.

In addition to scheduled internal audits, it may sometimes be necessary to conduct special audits as a follow-up to corrective actions, PT results, complaints, regulatory audits or alleged data integrity issues. These audits or investigations address specific issues. Review of their effectiveness may occur during the next scheduled audit unless findings are observed that cast doubt on the validity of data; in which case the review must take place as soon as possible.

15.2 External Audits

Management shall ensure that all areas of the laboratory are accessible to auditors as applicable and that appropriate personnel are available to assist in conducting the audit.

All records must be made available to Teklab's Accreditation Bodies.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, on-site auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information.

15.3 Performance Audits

Performance audits may be Proficiency Test Samples, internal single-blind samples, double-blind samples through a provider or client, or anything that tests the performance of the analyst and method.

Proficiency Test Samples are discussed in Section 26 – "Quality Assurance for Environmental Testing".

15.4 System Audits

The Laboratory's management system is audited though scheduled management reviews. Refer to Section 16 "Management Review" for more information.

15.5 Handling Audit Findings

Internal or external audit findings are responded to within an agreed time frame. The response may include action plans that could not be completed within the response time frame. A completion date is established by management for each action item and included in the response.

The development and implementation of corrective actions for findings is the joint responsibility of the Quality Department and the relevant Department supervisor (where applicable). Corrective actions are documented through the corrective action process described in Section 13 – "Corrective Actions".

Where the results of the internal audit indicate that operations or procedures are not in compliance, corrective actions must be taken. These corrective actions may include termination of all applicable analysis until the source of the problem can be identified and corrected. Laboratory supervisors, the Quality Department, and the Management team have authorization to halt non-conforming work at any time. All affected samples must be identified and clients whose samples were affected must be notified, in writing, within one week of the problem identification. The analysis cannot be resumed until the problem is demonstrated to be corrected (by the analysis of samples of known concentration), the reason for the problem and all corrective actions are documented and the Technical Director (or their designee) approves the resumption of analysis. All investigations that result in findings of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. See Section 17 (Data Integrity Investigation) for additional procedures for handling inappropriate activity.

Section 16 - MANAGEMENT REVIEWS

(TNI V1:M2 – Section 4.15)

Teklab's laboratory management reviews the Quality Assurance Plan to ensure its continuing suitability, effectiveness, and compliance with TNI Standards at least once every 12 months. This review is documented and includes at least the following:

16.1 Management Review Topics

- Monthly reports from the quality department concerning the laboratory quality system
- Suitability of policies and procedures
- Resources and training
- Reports from any management and supervisory personnel
- Outcomes of any recent internal audits
- Assessments by external bodies
- Results of interlaboratory comparisons or proficiency tests
- Changes in the volume or type of work undertaken
- Feedback from clients
- Complaints
- Recommendations for improvement
- Corrective and preventative actions

The outcome of this review is to introduce any necessary changes or improvements in the quality system and laboratory operations. A record of this review, its findings and the resulting actions/changes is maintained on the server and is archived in accordance with this manual.

16.2 Procedure

Laboratory management shall continuously review the Quality Assurance Plan to ensure its ongoing suitability, effectiveness, and compliance with TNI Standards. The review process includes (but is not limited to) the following:

- Annual Management Review
- Department meetings
- Monthly Quality reports
- Operations meetings – attended by management and the QA department
- Board of Director meetings

Staff meetings are part of the overall quality system and provide comprehensive departmental interaction that can aid in the planning and co-ordination of activities that may have a laboratory wide impact. Suggested improvements to the quality system, as well as potential sources of non-conformance are discussed as part of the laboratory Preventive Action Plan.

Management shall also receive monthly reports from the Quality Department regarding the status of Quality issues including (but not limited to) safety checks, current corrective actions and required laboratory SOP reading. When an ongoing problem is identified in the Quality System that requires attention; it is forwarded to management who assists the Quality Department in monitoring the problem and ensures the issue is resolved in a timely manner where possible.

Section 17 - DATA INTEGRITY

(TNI V1:M2 – Section 4.16)

In addition to covering data integrity investigations, this Section covers all topics related to ethics and data integrity policies, procedures and training.

Teklab Inc is committed to ensuring the integrity of its data and providing valid data of known and documented quality to its clients. The elements in Teklab's Ethics and Data Integrity program include:

- Documented data integrity procedures signed and dated by top management.
- An Ethics and Data Integrity Statement (included in job description) signed by all management and staff upon hiring.
- An Ethics and Data Integrity Statement signed after annual data integrity training. Teklab's Ethics and Data Integrity Policy can be found in the Quality Documents folder on the Teklab Server.
- Appendix A of this Quality Manual.
- Procedures for confidential reporting of alleged data integrity issues.
- Periodic in-depth data monitoring.
- An audit program that monitors data integrity (see Section 15 – "Audits") and procedures for handling data integrity investigations and client notifications.

17.1 Ethics and Data Integrity Procedures

The Ethics and Data Integrity Policy provides an over view of the program. Written procedures that are considered part of the Ethics and Data Integrity program include:

- Teklab's Ethics and Data Integrity Policy: "Ethics, Legal Responsibility, & Conflict of Interest" (Appendix A)
- Corrective action procedures (SOP#1280 and Section 13 of this QAM)
- Procedure for Data Integrity Investigations (See Section 17.4 Investigations)
- Data Integrity training procedures (See Section 17.2 Training)
- Internal audit procedures (SOP#1270 and See Section 15 of this QAM)

17.2 Training

Data integrity training is provided as a formal part of new employee orientation and a refresher is given annually for all employees. Training courses in data integrity, ethical and legal responsibilities, include the potential punishments and penalties for improper, unethical or illegal actions. Attendance for required training is mandatory and is monitored through a signature attendance sheet.

Evidence must be on file that each employee has read, acknowledged and understood their personal, ethical and legal responsibilities including the potential punishments and penalties for improper, unethical or illegal actions.

Data integrity training emphasizes the importance of proper written narration on the part of the analyst with respect to those cases where analytical data may be useful, but are in one sense or another partially deficient. Topics covered are provided in writing and provided to all trainees.

17.3 Confidential Reporting of Ethics and Data Integrity Issues

Confidential reporting of data integrity issues is assured through the following procedures:

- Teklab Inc's Ethics and Data Integrity Policy ("Ethics, Legal Responsibility, & Conflict of Interest" see Appendix A)
- Procedures for reporting Data integrity and Ethics issues outlined in initial and ongoing annual training. Training slides are available in the Quality Documents folder on the Teklab server.

17.4 Investigations

All investigations resulting from data integrity issues are conducted confidentially. They are documented and notifications are made to clients who received any negatively affected data that did not meet the client's data quality requirements. Procedures for investigation are detailed below:

- Any Teklab personnel who learn of a non-compliance related incident through the reporting protocol should immediately inform a member of Teklab Management verbally or in writing.
- Any ethical matters discussed with management personnel will remain confidential within Teklab's management. In cases involving possible violations of the law or TNI regulations, Teklab may be required to reveal information to the proper authorities.
- Teklab management is responsible for determining the seriousness of the incident.
- Teklab's management team shall thoroughly investigate each incident and retain all evidence and records.
- Investigation Documentation Includes:
    - Date of investigative Report
    - Date Incident First Reported
    - Date of Incident Occurrence
    - Type of Issue / Incident
    - Full Description of Issue
    - Description of Investigation
    - Description of Resolution

Section 18 – PERSONNEL AND TRAINING

(TNI V1:M2 – Section 5.2)

Teklab Inc employs competent personnel based on education, training, experience and demonstrated skills as required. The laboratory's organization chart can be found in Appendix B.

18.1 Overview

All personnel are responsible for complying with all quality and data integrity policies and procedures that are relevant to their area of responsibility.

All personnel who are involved in activities related to sample analysis, evaluation of results or who sign test reports, must demonstrate competency in their area of responsibility. Appropriate supervision is given to any personnel in training and the trainer is accountable for the quality of the trainee's work. Personnel are qualified to perform the tasks they are responsible for based on education, training, experience and demonstrated skills as required for their area of responsibility.

The laboratory provides goals with respect to education, training and skills of laboratory staff. These goals are outlined in the 1031 SOP and the employee's job description. Training needs are identified at the time of employment and when personnel are moved to a new position or new responsibilities are added. Ongoing training, as needed, is also provided to personnel in their current jobs. The effectiveness of the training must be evaluated before the training is considered complete.

A log of names, initials, and signatures for all individuals who are responsible for signing or initialing any laboratory records is maintained and stored in hard copy by the Quality Training Officer.

18.2 Job Descriptions

Job descriptions are available for all positions that manage, perform, or verify work affecting data quality, and are located in each employee's electronic training file located on the Teklab Inc Server. These files are stored securely. An overview of top management's responsibilities is included in Section 3 – "Management".

18.3 Training

All personnel must perform a successful Initial Demonstration of Capability prior to initiation of assigned analysis (See SOP#1031 for IDOC and Certification Statement Requirements).

All new personnel are trained on their applicable analysis by an experienced Teklab employee. Additional training needs for each individual are determined through review of their resume and work experience and one on one interaction with the individual's supervisor and/or trainer. All personnel must successfully complete an IDOC prior to termination of training. Ongoing training is determined on a case by case basis by the individual's supervisor or a representative of the Quality Department. See SOP#1031 and Section 19 of this QA Manual for more information on IDOCs/ADOCs.

The Quality Department is responsible for tracking all initial introductory training. Department Supervisors are responsible for initiating, coordinating and monitoring on the job training for analysts within their department. Training records maintained by the Quality Department are stored securely on the Teklab Inc Server and include personnel qualifications, education, experience and training pursuant to the requirements set forth in sections 4, 5 and 19 of this Quality manual. Training files are considered up-to-date when the following items are present:

- Certification that the employee has completed initial safety and quality training.
- Documentation of Initial Demonstration of Capability (IDOC).
- Certification that the employee has read, understood, and is using the latest version of the laboratory's in-house quality documentation, which relates to their job responsibilities.
- Certification that the technician has read, understood and agreed to perform the most recent version of the approved standard operating procedure.
- Documentation of academic education and of training courses or workshops on specific equipment, analytical techniques, or laboratory procedures.
- Job description signed by the employee that includes an agreement that they are aware of their ethical and legal responsibilities and will avoid any conflict of interest.
- Documentation of Annual Demonstration of Capability (ADOC) on applicable methods.

18.3.1 Ethical/Legal Responsibilities and Conflict of Interest

Teklab is organized so that confidence in its independence of judgment and integrity are maintained at all times and has processes to ensure that its personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work. Teklab has a proactive program for prevention and detection of improper, unethical or illegal actions. See Appendix A for Teklab's Ethics and Data Integrity Policy and Section 17 for more on Data Integrity.

All new personnel are trained during orientation and all personnel are trained, at least annually, on data integrity, ethical behavior, legal responsibilities and conflict of interest. Each Teklab job description includes an agreement with the employee that they are aware of their ethical responsibilities and will avoid any conflict of interest. See also Teklab Inc. NELAP Policy Ethics, Legal Responsibility, & Conflict of Interest for policy discussed during training.

Teklab Inc's legally responsible parties are the signatories in Section 1 (Introduction and Scope) of the Quality Manual.

18.3.2 Training for New Staff

All new staff members are given introductory training and orientation upon arrival. The training is documented on a training attendance sheet that outlines what was covered during the training sessions.

Training topics include (but not limited to):

- Data Integrity training
- Safety training
- Quality training

Initial Laboratory Training:

- All documentation involved with a new and unfamiliar task is read and understood by the trainee. Reading forms are initial and dated by the employee confirming that they have read and understood the material.
- Training is under the direct supervision of a qualified analyst.
- During the time the analyst is in training, the trainee may sign laboratory notebooks, logbooks, worksheets, etc. But they must be co-signed by the trainer who is responsible for the data generated.
- The trainee demonstrates competency in the new task before they can operate independently. The competency for a test method is accomplished by a successful IDOC as defined in Section 19 of this Quality Manual.
- Training documentation is maintained in the employees training record, which is stored electronically on the Teklab Inc server.

18.3.3 Ongoing Training

The employee attests, through signature, that they have read, understood, and agree to perform the latest version of any SOPs or policies that the analyst is responsible for following:

- Annual refresher Data Integrity Training.
- Annually, the analyst shows continued proficiency in each method they perform (see Section 19 on IDOC s and ADOCs)
- Attending training related to job function as applicable.
- Maintaining training documentation in the employees training record.
- Monthly Safety training.
- Monthly Quality training.

18.3.4 Education/Experience

Job descriptions for all Teklab personnel are maintained by the quality department. Each employee must read and sign their job description upon hiring or changing positions within the laboratory. The signed job descriptions are placed in each employees training file.

18.3.4.1

The laboratory ownership shall designate at least one individual as the Technical Director (or however named). These persons shall also:

1. Hold a bachelor's degree in the chemical, environmental, biological sciences, physical sciences or engineering, with at least twenty-four (24) college semester credit hours in chemistry
2. Have at least two (2) years of experience in the environmental analysis of representative inorganic or organic analytes for which the laboratory seeks or maintains accreditation. A master's or doctoral degree in one of the above disciplines may be substituted for one (1) year of experience.
3. Have a general knowledge of the analytical methods for which data review is performed.

See the TNI Standard V1M2 Section 5.2.6.2 for a list of Technical Director qualification exceptions.

18.3.4.2

The laboratory ownership shall designate at least one individual as the Quality Manager and/or Quality Officer. These persons shall also:

1) Hold a bachelor's degree in chemistry or related sciences or have completed enough course work to equal a major in science; and/or
2) Have a minimum of one-year experience as an analyst in a laboratory and/or
3) Have documented training in quality assurance and quality control (QA/QC) and at least 3yrs of experience in a Quality Assurance setting
4) Where applicable, have functions independent from laboratory operations;
5) Have a general knowledge of the analytical methods for which data review is performed;
6) Be an employee of the laboratory, but free from outside or managerial influence, so that they may objectively perform assessments and evaluate data

18.3.4.3

The laboratory director and/or ownership shall designate at least one individual as LABORATORY SUPERVISOR. The laboratory supervisor(s) shall:

1) Hold a minimum of a bachelor's degree in chemistry or related sciences or have completed enough course work in chemistry to equal a major in chemistry, or;
2) Have had a minimum of five years' experience in the analyses pertaining to the applicable fields of testing

The laboratory ownership may designate a laboratory supervisor as Technical director (however named). The Laboratory director/supervisor must fulfill the requirements of sections 18.3.4.1 and 18.3.4.3 above.

18.3.4.4

The Technical Director or supervisors shall designate the ANALYSTS. Analysts shall:

1) Hold a bachelor's degree in chemistry or related sciences or have completed enough course work in chemistry to equal a major in chemistry; or
2) Have had a minimum of two years' experience in the analysis pertaining to the applicable fields of testing for which the laboratory is accredited; or
3) For those instruments listed in 18.3.4.6 below:

- A) either:
    - i) have satisfactorily completed a minimum of four hours training that is offered by the equipment manufacturer, a professional organization, a university or another qualified training facility; or
    - ii) served a two-week period of apprenticeship under an experienced analyst; and
- B) After appropriate training pursuant to subsection 18.3.4.5(3A), perform the Initial Demonstration of Capability (IDOC) study as specified in Section 19 of this Quality Manual and the TNI Standard - EL-V1M2 (See SOP1031 for IDOC procedure); and
- C) Have on file annual documentation indicating one of the following:
    - Acceptable performance on a blind sample,
    - Another Initial demonstration of capability (IDOC),
    - four consecutive in-control laboratory control samples,
    - a documented process of analyst review using quality control (QC) samples
    - a certification that the technician has read, understood and agreed to perform the most recent version of the method, the approved method or standard operating procedure.
    - Such documentation shall demonstrate that the required training is up-to-date.

4) Be an employee of the laboratory, contract employee, or contracted temporary agency staff; and

The Technical Director or supervisors may designate individuals as ANALYSTS-IN-TRAINING. Analysts-in-training must at least meet the requirements in subsection 18.3.4.4.1 or 18.3.4.4.2 and be in the process of meeting the requirements of subsection 18.3.4.4 (3a). A laboratory supervisor, analyst or data auditor shall review and verify all data produced by analysts-in-training.

18.3.4.5
Analyses performed utilizing Automated Colorimetric (AC), Gas Chromatograph (GC), Gas Chromatograph/Mass Spectrometer (GC-MS), Inductively Coupled Plasma (ICP), Inductively Coupled Plasma Mass Spectrometer (ICP-MS), are only acceptable for the purposes of this manual when performed by a laboratory employee who meets the requirements in subsection 18.3.4.4 above.

18.3.4.6
A TECHNICIAN is a person who holds a minimum of a high school diploma or its equivalent. Any exceptions to this must be noted in the technician's job description. A technician must:

1) either:
    - A) Have satisfactorily completed a minimum of four hours training that is offered by the equipment manufacturer, a professional organization, a university or qualified training facility; or
    - B) Served a two-week period of apprenticeship under an experienced analyst or technician;

2) After appropriate training pursuant to subsection 18.3.4.6(1), perform the Initial Demonstration of Capability (IDOC) study as specified in Section 19 of this Quality Manual and the TNI Standard - EL-V1M2 (See SOP1031 for IDOC procedure); and;
3) Have on file annual documentation indicating one of the following:
    - Acceptable performance on a blind sample,
    - another Initial Demonstration of Capability (IDOC),
    - four consecutive in-control laboratory control samples,
    - a documented process of analyst review using quality control (QC) samples
    - a certification that the technician has read, understood and agreed to perform the most recent version of the method, the approved method or standard operating procedure.

   Such documentation shall demonstrate that the required training is up-to-date.

18.3.4.7

A person may be allowed to serve in any capacity as defined in subsections 18.3.4.1 through 18.3.4.6 when the person does not meet the training, educational, or experience requirements for the position under one of the following conditions:

A) Experience as an offset for educational requirements (one year of experience performing the applicable duties equals one year of education);
B) Education as an offset for experience requirements (one year of applicable education beyond a bachelor's degree equals one year of experience);
C) For analysts and technicians, have six months' laboratory experience as offset for the training and apprenticeship requirements set forth in 18.3.4.4 or 18.3.4.6 as applicable. Laboratory experience must be in the analytical technique for which the offset is requested.
D) For analysts and technicians, demonstration of ability to properly perform representative test procedures.

Section 19 - IDOC & ADOC

(TNI V1:M4 – Section 1.6)

19.1 Initial Demonstration of Capability (IDOC)

The IDOC is a procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.

Before reporting any data with a given method, a satisfactory IDOC is performed. Thereafter, each analyst demonstrates continuing proficiency through the procedures outlined in Annual Demonstration of Capability below.

Each analyst performs an IDOC prior to initiation of assigned sample analysis, unless the IDOC is not applicable to the approved test method, such as total volatile solids, pH, color, odor, temperature, dissolved oxygen or turbidity. Thereafter, continuing demonstration of method performance is accomplished per the QCI for the method.

IDOC studies are repeated whenever there is a change in analyst, instrument type, or approved test method that requires a change to the procedure in the SOP.

In cases where an individual has prepared and/or analyzed samples using a method that has been in use by the laboratory for at least one (1) year prior to applying for accreditation, and there have been no significant changes in instrument type or method, the ongoing DOC shall be acceptable as an initial DOC.

Teklab documents the completion of each demonstration of capability on a certification statement form. IDOCs are stored in the Teklab LIMS, and documented in the Employee Training Database (on the Teklab server), and in the employee's electronic training files which are stored on the Teklab Inc Server. All records related to the demonstration are retained.

IDOCs (Demonstration of Capability) are performed:

- Before using any method
- Each time there is a change in instrument type or *method and
- If the laboratory or analysts has not performed the method in a twelve-month period.
- When an analyte not currently found on the laboratory's list of accredited analytes is added to an existing accredited method, an IDOC shall be performed for that analyte

*Changes in method are assessed by the Technical Director (or their designee) and the applicable laboratory Supervisor. Changed deemed as significant require an IDOC to be performed.

The IDOC(s) for each analyst is stored in the Teklab LIMS, and documented in the Employee Training Database, in the employee's electronic training file and on employee electronic Demonstration of Capability (DOC) Forms which are all stored on the Teklab Inc Server. The DOC identifies the analyst(s) involved in preparation and/or analysis; matrix; analyte(s), class of analyte(s); the method(s) performed; the laboratory-specific SOP used for analysis; and the date(s) of analysis. The LIMS and server copy of the IDOC also contain a summary of the results used to calculate the mean recovery and standard deviations.

All raw data, preparation records, and calculations for each IDOC are retained and are available for review.

IDOC procedures are outlined in SOP#1031 - IDOCs and ADOCs

Interim Data Generation
Data produced by analysts and instrument operators while in the process of obtaining the required training or experience is acceptable when reviewed and validated by a fully qualified analyst or the immediate supervisor.

19.2 Annual Demonstration of Capability (ADOC)

After the initial demonstration of capability is completed, on-going proficiency is maintained and demonstrated at least annually. Each analyst is expected to consistently meet the QC requirements of the method, the laboratory SOP, client requirements and/or the TNI Standard. ADOCs are documented in the Employee Training Database (by the Quality Department), and in the employee's electronic training files which are stored on the Teklab Inc Server. All records related to the demonstration are retained.

Teklab can use the following procedures to demonstrate ongoing DOC:

a) acceptable performance of a blind sample (single blind to the analyst);
   Note: Successful analysis of a blind performance sample on a similar method using the same technology (e.g., GC/MS volatiles by purge and trap for Methods 524.2, 624 or 5030/8260) would only require documentation for one of the tests.
b) another initial DOC;
c) at least four (4) consecutive laboratory control samples with acceptable levels of precision and accuracy. The laboratory shall determine the acceptable limits for precision and accuracy prior to analysis. The laboratory shall tabulate or be able to readily retrieve four (4) consecutive passing LCSs for each method for each analyst each year;
d) a documented process of analyst review using QC samples. QC samples can be reviewed to identify patterns for individuals or groups of analysts and determine if corrective action or retraining is necessary;
e) if a) through d) are not technically feasible, then analysis of real-world samples with results within a predefined acceptance criteria (as defined by the laboratory or method) shall be performed.

Section 20 - ACCOMODATIONS AND ENVIRONMENTAL CONDITIONS

(TNI V1:M2 – Section 5.3)

20.1 Environmental

Laboratory facilities, including but not limited to energy sources, lighting and environmental conditions, shall be such as to facilitate correct performance of the tests. The technical requirements for accommodation and environmental conditions that can affect the results of tests and calibrations shall be documented. Due attention shall be paid, for example, to biological sterility, dust, electromagnetic disturbances, radiation, humidity, electrical supply, temperature, and sound and vibration levels, as appropriate to the technical activities concerned. Tests and calibrations shall be stopped when the environmental conditions jeopardize the results of the tests.

Prior to the initiation of new work, the laboratory management reviews the work to ensure that it has the appropriate facilities and resources to accomplish the work. Management also provides adequate workspaces to ensure an unencumbered work area for performing the approved test methods.

The laboratory is designed, operated and arranged so that incompatible analyses are separated and the potential for sample contamination is minimized. Such environmental conditions include:

- The volatile organic laboratory has a separate ventilation system. Access to the volatile organic laboratory is limited to use only as necessary. Air volatile analysis is isolated at a separate facility located at the Teklab Air Laboratory.

- The microbiology lab has access restricted to only microbiology and quality assurance department personnel. All fecal coliform analyses are performed at a separate time from any other microbiology analysis, with proper disinfection of the area between analysis times.
- The laboratory has one exhaust hood for sample receipt, three for inorganic analysis, one for metals prep, and three for organic prep. Organic analysis also has three fume absorbers.

Environmental conditions are monitored as required by the relevant specifications, methods and procedures or where they influence the quality of the results. Tests are stopped and corrective actions are taken and documented when the environmental conditions jeopardize the results of environmental tests.

New laboratory facilities shall be designed, operated and arranged so that all of the specifications of this section are met.

20.2 Work Areas

Teklab's facilities are maintained to permit the production of analytical data that meets the data quality of objectives of the applicable environmental regulation. Areas that affect the quality of laboratory activities are defined as any area within the physical boundaries of the building, except for the restrooms, lunch room and all hallways.

Good housekeeping is stressed. Employees must keep work spaces, instrumentation, and equipment clean and unencumbered.

The laboratory procedure for good housekeeping includes such measures as
- A part-time janitor
- periodic dedicated clean up days
- employees responsible for cleanliness of their own work area

20.3 Floor Plan

Floor plans can be found in Appendix C of this QA Manual.

20.4 Building Security

Areas that affect the quality of laboratory activities are secure areas and access is limited to Teklab, Inc. employees, anyone else entering these areas must be escorted by a Teklab, Inc. employee. Access to the laboratory facilities, during non-business hours, is controlled through a monitored building alarm system. The parking lot is also under video surveillance.

Section 21 - ENVIRONMENTAL METHODS AND METHOD VALIDATION

(TNI V1:M2 – Section 5.4 and Sections 1.4 and 1.5 of TNI V1:M4)

Methods and/or procedures are available for all activities associated with the analysis of the sample including preparation and testing. For purposes of this Section, "method" refers to both the sample preparation and determinative methods. All methods are in accordance with applicable professional technical standards, U.S. & Illinois EPA requirements. Teklab uses only methods mandated by legal requirements, recognized published methods or methods developed and validated by Teklab. Methods are not used for reporting results until competence for each matrix is demonstrated. Personnel are not permitted to depart from approved procedures without the proper validations and approval of the Technical Director and/or the Quality Manager (or designee), and approval of the client.

All analytical methods performed at Teklab have internally written Standard Operating Procedures (SOPs) or are copies of published methods, with any changes or selected options documented. Methods are based on the applicable reference method or methods (i.e. SW846, EPA 600, Standard Methods, NIOSH, IDPH, etc.). The laboratory shall ensure that it uses the latest valid edition of a standard unless it is not appropriate or possible to do so. When necessary, the standard shall be supplemented with additional details to ensure consistent application

Before being put into use, a test method is confirmed by a method validation process.

21.1 Method Selection

The laboratory selects methods that are appropriate to the customer needs. When the regulatory authority mandates or promulgates methods for a specific purpose, only those methods will be used.

If a method proposed by a customer is considered to be inappropriate or out-of-date, the customer is informed and the issue resolved before proceeding with analysis of any samples (see Section 6 – Review of Requests, Tenders and Contracts). If a method is not specified by the customer, an appropriate method will be selected using the process outlined below:

When a method is not specified by the customer, or the proposed method is inappropriate, the laboratory will select a method that is appropriate to the end use of the data. The laboratory selects methods that are appropriate to the customer needs. The customer will be informed of the selected method and must approve its use before being used to report data. When the regulatory authority mandates or promulgates methods for a specific purpose, only those methods will be used (see Section 6 – Review of Requests, Tenders and Contracts).

If there is not a regulatory requirement for the parameter/method combination, the parameter/method combination need not be validated as a non-reference method if it can be analyzed by another similar reference method of the same matrix and technology. (TNI V1 M4 1.4 - Method Selection)

21.2 Method Validation

Method Validation (MV) studies are used to verify the analytical procedure at different concentrations. An MV study is performed for each new analysis or test method and whenever a modification in methodology occurs that could affect the quantitation range of the analysis. MV studies include the determination of the following:

- Method detection limit – The method detection limit (MDL) is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results This number is used in LIMS and appears on final reports. The MDL is used to accommodate variances in multiple instrument MDL determinations and to minimize ongoing adjustments to the reporting limits.

- MDL_s - The method detection limit based on spiked samples

- MDL_b - The MDL based on method blanks

- PQL (practical quantitation limit) – The lowest level or concentration of an analyte that can be reported with a specific degree of confidence. For test methods utilizing a calibration curve, the PQL is equivalent to the lowest calibration standard. The PQL must be greater than the MDL and no greater than ten times the MDL. If regulatory limits are provided by the client, the PQL must be equal to or less than these.

- RL (Reporting Limit) – The PQL multiplied by any dilution or preparation factors. The RL appears on the final report. If a CRQL (client requested quantitation limit) exists for the sample and is greater than the final RL, the RL can be replaced with the CRQL at the client's request.

- MV (Method Validation Study) – The initial test method and/or instrument requirements of TNI and/or the referenced test method to validate that the laboratory is capable of achieving the required qualitative and quantitative detection and the required precision and accuracy of the method

See SOP 1030 'Method Detection Limits & Method Validation Studies' for detailed procedures on MDLs.

Selectivity

Selectivity is evaluated by following the checks established within each method. Examples are mass spectral tuning, second column confirmation, ICP inter-element interference checks, chromatograph retention time windows, instrument blanks, spectrochemical absorption or fluorescence profiles, co-precipitation evaluations, electrode response factors, and correlation coefficients. The acceptance criteria for mass spectral tuning is documented in the appropriate method SOP.

21.3 Estimation of Uncertainty of Measurement

Estimation and uncertainty of measurement are provided to clients upon request.

- If the standardized test method contains guidance to the uncertainty of evaluation, the method guidance is used for determination.

- If the standardized test method gives a typical uncertainty of measurement for test results this figure is quoted, provided there was full compliance with the test method in the performance of the test.

- If a standardized method implicitly includes the uncertainty of measurement in the test results, the results are reported accordingly.

Otherwise the estimation of uncertainty of measurement will be reported as follows:

> The confidence interval for the test method determined from the standard deviation of Laboratory Control samples or QC samples utilized by the laboratory in determining batch acceptance for the test method will be provided with the data as a statement of uncertainty of measurement. If the sample measurement is near the reporting limit or detectable limit, additional information will be given on the variability of low level data. A statement of sample homogeneity will also be included, as well as any other sample related factors that may have led to uncertainty of measurement.

In cases where the test method precludes rigorous, metrologically and statistically valid calculation of uncertainty of measurement, all the components of uncertainty of measurement are identified, a reasonable estimation on uncertainty is made, and the result is reported with explanation on the uncertainty.

21.4 Control Charts

Control charts are used to monitor the accuracy and precision of the procedures used at Teklab. They are used to determine what types of bias, if any, are occurring in analysis and to determine when an analysis or procedure is out of control.

PRECISION CONTROL CHARTS:
The precision control chart checks the duplicity of our methodologies. It uses the relative percent difference (RPD) between duplicate analyses.

ACCURACY CONTROL CHARTS:
The accuracy control chart checks the percent recovery of our methodologies. These check the percent recovery from LCSs and MSRs (Matrix Spike recoveries). This control chart cannot be made until at least twenty observations are made using samples of a known concentration. The Shewhart X-bar type chart is used for this measurement. The center line is the mean %R, the UWL and LWL (Upper and Lower Warning Limits) are calculated and plotted at +/- 2*sd; this represents a limit within which 95% of all subsequent %R calculations should fall, to ensure that the analysis/methodology is under control. The UCL and LCL (Upper and Lower Control Limits) are +/- 3*sd; this represents a limit within which 99% of all subsequent %R calculations should fall to ensure that the analysis/methodology is under control.

FREQUENCY AND CONSTRUCTION OF CONTROL CHARTS:
Data for accuracy and precision control charts will be updated continuously via the LIMS. The need to monitor a control chart for a particular analysis will be evident to the department supervisor if the quality control indicators for the test are not falling around the mean of the upper and lower control limits for the test. Data used to create control chart limits must be thoroughly reviewed for obvious outliers before inclusion in the control chart data set. Laboratory control limits for accuracy and precision will be updated as needed, with approval from the Technical Director.

INTERPRETATION OF CONTROL CHARTS:
The control charts are used to trend results and look for problems or bias in the way an analysis is run. If a condition exists which indicates an out of control process or process bias, as defined by typical analysis of Shewhart control charts (example: Seven points on same side of an X-bar chart or a point above or below the UCL or LCL), a significant event will have occurred. In that event, the Quality Manager, Technical Director and any needed technicians or analysts will direct an investigation to determine the cause or causes of the event and corrective action shall be implemented. After determination of a significant event, the applicable control charts will be updated with every new data point until the analysis is once again in control. A minimum of 10 data points will be plotted before the analysis can be said to be in control, once again.

21.5 Control of Data

To ensure that data are protected from inadvertent changes or unintentional destruction, the laboratory uses procedures to check calculations and data transfers (both manual and automated). See Section 5 – Control of Records for more information.

Note: Employees should not save important documents to the C Drive of their PCs, as information may be lost if the computer's hard drive fails. Documents should either be saved to designated folders on the F Drive or user-defined U Drives; both of which are located on the Teklab Server.

21.5.1 Computer and Electronic Data Requirements

The laboratory assures that computers, user-developed computer software, and automated equipment used for the acquisition, processing, recording, reporting, storage, or retrieval of environmental test data are:

- documented in sufficient detail and validated as being adequate for use;
- protected for integrity and confidentiality of data entry or collection, data storage, data transmission and data processing;
- maintained to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of environmental test data; and
- held secure including the prevention of unauthorized access to, and the unauthorized amendment of, computer records. Data archive security is addressed in Section 5 “Control of Records” and building security is addressed in Section 20 “Accommodations and Environmental Conditions”.

Computers and instrumentation are tracked via a database that contains information such as the PC/instrument name, operating system and associated software. Purchased Microsoft Office open licenses are also tracked in the database. The database is stored securely in the IT folder on the Teklab Server.

21.5.2 Data Reduction

The analyst calculates final results from raw data or appropriate computer programs provide the results in a reportable format. The test methods or SOPs provide required concentration units, calculation formulas and any other information required to obtain final analytical results.

The laboratory has manual integration procedures that must be followed when integrating peaks during data reduction. See SOP4026 Manual Integrations.

Data is collected and reported by analysts after completion of a run of analysis in which all Quality control parameters are within the specified limits.

Calculations used to determine concentrations of the analytes for each parameter are included or referenced in each SOP. The calculations involve calibration factors that relate a known concentration to a measured concentration. The units are based on the calibration concentrations that are also defined in each SOP. Raw data and final results are recorded in the analysis logsheet (by the analyst), or the original printed data package from the instrument is retained. The raw results and corresponding quality control results are downloaded or manually entered into the Laboratory Information System (LIMS). The lab supervisor or other data validator reviews the calculated results, ensures that the data is free from transcription and calculation errors and checks the corresponding quality control information (ICB, ICV, CCBs, CCVs, MS/MSDs and RSD/RPD results). If the quality control information is within specified limits and the calculations are correct, the lab supervisor or other data validator validates the records in the LIMS. See the applicable SOP (1020, 1270, 1280 and 1290) for identification of individuals responsible for assessing each QC data type.

Data for pH, temperature, Dissolved Oxygen, Turbidity, ORP and conductivity is read directly from the instrument. All other data must be calculated manually to some degree. It is the responsibility of the analyst to convert raw data into reportable values and the lab supervisor or other data validator to ensure calculations are correct and that quality control checks are within specified limits.

All analysis has its own individual data packet to record analysis, unless computer generated reports are deemed acceptable by the Quality Manager and/or Technical Director. See SOP 1291 Record Retention and Access. Data packets and/or computer-generated reports are maintained by the analysts responsible for performing the analysis and kept in the appropriate area of the laboratory. The data packet contains a cover sheet and a data sheet or sheets to record reagent and standard solution lot numbers. The data packets also contain information on any cleanup or separation procedure, sample ID codes, volumes and weights, if applicable. Problems noted during analysis are documented on the cover sheet of the data packet or computer generated report.

All raw data must be either retained in hard copy format and/or scanned to PDF and is maintained as described in Section 5 “Control of Records”.

21.5.3 Data Review Procedures

Data review procedures are located in Section 26.4 – “Data Review”.

Section 22 - CALIBRATION REQUIREMENTS: Equipment and Instruments

(Section 5.5 of TNI V1:M2 and 1.7.1 of TNI V1:M4)

22.1 General Equipment Requirements

Any equipment procured in the support of tests must be of adequate quality to sustain confidence in the laboratory’s tests, as specified by the SOP for each analytical method. Laboratory supervisors are responsible for informing the quality department of new equipment procurements and creating a maintenance log on the LIMS system. Where no independent assurance of the quality of the equipment is available, the equipment must be shown to produce acceptable results for the test method, within quality control limits of the test, before onset of sample analysis.

See General Equipment Maintenance SOP1210 for details on performance and documentation of equipment maintenance, inspection and cleaning. Manuals provided by the manufacturer of the equipment provide information on use, maintenance, safe handling and storage of the equipment. Any item of equipment subjected to overloading or mishandling which gives questionable results, or has been shown by verification or otherwise to be defective, shall be taken out of service. That equipment shall be clearly identified with a sign stating “OUT OF SERVICE” and wherever possible, stored in the rear storage area until it has been repaired and shown by calibration, verification or test to perform satisfactorily. The laboratory shall examine the effect of this defect on previous calibrations or tests. If it is shown that previous tests are affected, then procedures for nonconforming work are followed and results are documented (see Section 11 – “Control of Nonconforming Environmental Testing Work” and Section 13 – “Corrective Action”). The laboratory shall maintain documentation of all maintenance, calibration and instrument operation activities.

Proper instrument maintenance is essential to the success of any analytical laboratory. Teklab’s policy is to include instrument troubleshooting and maintenance as standard training for its analysts. Analysts gain a more thorough understanding of the analytical methodology and produce higher quality analytical results when they are capable of solving problems associated with instrument operation. Teklab employs service agreements and/or onsite/offsite service support to supplement our maintenance program whenever the analytical instrumentation requires expertise beyond our capabilities or safety concerns dictate the use of individuals with specialized training.

All instruments must be clearly labeled with unique identification (e.g. Milestone MPR-600/6S, Microwave 1).

Equipment is operated only by authorized and trained personnel (see Section 18 – “Personnel”).

Test equipment, including hardware and software, are safeguarded from adjustments that would invalidate the test result measurements by limiting access to the equipment and using password protection where possible (see Sections 21.6 – "Control of Data" and 5.2 "Records Management and Storage").

Each item of equipment and software used for testing and significant to the results is uniquely identified. Records of equipment and software are maintained and include the following:

a) identity of the equipment and its software;

b) manufacturer's name, type identification, serial number or other unique identifier;

c) checks that equipment complies with specifications of applicable tests;

d) current location;

e) manufacturer's instructions, if available, or a reference to their location;

f) dates, results and copies of reports and certificates of all calibrations, adjustments, acceptance criteria, and the due date of next calibration;

g) maintenance carried out to date; documentation on all routine and non-routine maintenance activities and reference material verifications;

h) any damage, malfunction, modification or repair to the equipment;

See Section Appendix F for a current list of Teklab equipment.

The laboratory documents and maintains records, whether hard copy or electronic, of instrument and equipment calibrations, including at a minimum:

- Calibration procedures, calibration frequency, calibration acceptance criteria;
- Procedures to label all calibration curves, including the date, approved test method, analyte, standard concentrations, and instrument response; and
- Procedures to label the axes of the calibration curve.

For electronic data processing systems, which automatically compute the calibration curve, the system records the equation for the curve and correlation coefficient. Laboratory personnel record correlation coefficient when the calibration curve is prepared manually.

See Section 5 of this manual for more information on Control of Records.

22.2 Support Equipment

The laboratory has equipment that is applicable to its accreditation.

Support Equipment includes, but is not limited to: balances, ovens, refrigerators, freezers, incubators, temperature measuring devices, and volumetric dispensing devices.

Before being placed into service, support equipment shall be calibrated or checked to establish that it meets the laboratory's specification requirements and complies with the relevant standard specifications. All support equipment is maintained in proper working order. Records are kept for all repair and maintenance activities, including service calls. Balances are calibrated annually by a member of the Quality Department. Records of calibrations are stored in the Quality Folder on the Teklab server.

All raw data records, where applicable, are retained to document equipment performance. These records include logbooks, data sheets, or equipment computer.

See SOP1210 for more information.

22.2.1 Support Equipment Maintenance

Regular maintenance of support equipment, such as balances is conducted at least annually. Maintenance on other support equipment, such as ovens, refrigerators, and thermometers is conducted on an as needed basis.

Records of maintenance to support equipment are documented in Instrument Maintenance Logs located in the LIMS or hard copy maintenance logbooks.

22.2.2 Support Equipment Calibration

Relevant SOPs:
SOP 1180 - Balance use, maintenance and calibration
SOP 1190 - Auto Pipet and Syringe use, maintenance and calibration
SOP 1200 - Dessicant maintenance
SOP 1210 - General Equipment Maintenance
SOP 1220 - Thermometer use, maintenance and calibration.
SOP 1230 - Refrigerator and freezer use, maintenance and calibration.
SOP 1240 - Oven use, maintenance and calibration.

All support equipment is calibrated or verified at least annually over the entire range of use using a National Metrology Institute traceable reference, such as NIST, when available. Note: If the temperature measuring device is used over a range of 10°C or less, then a single point verification within the range of use is acceptable.

The results the calibration of support equipment is within specifications, otherwise:

- equipment is removed from service until repaired
- records are maintained of correction factors to correct all measurements. If correction factors are used this information is clearly marked on or near the equipment.

Support equipment such as balances, ovens, refrigerators, freezers, and water baths are verified with a recognized National Metrology Institute traceable reference, such as NIST, when available, on each day of use, to ensure operation is within the expected range for the application for which the equipment is to be used. Acceptance criteria can be found in the applicable calibration SOP.

The laboratory identifies each refrigerator, freezer, thermometer, oven, and incubator in a way that establishes their use and distinguishes them from other similar equipment in the laboratory.

> Volumetric dispensing devices (except Class A glassware and Glass microliter syringes) are checked for accuracy on a quarterly basis.
>
> The laboratory checks the calibration of infra-red thermometers at least quarterly against a recognized National Metrology Institute traceable reference thermometer, such as NIST, when available. The comparisons are made at the temperature at which the thermometer will be used.
>
> The laboratory shall monitor and control method specific temperature requirements for incubators, heating blocks and water baths each day of use. The laboratory maintains documentation of the results.
>
> The calibration temperatures of laboratory hot blocks used for digestion are checked at least annually and after repairs. When digital readout is in units other than temperature, correlation of the digital readout to the temperature required for the test is documented. Temperature or digital readout is documented each day of use.
>
> Laboratory personnel calibrate turbidimeters on a daily basis or before each use, whichever is less frequent, pursuant to section 5.2.1 of “Manual for the Certification of Laboratories Analyzing Drinking Water”.

See applicable calibration SOPs for more information. See Sections 4 “Document Control” and 5 “Record Control” for details regarding documentation.

A pH meter having the accuracy of at least +/- 0.05 pH units and a scale readability of at least 0.01 pH units must be used for pH analysis.

A conductivity meter with an error not exceeding 1% or one µmhos/cm, whichever is greater, must be used by the laboratory.

All glassware used for purposes that may subject it to damage from heat or chemicals shall be of borosilicate glass. All volumetric glassware used for standard preparation shall be ASTM class A.

Teklab uses Class S or NVLAP approved certified weights to calibrate balances. The laboratory re-certifies its reference weights at least once every five years. Other laboratory weights are calibrated annually by a member of the Quality Department. Records of the calibrations are stored in the Quality Folder on the Teklab Server.

The laboratory ensures that the reference thermometer is calibrated at least once every five years.

22.3 Analytical Equipment

22.3.1 Maintenance for Analytical Equipment

All equipment is properly maintained, inspected, and cleaned.
Maintenance of analytical instruments and other equipment may include regularly scheduled preventive maintenance or maintenance on an as-needed basis. Instrument malfunction is documented in the LIMS, which become part of the laboratory's permanent records.

22.4 Instrument Calibration

Initial instrument calibration and continuing instrument calibration verification are an important part of ensuring data of known and documented quality. Calibration requirements are included in laboratory SOPs. Generally, procedures and criteria regarding instrument calibrations are provided or referenced in the individual SOPs.

If more stringent standards or requirements are included in a mandated method or by regulation, the laboratory shall demonstrate that such requirements are met. If it is not apparent which Standard is more stringent, then the requirements of the regulation or mandated method are to be followed.

Section 22.2.2 includes information on calibration of support equipment. The following Section covers calibration of analytical equipment.

22.4.1 Initial Calibration

Samples shall be associated with an acceptable initial calibration. If the initial calibration is not acceptable, corrective actions shall be performed and all associated samples re-analyzed. If reanalysis of the samples is not possible, data associated with an unacceptable initial calibration shall only be reported with appropriate data qualifiers.

The details of the initial calibration procedures including calculations, integrations, acceptance criteria, and associated statistics shall be included or referenced in the method or department SOP. When initial calibration procedures are referenced in the test method, then the referenced material shall be retained by the laboratory and be available for review.

Sufficient raw data records shall be retained to permit reconstruction of the initial calibration (e.g., calibration date, method, instrument, analysis date, each analyte name, and analyst's initials or signature; concentration and response, calibration curve or response factor; or unique equation or coefficient used to reduce instrument responses to concentration).

The laboratory shall use the most recent initial calibration analyzed prior to the analytical batch, unless otherwise specified by the method.

Standards used for calibration shall be traceable to a national standard, when commercially available.

The laboratory shall have a written procedure addressing removal and replacement of calibration standards. The procedure shall comply with the following requirements:

a. The laboratory may remove individual analyte calibration levels from the lowest and/or highest levels of the curve. Multiple levels may be removed, but removal of interior levels is not permitted.

b. The laboratory may remove an entire single standard calibration level from the interior of the calibration curve when the instrument response demonstrates that the standard was not properly introduced to the instrument, or an incorrect standard was analyzed. A laboratory that chooses to remove a calibration standard from the interior of the calibration shall remove that particular standard calibration level for all analytes. Removal of calibration points from the interior of the curve is not to be used to compensate for lack of maintenance or repair to the instrument.

c. The laboratory shall adjust the PQL/reporting limit and quantitation range of the calibration based on the concentration of the remaining high and low calibration standards.

d. The laboratory shall ensure that the remaining initial calibration standards are sufficient to meet the minimum requirements for number of initial calibration points as mandated in Table 1 below, the method, or regulatory requirements.

e. The laboratory may replace a calibration standard provided that:

    i. the laboratory analyzes the replacement standard within twenty-four hours of the original calibration standard analysis for that particular calibration level;

    ii. the laboratory replaces all analytes of the replacement calibration standard if a standard within the interior of the calibration is replaced; and

    iii. the laboratory limits the replacement of calibration standards to one calibration standard concentration.

f. The laboratory shall document a technically valid reason for either removal or replacement of any interior calibration point.

For regression or average response/calibration factor calibrations, the minimum number of non-zero calibration standards shall be as specified in table 1 below;

Table 1:

Type of Calibration	Minimum Number of Standards **
Threshold Testing *	1
Average Response	4
Linear Fit	5
Quadratic Fit	6

* *The initial one-point calibration shall be at the project-specified threshold level.*

** *Fewer calibration standards may be used only if equipment firmware or software cannot accommodate the specified number of standards. Documentation detailing that limitation shall be maintained by the laboratory.*

The lowest calibration standard shall be at or below the lowest concentration for which quantitative data are to be reported without qualification. The highest calibration standard shall be at or above the highest concentration for which quantitative data are to be reported without qualification.

Sample results shall be quantitated from the initial calibration and may not be quantitated from any continuing calibration verification unless otherwise required by regulation, method, or program.

Criteria for the acceptance of an initial calibration shall be established (e.g., correlation coefficient or relative standard deviation).

When test procedures are employed that specify calibration with a single calibration standard and a zero point (blank or zero, however specified by the method), the following shall occur:

a. The zero point and single calibration standard within the linear range shall be analyzed at least daily and used to establish the slope of the calibration.

b. To verify adequate sensitivity a standard shall be analyzed at or below the lowest concentration for which quantitative data are to be reported without qualification. This standard shall be analyzed prior to sample analysis with each calibration and shall meet the quantitation limit criteria established by the method. If no criteria exist, the laboratory shall specify criteria in the SOP.

For analysis of Aroclors which use a linear through origin model (or average response factor) the minimum requirement is to perform an initial multi-point calibration for a subset of Aroclors (e.g., a mixture of 1016/1260) and to use a one-point initial calibration to determine the calibration factor and pattern recognition for the remaining Aroclors.

22.4.2 Measure of Relative Error:

The laboratory shall use and document a measure of relative error in the calibration.

For calibrations evaluated using an average response factor, the determination of the relative standard deviation (RSD) is the measure of the relative error.

For calibrations evaluated using correlation coefficient or coefficient of determination, the laboratory shall evaluate relative error by either:

a. measurement of the Relative Error (%RE)

Relative error is calculated using the following equation:

$$\textbf{\% Relative Error} = \frac{X'_i - X_i}{X_i} \times 100$$

xi = True value for the calibration standard
x'i = Measured concentration of the calibration standard

This calculation shall be performed for 2 calibration levels: the standard at or near the mid-point of the initial calibration and the standard at the lowest level.

The Relative Error at both of these levels shall meet the criteria specified in the method. If no criterion for the lowest calibration level is specified in the method, the criterion and the procedure for deriving the criterion shall be specified in the laboratory SOP; or,

b. measurement of the Relative Standard Error (%RSE)

Relative Standard Error is calculated using the following equation:

$$\textbf{\% RSE} = 100 \times \sqrt{\sum_{i=1}^{N} \left[\frac{X'_i - X_i}{X_i} \right]^2 \Big/ (n - p)}$$

xi = True value of the calibration level i
x'i = Measured concentration of calibration level i
p = Number of terms in the fitting equation
(average = 1, linear = 2, quadratic = 3)
n = Number of calibration points

The RSE shall meet the criterion specified in the method. If no criterion is specified in the method, the maximum allowable RSE shall be numerically identical to the requirement for RSD in the method. If there is no specification for RSE or RSD in the method, then the RSE shall be specified in the laboratory SOP.

22.4.3 <u>Initial Calibration Verification (ICV)</u>:

All initial calibrations shall be verified with a standard obtained from a second manufacturer or a separate lot prepared independently by the same manufacturer.

For those methods where reporting non-detected analytes based on successful completion of a sensitivity check is allowed (similar to threshold testing but only for non-detects) the requirements of section 22.4 shall not prohibit the practice.

Some methods allow data within the linear range of the instrument, but above the daily calibration, to be reported without qualification. For these methods, the laboratory shall establish the upper reporting limit through analysis of a series of standards. The upper reporting limit is equal to the concentration of the highest standard meeting the method limits for accuracy. The laboratory shall establish linearity annually and check it at least quarterly with a standard at the top of the linear working range, or at the frequency defined by the method. The laboratory shall dilute samples with results above the linear calibration range, or qualify the over-range results as estimated values.

22.4.4 Continuing Calibration Verification (CCV):

The validity of the initial calibration shall be verified prior to sample analyses by a continuing calibration verification with each analytical batch. The details of the continuing calibration procedure, calculations and associated statistics shall be included or referenced in the method SOP.

Calibration shall be verified for each compound, element, or other discrete chemical species, except for multi-component analytes such as Aroclors, chlordane, total petroleum hydrocarbons, or toxaphene, where a representative chemical, related substance or mixture can be used.

The concentration of the calibration verification standard shall be equal to or less than half the highest level in the calibration.

Instrument continuing calibration verification shall be performed at the beginning and end of each analytical batch, and at the frequency defined in the method except:

a. If an internal standard is used, calibration verification shall be performed at the beginning of each analytical batch, and at the frequency defined in the method;

b. A second source ICV that passes the CCV criteria may be used in place of a CCV standard;

c. A laboratory control sample (LCS) may be used in place of a CCV (but not as a replacement for a failing CCV) for methods where the calibration goes through the same process as the LCS (using the CCV acceptance criteria).

Sufficient raw data records shall be retained to permit reconstruction of the continuing instrument calibration verification (e.g., method, instrument, analysis date, each analyte name, concentration and response, calibration curve or response factor, or unique equations or coefficients used to convert instrument responses into concentrations). Continuing calibration verification records shall explicitly connect the continuing calibration verification data to the initial calibration.

Criteria for the acceptance of a continuing instrument calibration verification shall be established. If the continuing instrument calibration verification results obtained are outside the established acceptance criteria, the following steps shall be taken:

a. If a cause for the calibration verification failure is identified that impacts *only* the calibration verification sample (e.g. a missed autosampler injection), then analysis may proceed if a second calibration verification sample is analyzed immediately and the result is within acceptance criteria. Samples analyzed previously shall be considered valid if bracketed by a passing calibration verification sample. The cause for the failure of the first calibration verification result shall be documented.

b. If the cause for the calibration verification failure is not identifiable or has impacted other samples, then corrective action shall be performed and documented. Prior to analyzing samples, the laboratory shall demonstrate acceptable performance after corrective action with calibration verification or a new initial calibration shall be performed. Samples analyzed prior to the calibration verification failure shall be reanalyzed or the results qualified if calibration verification bracketing is required.

c. Data associated with an unacceptable calibration verification shall be qualified if reported, and shall not be reported if prohibited by the client, a regulatory program or regulation. Data associated with calibration verifications that fail under the following special conditions shall still be qualified, but may use a different qualifier:

   i. When the acceptance criteria for the continuing calibration verification are exceeded high (i.e., high bias) and there are associated samples that are nondetects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be re-analyzed after a new calibration curve has been established, evaluated and accepted; or

   ii. When the acceptance criteria for the continuing calibration verification are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise the samples affected by the unacceptable verification shall be re-analyzed after a new calibration curve has been established, evaluated and accepted.

Section 23 – Standards and Reagents

(TNI V1:M2 – Section 5.6)

Measurement quality assurance comes in part from traceability of standards to certified materials.

All equipment used that may affect the quality of test results are calibrated prior to being put into service and on a continuing basis (see Section 22 “Calibration Requirements”). These calibrations are traceable to national standards of measurement where available.

If traceability of measurements to SI units is not possible or not relevant, evidence for correlation of results through interlaboratory comparisons, proficiency testing, or independent analysis is provided.

23.1 Reference Standards

Reference standards are standards of the highest quality available at a given location, from which measurements are derived (e.g. ASTM Class 1 weights, recognized National Metrology Institute traceable reference thermometers).

Reference Standards, such as ASTM Class 1 weights, are used for calibration only and for no other purpose. Reference standards, such as ASTM Class 1 weights, are calibrated by an entity that can provide traceability to national or international standards. The following reference standards are sent out to be calibrated to a national standard as indicated in Section 22 – “Calibration Requirements”

23.2 Standards and Reagents

Reference materials, where commercially available, are traceable to national standards of measurement, or to Certified Reference Materials, usually by a Certificate of Analysis.

Upon receipt, all reagents and standards shall be inspected, receipt dated, initialed, the lot number shall be recorded and an expiration date shall be assigned. No reagents or standards shall be used beyond their expiration date without verification of their continued validity.

The laboratory shall retain records for all standards, reagents, reference materials, and media, including the manufacturer/vendor, the manufacturer’s Certificate of Analysis or purity (if available), the date of receipt, and recommended storage conditions.

All reagents and standards shall be of adequate quality to sustain confidence in the laboratory’s test, as specified by the SOP for each analytical method. Laboratory supervisors are responsible for scanning and linking all Certificates of Analysis of standards into Teklab LIMS. Where no independent assurance of the quality of reagents or standards is available, the standard or reagent must be shown to produce acceptable results for the test method, within quality control limits of the test, before onset of sample analysis. See SOP1250 “Reagents and Standards” for more information.

23.3 Transport and Storage

The laboratory handles and transports reference standards and materials in a manner that protects the integrity of the materials. Reference standard and material integrity is protected by separation from incompatible materials and/or minimizing exposure to degrading environments or materials.

Reference standards and materials are stored according to manufacturer’s recommendations, method SOP requirements and separately from samples.

23.4 Labeling

The laboratory has procedures for purchase, receipt and storage of standards, reagents and reference materials. Purchase procedures are described in Section 7 – “Purchasing Services and Supplies”.

All containers of prepared standards and reagents are labeled with a unique identification number (using the LIMS identification system) and an expiration date (where applicable). This information is documented in the LIMS and all records retained.

23.4.1 Stock Standards and Reagents

The laboratory retains records supplied by the manufacturer/vendor, which include the manufacturers’ Certificate of Analysis or purity for standards, the date of receipt, recommended storage conditions and an *expiration date after which the material shall not be used unless its reliability is verified by the laboratory. These documents are retained for the same length of time as that required for the retention of documentation associated with the analytical results for which the standards or reagents were used.

If reference materials cannot be purchased with a Certificate of Analysis, the laboratory produces evidence of correlation of results through the analysis of a sample of known concentration which is traceable to national standards (proficiency testing), independent analysis or use of a suitable interlaboratory comparison.

Records shall include:

- the manufacturer/vendor name (or traceability to purchased stocks or neat compounds)
- the manufacturer’s Certificate of Analysis or purity (if supplied)
- the date of receipt
- recommended storage conditions

This information is logged into the applicable section of the LIMS. Certificates of Analysis for Standards are scanned and linked to the LIMS by the applicable department or a member of the quality department.

In methods where the purity of reagents is not specified, analytical reagent grade is used. If the purity is specified, that is the minimum acceptable grade**.** Purity is verified and documented according to Section 7 – “Purchasing Services and Supplies”.
*If the original container does not have an expiration date provided by the manufacturer or vendor, it is not required to be labeled with an expiration date.

23.4.2 Prepared Standards and Reagents

Preparation of standard solutions are documented to include; date of preparation, expiration date (expiration of the standard shall not exceed the preparation date of the parent standard or stock solution, unless reliability is verified by the laboratory), concentration of the parent standard or stock solution, concentration of standard working solution and the initials of the person preparing the solution. All standard solutions are prepared using class A or equivalent glassware and analytical balances. Standard concentrations (or a dilution thereof) are checked using an independent reference standard.

Reagent purity is checked through the use of Laboratory Control Blanks. Any contamination discovered in a reagent will be noted and that lot of reagent shall not be used.

The laboratory documents and maintains records concerning the receipt, use and traceability of analytical reagents and standards, including at a minimum:

- Verification of standards traceable to national standards. If traceability to a national standard is not possible, the lab demonstrates by appropriate means (e.g. analyses of PT samples) that the instrumentation/equipment is properly calibrated;
- Certificate of the origin, purity and traceability of all standards. These records include the date of receipt, storage conditions, and the date of opening.
- Procedures to ensure the traceability of working and intermediate standards to purchased stock standards or neat compounds which include the date of preparation and preparer's initials; and
- Procedures to clearly identify all prepared reagents and standards, including preparation date, concentrations, and preparer's initials;

See Section 5 of this Quality Manual for more information on control of records.

Section 24 - COLLECTION OF SAMPLES

(TNI V1:M2 – Section 5.7)

Regardless of the laboratory's level of control over sampling activities, all the requirements of this section are essential to ensure sample integrity and valid data and shall be followed by the laboratory. Sampling performed by Teklab, Inc. is governed by SOP 1150. Field sampling and any laboratory sub-sampling necessary to obtain sample aliquots for testing are covered in SOP 1150.

24.1 Sampling Containers and Kits

The laboratory offers clean sampling containers and kits for use by clients.
See the following Teklab SOPs for more information:
1081 Sample Kit Preparation
1083 5035 Sampling Kit Preparation
1090 Landfill Sample Bottles

24.2 Sampling Plan

The laboratory uses sampling plans provided by clients or prepared in consultation with the client. The plan must include any factors that must be controlled to ensure the validity of the test. Sampling plans and written sampling procedures are used for sampling substances, materials or products for testing. The plan and procedures are made available at the sampling location.

The laboratory's procedures for dealing with non-conformances are used when the client requests any deviations from the sampling plan or sampling procedures. The requests are documented and included in the final test report.

See the following Teklab SOPs for more information:
1150 Sampling Instructions
1151 Groundwater Sampling

Section 25 – Sample Receipt and Storage

(TNI V1:M2 – Section 5.8 and Section 1.7.4 of TNI V1:M4)

This section applies to samples received by Teklab and will be used to guide clients in sampling requirements specified in the "Federal Register, 40 CFR Part 136, Table II". Teklab does not reuse sample containers at this time except for air. See SOP 6000 SiloniteTM canisters for cleaning procedures for air containers.

25.1 Sample Receipt

When samples are received at the laboratory, the chain-of-custody is reviewed, the condition is documented, samples are given unique identifiers, and they are logged into the sample tracking system.

25.1.1 Chain of Custody

A customer service specialist or their designated representative indicates receipt of samples by signing the accompanying custody form. The supervisor or project manager reviews the signed form. The original signed custody form becomes part of the final data package that is reported to the client. The laboratory scans and files a copy of the signed custody form along with the final report as a permanent record of the sample receipt.

25.1.2 Legal/Evidentiary Chain of Custody

The laboratory has procedures for legal chain of custody services. If samples are noted as being used for legal/evidentiary purposes, special chain of custody procedures are put into place by the laboratory. See SOP1065 "Legal or Evidentiary Custody" for more information.

25.2 Sample Acceptance

Procedures for opening shipping containers and examining samples are provided in SOPs 1110 “Sample Pickup and Delivery” and 1070 “Sample Acceptance”.

Teklab has a sample acceptance policy that is made available to sample collection personnel (See SOP 1070 Sample Acceptance). It emphasizes the need for use of water resistant ink, providing proper documentation (to include sample ID, location, date and time of collection, collector’s name, preservation type, sample type and any special remarks about the sample), labeling of sample containers to include a unique sample ID, use of appropriate containers, adherence to holding times, and sample volume requirements. In addition, the laboratory has nonconformance/corrective action procedures to handle samples that do not meet the requirements above or show signs of damage, contamination or inadequate preservation. Data will be appropriately qualified where samples are reported that do not meet sample acceptance requirements.

On samples receipt the laboratory checks for the conditions above and logs the applicable information into the LIMS Sample Checklist. This checklist becomes part of the final report. Criteria regarding preservation, holding time and sample volume requirements can be found in 1000 series SOP Appendix B

If these conditions are not met, the laboratory follows SOP1070 and the client is contacted prior to any further processing, then

1) the sample is rejected as agreed with the client,
2) the decision to proceed is documented and agreed upon with the client,
3) the condition is noted on the Chain of Custody form and/or lab receipt documents, and;
4) the data are qualified in the case narrative or sample checklist of the final report.

25.2.1 Preservation Checks

See 1000 series SOP Appendix B for information on preservation requirements.

25.3 Sample Identification

The customer service specialists use LIMS to maintain an electronic log book to record, for each sample, the person delivering the sample, the person receiving the sample, the date and time received, source of sample, sample identification and a unique laboratory ID code. The laboratory ID code is used as the link that associates the sample with the field ID code, the date and time of sample collection, the date and time of sample receipt, the requested analysis (including applicable approved test method numbers), any comments resulting from inspection for sample rejection, and other related laboratory activities. The laboratory ID code is transferred to all sub-samples, extracts, and digestates. The custodians document the condition of the sample upon receipt (i.e. unsealed, broken container, etc.). A standardized format is used for the electronic log-in book.

Each sample container is identified by affixing a durable label which specifies the unique LIMS generated laboratory ID code for each container. The LIMS generated laboratory ID code includes the work order number, the lab number and the container identifier.

A work order number is generated by the LIMS system. The first two digits in the work order number indicate the year the sample was received by the laboratory, the third and fourth digit indicate the month received, the remaining four digits indicate the consecutive COC number for the month. Following the work order number, LIMS generates a consecutive lab number for each sample on the COC preceded by a dash. The lab number is followed by a letter to uniquely identify each sample fraction received. When 2 containers or vials are received for the sample fraction, the bottle labels are numbered (i.e. 1 of 2, 2 of 2) so that the analyst can document from which sample container or vial any sub-sample was taken.

All documentation received regarding the sample, such as memos or chain of custody, are scanned and retained with the final report on the Teklab Inc Server.

25.4 Sample Aliquots / Subsampling

In order for analysis results to be representative of the sample collected in the field, the laboratory has subsampling procedures. See SOP1150 for more information.

25.5 Sample Storage

Clean, dry, isolated cabinets and/or refrigerators that can be securely locked from the outside are designated as a "sample storage security areas". In the Teklab Air Laboratory, and the Kansas, Downers Grove and Springfield Service Centers, the entire facility is considered secure. The laboratory limits access to authorized laboratory personnel only. During operating hours, all samples remain in the laboratory secure areas. During non-operating hours, all samples are locked in the storage refrigerators or cabinets in the laboratory secure areas. The laboratory controls and documents access to all samples and sub samples designated as litigation samples by the client. Details can be found in SOP 1065 “Legal or Evidentiary Custody “.

The client must inform the laboratory of any heat-sensitive, light-sensitive, radioactive, or other sample materials having unusual physical characteristics or that require special handling. The custodian shall ensure samples are properly stored and maintained prior to analysis.

The custodian distributes samples to the laboratory supervisor or the appropriate laboratory cooler (or his or her representative) responsible for the lab analysis. Sample transfers within the laboratory are monitored by a sample custodian using the LIMS sample tracking system. Where possible, distribution of samples to the analyst performing the analysis must be made by the custodians.

Laboratory personnel are responsible for the care and custody of the sample once they receive it. They must be prepared to testify that the sample was in their possession and in view or secured in the laboratory at all times from the moment it was received from the custodian, until the completion of the analysis.

Drinking water Bacteria samples are delivered to the Microbiology laboratory immediately upon receipt. They are then logged into the LIMS, prior to analysis. Aqueous and solid samples to be analyzed for Fecal Coliform are stored separately from potable water samples.

The laboratory provides sample storage facilities that prevent cross-contamination of samples and meet the conditions specified by preservation protocols. Samples are stored away from all standards, reagents, food and other potentially contaminating sources. Sample fractions, extracts, leachates and other sample preparation products are stored according to this section, SOP1120 or according to specifications in the approved test method. The laboratory verifies that cross-contamination between samples has not occurred through the examination of storage areas or through the review of analytical data on laboratory blanks that are stored with samples.

Once the sample analyses are completed, the unused portion of the sample, together with all identifying labels, must be returned to the custodian. The returned, tagged sample/s should be retained in the custody room for a period of 30 days for aqueous and drinking water samples and no less than 2 weeks for solids and special wastes. Solids and special wastes are transferred to a storage shed where they are held for an additional 4 weeks when more room is needed in the walk in cooler (unless otherwise requested by the client). Volatile air samples are retained for three days after the final report is issued to the client and then disposed of. Litigation samples are retained until permission is given from the proper authority (See SOP1065 “Legal or Evidentiary Custody” for more information on Litigation Samples).

See SOP1120 “Sample Storage, Retention and Disposal” for more information.

25.6 Sample Disposal

Teklab complies with all applicable federal, state and local laws concerning the handling and disposal of hazardous waste. Teklab also complies with all applicable laws concerning the generation of air pollutants. All laboratory samples are disposed of according to Federal, State and local regulations. Procedures are described in SOP1120 “Sample Storage, Retention and Disposal” and SOP1130 “Waste Disposal” for the disposal of samples, digestates, leachates, and extracts. Records for sample disposal are kept indefinitely

25.7 Sample Transport

Samples that are transported under the responsibility of the laboratory, where necessary, are done so safely and according to storage conditions. This includes moving bottles within the laboratory. Appropriate DOT shipping instructions will be available to clients upon request. Specific safety operations are addressed outside of this document.

Sample shipping procedures are described in SOP 1100 Subcontracting and Shipping.

Section 26 - QUALITY ASSURANCE FOR ENVIRONMENTAL TESTING

(TNI V1:M2 – Section 5.9 and Section 1.7.2 and 1.7.3 of TNI V1: M4)

26.1 DEFINITIONS

Quality Control Indicators (QCI); such as Trip Blanks (TB), Duplicates (Dup), Initial Calibration Verification (ICV), Continuing Calibration Verification (CCV), Laboratory Control Blanks (LCB), Laboratory Control Samples (LCS), Standard Reference Materials (QC sample) and Matrix Spikes/Matrix Spike Duplicates (MS/MSD) will be analyzed to assess the quality of the data resulting from the field sampling program and in-house analysis.

Trip blanks (Equipment Blanks):
A trip blank is used to identify contamination from transport, shipping and site conditions. Trip blanks are analyte-free water taken to the field and returned to the laboratory unopened for analysis, to determine if contamination has occurred. Equipment blanks are used to identify contamination from sampling procedures. Equipment blanks are opened in the field, poured appropriately over or through the sample collection device and brought in for analysis to determine if contamination has occurred.

Field Blanks:
A Field Blank is exposed to the same field conditions as the sample, opened in the field. Its purpose is to assess the potential for field contamination.

Duplicate samples:
Analyzed to check for sampling and analytical reproducibility. Field duplicates are taken during sample collection. Internal duplicates are analyzed in the laboratory by splitting the sample and analyzing each split as an independent sample. See applicable SOP for frequency of matrix spike duplicates by analysis.

LCB (laboratory control blanks) or **MBLK** (method blanks):
A LCB is used to check contamination in the laboratory and is taken through the entire analytical procedure. The method blank consists of a matrix that is similar to the associated samples and is known to be free of the analytes of interest. These samples are used to verify the purity of all chemicals and reagents used in the methodologies and to prove the absence of contamination during the analytical procedure.

LCS samples (Laboratory control samples)**:**
The LCS is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then taken through the entire analysis to determine batch acceptance.

QC samples:
QC samples are purchased from an independent source to verify analytical procedures and calibrations. All QC samples must be NIST traceable reference materials, when available.

If a QC sample is not taken through the entire sample preparation procedure and is used for calibration verification (ex. GFAA), a LCS which has been taken through the entire procedure must also be analyzed.

Matrix spikes:
These provide information about the effect of the sample matrix on the preparation and measurement methodology. All matrix spikes and matrix spike duplicates are hereafter referred to as MS/MSD samples. These samples are always run with another aliquot of the sample that is not spiked. Spiking a sample tells us what effect the sample matrix (i.e. aqueous, solid, non-aqueous liquid) has on the parameter being measured. Sometimes the sample matrix will hide a parameter; a matrix spike will help identify this effect by showing a low recovery. Because matrix spikes give more information about the sample and its matrix, they are preferred to running duplicates. Some analysis (pH and Temp for example) do not lend themselves to matrix spikes very easily, therefore some analysis does not use matrix spikes (inorganic/physical analysis only).

Batch:
Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents.

Prep Batch:
Composed of one (1) to twenty (20) environmental samples of the same quality systems matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be twenty-four (24) hours

Analytical Batch:
Composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples.

TCLP METALS AND ORGANICS**:** Every unique TCLP sample matrix will be run both with and without matrix spikes, under direction of US EPA SW-846. However, as generally accepted laboratory practice, Teklab will not run TCLP matrix spikes on every sample, unless requested by the client. The frequency of matrix spiking (detailed in the applicable SOP) will be followed unless otherwise requested.

NOTE: Some clients may request specific types of quality control analysis. Those instances will be handled on a case by case basis.

26.2 Essential Quality Control Procedures

Teklab Inc has procedures for monitoring the validity of the testing it performs. The qualities of test results are recorded in such a way that trends are detectable, and where practicable, are statistically evaluated. To evaluate the quality of test results, the laboratory utilizes various evaluation aids such as certified reference materials, proficiency testing samples and control charting.

Quality control data are analyzed and when found to be outside pre-defined criteria, action is taken to correct the problem and to prevent incorrect results from being reported. Data associated with quality control data outside of criteria and still deemed reportable will be qualified so the end user of the data may make a determination of the usability of the data - see Section 27 – “Reporting of Results”. The quality control procedures specified in test methods are followed by laboratory personnel. Where multiple control procedures are offered, and it is not clear which is the most stringent, that mandated by the test method or regulation is followed.

Teklab utilizes the quality control procedures set forth in this section if the approved test method does not specify any quality control procedures or the quality control procedures contained in the approved test method are less stringent.

Teklab assesses and evaluates the results of all quality control procedures on an on-going basis.

A) Written procedures to ensure that all results from all quality control procedures are reviewed and the decision made to accept, reject, or qualify sample data before the data is reported.
B) Written criteria for accepting, rejecting, or qualifying sample data based on each quality control procedure.
   i) Teklab uses the acceptance criteria contained in the approved test method for evaluating the results of each of the quality control procedures and for accepting, rejecting, and qualifying sample data.
   ii) If the approved test method does not specify the criteria for evaluating the results of each of the quality control procedures and for accepting, rejecting, and qualifying data, Teklab establishes written criteria.
C) If a quality control procedure results in the laboratory rejecting or qualifying sample data, the laboratory may implement corrective actions. When analyzing reference materials, the laboratory uses the acceptance criteria supplied by the manufacturer.
D) The laboratory completes corrective actions and maintains written records as required in Section 5 of this manual.

Written procedures to monitor routine quality controls including acceptance criteria are located in the test method SOPs, except where noted, and include such procedures as:

- use of laboratory control samples and blanks to serve as positive and negative controls for chemistry methods;
- use of laboratory control samples to monitor test variability of laboratory results;
- use of calibrations, continuing calibrations, certified reference materials and/or PT samples to monitor accuracy of the test method;
- measures to monitor test method capability, such as limit of detection, limit of quantitation, and/or range of test applicability, such as linearity;
- use of regression analysis, internal/external standards, or statistical analysis to reduce raw data to final results;
- use of reagents and standards of appropriate quality and use of second source materials as appropriate;
- procedures to ensure the selectivity of the test method for its intended use;

- measures to assure constant and consistent test conditions, such as temperature, humidity, etc., when required by test method;

26.3 Internal Quality Control Practices

Analytical data generated with QC samples that fall within all prescribed acceptance limits indicate the test method is deemed to be in control.

QC samples that fall outside QC limits indicate the test method are is out of control (nonconforming) and that corrective action is required and/or that the data should be qualified (see Section 11 – "Control of Nonconforming Environmental Testing Work" and Section 13 - "Corrective Actions").

Detailed QC procedures and QC limits are included or referenced in test method standard operating procedures (SOPs), or where unspecified in the SOPs, are detailed in the method.

See applicable SOP for Duplicate and Matrix Spike concentrations and frequency.

26.3.1 General Controls

Teklab follows the quality control procedures and quality control indicators (QCI) specified below:

Laboratory Control Blank (LCB)
A minimum of 1 laboratory control blank (LCB) is analyzed with each preparation batch of environmental samples and carried through the entire analytical process. LCBs are not required for approved test methods, including but not limited to: pH, temperature and conductivity, for which method blanks are not appropriate. For analysis in which no separate preparation method is used, LCBs are prepared at the beginning each batch and once every 20 samples in between.

A) A batch of drinking water sample data meets the requirements of this section only when the method blank does not contain an analyte of interest at a concentration greater than the MDL.

B) A batch of environmental sample data, except for drinking water sample data, meets the requirements of this section when the method blank does not contain an analyte of interest at a concentration greater than the highest of the following:
   i) The MDL or PQL whichever the client requires for the reporting limit
   ii) 10% of the regulatory limit for that analyte, or
   iii) 10% of the measured concentration for that analyte in any environmental sample in the batch.

C) The provisions of subsection 26.2.1 Laboratory Control Blank(B) do not apply in those instances where the method blank criteria have not been met and there are non-detect results for the corresponding analyte in the environmental samples associated with the method blank. In such instances, the non-detect results may be reported with a comment in the sample narrative.

D) The following corrective actions are to be taken when (26.2.1 Laboratory Control Blank) (A), (B), or (C) above are not met:
  - i) The run of analysis is terminated (and no sample results are reported);
  - ii) The source of the contamination is identified, eliminated and documented;
  - iii) The samples are reanalyzed and results are reported only after the conditions of (26.2.1 Laboratory Control Blank) (A), (B) or (C) above are met.
  - iv) If corrective actions cannot be taken (i.e. insufficient sample), the results may be reported with the appropriate qualifiers.

Matrix spikes (MS)
Matrix Spikes are performed at a rate of one per 20 or fewer environmental samples per matrix type, per sample extraction or preparation procedure.

A) The laboratory utilizes the spiking analytes specified in the approved test method, except when the approved test method indicates that all method analytes are to be matrix spiked. In such cases the laboratory shall spike the target analytes for the sample or any client requested analytes.

B) If there are no specified spiking analytes, the laboratory spikes per the following:
  - i) For those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike or spikes are chosen that represent the chemistries and elution patterns of the components to be reported.
  - ii) For those test methods that have extremely long lists of analytes, a representative number are chosen using the following criteria for choosing the number of analytes to be spiked.
    - a. For methods that include 1-10 targets, all components are spiked;
    - b. For methods that include 11-20 targets, at least 10 or 80%, whichever is greater are spiked;
    - c. For methods with more than 20 targets, 16 or more components are spiked.

C) The laboratory selects samples on a rotating basis to receive matrix spike analysis from among various client samples, waste streams, monitoring locations and other applicable locations. Matrix spikes are selected randomly, unless specified by the client.

D) Matrix spikes are not required for approved test methods in which materials for matrix spiking are not available, including but not limited to: total suspended solids, total dissolved solids, total volatile solids, flash point, reactivity, pH color, odor, temperature, dissolved oxygen and turbidity.

E) Matrix spike recoveries are within the acceptance limits when:
  i) They are within the limits given in the approved method (when available), laboratory established limits, or those given by laboratory generated control charts, or
  ii) The matrix spike concentration is less than 20% of the sample concentration, or
  iii) a diluted sample, which is bench spiked, shows a spike recovery within the acceptance criteria given in (F)(i) above. (Note: the reporting limit must be elevated by the dilution factor.)

F) The following corrective actions are taken when (F)(i), (ii), (iii) above are not met:
  i) The samples are reanalyzed, if necessary, and results are reported only after the conditions of (F)(i), (ii) or (iii) above are met, or
  ii) Sample results are qualified, when reporting to customer, as showing adverse matrix effects.

Matrix spike duplicates (MSD)/sample duplicates

MSDs or Sample duplicates are performed at a rate of one per 20 or fewer environmental samples per matrix type, per sample extraction or preparation procedure.

A) Matrix spike duplicates are performed on the same environmental sample chosen for matrix spike analyses.

B) Samples are selected on a routine basis to receive sample duplicate analyses from among various client samples, waste streams, monitoring locations and other applicable locations. Matrix spike duplicates and/or matrix duplicate samples are selected randomly, unless specified by the client.

C) The laboratory documents, as required in section 10 of this manual, the procedure used to select the sample for matrix spike duplicates or sample duplicate analysis.

D) Relative Percent Differences (RPD) are within the acceptance limits when they are within the limits given in the approved method or those given by laboratory generated control charts. The matrix duplicate provides a usable measure of precision only when target analytes are found in the sample chosen for duplication.

E) The following corrective actions are to be taken when (D) above is not met:
  i) The sample is reanalyzed, if necessary and results are reported only after the conditions of (D) above are met.
  ii) Sample results for matrix spike duplicates or sample duplicates RPD, which do not meet the acceptance criteria of (D), are to be qualified when reporting to the customer as showing adverse matrix effects or problems with the samples composition.

Laboratory control samples (LCS)

LCSs are analyzed at a minimum of one per preparation batch, except for analytes for which spiking solutions are not available such as, total volatile solids, pH, color, odor, temperature, dissolved oxygen or turbidity. In those instances, for which no separate preparation method is used, the batch is defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples. Air Testing: If a calibration solution must be used for the LCS, the client shall be notified prior to the start of analysis. Also the concentration of the LCS shall be relevant to the intended use of the data and either at a regulatory limit or below it.

A) The laboratory may use the results of these LCS analyses to determine batch acceptance.

B) The LCS is a quality system matrix, known to be free of analytes of interest, spiked with a known and verified concentration of analytes. All analyte concentrations must be within the calibration range of the methods. The components to be spiked shall be as specified by the mandated test method or other regulatory requirement or as requested by the client. In the absence of specified spiking components, the laboratory shall spike per the following:

  i) For those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike or spikes are chosen that represent the chemistries and elution patterns of the components to be reported.

  ii) For those test methods that have extremely long lists of analytes, a representative number are chosen. The analytes selected shall be representative of all analytes reported. The following criteria shall be used for determining the minimum number of analytes to be spiked.

    a. For methods that include 1-10 targets, all components are spiked;
    b. For methods that include 11-20 targets, at least 10 or 80%, whichever is greater are spiked;
    c. For methods with more than 20 targets, 16 or more components are spiked.

  However, the laboratory shall ensure that all targeted components are included in the spike mixture over a two (2) year period

C) The laboratory may use the matrix spike samples as specified in subsection 26.2.1 Matrix Spikes (A) as a LCS when the matrix spike acceptance criteria are as stringent as the LCS acceptance criteria. However, if the laboratory prepares a LCS, the laboratory shall analyze the LCS and use the results to determine batch acceptance. The laboratory shall not use the analyses of matrix spike samples as specified in subsection 26.2.1 Matrix Spikes (A) to override, ignore, or replace an LCS analysis that fails to meet the acceptance criteria. (If there is insufficient sample for reanalysis and the client is unable to re-sample, the data must be reported to the client with the appropriate qualifiers indicating the QC deviation. In control matrix spike and surrogate recoveries will help support the batch acceptance).

D) The analytes must be obtained from a second source if the LCS is to be used to verify the instrument calibration.

E) LCS recoveries are within the acceptance limits when they are within the limits given in the approved method (when available), laboratory established limits, those given by laboratory generated control charts, or client specified assessment criteria.

F) The following corrective actions are to be taken when (E) above is not met:

  i) The run of analysis is terminated (and no sample results are reported);

- ii) The reason for the unacceptable recovery is identified, eliminated and documented;
- iii) The sample batch is reanalyzed and results are reported only after the conditions of (E) above are met.
- iv) If corrective actions cannot be taken (i.e. insufficient sample), the clients involved are contacted and the samples are recollected or the results are reported with the appropriate qualifiers, according to the client's instructions.

G) If a large number of analytes are in the LCS, it becomes statistically likely that a few will be outside control limits. This may not indicate that the system is out of control; therefore, corrective action may not be necessary. Upper and lower marginal exceedance (ME) limits determine when corrective action is needed. A ME is defined as being beyond the LCS control limit (3 standard deviations), but within the ME limits. ME limits are between 3 and 4 standard deviations around the mean. Marginal exceedances must be random. If the same analyte exceeds the LCS control limit consecutively, it is an indication of a systemic problem. Marginal exceedance limits can be determined by using the control charting feature in Teklab LIMS. It is the responsibility of the laboratory supervisor utilizing a ME allowance, to monitor the LIMS data and assure random behavior. The number of allowable marginal exceedances is as follows:

1. >90 analytes in LCS, 5 analytes allowed in ME of the LCS control limit;
2. 71-90 analytes in LCS, 4 analytes allowed in ME of the LCS control limit;
3. 51-70 analytes in LCS, 3 analytes allowed in ME of the LCS control limit;
4. 31-50 analytes in LCS, 2 analytes allowed in ME of the LCS control limit;
5. 11-30 analytes in LCS, 1 analytes allowed in ME of the LCS control limit;
6. <11 analytes in LCS, 0 analytes allowed in ME of the LCS control limit.

Surrogates

Surrogate compounds are added to all samples, standards, and blanks whenever possible, when conducting analysis by approved test methods utilizing organic chromatography.

A) The compounds specified are chosen to represent the various chemistries of the target analytes in the method or the measurement quality objectives. They are often specified by the mandated method and are deliberately chosen for their being unlikely to occur as an environmental contaminant. Often this is accomplished by using deuterated analogs of select compounds.

B) The surrogate recoveries are within the acceptance limits when they are within the limits given in the approved method or, if not specified, the limits given by the laboratory generated control charts.

C) The following corrective actions are to be taken when (B) above is not met:

- i) If the surrogates are out of control for a method blank or LCS, the associated batch must be evaluated to determine if this affected any of the individual sample results. Any affected samples must be reanalyzed, if possible. If the second run of analysis shows acceptable recoveries, the reason for the initial poor recoveries must be determined, eliminated and documented. The analysis with the acceptable result is to be reported.

ii) Sample results with out of control surrogates must be qualified when reporting to the customer as showing adverse matrix effects.

Teklab monitors tabulations and quality control charts of the results from all quality control indicators via the LIMS

A) For each approved test method, or combination of similar test methods; and
B) For each matrix.

Tabulations, quality control charts or any combination of tabulations and quality control charts of results of quality control indicators include or are linked electronically to the following information:

A) Title;
B) Identification of standard operating procedures (SOP) which requires collection of quality control procedure data;
C) Name of quality control procedure being tabulated;
D) Analytical method;
E) Analyte;
F) Analyte units of measure;
G) Matrix;
H) Fortification concentration;
I) Mean;
J) Standard deviation;
K) Upper control limit (UCL);
L) Lower control limit (LCL);
M) Upper warning limit (UWL);
N) Lower warning limit (LWL);
O) Date of analysis;
P) Sample/QC Sample ID;
Q) Analyst's identification;

References for Minimum QC Requirements:
The individual and overall level of QC effort will be, at a minimum, equivalent to the level of QC effort specified under the NELAP certification program. The level of QC effort for samples not covered by NELAP certification will be, at a minimum, the QC required by the specified test method ("SW-846, Standard Methods for the Examination of Water, Wastewater", or "Methods for Chemical Analysis of Water and Wastewater" EPA 600). The level of QC effort for testing TCLP organic (Volatile, Semi-Volatile and Pesticide/Herbicide and PCB) will conform to Protocols of SW-846.

Accuracy, Precision and Sensitivity of Analysis
The fundamental QA/QC objective with respect to accuracy, precision and sensitivity of laboratory analytical data is to achieve the QC acceptance criteria of the analytical protocols. The accuracy, precision and sensitivity of all parameters are listed or referenced in the individual SOPs

26.4 Proficiency Test Samples or Interlaboratory Comparisons

Laboratory performance is monitored internally through the review of worksheets or batches, examination of analyst techniques, internal blind QC samples and participation in performance evaluation studies (PTs). Examples of this are performance studies from approved TNI PT providers, such as WP, WS, AE and RCRA studies and client provided blind Quality Control studies. These studies are intended to evaluate laboratory performance and help identify problems that exist.

When a regulatory program has additional PT requirements for FoPTs not covered by the TNI standard, then the laboratory shall follow those requirements.

26.4.1 Compliance to Accreditation Requirements

The laboratory must successfully analyze at least two TNI-compliant PT samples per calendar year for each field of accreditation where corresponding FoPTs exist in the TNI FoPT tables and for which the laboratory seeks to obtain or maintain accreditation. An exception is made for analytes where there is no PT available from any TNI approved PT provider at least twice per year. In such cases the laboratory will run the PTs in the minimum time frame the PTs are available and not at all if they are not available.

For initial accreditation(s) the laboratory shall direct the PT Provider to provide all relevant PT study results to the AB to support their accreditation application.

The laboratory shall report results in such a way that there is a specific match between the analytical result for the FoPT and the corresponding Field of Accreditation for which the PT sample was analyzed.

The successive PTs are analyzed at a maximum of 7 months apart with a minimum of 7 days between. When the PT is being used for corrective action to reinstate accreditation or when applying for initial accreditation, the dates of successive PT samples for the same accreditation FoPT is at least 7 days apart.

To obtain and/or maintain TNI accreditation Teklab must also:

a. Successfully complete two PT studies for each requested PT field of testing within the most recent three rounds attempted.
b. Have the most recent three rounds attempted occurring within 18 months of the laboratory's application date.
c. The opening date of the second study must be at least seven (7) calendar days after the closing date of the first study.
d. Continue to complete PT studies for each PT field of testing and maintain a history or at least two acceptable PT studies for each field of testing out the most recent three.
e. Obtain PT samples from an TNI approved PT Provider.
f. Authorize the PT provider to release all accreditation and remediation results and acceptable/not acceptable status directly to their NELAP primary accrediting authority in addition to Teklab.
g. Ensure that all PT samples are handled in the same manner as real environmental samples utilizing the same staff, methods, procedures, equipment,

facilities and frequency of analysis, as normally used for routine analysis of that analyte and matrix type.

h. The laboratory shall also handle and prepare the PT study samples in accordance with the instructions provided by the PT Provider.
i. Ensure that corrective actions are taken for any failed studies, including determining root cause of the failure. Ensure that documentation of the any corrective actions is provided to the primary accrediting authority.
j. Make available to the assessors of the Primary Accrediting Authority, during on-site audits of Teklab, all laboratory records related to the PT samples and their reporting.

A laboratory seeking to have its accreditation reinstated for an FoPT after suspension, revocation or after suspension due to not supplying a requested corrective action report, shall meet the requirements for continued accreditation as described in Section 5.2 of the TNI 2016 Standard (V1M1).

26.4.2 PT Sample Handling and Analysis

Proficiency Testing (PT) samples are treated as typical samples in the normal production process where possible, including the same analysts, preparation, calibration, quality control and acceptance criteria, sequence of analytical steps, number of replicates, and sample log-in. PT samples are not analyzed multiple times unless routine environmental samples are analyzed multiple times. Where PT samples present special problems in the analysis process, they will be treated as laboratory samples where clients have special requests.

The type, composition, concentration and frequency of quality control samples analyzed with the PT samples are the same as with typical samples.

Prior to the closing date of a study, Teklab personnel must not:

- Subcontract analysis of a PT sample to another laboratory being run for accreditation purposes.
- Knowingly receive and analyze a PT for another laboratory being run for accreditation purposes.
- Communicate with an individual from another laboratory concerning the analysis of the PT sample.
- Attempt to find out the assigned value of a PT from the PT Provider.

For chemistry PT results where the concentrations are below the calibration range established by the initial calibration curve, the following actions are acceptable:

a) the laboratory may re-scale its initial calibration curve to bracket the concentration of the PT sample result; or
b) the laboratory may report the results, as measured with the initial calibration curve, without qualification to the PT Provider, provided the laboratory adheres to the requirements noted in 26.4.3 below.

26.4.3 PT Reporting Procedure (TNI 2016 V1M1 Section 4.2)

Teklab shall evaluate and report the analytical result for accreditation Fields of Proficiency Testing (FoPT) as follows:

a) If the analytical result is a numeric value above or equal to the PTRL, the laboratory shall report the value. If the PTRL is less than the laboratory's LOQ, the laboratory shall report the result without the qualification of result required in Volume 1, Module 4 of the 2016 TNI Standard.
b) If the analytical result is a numeric value below the PTRL, the laboratory shall report one of the following:

I. <PTRL or,

II. the obtained analytical result, if the result is between the LOQ and the PTRL, or,

III. <LOQ, if the analytical result is below the LOQ and the PTRL.

c) If the analytical result is a "non-detect", the laboratory shall report one of the following:

I. <PTRL, or

II. <LOQ**

NOTE: ** In the case where the laboratory LOQ is greater than the PTRL: If the laboratory chooses to report a value of <LOQ and the analyte is present above the PTRL, the result will be scored as "Not Acceptable" by the PT Provider.

The PTRL value shall not be adjusted for sample amount used or percent moisture.

The laboratory shall report the analytical results for accreditation and experimental FoPTs to the Proficiency Testing Provider (PTP) on or before the closing date of the study using the reporting format specified by the PTP.

On or before the closing date of the study, the laboratory shall authorize the PTP to release the laboratory's final evaluation report directly to the laboratory's Primary Accreditation Body (AB)

Teklab must ensure that corrective actions are taken for any failed studies, including determining root cause of the failure. It must also ensure that documentation of the any corrective actions is provided to the primary accrediting authority. The laboratory institutes corrective action procedures for failed PT samples following the guidelines in Section 13 – "Corrective Action". When requested, the root cause investigation and corrective action documentation shall be provided to the Primary AB within thirty (30) calendar days of the request.

The laboratory must maintain a copy of the online data entry summary when the PT results are submitted online. These data summary documents are stored on the server in the applicable Proficiency Testing folder. Electronic copies of PT data and documentation are stored on the server or storage hardware indefinitely.

When requested, the laboratory shall submit 'analytical data packages' (however named) to the accrediting authority for analytes/methods that are not readily available on Performance testing studies.

Teklab must make available to the assessors of the Primary Accrediting Authority, during on-site audits of Teklab, all laboratory records related to the PT samples and their reporting.

26.5 Data Review

The laboratory reviews all data generated in the laboratory for compliance with SOP, laboratory and, where appropriate, client requirements. See SOP1290 for information on data review.

26.6 Water Quality

Three water sources are in use at the Teklab, Inc. Collinsville facility: general deionized water, volatiles lab deionized water, and metals lab deionized water.

a. General laboratory deionized water produced by running tap water through an activated carbon filter (tank 1) followed by a cation exchange resin bed filter (tank 2) followed by an anion exchanged resin bed filter (tank 3) followed by two mixed bed resin filter (tank 4 and 5). Tank 5 serves as a backup tank. Tank 4 and 5 are monitored to ensure the resistivity is greater than 1 megohm-cm. An audible alarm will sound if resistivity is less than 1 megohm-cm.

b Volatiles lab deionized water uses general laboratory deionized water as the feed water then passes it through one more activated carbon filter, to remove all trace amounts of organics, then passes through a 0.45µm filter to trap any carbon residue that may leave the carbon filter. This water has a minimum quality of medium water quality.

c. Metals lab deionized water uses general laboratory water as the feed water then passes through a Thermo brand "high capacity" 2 bed resin filter followed by 2 Thermo brand " Ultrapure DI" filters with mixed resin beds. This water passes through an in-line resistivity meter, where all readings are greater than 15 megohm-cm with typical readings of 18megohm-cm. This water meets high quality water specifications.

Section 27 – Reporting the Results

(TNI V1:M2 – Section 5.10)

The result of each test performed is reported accurately, clearly, unambiguously, and objectively and complies with all specific instructions contained in the test method. Laboratory results are reported in a test report that includes all the information requested by the client and necessary for the interpretation of the test results and all information required by the method used. See SOP#1290 for more information on reporting of results.

The laboratory pays particular care and attention to the arrangement of the report, especially with regard to presentation of the sample results and ease of assimilation by the reader. The format is carefully and specifically designed for each type of approved test method carried out, but the headings are standardized as far as possible.

27.1 Test Reports

The laboratory issues sample data or sample result reports accurately and in a manner that is understandable to the recipient. Each test report generated contains the following information (unless the laboratory has a valid reason for not doing so, such as a written agreement with the client).

- Name, address and phone number of the laboratory;
- Name and address of client and project;
- The TNI logo with the phrase “NELAP accredited Laboratory”. The laboratory’s accreditation number appears on the case narrative page of each report;
- Unique identification of the report (such as work order number) and of each page and identification of the total number of pages. Each page in each section is identified as a number of the total report pages, for example 3 of 10 or 1 of 20.
- Report title, such as “Laboratory Results”;
- Description and identification of samples (including client ID code);
- Date of sample receipt, sample collection and sample analysis (time of sample collection, if provided by client, and time of sample preparation (if requested by the client) and analysis, if the required holding time for either activity is less than or equal to 48 hours);
- Approved test method and preparation method utilized, including revision numbers;
- Clear indication of TNI accredited analysis by listing the letters “NELAP” next to each accredited analyte. Analytes that are not NELAP accredited are designated by an asterisk in the certification column. An explanation of the asterisk is also noted in the Definitions section of the final report;
- Sample results with any failures or deviations from approved test methods or QC criteria identified in the case narrative, sample narrative, and/or with data qualifiers;
- Signature and name or electronic signature and name, and title of the individuals accepting responsibility for the content of the report and date of issue;
- Clear identification, including the lab name or accreditation number of any sample results that were generated by a subcontracted laboratory;
- A description of the calculations or operations performed on the data, a summary and analysis of the data, and a statement of conclusions drawn from the analysis;

- Identification of the reporting units, such as µg/L or mg/kg;
- A statement that the report shall not be reproduced, except in full, without the written approval of the laboratory, where appropriate;
- Where applicable, a statement to the effect that the sample results relate only to the analytes of interest tested or to the sample as received by the laboratory;
- Where applicable, characterization and condition of the sample;
- Where applicable, reference to sampling procedure and plan; and
- Clear, unequivocal identification of analytical results generated by an approved test method, for which the laboratory is accredited in accordance with the laboratory's accreditation.

27.2 Supplemental Test Report Information

When necessary for interpretation of the results or when requested by the client, test reports include the following additional information:

a) deviations from, additions to, or exclusions from the test method, information on specific test conditions, such as environmental conditions, and any non-standard conditions that may have affected the quality of the results, and any information on the use and definitions of data qualifiers;
b) a statement of compliance/non-compliance when requirements of the management system are not met, including identification of test results that did not meet the laboratory and regulatory sample acceptance requirements, such as holding time, preservation, etc.;
c) where applicable and when requested by the client, a statement on the estimated uncertainty of the measurement is available
d) Teklab does not include opinions and interpretations in laboratory reports
e) additional information which may be required by specific methods or client;
f) qualification of results with values outside the calibration range as appropriate.

27.3 Environmental Testing Obtained from Subcontractors

When Teklab must subcontract analysis due to workload, need for further expertise, temporary incapacity, or on a continuing basis, work is placed with a laboratory accredited under NELAP for the test to be performed or with a laboratory that meets the applicable statutory and regulatory requirements for performing the tests and submitting the results of test performed.

All subcontracted analyses and the name of the subcontracted lab are documented in the case narrative of the final report. Any non-NELAP accredited work is designated by an asterisk in the certification column.

The intent to subcontract analysis is specified in the project quote when Teklab intends to subcontract any part of a project. When possible, Teklab will advise the client in writing of any subcontracted analysis.

Teklab maintains a register of all subcontractors that it uses for environmental tests and a record of the evidence of compliance for each. The subcontractors may report their results in writing or electronically. A copy of the subcontractor's report is made available to the client if requested. A record of subcontracted analysis is retained at Teklab and is archived in accordance with this manual. See Section 10 for more information on Subcontracting.

27.4 Electronic Transmission of Results

The laboratory ensures that when clients require transmission of test results by telephone, fax or other means, laboratory personnel follow documented procedures that ensure the requirements of the TNI Standard and associated procedures to protect the confidentiality and proprietary rights of the client are met (see Section 21-"Environmental Methods and Method Validation"). All electronic transmissions are limited to the contracting client and their designated recipients. Any transmission to a third party requires written confirmation by the contracting client.

27.4.1 Electronic Data Deliverables (EDDs)

EDDs are client driven deliverables that can be produced in various file formats; such as text and Excel files. EDDs, when requested by a client, are provided in addition to the final report. EDDs are prepared using Microsoft Access/VBA, which exports the EDD into the file type the client has requested. EDD files are prepared by Project Managers for the client. Teklab's IT Programmer develops the EDD per client request.

Some clients EDDs are developed to use Equis Data Processor (EDP) software to check the EDD file using the client provided format and reference files. The EDP software checks for, amongst other things, formatting errors and valid values. Problematic EDDs are rejected and flagged for specific errors, helping facilitate any corrections before the EDD is sent to the customer. All electronic transmissions follow Section 27.4 above.

27.5 Amendments to Test Reports

Material amendments to a test report after it has been issued are made only in the form of another document or data transfer. All supplemental reports meet all the requirements for the initial report and the requirements of this Quality Manual.

See SOP1290 for more information on revised reports.

27.6 Electronic signatures

Electronic signatures used in LIMS reports are stored securely in the LIMS SQL tables. Electronic signatures used for purposes out with the LIMS (e.g. signing SOPs, Teklab correspondence) should be stored on the users U Drive.

27.7 Report Signatories

Below is a list of parties authorized to release testing results to clients.

Elizabeth Hurley	Director of Customer Service	Elizabeth A. Hurley
Shelly Hennessy	Project Manager	Shelly A Hennessy
Marvin Darling	Project Manager	Marvin L. Darling II
Patrick Riley	Project Manager	Patrick Riley
Aaron Renner	Project Manager	

Section 28 - Safety

Safety is the number one priority of every employee at Teklab, Inc. Teklab trains employees to ensure that no work is performed in an unsafe environment. Where safety practices are included as part of an approved test method, these practices are strictly followed. While more specific safety criteria are not an aspect of this manual, laboratory personnel must always apply appropriate safety practices.

The specifics of the Teklab safety program are detailed in the Teklab Chemical Hygiene Plan and are defined by the Teklab Safety Officer at monthly safety meetings. Teklab complies with and exceeds all applicable OSHA regulations concerning safe laboratory and workplace operations. See SOP 1161 for more information on Safety.

Teklab's Emergency Action Plan (EAP) is reviewed at least annually by the Safety Officer. Fire/spill drills are conducted annually.

Section 29 - Bibliography

References:

1. The 2016 TNI Standard Volume 1; Management and Technical Requirements for Laboratories Performing Environmental Analysis
2. "Test Method for The Evaluation of Solid Wastes SW846"," Laboratory Manual Physical/Chemical Properties", volumes 1A, 1B, and 1C, 3rd edition, Office of Solid Waste and Emergency Response, Environmental Protection Agency.
3. "Standard Method for the Examination of Water and Wastewater" online.
4. 40 CFR Part 136, Appendix B rev2.

Test Code: SV_OA2_MW_S
Test Number: SW8015M/OA2
Test Name: SW-846 3546, 8015B, Total Petroleum Hydrocarbons (OA-2) by GC/F
Matrix: Solid **Units:** mg/Kg

METHOD DETECTION/REPORTING LIMITS

Type	Analyte	Synonym	MDL	PQL	EPA Lbl
A	Diesel		3.1	5	NELAP
A	Kerosene		1.8	5	NELAP
A	Mineral Spirits		1.4	5	NELAP
A	Motor Oil		2.3	5	NELAP

Test Code: SV_OA2_W
Test Number: SW8015M/OA2
Test Name: SW-846 3510C, 8015B, Total Petroleum Hydrocarbons (OA-2) by GC/
Matrix: Aqueous **Units:** mg/L

METHOD DETECTION/REPORTING LIMITS

Type	Analyte	Synonym	MDL	PQL	EPA Lbl
A	Diesel		0.13	0.25	NELAP
A	Kerosene		0.08	0.4	NELAP
A	Mineral Spirits		0.07	0.4	NELAP
A	Motor Oil		0.1	0.4	NELAP

TEKLAB, INC.
STANDARD OPERATING PROCEDURE FOR THE EXTRACTION OF SEMI-VOLATILE ORGANICS IN AN AQUEOUS MATRIX USING A SEPARATORY FUNNEL
3 Shaker

SCOPE

The use of this SOP is governed by the TEKLAB Quality Assurance Manual and associated SOPs including but not limited to, 1030, 1031, 1250, 1280, 1290, and 1310. Implementation of this SOP must always comply with the requirements of the Quality Assurance Manual and the applicable Section 1000 SOPs. For any necessary sub-sampling refer to SOP 1150. Refer to section 5 and 27 of the Quality Manual for record keeping and reporting information.

This SOP is in accordance with SW-846 methods 3500B, 3510C, and the preparation section of US EPA method 608.3. It describes the procedure Teklab uses for isolating organic compounds from aqueous samples and both TCLP and SPLP extracts. The SOP also describes the concentration steps needed for samples to be analyzed by SW-846 methods 8270, 8081, 8082, 8015, US EPA method 608.3, and the Kansas Method for the Determination of Mid-Range Hydrocarbons (MRH) and High-Range Hydrocarbons (HRH).

This method is restricted to use by or under the supervision of trained analysts. Each analyst must perform an Initial Demonstration of Capability (IDOC) on this, or a similar method, prior to working with environmental samples without direct supervision. This will show the ability to generate acceptable results with this method.

SUMMARY

This SOP is to be followed when preparing aqueous samples for organic analysis with the following prep codes or test codes (test codes are subject to change, see LIMS for a comprehensive list of test codes).

Prep Code	Summary	Analysis Test Code(s)
SV_PSTPCB_W	A measured volume of sample is extracted with methylene chloride using a separatory funnel. The extract is dried, by draining it through a glass column with sodium sulfate, then concentrated, solvent exchanged into hexane and/or acid washed then transferred to an amber glass vial.	SV_608.3E_W SV_8081B_SPLP SV_8081BS_W SV_8081BTCLP SV_8082S_W SV_8082SPLP SV_8082TCLP SV_LF_8082_W
SV_OA2PR_W	A measured volume of sample is extracted with methylene chloride using a separatory funnel. The extract is dried, by draining it through a glass column with sodium sulfate, then concentrated and transferred to an amber glass vial.	SV_OA2_W SV_OA2_SPLP
SV_AGSIMS_W	A measured volume of sample is extracted with methylene chloride using a separatory funnel. The extract is dried, by draining it through a glass column with sodium sulfate, then concentrated and transferred to an amber glass vial.	SV_8270S_AG_W_SIMS

SV_MHRHPR_W	A measured volume of sample is acidified then extracted with methylene chloride using a separatory funnel. The extract is dried, by draining it through a glass column with sodium sulfate, then concentrated, solvent exchanged into hexane, and transferred to an amber glass vial.	SV_MHRH_W
SV_8015SPR_W	A measured volume of sample is extracted with methylene chloride using a separatory funnel. The extract is dried, by draining it through a glass column with sodium sulfate, then concentrated and transferred to an amber glass vial.	SV_8015S_W

SAFETY

Eye protection and gloves are absolutely required with this procedure. Use extreme caution when working with solvents, acid and glassware. Read the appropriate SDS for more safety information and to ensure proper handling of the solvents and reagents used during this procedure.

- Methylene Chloride
- Hexane
- Sulfuric Acid Trace

EQUIPMENT AND SUPPLIES

- Graduated cylinders, 100mL, 250mL, and 1L
- Separatory funnels, 125mL, 250mL, and 2L with Teflon stopcocks and penny head stoppers
- Heated water bath capable of temperature control ± 5 degrees C
- Glass wool
- Glass drying column with glass wool plug
- Balance (top loading)
- Evaporative flask, 500mL Kuderna - Danish (K-D) apparatus
- Concentrator tips, 10mL
- Snyder columns, three ball
- Pasteur glass pipettes, 5 ¾ inch disposable
- Pipette bulbs, draining column red bulb and 3CC bulbs
- Teflon boiling stones
- Amber auto sampler vials, 2mL with Teflon lined screw cap
- 40 ml clear vials with Teflon lined screw caps
- Syringes, 10µL, 25µL, 50µL, 100µL, 250µL, 500µL, and 1000µL
- Erlenmeyer flasks, 2L
- Repipettors, 60mL
- Refrigerated recirculator/chiller
- Flasks, 500mL
- Solvent recovery heads
- Concentrator apparatus
- Beakers, 400mL, 2L, and Nalgene pitcher
- Concentrator tip trays
- Keck clips
- pH paper

- TurboVap evaporation apparatus
- Drying oven (temperature set to approximately 130 °C)
- Glas-Col brand 3D orbital shaker (set at 70)
- Fisher Model 231 touch mixer or equivalent
- Glass scoop, 30g
- Lab jacks
- Thermometers
- Vortex, Fischer Scientific
- Centrifuge
- Glass stir rods, long
- Funnels, glass 125mm, 1.5 stem and stainless steel 100mm, 1.5 stem
- Solvent resistant squirt bottles
- Solvent resistant carboys, 9L and 20L
- Teflon K-D stoppers
- Timer
- 0.45 µm syringe filters
- 3 mL disposable syringes
- (2) Bench top Shaker (Glas-Col catalog # 099A S60012 & 099A S60024 variable speed) set speed at 80 rpm

REAGENTS AND STANDARDS

- Methylene chloride (CH_2Cl_2), Fisher Scientific GC grade or equivalent
- Sodium sulfate($NaSO_4$), granular (muffled at 550°C for 4 hours prior to use)
- Sulfuric acid, (1:1) reagent grade or equivalent, add equal volume of conc. sulfuric acid to deionized water slowly and allow to come to room temperature before use
- Hexane, Fisher Scientific ACS grade or equivalent
- Sulfuric Acid, Fisher Scientific Trace metal grade or equivalent
- PSTPCB Surrogate solution at 5.0µg/mL (analyst prepared)
- PCB Spike solution at 10µg/mL (analyst prepared)
- PST Spike solution at 5.0 µg/mL (analyst prepared)
- OA2 Surrogate solution at 200µg/mL (analyst prepared)
- OA2 Spike solution at 5000µg/mL (analyst prepared)
- 8270AGSIMS Spike solution at 10µg/mL (analyst prepared)
- 8270AGSIMS Surrogate solution at 10µg/mL (analyst prepared)
- MRH/HRH Spike solution at 100µg/mL (analyst prepared)
- MRH/HRH Surrogate solution at 40µg/mL (analyst prepared)
- Nitrogen gas
- Deionized water (DI)
- Sodium Chloride (NaCl), granular (muffled at 500°C for 4 hours prior to use)
- See SOP 4022 Standard Prep and Tracking for storage conditions and labeling of standards.
- See section 5 of the quality manual for record keeping information.

CALIBRATION

N/A

QUALITY CONTROL (Quality Manual Section 26)

- Prep Batch
  A prep batch is a set of 20 or fewer environmental samples of the same matrix extracted using the same procedure and reagents within the same 24-hour time period. See Table 1 for a list of minimum QC requirements per prep batch for Pest/PCB split samples.

- Method Blank
  Each prep batch must contain a MBLK. Surrogate added varies by test code (see Table A)

- Laboratory Control Samples
  Each prep batch must contain and LCS/LCSD. Spike added varies by test code (see Table B)

- Matrix Spike and Matrix Spike Duplicate
  An MS/MSD should be performed if sample amount permits. Spike added varies by test code (see Table B)

- Surrogate
  Surrogates are spiked into every sample, MBLK, LCS, LCSD, and MS/MSD. Surrogate added varies by test code (see Table A)

CORRECTIVE ACTION (Quality Manual Chapter 13)

Quality control excursions may result in re-preparation of the associated samples.
All other corrective actions are performed per Quality Manual Chapter 13

INTERFERENCES

Contamination in solvents, reagents, glassware and other sample processing equipment can cause analytical interference. All of these materials must be proven to be free of contaminants under the conditions of analysis by running laboratory method blanks. Matrix interference may be caused by contaminants that are co-extracted from the sample and will vary from sample to sample.

PROCEDURE

Safety Note: **"All steps of this procedure involving pouring, venting, or draining of methylene chloride must be performed inside the fume hood with a Plexiglas partition/shield in front of the worker."**

1) Label a 2L separatory funnel and K-D flask with the appropriate sample identifier for each extract.
2) Insert a drying column plugged with glass wool into the wooden rack to the right of each separatory (sep.) funnel.
3) Attach a 10mL concentrator tip to each K-D flask. Set the corresponding K-D/tip underneath each drying column.
4) For SV_OA2_W, SV_8015SPR_W and SV_MHRHPR_W test codes the glassware needs to be rinsed with CH_2Cl_2.
5) Check the pH of each sample before pouring into each sep. funnel. Each sample should have a neutral pH of ~7. If the pH has to be adjusted, be sure to make the adjustment after pouring the sample into each sep. funnel, so that the original sample left in the bottle is not affected.
    i) For SV_PSTPCB_W, SV_OA2PR_W, SV_8015SPR_W, and SV_AGSIMS_W test codes, if the sample is basic; pour the sample into each sep. funnel and add sulfuric acid a few drops at a time until a pH of ~7 is achieved.

- **ii)** For SV_PSTPCB_W, SV_OA2PR_W, SV_8015SPR_W, and SV_AGSIMS_W test codes, if the sample is acidic; pour the sample into each sep. funnel and add sodium hydroxide a few drops at a time until a pH of ~7 is achieved.
- **iii)** For SV_MHRHPR_W, check the pH. If it is greater than 2, acidify the samples to a pH of 2 or less using 1:1 sulfuric acid.

6) Pour 1L of sample into each sep. funnel (DI water is used for each MBLK, LCS/LCSD). Add 60mL of methylene chloride to each sep. funnel. For SV_8015SPR_W and SV_OA2PR_W, 500mL of sample is used with 30mL of methylene chloride. For SV_OA2PR_W, mark the level of the sample in the container with a permanent marker and pour the entire contents of the sample container into the sep funnel – then rinse the bottle with the 30mL of methylene chloride and pour it into the separatory funnel.
    - i. For 600 series samples the entire bottle of sample should be used and then rinsed with the first 60mL extraction portion of methylene chloride.
    - ii. For TCLP samples 100mL of sample and 900 mL of DI water should be used.
    - iii. For AG SIMS ~30g NaCl should be added and dissolved prior to adding the solvent.
7) Add ~30g sodium sulfate to each drying column.
8) Open a prep batch in LIMS and load the samples.
9) Spike and surrogate per Tables A and B below (addition of spike and surrogate should be verified by a second person.)

Table A

Prep Code	Surrogate Solution Name	Amount (µL)
SV_PSTPCB_W	PEST/PCB Surrogate	25uL
SV_AG_SIMS_W	AG SIMS Surrogate *	100uL
SV_OA2PR_W	OA2 Surrogate **	200uL
SV_MHRHPR_W	MRH/HRH Surrogate	1000uL
SV_8015SPR_W	OA2 Surrogate **	200uL

***Do not add AG_SIM surrogate to LCS/LCSD and MS/MSD. (AG_SIM spike mix contains AG_SIM surrogate.)**

****OA2 surrogate solution must be sonicated to ensure that any analyte that has precipitated out during storage is dissolved into the solution before use.**

Table B

Prep Code	Type	Spike Solution Name	Amount (µL)
SV_PSTPCB_W (including TCLPs)	LCSPST/LCSPSTD & MS/MSD	PEST Spike	25uL
	LCSPCB/LCSPCBD & MS/MSD	PCB Spike	250uL
SV_AG_SIMS_W	LCS/LCSD & MS/MSD	AG_SIMS Spike	100uL
SV_OA2PR_W	LCS/LCSD & MS/MSD	OA2 Spike	100uL
SV_MHRHPR_W	LCS/LCSD & MS/MSD	MRH/HRH Spike*	2000uL
SV_8015SPR_W	LCS/LCSD & MS/MSD	OA2 Spike	100uL

***Solution must be warmed prior to use to ensure that any precipitate is brought into solution.**

10) Cap each sep. funnel. Gently shake and vent into the fume hood. Repeat until all excess fumes are vented.
11) Place each sep. funnel on the shaker table and shake for two minutes with the stopcock open.
12) Close all the stopcocks, and place each sep. funnel back into its position in the fume hood.

13) Remove the stoppers and drain the methylene chloride (bottom layer) from each sep. funnel through the corresponding drying column so that it drains into K-D/tip.
14) Add 60mL of methylene chloride into each separatory funnel. For SV_8015SPR_W add 30mL of methylene chloride into each separatory funnel. For SV_OA2PR_W use the 30mL of methylene chloride to rinse the sample container, then pour it into the separatory funnel.
15) Repeat steps 10-14 (2nd shake)
16) Repeat steps 10-12 (3rd shake)
17) After the 3rd shake each sample must sit for 10 minutes to allow for separation of the methylene chloride from the water.
18) After the 10-minute wait break up any emulsions and drain all CH_2Cl_2 through the drying column. **See the emulsion note 1b. below the procedure for more information.**
19) Blow air through each drying column with the red pipette bulb.
20) For SV_OA2PR_W, add DI water to the sample container up to the line previously marked with the permanent marker, then pour the DI into a graduated cylinder and record the initial volume for each sample.
21) Remove each K-D/tip from its drying column and add one boiling chip to each extract.
22) Ensure that the cook down refrigerated recirculator/chiller is on and that the temperature is below 10°C.
23) Connect a Snyder column to each K-D/tip. Hang each extract on a cookdown apparatus.
24) Concentrate each extract down to ~3-5 mL in a hot water beaker set to ~55-65°C.
25) Let each K-D/tip cool to ~room temperature and remove from the cookdown apparatus.
    a) Dry each connection where the K-D connects to the tip with a paper towel, remove the tip, and label it with the appropriate sample ID.
26) Place each tip in the TurboVap and blow the extract down to <1mL. The TurboVap should be set to 40°C and the gas pressure between ~10-15 psi.
27) After OA2 and AG_SIMS are blown down draw the extract up in a clean 1 mL syringe, add a small amount of clean methylene chloride to the tip, and draw it up to adjust the final volume of the extract to 1mL.
28) After PST/PCB or MRH/HRH samples are blown down do a hexane exchange.
29) Hexane Exchange: Bring extract volume to 4-5mL with hexane. Mix extract with hexane by blowing air bubbles throughout the tip. Concentrate the extract below 1mL. Repeat this step two more times.
30) After the third hexane exchange, for PST/PCB samples concentrate the extract below 1mL and bring the extract to final volume of 5mL with fresh hexane. For MRH/HRH samples concentrate the extract just below 1mL, draw the extract up in a clean 1mL syringe, add a small amount of clean hexane to the tip, and draw it up to adjust the final volume of the extract to 1mL.
31) For PEST samples, indicated on the backlog with a check mark in the "PST" column, transfer ~ 2mL of the extract into the corresponding 2mL vial and immediately cap. All vialing steps should be performed in front of the ductless fume absorber.
32) For PCB samples, indicated on the backlog with a check mark in the "PCB" column, transfer the remaining extract into a clear 40mL vial that contains 10mL of concentrated sulfuric acid. Wearing a lab coat is suggested when working with sulfuric acid. Repeat for all the PCB samples.
33) Vortex each 40mL vial until sufficiently mixed.
34) Allow the mixture to separate into layers. The top layer is the hexane extract layer, and the bottom layer is the sulfuric acid layer. If the mixture does not separate into two layers, centrifuge the 40mL vial until separation occurs.
35) Once the hexane layer (top layer) is transparent, transfer ~ 1mL of the extract into the corresponding "YELLOW HIGHLIGHTED" 2mL vial and immediately cap.

See the note 1c. below the procedure for more information.

1a. Initial volumes less than 1000mL

If the sample is very soapy, oily, dark, and/or thick, less than 1000mL may be extracted. The reason for a reduced initial volume will be recorded in the comment section of the paperwork.

1b. Emulsions

The formation of emulsions is a common problem with aqueous extractions. Emulsions must be separated before draining.

The following procedures may be used to break up emulsions:

- Use a long glass stir rod to break up the emulsion
- Drain the emulsion into a 125mL or 250mL sep. funnel
- Centrifuge the emulsion

Record the presence of an emulsion in the sample's comment section of the prep batch work.

1c. Copper cleanup for PCBs

All MBLKs, LCS/Ds, MDLs, and samples (including MS/Ds) may get a copper cleanup. Weigh ~0.5 grams of copper powder in to a 2mL vial prior to transferring ~1mL of the extract into the vial. Alternatively, if copper cleanup is not performed, the analyst may perform a sulfur cleanup using the TBA sulfite procedure if needed.

ROUTINE MAINTENANCE

N/A

DATA ANALYSIS AND CALCULATIONS

N/A

REFERENCES/METHOD DEVIATIONS

Method 3510C:

1. Between shaking and draining the methylene chloride, the method calls for allowing the organic layer to separate from the aqueous layer for a minimum of 15 minutes. Teklab performs a 10 minute wait after the final shake only (7.6). Adequate separation of the solvent from the water is achieved. The effectiveness of this deviation is demonstrated by consistent acceptable QC performance.
2. For the extraction of Ag SIMS ~30g of NaCl is dissolved in the samples prior to extraction. The ionic bond formed between the salt and the water effectively 'salts out' analytes that would typically bond with the water (ie Terbufos) and does not have an adverse effect on the extraction of any other analytes as demonstrated by the acceptable extractions of QC and PT studies.

Method 6XX:

1. Between shaking and draining the methylene chloride, the method calls for allowing the organic layer to separate from the aqueous layer for a minimum of 15 minutes (10.2.3). Teklab performs a 10 minute wait after the final shake only. Adequate separation of the solvent from the water is achieved. The effectiveness of this deviation is demonstrated by consistent acceptable QC performance.
2. The method calls for pouring the sample by marking the meniscus on the bottle, pouring the sample, adding water to the level of the meniscus, and pouring that water into a graduated cylinder(10.2.2). Teklab determines the initial volume by pouring the sample directly into a graduated cylinder. This deviation is equally if not more accurate than the suggested technique.

Kansas Method for the Determination of MRH and HRH:

1. Between shaking and draining the methylene chloride, the method calls for allowing the organic layer to separate from the aqueous layer for a minimum of 5 minutes (9.1.1.5) Teklab performs a 10 minute wait after the final shake only. Adequate separation of the solvent from the water is achieved. The effectiveness of this deviation is demonstrated by consistent acceptable QC performance.
2. The method calls for pouring the sample by marking the meniscus on the bottle, pouring the sample, adding water to the level of the meniscus, and pouring that water into a graduated cylinder (9.1.1.1 & 9.1.1.7). Teklab determines the initial volume by pouring the sample directly into a graduated cylinder. This deviation is equally if not more accurate than the method suggested technique.
3. The method suggests to concentrate the extracts at 80-90°C (9.1.1.10). Teklab concentrates the extracts at 55-65°C for safety reasons due to the way concentration area is set up. Concentration at a lower temperature only affects the time it takes to concentrate the extract.
4. The method calls for the hexane exchange directly in the K-D flask (9.1.1.11). Teklab performs the hexane exchange in the tip as listed in the procedure section of this SOP. This method achieves the same end and is more conducive based on the way the concentration area is set up.

TABLES AND DIAGRAMS

	PSTPCB (PCB only)	**PSTPCB (PST only)**	**PSTPCB (both in batch)**	**PSTPCB (both on individual sample)**
LCSPST-#		X	X	X
LCSPSTD-#		X	X	X
LCSPCB-#	X		X	X
LCSPCBD-#	X		X	X
MBLK-#	X	X	X	X
MSPST		X	X	
MSPSTD		X	X	
MSPCB	X		X	X
MSPCBD	X		X	X

Table 1 Minimum Essential Quality Control for Prep Batches

METHOD PERFORMANCE

MDL/Method Validation: See Quality Manual Chapter 21
IDOC/ADOC: See Quality Manual Chapter 19

SAMPLE HANDLING

See 1000 series SOP Appendix B

POLLUTION PREVENTION

See 1000 series SOP Appendix D

WASTE MANAGEMENT

See 1000 series SOP Appendix D

6/29/2023
Approving Authority Approval/Effective Date

DEFINITIONS

Batch:
A Batch is environmental samples of the same matrix that are prepared together with the same process and personnel, using the same lot(s) of reagents. A "Preparation Batch" is composed of one to 20 environmental samples of the same TNI-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first sample and start of processing of the last sample being 24 hours. An "Analytical Batch" is composed of environmental samples (extracts, digestates, or concentrates) which are analyzed together as a group. An analytical batch can exceed 20 samples.

IDOC(Initial demonstration of Capability):
A DOC analyzed to establish competency of an analyst before the analyst is allowed to analyze samples without supervision.

LCS(Laboratory control samples)**:**
The LCS is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then taken through the entire analysis to determine batch acceptance.

Matrix: *These matrix definitions are to be used for purposes of batch and quality control requirements*:

Air and Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device.

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, ground water effluents, and TCLP or other extracts.

Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.

Drinking Water: Any aqueous sample that has been designated a potable or potential potable water source.

Non-Aqueous Liquid: Any organic liquid with <15% settleable solids.

Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Solids: Includes soils, sediments, sludges and other matrices with >15% settleable solids.

MBLK(method blanks) or **LCB**(laboratory control blanks):
A LCB is used to check contamination in the laboratory and is taken through the entire analytical procedure. The method blank consists of a matrix that is similar to the associated samples and is known to be free of the analytes of interest. These samples are used to verify the purity of all chemicals and reagents used in the methodologies and to prove the absence of contamination during the analytical procedure.

MS(Matrix spike):
These provide information about the effect of the sample matrix on the preparation and measurement methodology. All matrix spikes and matrix spike duplicates are hereafter referred to as MS/MSD samples. These samples are always run with another aliquot of the sample that is not spiked. Spiking a sample tells us what effect the sample matrix (i.e. aqueous, solid, non-aqueous liquid) has on the parameter being measured. Sometimes the sample matrix will hide a parameter; a matrix spike will help identify this effect by showing a low recovery. Because matrix spikes give more information about the sample and its matrix, they are preferred to running duplicates. Some analyses (pH and Temp for example) do not lend themselves to matrix spikes very easily, therefore some analyses do not use matrix spikes (inorganic/physical analysis only).

Main document changes and comments

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SV_8015SPR_W	A measured volume of sample is extracted with methylene chloride using a separatory funnel. The extract is dried, by draining it through a glass column with sodium sulfate, then concentrated and transferred to an amber glass vial.	SV_8015S_W

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For SV_8015SPR_W and SV_OA2PR_W, 500mL of sample is used with 30mL of methylene chloride. For SV_OA2PR_W, mark the level of the sample in the container with a permanent marker and pour the entire contents of the sample container into the sep funnel – then rinse the bottle with the 30mL of methylene chloride and pour it into the separatory funnel.
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SV_8015SPR_W	OA2 Surrogate **	200uL

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SV_8015SPR_W	LCS/LCSD & MS/MSD	OA2 Spike	100uL

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For SV_OA2PR_W and SV_8015SPR_W add 30mL of methylene chloride into each separatory funnel. For SV_OA2PR_W use the 30mL of methylene chloride to rinse the sample container, then pour it into the separatory funnel.

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For SV_OA2PR_W, add DI water to the sample container up to the line previously marked

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with the permanent marker, then pour the DI into a graduated cylinder and record the initial volume for each sample.

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Text Box changes

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Footnote changes

Endnote changes

TEKLAB, INC.
STANDARD OPERATING PROCEDURE FOR MICROWAVE EXTRACTION OF SEMI-VOLATILE ORGANICS IN SOLIDS

SCOPE

The use of this SOP is governed by the TEKLAB Quality Assurance Manual and associated SOPs including but not limited to, 1030, 1031, 1250, 1280, 1290, and 1310. Implementation of this SOP must always comply with the requirements of the Quality Assurance Manual and the applicable Section 1000 SOPs. For any necessary sub-sampling refer to SOP 1150. Refer to sections 5 and 27 of the Quality Manual for record keeping and reporting information.

This SOP is in accordance with SW-846 method 3546. It describes the procedure Teklab uses for isolating semi-volatile organic compounds from solid matrices such as soil, sludge, waste, and wipe samples.

This method is restricted to use by or under the supervision of trained analysts. Each analyst must perform an Initial Demonstration of Capability (IDOC) on this method prior to working with environmental samples without direct supervision.

SUMMARY

This SOP is to be followed when preparing samples with the following test codes:

Prep Code	Summary	Analysis Test Code(s)
SV_BNA_MW_S	A measured weight of sample is dried by mixing with sodium sulfate and extracted with methylene chloride using a microwave extraction system. The extract is filtered by draining through a glass funnel with filter paper and sodium sulfate, then concentrated and transferred to an amber glass vial.	SV_8270S_MW_S SV_TPH_DRO_MW_S SV_8270S_MW_S_SIMS
SV_P_SIMS_MW_S		SV_PEST_MW_S_SIMS
SV_AG_SIMS_MW_S		SV_8270S_AG_MW_S_SIMS
SV_OA2PR_MW_S		SV_OA2_MW_S

Note: Corresponding 'wipe' test codes may be performed using this procedure as well.

SAFETY

Eye protection and gloves are required with this procedure. Use extreme caution when working with solvents.

When working the microwave, the vessels may be warm after the microwave program finishes. It is critical to allow the samples to cool to approximately room temperature before opening the TFM vessels, otherwise warm solvent could spray out the vessels due to pressure buildup.

Read the appropriate SDS for additional safety information and to ensure proper handling of the following solvents used during this procedure:

- **Methylene Chloride**

EQUIPMENT & SUPPLIES

- Milestone Ethos X Advanced Microwave Extraction System
- Fast EX microwave rotor body
- Disposable glass culture tubes, 100mL
- TFM 100mL pressure reactor vessels with weflon rings, caps, and screw lids
- ACM automatic capping module torque drill
- Concentrator Tips, 10mL
- Glass funnels
- Turbovap nitrogen evaporation apparatus
- Organomation nitrogen evaporation apparatus
- Balance (top loading)
- Pasteur glass pipets, 5 and ¾ inch, disposable
- Amber autosampler vials, 2mL with Teflon lined screw caps
- Stainless steel forceps
- Stainless steel spatulas
- Syringes (various sizes)
- Ahlstrom qualitative filter paper or equivalent
- Wooden tongue depressors
- Beakers (various sizes)
- Dispensette Organic S bottle top dispenser
- Weflon rings

REAGENTS & STANDARDS (Quality Manual Chapter 23)

- Methylene chloride (CH2Cl2), Honeywell B&J GC grade or equivalent
- Sodium sulfate (NaSO4), granular (muffled at 500°C for 4 hours prior to use)
- Tinted Base/Neutral and Acid surrogate spiking solution, 100/200 µg/mL (purchased)
- BNA Prep Spikes A and B, 200 µg/mL (analyst prepared)
- DRO Spike, 4000 µg/mL (analyst prepared)
- PSIM Spike, 10/200 µg/mL (analyst prepared)
- AG SIM Spike, 10 µg/mL (analyst prepared)
- AG SIM Surrogate, 10 µg/mL (analyst prepared)
- OA2 Spike, 5000 µg/mL (analyst prepared)
- OA2 Surrogate, 400 µg/mL (analyst prepared)
- Nitrogen gas
- Deionized water
- See SOP 4022 Standard Prep and Tracking for storage conditions and labeling of standards
- See section 5 of the quality manual for record keeping information

CALIBRATION

N/A

QUALITY CONTROL (Quality Manual Section 26)

- Prep Batch
  A prep batch is a set of 20 or fewer samples of the same matrix extracted using the same procedure and reagents within the same 24-hour time period.

- Method Blank
  Each prep batch must contain a method blank (MBLK). The MBLK is prepared by adding the appropriate surrogate (see Table A) to ~30g of granular sodium sulfate and extracting per the procedure section of this SOP.

- Laboratory Control Sample
  Each prep batch must contain a laboratory control sample (LCS). The LCS is prepared by adding the appropriate spike and surrogate (see Tables A and B) to ~30g of granular sodium sulfate and extracting per the procedure section of this SOP.

- Matrix Spike and Matrix Spike Duplicate
  Each batch should contain a matrix spike and matrix spike duplicate (MS/MSD) if sample amount permits. If there is insufficient sample to perform and MS/MSD, a laboratory control sample duplicate (LCSD) must be extracted instead. The MS/MSD are prepared by adding the appropriate spike and surrogate (see Tables A and B) to ~30g of any random sample in the prep batch.

- Surrogate
  The appropriate surrogate is added to every sample, MBLK, LCS, and MS/MSD in the batch (see Table A).

CORRECTIVE ACTION (Quality Manual Chapter 13)

Quality control excursions may result in re-preparation of the associated samples. All other corrective actions are performed per Quality Manual Chapter 13.

INTERFERENCES

Contamination in solvents, reagents, glassware, and other sample processing equipment can cause analytical interferences. All of these materials must be proven to be free of contaminants under the conditions of analysis by running laboratory method blanks. Matrix interferences may be caused by contaminants that are co-extracted from the sample and will vary from sample to sample.

PROCEDURE

1. Insert a 100mL disposable glass culture tube into each TFM pressure reactor containing a weflon ring and place them on the microwave rotor.
2. Write out the prep batch sheet and indicate which spot (1 through up to 24) each sample will be in on the microwave rotor.
3. Add ~30g of sodium sulfate to each MBLK, LCS and LCSD. For wipe samples, add a torn up piece of filter paper in addition to the sodium sulfate.
4. Homogenize the samples.

5. Weigh ~30g of each sample into a 100mL glass culture tube and record the weight to the nearest 0.01g on the batch sheet. Depending on the required reporting limits and/or the composition of the sample, a larger or smaller aliquot may be used. For wipe samples, transfer the entire wipe into the culture tube, rinse the sample jar with methylene chloride, and pour the rinse into the tube with the sample.
6. Add ~30g of sodium sulfate to the samples in each vessel and mix the sodium sulfate and the sample until a free flowing texture is created. Add additional sodium sulfate if necessary. If necessary due to sample matrix, the sample and sodium sulfate may be mixed in a beaker and transferred to the culture tube.
7. Place the rotor holding all of the vessels into a fume hood.
8. Open a prep batch in LIMS and load all the QC and samples into the batch.
9. With another worker present to verify the process, and the appropriate spike and surrogate to each item in the batch according to Tables A and B.
10. Add 40mL of methylene chloride to each tube. If a larger or smaller sample aliquot was used, the amount of methylene chloride may be adjusted accordingly. Ensure that the solvent goes above the top of the sample, otherwise add an additional 5mL solvent at a time until the sample is completely covered.
11. Place the TFM caps over the glass culture tubes on each vessel, and lightly screw on the lids for each vessel.
12. Tighten each lid using the cordless ACM capping module torque drill.
13. Turn on the Ethos X microwave and place the rotor inside.

14. Ensure that method 3546 is loaded, if not load it from the recent methods list. The parameters for this method are: Ramp for 15 minutes to 110°C at 1400W, hold at 110°C for 10 minutes at 1400W, vent for 20 minutes – total run time is 45 minutes.
15. After the method is loaded press the green 'play' button, then enter the number of vessels in the rotor, then press the green 'play' button again.
16. After the program is complete, remove the rotor from the microwave.
17. Once the samples are cooled to ~room temperature, open the vessels using the reverse setting on the cordless ACM capping module torque drill.
18. For each extract, place a glass funnel containing filter paper into a clean 100mL culture tube.
19. Add ~10g of sodium sulfate to the funnel containing the filter paper.
20. Use a permanent marker to label each culture tube with the corresponding sample IDs.
21. Filter each extract through the sodium sulfate and into the culture tube. Rinse the original culture tube with methylene chloride and pour the rinsate through the filter as well.
22. Once the extract has finished draining, remove the glass funnel.
23. Place each culture tube into a spot on the Organomation nitrogen evaporator.
24. Blow each extract down to ~4mL.
25. Transfer each extract from the culture tube to a 10mL concentrator tip (labeled with the corresponding sample ID using permanent marker), rinse the culture tube and add the rinsate to the tip as well.
26. Place the concentrator tip into the Turbovap nitrogen evaporator and blow the sample down just below 1mL at a pressure of ~10-12psi.

27. Draw the extract into a 1mL syringe and use clean methylene chloride to adjust the final volume to exactly 1mL. Depending on the required reporting limits and/or the initial weight, a higher or lower final volume may be used.
28. Place the final extract into a 2mL amber autosampler vial labeled with the corresponding sample ID (printed from LIMS) and cap with a Teflon lined screw cap. Record the final volume on the prep batch sheet, then record all corresponding data in the LIMS batch and close the batch.

ROUTINE MAINTENANCE

N/A

DATA ANALYSIS AND CALCULATIONS

N/A

REFERENCES/METHOD DEVIATIONS

N/A

TABLES AND DIAGRAMS

TABLE A

Prep Code	Surrogate Solution Name	Amount (µL)
SV_BNA_MW_S	Tinted BNA Surrogate	250
SV_P_SIMS_MW_S	Tinted BNA Surrogate	50
SV_AG_SIMS_MW_S	AG SIM Surrogate*	100
SV_OA2PR_MW_S	OA2 Surrogate**	200

***Do not add AG SIM surrogate to LCS/LCSD and MS/MSD. (AG SIM Spike mix contains the surrogate compounds.**

****OA2 surrogate solution must be sonicated to ensure that any analyte that has precipitated out during storage is dissolved into the solution before use. This is performed in a "low power" jeweler's type sonicator bath.**

TABLE B

Prep Code	Type	Spike Solution Name	Amount (µL)
SV_BNA_MW_S	LCS/LCSD and MS/MSD	BNA Prep Spike A	250
		BNA Prep Spike B	250
	LCSDRO/LCSDROD and MS/MSD	DRO Spike	250
SV_P_SIMS_MW_S	LCS/LCSD and MS/MSD	PSIM Spike	100
SV_AG_SIMS_MW_S	LCS/LCSD and MS/MSD	AG SIM Spike	100
SV_OA2PR_MW_S	LCS/LCSD and MS/MSD	OA2 Spike	100

METHOD PERFORMANCE

MDL/Method Validation: See Quality Manual Chapter 21
IDOC/ADOC: See Quality Manual Chapter 19

SAMPLE HANDLING

See 1000 Series SOP Appendix B

POLLUTION PREVENTION

See 1000 Series SOP Appendix D

WASTE MANAGEMENT

See 1000 Series SOP Appendix D

Stephen

9/6/2023

Approving Authority Approval/Effective Date

DEFINITIONS

ADOC(Annual Demonstration of Capability):
A procedure to demonstrate an analyst's continuing proficiency at performing a specific analysis.

Batch:
A Batch is environmental samples of the same matrix that are prepared together with the same process and personnel, using the same lot(s) of reagents. A "Preparation Batch" iscomposed of one to 20 environmental samples of the same TNI-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first sample and start of processing of the last sample being 24 hours. An "Analytical Batch" is composed of environmental samples (extracts, digestates, or concentrates) whichare analyzed together as a group. An analytical batch can exceed 20 samples.

IDOC(Initial demonstration of Capability):
A DOC analyzed to establish competency of an analyst before the analyst is allowed to analyzesamples without supervision.

LCS(Laboratory control samples):
The LCS is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then taken through the entire analysis to determine batch acceptance.

Matrix: *These matrix definitions are to be used for purposes of batch and quality control requirements:*

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, ground water effluents, and TCLP or other extracts.

Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.

Drinking Water: Any aqueous sample that has been designated a potable or potential potable water source.

Non-Aqueous Liquid: Any organic liquid with <15% settleable solids.

Solids: Includes soils, sediments, sludges and other matrices with >15% settleable solids.

MBLK(method blanks) or **LCB**(laboratory control blanks):
A LCB is used to check contamination in the laboratory and is taken through the entire analytical procedure. The method blank consists of a matrix that is similar to the associated samples and is known to be free of the analytes of interest. These samples are used to verify the purity of all chemicals and reagents used in the methodologies and to prove the absence of contamination during the analytical procedure.

MDL(Method detection limit):
The method detection limit (MDL) is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results. This number is used in LIMS and appears on final reports. The MDL is used to accommodate variances in multiple instrument MDL determinationsand to minimize ongoing adjustments to the reporting limits.

MS(Matrix spike):
These provide information about the effect of the sample matrix on the preparation and measurement methodology. All matrix spikes and matrix spike duplicates are hereafter referred to as MS/MSD samples. These samples are always run with another aliquot of the sample that is not spiked. Spiking a sample tells us what effect the sample matrix (i.e. aqueous, solid, non-aqueous liquid) has on the parameter being measured. Sometimes the sample matrix will hide a parameter; a matrix spike will help identify this effect by showing a low recovery. Because matrix spikes give more information about the sample and its matrix, they are preferred to running duplicates. Some analyses (pH and Temp for example) do not lend themselves to matrix spikes very easily; therefore some analyses do not use matrix spikes (inorganic/physical analysis only).

Main document changes and comments

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Evaporative Flasks, 500mL Kuderna-Danish (K-D)

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Teflon boiling stones
Heated water baths
Lab jacks

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Keck clips

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Weflon rings

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containing a weflon ring

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vessel

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tube

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and place the rotor inside.

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Place the rotor body in the microwave.

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may be opened

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connect a 10mL concentrator tip to a K-D flask. P

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the K-D flask

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to a clean 100mL culture tube

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For OA2, PSIMS, or BNA SIMS test codes, rinse the filter and glassware with methylene chloride.

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Print labels from LIMS and attach a label to each K-D flask.

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Use a permanent marker to label each culture tube with the corresponding sample IDs.

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K-D flask

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culture tube

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original

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tube with methylene chloride and pour the rinsate through the filter as well.

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tube
with methylene chloride and pour the rinse through the filter as well.

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Add a boiling chip to each K-D flask/concentrator tip. Place a Snyder column on each K-D flask.

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Place each culture tube into a spot on the Organomation nitrogen evaporator.

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Place the K-D flask/concentrator tip in a hot water bath between ~55-65°C and cook the extract down to ~4-5mL.

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Blow each extract down to ~4mL.

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Allow the glassware to cool, use a paper towel to remove any residual water from the connection joint of the K-D flask and the concentrator tip, and remove the concentrator tip from the K-D flask labeling it with the appropriate sample ID.

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Transfer each extract from the culture tube to a 10mL concentrator tip (labeled with the corresponding sample ID using permanent marker), rinse the culture tube and add the rinsate to the tip as well.

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Turbovap

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labeled with the corresponding sample ID (printed from LIMS)

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Text Box changes

Header and footer text box changes

Footnote changes

Endnote changes

TEKLAB, INC.
STANDARD OPERATING PROCEDURE FOR ANALYSIS OF TOTAL PETROLEUM HYDROCARBONS BY CAPILLARY COLUMN GC/FID

SCOPE

The use of this SOP is governed by the TEKLAB Quality Assurance Manual and associated SOPs including but not limited to, 1030, 1031, 1250, 1280, 1290, 1310, and 4026. Implementation of this SOP must always comply with the requirements of the Quality Assurance Manual and the applicable Section 1000 SOPs. For any necessary sub-sampling, refer to SOP 1150.

This SOP describes the procedures for the analyzing of samples for total petroleum hydrocarbons (TPHs/OA2s) in extracts from solids, aqueous and non-aqueous liquid matrices in accordance with method OA2. Extracts have a hold time of 40 days from extraction.

Table #2 lists the compounds that are routinely reported by this procedure and it gives the Reporting Limits (RL) for each matrix. The RLs given are based on the low-level standard, sample amount extracted, and the final sample volume. Matrix interference may result in higher RLs than those listed. Annual mdl studies may affect the RLs listed in the table.

SUMMARY

This method presents conditions for the analysis of prepared extracts of TPHs. The samples are first extracted using applicable SW-846 method 3510C for aqueous samples, 3550B for solids, and 3580A for non-aqueous liquids (the latest revision of Teklab Inc. SOP's 4115, 4116 and 4110 respectively). The TPHs are injected onto the column, separated and detected by flame ionization detection (FID). Quantitation is by the external standard method.

SAFETY

Safety glasses and appropriate gloves must be worn while handling samples, standards, solvents or reagents. Laboratory coats may be used for additional safety. Standards and samples must be handled with extreme care to avoid excess exposure. Contaminated gloves and clothing must be removed immediately. Read the SDS for Methylene Chloride for safety information used in this procedure.

Hydrogen gas is explosive. Excessive Hydrogen gas may build up inside the oven, creating an explosive environment. Do not leave column disconnected from a lit FID flame.

EQUIPMENT & SUPPLIES

- Hewlett-Packard 5890 GC with HP 7673A Autosampler, 1.0µL injection onto a single capillary column and flame ionization detector (FID).
- J & W column configuration:
  J & W Scientific DB-5MS 30 meter x 0.32mm ID x 0.25µm film thickness
  Columns are mounted in a glass injection port insert with press fit union.
- WIN Chemstation using Microsoft Windows 98 and HP Enviroquant software.
- Glass Syringes-25µL ,250µL, and 1000µL
- Glass Pastuer pipets
- Class A Volumetric flasks with glass stoppers
- 8mL Amber vials with screw caps

- 2mL Clear vials with snap-on lids or crimp top caps
- Glass injection port liners with ferrules
- Low bleed septa
- Top Loader balance capable of measuring 0.01g

REAGENTS AND STANDARDS (Quality Manual Chapter 23)

- Gases for carrier and make-up: Hydrogen and Nitrogen
  Gases for the flame: Hydrogen and Air from an air compressor.
- The reagent used for extraction and final extract volume is Methylene chloride (it is of reagent grade (AR) or better).
  - Stock Standards (Primary)
    The stock standards are purchased as certified solutions (traceable to national standards where available). The stock standards are stored according to the manufacturer's instructions. All stock standards must be replaced by the expiration date provided by the manufacturer or sooner if comparison with check standards prepared from an independent source indicates a problem. **Stock standards expire one year from open date or the manufacturer's expiration date, whichever is sooner.**
  - Stock Standards (Secondary)
    1.25 mL of the Primary Stock standard is diluted to 5 mL in Methylene Chloride to provide the Level-6 stock that is used to prepare the calibration curves.
- Calibration Standards
  The calibration standards are prepared as dilutions of the stock standards with methylene chloride. Calibration standards must be stored at <6ºC. The standards must be replaced at least every six months or sooner if comparison with check standards indicates a problem. **Calibration standards expire six months from preparation, or the manufacturers expiration date, whichever is sooner**.

TPH/OA2 Curve
Level-6 Stock – 5000ug/ml

Concentration	Stock	Methylene Chloride	Final Volume	Stock/Solvent for 250ul Final Volume
2500 ug/mL	125 uL	125uL	250 uL	125uL/125uL
1000 ug/mL	200 uL	800 uL	1 mL	50uL/200uL
500 ug/mL	100 uL	900 uL	1 mL	25uL/225uL
250 ug/mL	50 uL	950 uL	1 mL	12.5 uL/237.5 uL
100 ug/mL	20 u uL	980 uL	1 mL	5uL/245uL

- Quality Control (QC) Standards
  The QC standards (matrix spiking and LCS standards) are prepared and stored in the same way as the calibration standards.
- Surrogate Standards
  The surrogate standard is prepared as a dilution of the stock standard and follows the same criteria as the QC standards. The surrogate used in this method is n-Tetracontane (C-40). (See Table #1) **This standard needs warmed and vortexed before using.**
- See SOP 4022 Standard Prep and Tracking for storage conditions and labeling of standards.

CALIBRATION (Quality Manual Chapter 22)

All samples are quantitated by external calibration. This method assumes a proportional relationship between the calibration standard and the analyte in the sample. An analyte in the sample is quantitated from the initial calibration curve of one of the four standard analytes. The appropriate standard analyte is chosen by comparing the retention time range of the standard to the retention time range of the hydrocarbon pattern found in the sample. Quantitation is performed by using any of the following: the average response factor (aRF) [Eq. #1], linear regression [Eq. #2], or Quadratic curve [Eq. #3]. Average Response can be used if the RSD is less than 20%. The correlation coefficient must be greater than or equal to 0.99 for the linear regression and quadratic calibration to be valid. The initial calibration curve is generated by running at least five levels (six if a quadratic fit is employed) of the calibration standard (Diesel, Kerosene, Mineral Spirits and Motor Oil). The lowest level of the curve must be a concentration at or below the reporting limit. The other levels will define the working range of the detector. The recommended levels are given in Table #1. If the initial calibration does not meet the above criteria it must be rejected and the cause determined. A new initial calibration will then be analyzed.

An initial calibration verification from a second source must be performed before a new curve can be used to analyze samples. A level 3 or level 4 standard may be used as the ICV. The ICVs are controlled charted. If the ICV does not pass the criteria in LIMS a corrective action must be taken. The corrective action would include re-analyzing the ICV or generating a new calibration curve.

A new calibration curve must be generated after major changes to the system that would result in the continuing calibration check not passing its criteria. Major changes may include changing the column, changing the FID detector or any contamination that results in a major change in sensitivity of the detector.

Equations:

Eq. #1 avg. response factor equation:

$$\text{Response Factor (RF)} = \frac{\text{Area of Peak}}{\text{Mass Injected (ng)}}$$

$$\text{Avg. Response Factor} = \frac{\text{Sum of RFs for each calibration level}}{\text{Number of calibration levels}}$$

Eq. #2 linear regression equation:

$$y = mx + b$$

where:

y = calculated concentration
m = slope of the linear regression line
x = the response/area of the integrated peak(s)
b = the y-intercept

Eq. #3 quadratic equation

$$y = ax + cx^2 + b$$

where: y = Instrument response
x = Concentration
a= Slope

Eq. #4 % Drift equation:

$$\%D = \frac{\text{Calculated Conc.} - \text{Theoretical Conc.}}{\text{Theoretical Conc} * 100}$$

QUALITY CONTROL (Quality Manual Section 26)

- **Prep Batch**
  A prep batch is a set of 20 or fewer samples of the same matrix extracted using the same procedure and reagents within the same 24-hour time period. Each prep batch must contain a method blank (MBLK), a laboratory control sample (LCS), and a matrix spike/matrix spike duplicate (MS/MSD). If insufficient sample is available for the MS/MSD then a LCS duplicate (LCSD) must be substituted in place of the MS/MSD. See section 26 of the Quality Manual for matrix spike sample selection instructions.
- **Analytical Batch**
  An analytical batch is composed of environmental samples that are analyzed together as a group using the same calibration curve or factor. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.
- **Method Blank**
  The method blank (MBLK) contains reagent water for aqueous samples and sodium sulfate for solid samples. The surrogate is added to the MBLK and it is carried through the same extraction and analytical procedure as the samples. The MBLK must not contain any target analyte at or above the reporting limit. Samples with non-detectable results associated with a contaminated blank may be reported without qualification. Corrective action must occur if an analyte was positively identified in a sample at a concentration between the reporting limit to 10 times the amount found in a contaminated blank. The corrective action would be the re-extraction and re-analysis of the affected samples with an acceptable MBLK. If; however, the contamination did not follow the pattern of any of the target compounds and in no way interferes with the analysis of the compounds then the samples may be reported with an appropriate statement added to the case narrative. If the surrogate recovery in the MBLK is outside of the established control limits, the prep batch is considered out of control and must be re-extracted and re-analyzed if sample amount permits. If there is insufficient sample to re-extract the samples, appropriate qualifiers and/or an explanation in the case narrative or sample narrative must be reported with the data.
- **Laboratory Control Sample**
  The laboratory control samples (LCS/LCSD) are spiked with Diesel standard (see Table #3). The LCS standard is prepared according to SOP4022 to a final concentration of 5000µg/mL. The recovery of the analyte(s) is control charted. If the recovery of this analyte is outside of the established control limits, the analysis is out of control. If after re-analysis the LCS is still out of control, corrective action must occur. The normal corrective action is the re-extraction and reanalysis of the entire prep batch if sample amount permits. If insufficient sample remains for re-extraction, appropriate qualifiers and/or an explanation in the case narrative must be reported with the data. The recoveries of these analytes are control charted and can be found in LIMS. Refer to the Appendix of this SOP for examples of control limits
- **Matrix Spike and Matrix Spike Duplicate/Sample Duplicate**
  The matrix spike and matrix spike duplicate (MS/MSD) are spiked with Diesel standard (see Table #3). The MS/MSD standard is prepared according to SOP4022 to a final concentration of 5000µg/mL. The recovery and the relative percent difference (RPD) of these analytes are

control charted and can be found in LIMS. Refer to Appendix of this SOP for examples of control limits. If any of the recovery criteria for this analyte are not met, the data must be reported with appropriate data qualifiers and/or an explanation in the case narrative. Data qualifier definitions are found in Table 4.

- **Surrogates**
  The surrogate (C-40) is spiked into every sample, MBLK, LCS, and MS/MSD. The surrogate standard is prepared according to SOP4022 to a final concentration of 200µg/mL. The surrogate standard is sonicated prior to use as recommended by the manufacturer. If the surrogate recovery in the MBLK is outside of the established control limits, the analytical batch is considered out of control and must be re-extracted and re-analyzed if sample amount permits. If insufficient sample remains for re-extraction, appropriate qualifiers and/or an explanation in the case narrative must be reported with the data. If the surrogate recovery in a sample is outside the control limits and can be shown that it is the result of matrix interference, the data is reported with appropriate data qualifiers. If the surrogate recovery in a sample is outside of the control limits and can be shown that it is the result of matrix interference, a statement is added to the case narrative of the final report. If the surrogate recovery in a sample is outside the control limits but was not caused by matrix interference, any affected samples are re-extracted and re-analyzed if sample amount permits. If there is insufficient sample to re-extract, an appropriate statement is added to the case narrative. Data qualifier definitions are found in Table 4. The recoveries are determined and control charted and can be found in LIMS. Refer to Appendix of this SOP for examples of control limits.

Quality Control:

$$\text{Percent Recovery 1}^{\text{st}}\text{ Spike} = \frac{(X_2 - X_1)}{\text{Spike Conc.}} * 100$$

$$\text{Percent Recovery 2}^{\text{nd}}\text{ Spike} = \frac{(X_3 - X_1)}{\text{Spike Conc.}} * 100$$

$$\text{RPD} = \frac{|(X_2 - X_3)|}{(X_2 + X_3)/2} * 100$$

X_1 = Concentration of unspiked sample
X_2 = Concentration of 1st spiked sample
X_3 = Concentration of 2 nd spiked sample.

CORRECTIVE ACTION (Quality Manual Chapter 13) Low surrogate (C-40): Replace liner

INTERFERENCES

- Contamination in solvents, reagents, glassware and other sample processing equipment can cause analytical interferences. Care should be exercised in keeping dirty Oil and Grease glassware from the water in which organic glassware is washed. All of these materials must be proven to be free of contaminants under the conditions of analysis by running laboratory method blanks.
- Matrix interference may be caused by contaminants that are co-extracted from the sample and will vary from sample to sample. The presence of interference may raise the quantitation limits for individual samples.

- Phthalate esters, which are common plasticizers, can pose a major problem. Avoiding contact with any plastic materials minimizes interference from phthalates

PROCEDURE

The general procedure is outlined in SW-846 and method OA2.

Sample extracts and the Diesel Calibration standard need warmed before injecting. This may be accomplished by setting them near the FID detector or a similar heat source. This is to make sure the surrogate (C-40) goes into solution.

- Calibration Checks:
  A continuing calibration check for all analytes must be analyzed at the beginning of each twelve hour shift to verify the calibration curve. This is done by the analysis of a mid-level calibration standard for each of the four analytes (Diesel, Kerosene, Mineral Spirits, and Motor Oil). Additionally, a mid-level Kerosene/Motor Oil may be analyzed periodically throughout the sequence and must be analyzed at the end of the analytical batch.
  The actual concentration of the target analyte in the calibration check is compared to the theoretical concentration in the standard and a % drift (%D) is calculated. This %D must be +/- 15%. If the acceptance criteria are exceeded high and the associated samples are non-detects for the compounds in question, then the samples may be reported. Otherwise, the samples must be re-analyzed after a calibration check that has met the acceptance criteria has been analyzed. If the acceptance criteria are exceeded low the samples may be reported if the maximum regulatory limit is exceeded. Otherwise, the samples must be re-analyzed after a calibration check that has met the acceptance criteria has been analyzed. A calibration check must be analyzed at the beginning and end of each analytical batch. A level 3 or level 4 standard may be used as a calibration check.

GC Conditions/column analysis:

1. Column:
   - Carrier gas: hydrogen
     Flow rate: Constant flow 3mL/min.
   - Initial temperature: 60°C with hold time of zero minutes
   - Program: 40° C/minute with final temperature of 330°C with hold time of 7.5 minutes
   - Total run time: 14.25 minutes

2. Injector:
   - Temperature: 320°C
   - Sample injection: on-column injection with 1µL of sample at fast injection rate, which is injected onto the column through a glass injection port liner with glass wool plug
   - Purge off On 0.5min Off 0.0 min Splitless checked
3. Detectors:
   - Temperature: 345°C
   - Make-up gas: nitrogen
     Flow rate: 47.5 ml/min.
   - Flame gases: hydrogen and air
     Flow rate: Hydrogen - 40 mL/min., Air – 420mL/min.

Calibration:

- TEKLAB uses 1µL injection of each calibration standard and sample extract .
- Calibration factors are calculated by the external standard technique.
- Initial calibration: the analysis of at least a five point calibration curve (six for quadratic) for Diesel, Motor Oil, Kerosene and Mineral Spirits. The surrogate is calibrated from the Diesel calibration curve.

ROUTINE MAINTENANCE

Replace liner when needed. Typically daily.
Replace septa when needed. Typically once a week.

DATA ANALYSIS AND CALCULATIONS

- Calibration Curve:
  The initial calibrations are calculated for curve fit using the HP software after peak integration has been reviewed and accepted by the analyst. The correlation coefficient must be greater than or equal to 0.99 for the linear regression and quadratic calibration to be valid. Less than 20% RSD for average response factor.

- The high and low standards of the initial calibration curve define the acceptable quantitation range for all the TPH/OA2 analytes. If any sample is determined above this range, the extract must be diluted and re-analyzed.

- A mid-level standard for each hydrocarbon type is used to verify the calibration of the instrument prior to the beginning of analysis. A mid-level standard of one of the hydrocarbon types is used to verify the calibration of the instrument at the end of the analytical run. The Kerosene/Motor Oil standard is typically ran at the mid level as the CCV. Kerosene is a representative for Diesel and Mineral Spirits. Diesel and Mineral Spirits are considered passing if the Kerosene portion of the standard passes QC requirements.

- The surrogate calibration curve is calculated from the Diesel calibration curve.

- Qualitative Identification:
  Identification of TPH/OA2 occurs when peaks found in a sample chromatogram fall within the retention time ranges and the calculated concentration is above the reported detection limit. The main source of identification for multi-response analytes is the analyst’s use of pattern recognition from the standard as the confirmatory identification. See SOP 4026 for instructions on chromatographic peak integration.

- Quantitation:
  The concentration of an analyte in a sample is determined by the external calibration procedure and quantitated from the initial instrument calibration. Samples that are over the calibration range must be diluted or reported as an estimated value. The LIMS makes adjustments for dilutions and alternate final volume. A concentration is calculated using the sum of the areas of all the peaks within the retention time range. The following equations are used for aqueous and non-aqueous samples:

For aqueous samples:

$$\text{Concentration } (\mu g/L) = \frac{((m * x) + b) * V_t * D)}{(V_I * V_s)}$$

For non-aqueous samples:

$$\text{Concentration } (mg/Kg) = \frac{((m * x) + b) * V_t * D)}{(V_I * W)}$$

Where:

x = Area of the peaks for the analyte in the sample.
m = the slope of the linear regression line
b = the y-intercept of the linear regression line
V_t = Total volume of the concentrated extract (µL)
D = Dilution factor
V_I = Volume of extract injected (µL)
V_s = Volume of sample extracted (ml)
W = Weight of sample extracted (g). The wet weight or dry weight may be used depending on the client requests

Solid samples may be calculated to a dry weight basis by using the Pmoist selection in LIMS Samples requiring results on a dry weight basis should also request a total solids analysis. The technician assigned to the total solids analysis will enter the Pmoist result in LIMS. Once the Pmoist factor is entered calculation of a sample in LIMS will convert the result to a dry weight basis and change the units to mg/Kg-dry.

There are many hydrocarbon compounds found in the environment. When hydrocarbons are detected which do not match the pattern of any standard and fall within RT of known analyte, they are quantitated using the analyte curve that contains the unknown within its RT window and flagged with a "#" in the UQual column.

REFERENCES/METHOD DEVIATIONS

To best represent any matrix interferences that may be present in the samples analyzed, Teklab reports all surrogate recoveries from the most concentrated analysis.
Method OA2 states that standards should be purchased from a commercial source and whenever possible should be the actual fuel that has contaminated a particular site. Teklab uses certified standards that are traceable to known reference materials. This conforms to the requirements in NELAC for standard preparation.

See SOP 1000 series Appendix D

TABLES & DIAGRAMS

TABLE #1
TPH CALIBRATION LEVELS, µg/mL

	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6[1]
Mineral Spirits	100	250	500	1000	2500	5000
Kerosene	100	250	500	1000	2500	5000
Diesel	100	250	500	1000	2500	5000
Motor Oil	100	250	500	1000	2500	5000
Amount of Level 6 Stock used to 250µL final volume	5µL	12.5µL	25µL	50µL	125µL	
SURROGATE:						
n- Tetracontane (C-40)	4	10	20	40	100	200

[1] Level 6 is optional and should be used only if linearity can be maintained on the instrument to this level.

Note: One standard must be at or below the regulatory limit/decision level, if known unless the regulatory limit is less than the laboratory detection limits.

TABLE #2.
STANDARD ANALYTE LIST, REPORTING LIMITS (PPM)

Compound	Aqueous	Aqueous	Solids	Solids	Non-aqueous liquids	Non-aqueous liquids
	MDL	**PQL**	**MDL**	**PQL**	**MDL**	**PQL**
Mineral Spirits	0.020	0.40	1.2	5.0	1000	1500
Kerosene	0.060	0.40	1.2	5.0	1000	1500
Diesel	0.050	0.25	3	5.0	1000	1500
Motor Oil	0.030	0.40	1.9	5.0	1000	1500

The following concentration factors are assumed in calculating the Reporting Limits:

	Extraction Volume	Final Volume
Aqueous samples	1000 mL	1.0 mL
Solids	30 g	1.0 mL
Non-aqueous liquids	1 g	10 mL

Note: MDLs and PQLs may change based on ongoing MDL and MDLb data collection

TABLE #3
SPIKED COMPOUNDS THAT ARE CONTROL CHARTED AND APPROXIMATE SPIKED CONCENTRATION (PPM)

	Aqueous samples	Solids	Non-aqueous liquids
<u>Compound</u>			
Diesel	0.50	16.7	500
SURROGATES			
n- Tetracontane (C-40)	0.02	0.67	20

Table 4
8015 Data Qualifier Definitions

B	Analyte detected in the associated method blank
S	Spike recovery outside of quality control limits
R	RPD outside of quality control limits
J	Over MDL but less than PQL
E	Over calibration range
X	Over the maximum contaminate level of client
#	Unknown Hydrocarbon

METHOD PERFORMANCE
See SOP 1000 series Appendix C

SAMPLE HANDLING
See SOP 1000 series Appendix B

POLLUTION PREVENTION
See SOP 1000 series Appendix D

WASTE MANAGEMENT
See SOP 1000 series Appendix D

SIGNATURE

6/20/23

Approving Authority　　　Date (Approval/Effective)

The use of this SOP is governed by the TEKLAB Quality Assurance Manual and associated SOPs including but not limited to 1030, 1031, 1250, 1280, 1290, and 1310. Implementation of this SOP must always comply with the requirements of the Quality Assurance Manual and the applicable Section 1000 SOPs. For any necessary sub-sampling refer to SOP 1150.

DEFINITIONS

Batch:
A Batch is environmental samples of the same matrix that are prepared together with the same process and personnel, using the same lot(s) of reagents. A “Preparation Batch” is composed of one to 20 environmental samples of the same TNI-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first sample and start of processing of the last sample being 24 hours. An “Analytical Batch” is composed of environmental samples (extracts, digestates, or concentrates) which are analyzed together as a group. An analytical batch can exceed 20 samples.

Calibration Curve:
The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.

CCB(Continuing Calibration Blank):
The CCB is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest. This sample is then analyzed to check the state of calibration of an instrument as sample are being analyzed.

CCV(Continuing Calibration Verification)**:**
The CCV is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then analyzed to check the state of calibration of an instrument as sample are being analyzed.

DOC(Demonstration of Capability):
A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.

DUP(Duplicate samples):
Analyzed to check for sampling and analytical reproducibility. Field duplicates are taken during sample collection. Internal duplicates are analyzed in the laboratory by splitting the sample and analyzing each split as an independent sample. See applicable SOP for frequency of matrix spike duplicates by analysis.

ICB(Initial Calibration Blank):
The ICB is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest. This sample is then analyzed to determine the state of calibration of an instrument before sample analysis is initiated.

ICV(Initial Calibration Verification)**:**
The ICV is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then analyzed to determine the state of calibration of an instrument before sample analysis is initiated.

IDOC(Initial demonstration of Capability):
A DOC analyzed to establish competency of an analyst before the analyst is allowed to analyze samples without supervision.

LCS(Laboratory control samples)**:**
The LCS is prepared from a matrix that is similar to the associated samples known to be free of the analytes of interest and spiked with known and verified concentrations of analytes. This sample is then taken through the entire analysis to determine batch acceptance.

Matrix: *ThehsmatrixsdhfinitionesarhstosbhsuehdsforspurpoehesofsbatcTsandsqualityscontrolsrhquirhmhnte*:

AirsandsEmieeione: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device.

Aquhoue: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, ground water effluents, and TCLP or other extracts.

Biologicals ieeuh: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

CThmicalsWaeth: A product or by-product of an industrial process that results in a matrix not previously defined.

DrinkingsWathr: Any aqueous sample that has been designated a potable or potential potable water source.

Non-AquhouesLiquid: Any organic liquid with <15% settleable solids.

Salinh/Eetuarinh: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Solide: Includes soils, sediments, sludges and other matrices with >15% settleable solids.

MBLK(method blanks) or **LCB**(laboratory control blanks):
A LCB is used to check contamination in the laboratory and is taken through the entire analytical procedure. The method blank consists of a matrix that is similar to the associated samples and is known to be free of the analytes of interest. These samples are used to verify the purity of all chemicals and reagents used in the methodologies and to prove the absence of contamination during the analytical procedure.

MDL(Method detection limit):
The method detection limit (MDL) is defined as the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results. This number is used in LIMS and appears on final reports. The MDL is used to accommodate variances in multiple instrument MDL determinations and to minimize ongoing adjustments to the reporting limits.

MS(Matrix spike):
These provide information about the effect of the sample matrix on the preparation and measurement methodology. All matrix spikes and matrix spike duplicates are hereafter referred to as MS/MSD samples. These samples are always run with another aliquot of the sample that is not spiked. Spiking a sample tells us what effect the sample matrix (i.e. aqueous, solid, non-aqueous liquid) has on the parameter being measured. Sometimes the sample matrix will hide a parameter; a matrix spike will help identify this effect by showing a low recovery. Because matrix spikes give more information about the sample and its matrix, they are preferred to running duplicates. Some analyses (pH and Temp for example) do not lend themselves to matrix spikes very easily, therefore some analyses do not use matrix spikes (inorganic/physical analysis only).

PQL(Practical Quantitation Limit):
The PQL is the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operation conditions.

PQLSTD:
The Standard in the curve at or below the limit of quantitation.

QC sample:
QC samples are purchased from an independent source to verify analytical procedures and calibrations. All QC samples must be NIST traceable reference materials, when available.

If a QC sample is not taken through the entire sample preparation procedure and is used for calibration verification (ex. GFAA), a LCS which has been taken through the entire procedure must also be analyzed.

8.2 APPENDIX B - SOPS

Standard Operating Procedures for Collection of Airborne Asbestos Fibers

This SOP describes the collection of airborne asbestos fibers using calibrated sampling pumps with MCEF and analysis by PCM.

1. The sampling medium for air samples shall be mixed cellulose ester filter membranes. These shall be designated by the manufacturer as suitable for asbestos counting.
2. The air samples will be collected on open-face, 25-mm-diameter air monitoring cassettes (MCEF) with 0.8 µm pore size. Do not reuse or reload cassettes for asbestos sample collection.
3. The filter assembly will be attached with flexible Tygon® tubing (or an equivalent material) to a battery-powered 1/6-horsepower vacuum pump operating at an airflow rate of approximately 2.0 liters per minute to achieve the target air volume of 60 liters of air for a 30-minute excursion sample and approximately 2.0 liters per minute to achieve the target air volume of 960 liters of air over eight hours.
4. Where possible, a sufficient air volume for each air sample shall be collected to yield between 100 and 1,300 fibers per square millimeter on the membrane filter. If a filter darkens in appearance or if loose dust is seen on the filter, a second sample shall be started.
5. Each pump will be equipped with a flow control regulator to maintain the initial flow rate of within +/- 10% throughout the sampling period. The pumps are sealed units with the cassette being the protecting the tubing and interior or the pump. Therefore, decontamination is not required.
6. The air sampling pumps will be attached to the Site fencing approximately five feet above the ground or at the elevation best suited to achieve an unobstructed representative air sample.
7. Calibrate each personal sampling pump before and after use with a representative filter cassette installed between the pump and the calibration devices.
8. For the personnel sampling, the air sampling pumps will be attached to Site workers with the sampling media near their approximate “breathing zone” which is approximately six to nine inches from their face.
9. Duplicate samples will be collected at a rate of one per day of demolition and will consist of placing a second vacuum pump adjacent to a sampling pump along the fence line.
10. One closed field blank will be collected each day of sampling during demolition and debris removal. Closed field blanks are filter cassettes that have been transported to the Site and then sent to the laboratory without being opened. The open field blank will be analyzed and the closed field blank will be archived. The closed field blank will only be analyzed if the open field blank show asbestos contamination.
11. Ship the samples in a rigid container with sufficient packing material to prevent dislodging the collected fibers. Packing material that has a high electrostatic charge on its surface (e.g., expanded polystyrene) cannot be used because such material can cause loss of fibers to the sides of the cassette.

Standard Operating Procedures for Soil Screening with Photoionization Detector

This SOP discusses the methodologies for maintenance and use of PID in the field in order to screen for VOCs. The following section summarizes the field procedures and handling for PIDs to ensure accurate results and good maintenance of the equipment. This SOP should be used in conjunction with the user guide for the PID. The user guides are stored with the appropriate PID for reference and should be taken into the field when the PID is being used.

1. Blackstone owns a MiniRAE 3000 that will be used during field screening activities. The PID is stored in a secure location with the user guide, battery chargers, spare lamps (10.6 and 11.7 eV), spare filters, calibration gas and pressure gauges. For PID-specific information, refer to the user guide for a step-by-step process of using the PID. The PID will require laboratory calibration to verify that the PID is in good working condition. The PID may be sent in for laboratory calibration more frequently if it is malfunctioning and replacing the lamp and filters does not remedy the problem.
2. Prior to using the PID it is good practice to charge the PID for at least 10 hours. Confirm that the PID is fully charged by checking the battery icon on the PID display.
3. Prior to leaving the field, confirm that the PID components are properly stowed in the carrying case.
4. Calibration of the PID should be conducted onsite each time it is used and at the beginning of the field activities. If field activities take longer than a day, then the PID should be recalibrated at the beginning of each day. Calibration of the PID should also be completed after replacing the lamp and allowing for a five-minute run period prior to calibration. Calibration completion and results of the calibration should be recorded on the appropriate calibration form.
5. Calibration of the PID is a two-point process that utilizes fresh air and a designated span gas. Before collecting any PID field measurements, calibrate the PID starting first with fresh air and then completing the span gas calibration. If the fresh air calibration does not result in a 0.0 ppm reading (±10%) then attach the carbon filter and complete the fresh air calibration again. After successfully completing the fresh air calibration, calibrate the PID using the span gas.
6. Isobutylene is the span gas that is used to complete the second step of the calibration. This calibration should result in a reading of 100 ppm (±10%). Once the calibration is completed and successful, field measurements can be collected. If a reading of 100 ppm (±10%) is not achieved during calibration, repeat the process using the span gas. If again the calibration is not successful, check that the filters are placed correctly in the PID, restart the device, and complete the span gas calibration again. If the calibration is still leading to a result that is out of the acceptable range then replace the lamp with a lamp of the same rating, allow for the PID to run for at least five minutes, and then complete the two-point calibration starting with the fresh air calibration.
7. Samples collected in association with a sampling event should be treated in the same manner so that the results of screening are comparable. Prior to collecting a PID reading, the soil sample should be characterized and then placed in a re-sealable bag. Fill the bag to half full and wait at least ten minutes before collecting a reading from the sample. Disturb a small portion of the soil sample in the sealed bag. Open the bag to less than one inch at the top and the PID sensor should be inserted into the bag. Close the opening around the PID sensor and record the reading from the PID once it has stabilized. Next, remove the PID sensor from the bag and reseal it completely. Additional field screening may be needed as specified by the

project manager. However, the PID should be the first field screening instrument used when multiple instruments are to be used. After the field screening is complete, collect the soil sample for analysis from the remaining undisturbed portion of the soil interval within the bag and place into the appropriate sample containers.

8. The PID should read 0.0 ppm after it has been removed from the bag. Allow for the PID to decrease to a value of 0.0 ppm before using the PID to collect another reading. If the PID does not appear to be responding or is malfunctioning, confirm that the PID is operating correctly by completing a bump test with the span (calibration) gas. Complete any calibration and repairs if the device is not functioning correctly.
9. The PID should be allowed to run continuously during field activities to monitor the ambient air conditions. If a sustained level of 5 ppm or any unusual chemical odor is observed for at least five minutes, personnel will don a half-face air purifying respirator and follow instructions as set in SOPs.

Standard Operating Procedures for Chain of Custody Procedures

Sample custody procedures are based on the Environmental Protection Agency (EPA)-recommended procedures which emphasize careful documentation of sample collection and sample transfer. To ensure that the important information pertaining to each sample is recorded, the documentation procedures listed herein will be executed.

The following SOPs will be strictly followed in order to maintain and document sample custody. A sample is considered to be under proper custody if:

- It is in actual possession of the responsible person.
- It is in view, following physical possession.
- It is in the possession of a responsible person and is locked or sealed to prevent tampering.
- It is in a secure area awaiting transfer of custody.

1. Sample custody is documented by a “Chain-of-Custody Record”. The custody record is completed by the individual designated by the Project Manager as being responsible for sample handling and shipment to a designated laboratory. The information recorded will include:
    - Project Manager - Print the name of the project representative to whom lab reports and correspondence are to be addressed.
    - Sampler Name - Provide name and signature of sampler/samplers.
    - Project Number - Print the project number (used on lab reports).
    - Sample I.D. - Write the identification number of the sample.
    - Date/Time - Sampled Date and time (military) the sample was collected.
    - Special Instructions - In the special instructions section of the chain-of-custody form; sample method, turnaround time, or other conditions of note may be listed as required in the sampling plan or deemed appropriate in the field. Print or mark the type of analysis and laboratory quantification levels required. Make sure these levels are at least as low as required. Detection limits may be specified in special instructions box.
    - Relinquished By - Print the name of the person giving up the sample and provide signature. The first person to relinquish must be same as sampler.
    - Company - Print the name of the organization giving up the sample.
    - Date/Time - Print the date and time at which the sample was collected.
    - Received By - Obtain the signature of the receiving person.
    - Organization - Print the name of the receiving organization.
    - Print the date and time at which the sample was received.

The chain-of-custody form will consist of one original and the sampler will ship the original to the lab.

2. The field personnel initially taking the sample(s) are responsible for the care and custody of the sample(s) until it is properly transferred or delivered to laboratory personnel. Samples must be accompanied by a chain-of-custody record, consisting of an copy.
3. When transferring in possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. The condition of the shipping container and the samples if the shipping container is opened shall be noted on the chain of custody form or a sample receipt form, which will remain with the chain-of-custody. The company from which

the sample is relinquished and to which it is delivered and the reason for transfer will be noted. This record documents the transfer of samples from the custody of the sampler to that of another person, or the permanent laboratory.

4. It is the Project Manager's responsibility to ensure that shipping data are consistent and that they are made part of the permanent job file. The first noted person to relinquish must be the same as the sampler name.

Standard Operating Procedures for Equipment Decontamination

This SOP describes the decontamination procedures for the Project.

1. Non-disposable equipment will be thoroughly decontaminated in accordance to the following procedures prior to leaving a site or containerized for decontamination off site to prevent cross-contamination to other sites. Non-disposable sampling equipment will be thoroughly decontaminated in accordance with the following procedures prior to collecting each sample, between sample points, and at the end of field activities to avoid cross-contamination. Under no circumstances is potentially contaminated equipment to be allowed to leave the site.
    - Remove as much media from the equipment as possible prior to washing.
    - Wash the equipment using detergent water (Alconox is preferred if compatible with the equipment and analysis to be performed).
    - Rinse the material with tap water.
    - Repeat steps 2 and 3 for two more times.
    - Rinse with deionized water.
    - If step six is required, rinse one more time with deionized water.
    - Place on a rack in a contaminant free area to air dry or wipe dry with a contaminant free towel.
2. The drilling subcontractor is responsible for the decontamination of non-disposable drilling equipment (augers, sampling spoons, etc.). The environmental professional should verify that decontamination procedures used by the drilling subcontractor are adequate and fully executed in between sampling locations.
3. The UST removal subcontractor is responsible for the decontamination of non-disposable equipment (excavator, backhoe, etc.). The environmental professional should verify that decontamination procedures used by the drilling subcontractor are adequate and fully executed in between sampling locations.

1.0 Objectives and Rationale

The following sections summarize the field procedures for soil sampling to ensure quality control and to secure fully representative samples that meet the requirements of the sampling plan. Soil samples can be collected from a variety of conditions and locations as required by a permit, a sampling plan, or the project manager. The sampling method may vary; however, basic protocol must be followed to ensure sample integrity, data utility, and employee, public, and environmental safety. Suitable collection equipment will be constructed of a compatible material that does not affect the sample media or the analytical constituents. Samples will be placed into an appropriate laboratory–provided sample containers. The sample will then be labeled, logged, and placed in a cooler containing ice in order to preserve sample integrity.

Field personnel should wear appropriate personal protective equipment while handling sampling equipment and containers, sampling soils, and decontaminating equipment. Disposable nitrile gloves should be changed as each soil horizon/interval is handled.

The procedures for soil collection presented in this SOP are designed to ensure the following:

- samples and field measurements are consistent with the project objectives.
- samples are collected in a manner that provides the highest level of safety for field personnel, the public, and the environment.
- samples are collected efficiently and provide the highest achievable data quality.
- ensure cross-contamination between soil samples is not present via good housekeeping procedures and proper equipment decontamination.

2.0 Sampling Equipment Methodologies

2.1 Surface Soils (soils to a depth of one foot)

Surface soils will be sampled utilizing a spade, scoop, hand auger, or trowel constructed of a material compatible with the analyte of interest and the material sampled. Unless otherwise specified by the sampling plan, a minimum of one inch of soil will be removed to expose fresh soil. The sample will then be collected from fresh soil using the appropriate sampling equipment.

2.2 Subsurface Soils (soils deeper than one feet)

Subsurface soils will be sampled by excavating (less than 5 feet or deeper in certain cases) or by drilling to the appropriate. Samples will not be collected from drilling method requiring the use of drilling fluids or the flights of drilling system unless specifically required in the sampling plan.

When collecting the sample with excavation type equipment the following procedure will be followed:

- Excavate to a depth within ½ of the excavation equipment's excavating capacity (½ a backhoe's bucket or ½ a spade full).
- Decontaminate the excavation equipment.

- Collect the sample remembering the sample is the deeper half of the material excavated.

When collecting the sample with drilling equipment follow the following procedure:

Hollow Stem Auger Drilling
- If a split spoon sampler is used with a liner constructed of compatible material:
- Drill to a depth within ½ the split spoon's length above the desired sample depth.
- Insert an uncontaminated liner.
- Continue drilling to collect the sample per established drilling methods.
- If a split spoon sampler is used without a liner:
- Drill to a depth within ½ the split spoon's length above the desired sample depth.
- Decontaminate the split spoon per procedures listed in that section.
- Continue drilling to collect the sample.

Bucket Augering
- Drill to a depth within ½ the bucket's length above the desired sample depth.
- Decontaminate the bucket.
- Continue drilling to collect the sample.

Direct Push Technologies
- Push to within one foot of the desired depth.
- Remove the push rod and add the sampler section.
- Re-push through the sample point.

In some cases, soil conditions will not allow for the removal of the push rod without the collapse of the push hole. In this case a continuous sample method may be employed. If continuous sampling is to be undertaken; the sampler should be decontaminated prior to collecting the sample of interest.

1.0 Soil Sampling Methodologies

This section discusses the methodologies to be used in collecting soil samples. The collection technique to be used will be based on the test parameters that will be analyzed. Methods utilized must be acceptable according to industry practices.

Sample horizons are chosen for laboratory analysis based on the QAPP in conjunction with field observations. Soil borings are logged for lithology and observations such as staining or odors. Field screening tools can be used in conjunction with the observations made by an environmental professional to provide the most useful information possible. Field observation relies on the skill and experience of the field personnel to visually identify signs of the analyte, materials related to the analyte, and process or site conditions that may indicate a relatively higher likelihood of the analytes presence. Experience used in conjunction with field screening provides an effective tool in maximizing representative data collection. Specific instruments utilized by Blackstone are listed and discussed in the equipment-specific SOPs.

Soil intervals are containerized in a re-sealable baggie after the material has been logged. Care should be taken to disturb the sample **as little** as possible during any transfer of soil to the baggie and the baggie should be sealed in between any activity prior the completion of the sample collection.

The sample is then screened as applicable according to the requirements of the SOP. When sampling for VOCs, the first field screening conducted should be for organic vapors. This is completed by inserting a PID into the baggie and collecting the field screening measurement. This measurement in conjunction with physical observations allows the field personnel the opportunity to select the appropriate soil interval for the VOC samples to yield the most valuable data. PID screening should be conducted as quickly as possible from each soil interval's baggie and samples for VOC analyses should be taken promptly from the least disturbed portion of the soil interval within the selected soil-interval baggie.

1.0 Objectives and Rationale

The following sections summarize the field procedures for groundwater sampling to ensure quality control and to secure fully representative samples. Preservation of samples is required to retain integrity. The most common preservation techniques include pH adjustment and temperature control. Field personnel will use U.S. EPA-recommended container types and adhere to U.S. EPA recommended preservation techniques and holding times for the parameters of concern.

The procedures presented are designed to ensure the following:

- Sample and field measurements are consistent with project objectives.
- Samples are identified, preserved, and transported in such a manner as to ensure the integrity and validity of the samples.
- Field measurements are collected in a manner to allow for comparison between existing and newly collected data so as to provide an adequate database for achieving the objectives and ensuring quality.

1.2 Quality Assurance Procedures

The sampler will wear gloves while measuring water levels, purging wells, sampling wells, and decontaminating equipment. Gloves will be changed after each sample to prevent cross contamination. Pre-washed and pre-preserved sample containers will be provided by the laboratory chosen by Blackstone and will be prepared in accordance with U.S. EPA quality control procedures.

When collecting a sample for a particular analysis (e.g., VOCs) requiring multiple containers, bottles will be filled from the same bailer or sample hose, if possible. If an additional sample volume is required to fill the bottles, it will be retrieved in the same manner for consistency. Agitation will be avoided, particularly when volatile organic analyses are to be conducted. Bottles will be filled in the order of most volatile to least volatile analysis type (VOCs to SVOCs to inorganics). Samples for volatile organic analysis will be collected in glass vials treated with hydrochloric acid as a preservative, allowing no headspace between the liquid and the lid of the vial. This will be accomplished by filling the bottle such that a meniscus forms over the lip, and then fitting the cap securely. Headspace will be checked by inverting the bottle and tapping the lid to see if air bubbles are visible in the bottle. If an air bubble appears, the procedure is repeated. If air bubbles are still present following resampling, an un-preserved vial will be collected, allowing no headspace using the same methodology as is used for filling a preserved vial. The un-preserved vial will be submitted to the laboratory, and the lack of preservative will be indicated on the chain of custody. A note indicating the shortened hold time will also be included on the chain of custody. Groundwater samples will be filled directly from the sampling device into the various bottles, except samples to be analyzed for dissolved metals, which will pass through an appropriate dedicated filter.

2.0 Groundwater Sampling Procedures

2.1 Sampling Procedure for Temporary (Drop Screen) Monitoring Wells

Groundwater may be sampled via temporary wells.

- A stainless-steel drop screen is placed at the interval of interest.
- A peristaltic pump using dedicated tubing is deployed for purging each temporary well.
- Once turbidity has decreased to ~100 NTU, samples are collected via a peristaltic pump.

The next three steps apply to sample collection via low-flow pump only and should be ignored when a bailer is used.

- Prepare the sampling device for use.
- Connect the YSI 556 or similar flow cell device in line with the pump, when applicable.
- Begin pumping or purging the well while measuring stabilization parameters as indicated above.
- When stabilization is achieved, fill bottles from most volatile to least volatile (If taking splits / dupes / MS/MSDs, fill the bottles for each analyte at the same time, rather than filling by bottle set).
- Decontaminate the water level meter and any non-dedicated sampling equipment following the decontamination SOP.

ASBESTOS and OTHER FIBERS by PCM 7400

FORMULA: Various MW: Various CAS: see Synonyms RTECS: Various

METHOD: 7400, Issue 2	**EVALUATION: FULL**	**Issue 1: Rev. 3 on 15 May 1989** **Issue 2: 15 August 1994**

OSHA: 0.1 asbestos fiber (> 5 µm long)/cc; 1 f/cc, 30 min excursion; carcinogen
MSHA: 2 asbestos fibers/cc
NIOSH: 0.1 f/cc (fibers > 5 µm long), 400 L; carcinogen
ACGIH: 0.2 f/cc crocidolite; 0.5 f/cc amosite; 2 f/cc chrysotile and other asbestos; carcinogen

PROPERTIES: solid, fibrous, crystalline, anisotropic

SYNONYMS [CAS #]: actinolite [77536-66-4] or ferroactinolite [15669-07-5]; amosite [12172-73-5]; anthophyllite [77536-67-5]; chrysotile [12001-29-5]; serpentine [18786-24-8]; crocidolite [12001-28-4]; tremolite [77536-68-6]; amphibole asbestos [1332-21-4]; refractory ceramic fibers [142844-00-6]; fibrous glass

SAMPLING

SAMPLER:	FILTER (0.45- to 1.2-µm cellulose ester membrane, 25-mm; conductive cowl on cassette)
FLOW RATE*:	0.5 to 16 L/min
VOL-MIN*: **-MAX*:**	400 L @ 0.1 fiber/cc (step 4, sampling) *Adjust to give 100 to 1300 fiber/mm^2
SHIPMENT:	routine (pack to reduce shock)
SAMPLE STABILITY:	stable
BLANKS:	2 to 10 field blanks per set

ACCURACY

RANGE STUDIED:	80 to 100 fibers counted
BIAS:	see EVALUATION OF METHOD
OVERALL PRECISION ($\hat{S}_{rT}$):	0.115 to 0.13 [1]
ACCURACY:	see EVALUATION OF METHOD

MEASUREMENT

TECHNIQUE:	LIGHT MICROSCOPY, PHASE CONTRAST
ANALYTE:	fibers (manual count)
SAMPLE PREPARATION:	acetone - collapse/triacetin - immersion method [2]
COUNTING RULES:	described in previous version of this method as "A" rules [1,3]
EQUIPMENT:	1. positive phase-contrast microscope 2. Walton-Beckett graticule (100-µm field of view) Type G-22 3. phase-shift test slide (HSE/NPL)
CALIBRATION:	HSE/NPL test slide
RANGE:	100 to 1300 fibers/mm^2 filter area
ESTIMATED LOD:	7 fibers/mm^2 filter area
PRECISION ($\bar{S}_r$):	0.10 to 0.12 [1]; see EVALUATION OF METHOD

APPLICABILITY: The quantitative working range is 0.04 to 0.5 fiber/cc for a 1000-L air sample. The LOD depends on sample volume and quantity of interfering dust, and is <0.01 fiber/cc for atmospheres free of interferences. The method gives an index of airborne fibers. It is primarily used for estimating asbestos concentrations, though PCM does not differentiate between asbestos and other fibers. Use this method in conjunction with electron microscopy (e.g., Method 7402) for assistance in identification of fibers. Fibers < ca. 0.25 µm diameter will not be detected by this method [4]. This method may be used for other materials such as fibrous glass by using alternate counting rules (see Appendix C).

INTERFERENCES: If the method is used to detect a specific type of fiber, any other airborne fiber may interfere since all particles meeting the counting criteria are counted. Chain-like particles may appear fibrous. High levels of non-fibrous dust particles may obscure fibers in the field of view and increase the detection limit.

OTHER METHODS: This revision replaces Method 7400, Revision #3 (dated 5/15/89).

REAGENTS:

1. Acetone,* reagent grade.
2. Triacetin (glycerol triacetate), reagent grade.

*See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Sampler: field monitor, 25-mm, three-piece cassette with ca. 50-mm electrically conductive extension cowl and cellulose ester filter, 0.45- to 1.2-µm pore size, and backup pad.
   NOTE 1: Analyze representative filters for fiber background before use to check for clarity and background. Discard the filter lot if mean is ≥ 5 fibers per 100 graticule fields. These are defined as laboratory blanks. Manufacturer-provided quality assurance checks on filter blanks are normally adequate as long as field blanks are analyzed as described below.
   NOTE 2: The electrically conductive extension cowl reduces electrostatic effects. Ground the cowl when possible during sampling.
   NOTE 3: Use 0.8-µm pore size filters for personal sampling. The 0.45-µm filters are recommended for sampling when performing TEM analysis on the same samples. However, their higher pressure drop precludes their use with personal sampling pumps.
   NOTE 4: Other cassettes have been proposed that exhibit improved uniformity of fiber deposit on the filter surface, e.g., bellmouthed sampler (Envirometrics, Charleston, SC). These may be used if shown to give measured concentrations equivalent to sampler indicated above for the application.
2. Personal sampling pump, battery or line-powered vacuum, of sufficient capacity to meet flow-rate requirements (see step 4 for flow rate), with flexible connecting tubing.
3. Wire, multi-stranded, 22-gauge; 1″ hose clamp to attach wire to cassette.
4. Tape, shrink- or adhesive-.
5. Slides, glass, frosted-end, pre-cleaned, 25- × 75-mm.
6. Cover slips, 22- × 22-mm, No. 1½, unless otherwise specified by microscope manufacturer.
7. Lacquer or nail polish.
8. Knife, #10 surgical steel, curved blade.
9. Tweezers.

EQUIPMENT (continued):

10. Acetone flash vaporization system for clearing filters on glass slides (see ref. [5] for specifications or see manufacturer's instructions for equivalent devices).
11. Micropipets or syringes, 5-µL and 100- to 500-µL.
12. Microscope, positive phase (dark) contrast, with green or blue filter, adjustable field iris, 8 to 10× eyepiece, and 40 to 45× phase objective (total magnification ca. 400×); numerical aperture = 0.65 to 0.75.
13. Graticule, Walton-Beckett type with 100-µm diameter circular field (area = 0.00785 mm^2) at the specimen plane (Type G-22). Available from Optometrics USA, P.O. Box 699, Ayer, MA 01432 [phone (508)-772-1700], and McCrone Accessories and Components, 850 Pasquinelli Drive, Westmont, IL 60559 [phone (312) 887-7100].

    NOTE: The graticule is custom-made for each microscope. (see APPENDIX A for the custom-ordering procedure).
14. HSE/NPL phase contrast test slide, Mark II. Available from Optometrics USA (address above).
15. Telescope, ocular phase-ring centering.
16. Stage micrometer (0.01-mm divisions).

SPECIAL PRECAUTIONS: Acetone is extremely flammable. Take precautions not to ignite it. Heating of acetone in volumes greater than 1 mL must be done in a ventilated laboratory fume hood using a flameless, spark-free heat source.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. To reduce contamination and to hold the cassette tightly together, seal the crease between the cassette base and the cowl with a shrink band or light colored adhesive tape. For personal sampling, fasten the (uncapped) open-face cassette to the worker's lapel. The open face should be oriented downward.

    NOTE: The cowl should be electrically grounded during area sampling, especially under conditions of low relative humidity. Use a hose clamp to secure one end of the wire (Equipment, Item 3) to the monitor's cowl. Connect the other end to an earth ground (i.e., cold water pipe).
3. Submit at least two field blanks (or 10% of the total samples, whichever is greater) for each set of samples. Handle field blanks in a manner representative of actual handling of associated samples in the set. Open field blank cassettes at the same time as other cassettes just prior to sampling. Store top covers and cassettes in a clean area (e.g., a closed bag or box) with the top covers from the sampling cassettes during the sampling period.
4. Sample at 0.5 L/min or greater [6]. Adjust sampling flow rate, Q (L/min), and time, t (min), to produce a fiber density, E, of 100 to 1300 fibers/mm^2 (3.85×10^4 to 5×10^5 fibers per 25-mm filter with effective

collection area $A_c = 385\ \text{mm}^2$) for optimum accuracy. These variables are related to the action level (one-half the current standard), L (fibers/cc), of the fibrous aerosol being sampled by:

$$t = \frac{A_c \times E}{Q \times L \times 10^3}.$$

NOTE 1: The purpose of adjusting sampling times is to obtain optimum fiber loading on the filter. The collection efficiency does not appear to be a function of flow rate in the range of 0.5 to 16 L/min for asbestos fibers [7]. Relatively large diameter fibers (>3 µm) may exhibit significant aspiration loss and inlet deposition. A sampling rate of 1 to 4 L/min for 8 h is appropriate in atmospheres containing ca. 0.1 fiber/cc in the absence of significant amounts of non-asbestos dust. Dusty atmospheres require smaller sample volumes (≤400 L) to obtain countable samples. In such cases take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high flow rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres, where targeted fiber concentrations are much less than 0.1 fiber/cc, use larger sample volumes (3000 to 10000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust. If ≥50% of the filter surface is covered with particles, the filter may be too overloaded to count and will bias the measured fiber concentration.

NOTE 2: OSHA regulations specify a minimum sampling volume of 48 L for an excursion measurement, and a maximum sampling rate of 2.5 L/min [3].

5. At the end of sampling, replace top cover and end plugs.
6. Ship samples with conductive cowl attached in a rigid container with packing material to prevent jostling or damage.

   NOTE: Do not use untreated polystyrene foam in shipping container because electrostatic forces may cause fiber loss from sample filter.

SAMPLE PREPARATION:

NOTE 1: The object is to produce samples with a smooth (non-grainy) background in a medium with refractive index ≤ 1.46. This method collapses the filter for easier focusing and produces permanent (1–10 years) mounts which are useful for quality control and interlaboratory comparison. The aluminum "hot block" or similar flash vaporization techniques may be used outside the laboratory [2]. Other mounting techniques meeting the above criteria may also be used (e.g., the laboratory fume hood procedure for generating acetone vapor as described in Method 7400—revision of 5/15/85, or the non-permanent field mounting technique used in P&CAM 239 [3,7–9]). Unless the effective filtration area is known, determine the area and record the information referenced against the sample ID number [1,9–11].

NOTE 2: Excessive water in the acetone may slow the clearing of the filter, causing material to be washed off the surface of the filter. Also, filters that have been exposed to high humidities prior to clearing may have a grainy background.

7. Ensure that the glass slides and cover slips are free of dust and fibers.
8. Adjust the rheostat to heat the "hot block" to ca. 70 °C [2].

   NOTE: If the "hot block" is not used in a fume hood, it must rest on a ceramic plate and be isolated from any surface susceptible to heat damage.
9. Mount a wedge cut from the sample filter on a clean glass slide.
   a. Cut wedges of ca. 25% of the filter area with a curved-blade surgical steel knife using a rocking motion to prevent tearing. Place wedge, dust side up, on slide.

      NOTE: Static electricity will usually keep the wedge on the slide.
   b. Insert slide with wedge into the receiving slot at base of "hot block". Immediately place tip of a micropipet containing ca. 250 µL acetone (use the minimum volume needed to consistently clear the filter sections) into the inlet port of the PTFE cap on top of the "hot block" and inject the

acetone into the vaporization chamber with a slow, steady pressure on the plunger button while holding pipet firmly in place. After waiting 3 to 5 s for the filter to clear, remove pipet and slide from their ports.

CAUTION: Although the volume of acetone used is small, use safety precautions. Work in a well-ventilated area (e.g., laboratory fume hood). Take care not to ignite the acetone. Continuous use of this device in an unventilated space may produce explosive acetone vapor concentrations.

c. Using the 5-µL micropipet, immediately place 3.0 to 3.5 µL triacetin on the wedge. Gently lower a clean cover slip onto the wedge at a slight angle to reduce bubble formation. Avoid excess pressure and movement of the cover glass.

NOTE: If too many bubbles form or the amount of triacetin is insufficient, the cover slip may become detached within a few hours. If excessive triacetin remains at the edge of the filter under the cover slip, fiber migration may occur.

d. Mark the outline of the filter segment with a glass marking pen to aid in microscopic evaluation.

e. Glue the edges of the cover slip to the slide using lacquer or nail polish [12]. Counting may proceed immediately after clearing and mounting are completed.

NOTE: If clearing is slow, warm the slide on a hotplate (surface temperature 50 °C) for up to 15 min to hasten clearing. Heat carefully to prevent gas bubble formation.

CALIBRATION AND QUALITY CONTROL:

10. Microscope adjustments. Follow the manufacturer's instructions. At least once daily use the telescope ocular (or Bertrand lens, for some microscopes) supplied by the manufacturer to ensure that the phase rings (annular diaphragm and phase-shifting elements) are concentric. With each microscope, keep a logbook in which to record the dates of microscope cleanings and major servicing.
    a. Each time a sample is examined, do the following:
        (1) Adjust the light source for even illumination across the field of view at the condenser iris. Use Kohler illumination, if available. With some microscopes, the illumination may have to be set up with bright field optics rather than phase contract optics.
        (2) Focus on the particulate material to be examined.
        (3) Make sure that the field iris is in focus, centered on the sample, and open only enough to fully illuminate the field of view.
    b. Check the phase-shift detection limit of the microscope periodically for each analyst/microscope combination:
        (1) Center the HSE/NPL phase-contrast test slide under the phase objective.
        (2) Bring the blocks of grooved lines into focus in the graticule area.

        NOTE: The slide contains seven blocks of grooves (ca. 20 grooves per block) in descending order of visibility. For asbestos counting, the microscope optics must completely resolve the grooved lines in block 3 although they may appear somewhat faint, and the grooved lines in blocks 6 and 7 must be invisible when centered in the graticule area. Blocks 4 and 5 must be at least partially visible but may vary slightly in visibility between microscopes. A microscope which fails to meet these requirements has resolution either too low or too high for fiber counting.

        (3) If image quality deteriorates, clean the microscope optics. If the problem persists, consult the microscope manufacturer.
11. Document the laboratory's precision for each counter for replicate fiber counts.
    a. Maintain as part of the laboratory quality assurance program a set of reference slides to be used on a daily basis [13]. These slides should consist of filter preparations including a range of loadings and background dust levels from a variety of sources including both field and reference samples (e.g., PAT, AAR, commercial samples). The Quality Assurance Officer should maintain custody of the reference slides and should supply each counter with a minimum of one reference

slide per workday. Change the labels on the reference slides periodically so that the counter does not become familiar with the samples.

b. From blind repeat counts on reference slides, estimate the laboratory intra- and intercounter precision. Obtain separate values of relative standard deviation (S_r) for each sample matrix analyzed in each of the following ranges: 5 to 20 fibers in 100 graticule fields, >20 to 50 fibers in 100 graticule fields, and >50 to 100 fibers in 100 graticule fields. Maintain control charts for each of these data files.

NOTE: Certain sample matrices (e.g., asbestos cement) have been shown to give poor precision [9].

12. Prepare and count field blanks along with the field samples. Report counts on each field blank.

NOTE 1: The identity of blank filters should be unknown to the counter until all counts have been completed.

NOTE 2: If a field blank yields greater than 7 fibers per 100 graticule fields, report possible contamination of the samples.

13. Perform blind recounts by the same counter on 10% of filters counted (slides relabeled by a person other than the counter). Use the following test to determine whether a pair of counts by the same counter on the same filter should be rejected because of possible bias: Discard the sample if the absolute value of the difference between the square roots of the two counts (in fiber/mm^2) exceeds $2.77XS_r'$ where X = average of the square roots of the two fiber counts (in fiber/mm^2) and $S_r' = S_r / 2$ where S_r is the intracounter relative standard deviation for the appropriate count range (in fibers) determined in step 11. For more complete discussions see reference [13].

NOTE 1: Since fiber counting is the measurement of randomly placed fibers which may be described by a Poisson distribution, a square root transformation of the fiber count data will result in approximately normally distributed data [13].

NOTE 2: If a pair of counts is rejected by this test, recount the remaining samples in the set and test the new counts against the first counts. Discard all rejected paired counts. It is not necessary to use this statistic on blank counts.

14. The analyst is a critical part of this analytical procedure. Care must be taken to provide a non-stressful and comfortable environment for fiber counting. An ergonomically designed chair should be used, with the microscope eyepiece situated at a comfortable height for viewing. External lighting should be set at a level similar to the illumination level in the microscope to reduce eye fatigue. In addition, counters should take 10- to 20-minute breaks from the microscope every one or two hours to limit fatigue [14]. During these breaks, both eye and upper back/neck exercises should be performed to relieve strain.

15. All laboratories engaged in asbestos counting should participate in a proficiency testing program such as the AIHA-NIOSH Proficiency Analytical Testing (PAT) Program for asbestos and routinely exchange field samples with other laboratories to compare performance of counters.

MEASUREMENT:

16. Center the slide on the stage of the calibrated microscope under the objective lens. Focus the microscope on the plane of the filter.

17. Adjust the microscope (Step 10).

NOTE: Calibration with the HSE/NPL test slide determines the minimum detectable fiber diameter (ca. 0.25 µm) [4].

18. Counting rules: (same as P&CAM 239 rules [1,10,11]: see examples in APPENDIX B).

a. Count any fiber longer than 5 µm which lies entirely within the graticule area.

   (1) Count only fibers longer than 5 µm. Measure length of curved fibers along the curve.

   (2) Count only fibers with a length-to-width ratio equal to or greater than 3:1.

b. For fibers which cross the boundary of the graticule field:

   (1) Count as ½ fiber any fiber with only one end lying within the graticule area, provided that the fiber meets the criteria of rule a above.

(2) Do not count any fiber which crosses the graticule boundary more than once.
(3) Reject and do not count all other fibers.

c. Count bundles of fibers as one fiber unless individual fibers can be identified by observing both ends of a fiber.

d. Count enough graticule fields to yield 100 fibers. Count a minimum of 20 fields. Stop at 100 graticule fields regardless of count.

19. Start counting from the tip of the filter wedge and progress along a radial line to the outer edge. Shift up or down on the filter, and continue in the reverse direction. Select graticule fields randomly by looking away from the eyepiece briefly while advancing the mechanical stage. Ensure that, as a minimum, each analysis covers one radial line from the filter center to the outer edge of the filter. When an agglomerate or bubble covers ca. 1/6 or more of the graticule field, reject the graticule field and select another. Do not report rejected graticule fields in the total number counted.

NOTE 1: When counting a graticule field, continuously scan a range of focal planes by moving the fine focus knob to detect very fine fibers which have become embedded in the filter. The small-diameter fibers will be very faint but are an important contribution to the total count. A minimum counting time of 15 s per field is appropriate for accurate counting.

NOTE 2: This method does not allow for differentiation of fibers based on morphology. Although some experienced counters are capable of selectively counting only fibers which appear to be asbestiform, there is presently no accepted method for ensuring uniformity of judgment between laboratories. It is, therefore, incumbent upon all laboratories using this method to report total fiber counts. If serious contamination from non-asbestos fibers occurs in samples, other techniques such as transmission electron microscopy must be used to identify the asbestos fiber fraction present in the sample (see NIOSH Method 7402). In some cases (i.e., for fibers with diameters >1 µm), polarized light microscopy (as in NIOSH Method 7403) may be used to identify and eliminate interfering non-crystalline fibers [15].

NOTE 3: Do not count at edges where filter was cut. Move in at least 1 mm from the edge.

NOTE 4: Under certain conditions, electrostatic charge may affect the sampling of fibers. These electrostatic effects are most likely to occur when the relative humidity is low (below 20%), and when sampling is performed near the source of aerosol. The result is that deposition of fibers on the filter is reduced, especially near the edge of the filter. If such a pattern is noted during fiber counting, choose fields as close to the center of the filter as possible [5].

NOTE 5: Counts are to be recorded on a data sheet that provides, as a minimum, spaces on which to record the counts for each field, filter identification number, analyst's name, date, total fibers counted, total fields counted, average count, fiber density, and commentary. Average count is calculated by dividing the total fiber count by the number of fields observed. Fiber density (fibers/mm^2) is defined as the average count (fibers/field) divided by the field (graticule) area (mm^2/field).

CALCULATIONS AND REPORTING OF RESULTS

20. Calculate and report fiber density on the filter, E (fibers/mm^2), by dividing the average fiber count per graticule field, F / n_f, minus the mean field blank count per graticule field, B / n_b, by the graticule field area, A_f (approx. 0.00785 mm^2):

$$E = \frac{(F/n_f - B/n_b)}{A_f}, \text{ fibers/mm}^2.$$

NOTE: Fiber counts above 1300 fibers/mm^2 and fiber counts from samples with >50% of filter area covered with particulate should be reported as "uncountable" or "probably biased." Other fiber counts outside the 100–1300 fiber/mm^2 range should be reported as having "greater than optimal variability" and as being "probably biased."

21. Calculate and report the concentration, C (fibers/cc), of fibers in the air volume sampled, V (L), using the effective collection area of the filter, A_c (approx. 385 mm^2 for a 25-mm filter):

$$C = \frac{EA_c}{V \times 10^3}.$$

NOTE: Periodically check and adjust the value of A_c, if necessary.

22. Report intralaboratory and interlaboratory relative standard deviations (from Step 11) with each set of results.

    NOTE: Precision depends on the total number of fibers counted [1,16]. Relative standard deviation is documented in references [1,15–17] for fiber counts up to 100 fibers in 100 graticule fields. Comparability of interlaboratory results is discussed below. As a first approximation, use 213% above and 49% below the count as the upper and lower confidence limits for fiber counts greater than 20 (Figure 1).

EVALUATION OF METHOD:

Method Revisions:

This method is a revision of P&CAM 239 [10]. A summary of the revisions is as follows:

1. Sampling:
   The change from a 37-mm to a 25-mm filter improves sensitivity for similar air volumes. The change in flow rates allows for 2-m^3 full-shift samples to be taken, providing that the filter is not overloaded with non-fibrous particulates. The collection efficiency of the sampler is not a function of flow rate in the range 0.5 to 16 L/min [10].
2. Sample preparation technique:
   The acetone vapor-triacetin preparation technique is a faster, more permanent mounting technique than the dimethyl phthalate/diethyl oxalate method of P&CAM 239 [2,4,10]. The aluminum "hot block" technique minimizes the amount of acetone needed to prepare each sample.
3. Measurement:
   a. The Walton-Beckett graticule standardizes the area observed [14,18,19].
   b. The HSE/NPL test slide standardizes microscope optics for sensitivity to fiber diameter [4,14].
   c. Because of past inaccuracies associated with low fiber counts, the minimum recommended loading has been increased to 100 fibers/mm^2 filter area (a total of 78.5 fibers counted in 100 fields, each with field area = 0.00785 mm^2.) Lower levels generally result in an overestimate of the fiber count when compared to results in the recommended analytical range [20]. The recommended loadings should yield intracounter S_r in the range of 0.10 to 0.17 [21–23].

Interlaboratory Comparability:

An international collaborative study involved 16 laboratories using prepared slides from the asbestos cement, milling, mining, textile, and friction material industries [9]. The relative standard deviations (S_r) varied with sample type and laboratory. The ranges were:

Rules	Intralaboratory S_r	Interlaboratory S_r	Overall S_r
AIA (NIOSH A Rules)*	0.12 to 0.40	0.27 to 0.85	0.46
Modified CRS (NIOSH B Rules)†	0.11 to 0.29	0.20 to 0.35	0.25

*Under AIA rules, only fibers having a diameter less than 3 µm are counted and fibers attached to particles larger than 3 µm are not counted. NIOSH A Rules are otherwise similar to the AIA rules.

†See Appendix C.

A NIOSH study conducted using field samples of asbestos gave intralaboratory S_r in the range 0.17 to 0.25 and an interlaboratory S_r of 0.45 [21]. This agrees well with other recent studies [9,14,16].

At this time, there is no independent means for assessing the overall accuracy of this method. One measure of reliability is to estimate how well the count for a single sample agrees with the mean count from a large number of laboratories. The following discussion indicates how this estimation can be carried out based on measurements of the interlaboratory variability, as well as showing how the results of this method relate to the theoretically attainable counting precision and to measured intra- and interlaboratory S_r. (NOTE: The following discussion does not include bias estimates and should not be taken to indicate that lightly loaded samples are as accurate as properly loaded ones).

Theoretically, the process of counting randomly (Poisson) distributed fibers on a filter surface will give an S_r that depends on the number, N, of fibers counted:

$$S_r = 1/N^{1/2}.$$

Thus S_r is 0.1 for 100 fibers and 0.32 for 10 fibers counted. The actual S_r found in a number of studies is greater than these theoretical numbers [17,19–21].

An additional component of variability comes primarily from subjective interlaboratory differences. In a study of ten counters in a continuing sample exchange program, Ogden [15] found this subjective component of intralaboratory S_r to be approximately 0.2 and estimated the overall S_r by the term:

$$\frac{[N + (0.2 \times N)^2]^{1/2}}{N}.$$

Ogden found that the 90% confidence interval of the individual intralaboratory counts in relation to the means were $+2\ S_r$ and $-1.5\ S_r$. In this program, one sample out of ten was a quality control sample. For laboratories not engaged in an intensive quality assurance program, the subjective component of variability can be higher.

In a study of field sample results in 46 laboratories, the Asbestos Information Association also found that the variability had both a constant component and one that depended on the fiber count [14]. These results gave a subjective interlaboratory component of S_r (on the same basis as Ogden's) for field samples of ca. 0.45. A similar value was obtained for 12 laboratories analyzing a set of 24 field samples [21]. This value falls slightly above the range of S_r (0.25 to 0.42 for 1984–85) found for 80 reference laboratories in the NIOSH PAT program for laboratory-generated samples [17].

A number of factors influence S_r for a given laboratory, such as that laboratory's actual counting performance and the type of samples being analyzed. In the absence of other information, such as from an interlaboratory quality assurance program using field samples, the value for the subjective component of variability is chosen as 0.45. It is hoped that the laboratories will carry out the recommended interlaboratory quality assurance programs to improve their performance and thus reduce the S_r.

The above relative standard deviations apply when the population mean has been determined. It is more useful, however, for laboratories to estimate the 90% confidence interval on the mean count from a single sample fiber count (Figure 1). These curves assume similar shapes of the count distribution for interlaboratory and intralaboratory results [16].

For example, if a sample yields a count of 24 fibers, Figure 1 indicates that the mean interlaboratory count will fall within the range of 227% above and 52% below that value 90% of the time. We can apply these percentages directly to the air concentrations as well. If, for instance, this sample (24 fibers counted) represented a 500-L volume, then the measured concentration is 0.02 fibers/mL (assuming 100 fields counted, 25-mm filter, 0.00785 mm^2 counting field area). If this same sample were counted by a group of laboratories, there is a 90% probability that the mean would fall between 0.01 and 0.08 fiber/mL. These limits should be reported in any comparison of results between laboratories.

Note that the S_r of 0.45 used to derive Figure 1 is used as an estimate for a random group of laboratories. If several laboratories belonging to a quality assurance group can show that their interlaboratory S_r is smaller, then it is more correct to use that smaller S_r. However, the estimated S_r of 0.45 is to be used in the absence of such information. Note also that it has been found that S_r can be higher for certain types of samples, such as asbestos cement [9].

Quite often the estimated airborne concentration from an asbestos analysis is used to compare to a regulatory standard. For instance, if one is trying to show compliance with an 0.5 fiber/mL standard using a single sample on which 100 fibers have been counted, then Figure 1 indicates that the 0.5 fiber/mL standard must be 213% higher than the measured air concentration. This indicates that if one measures a fiber concentration of 0.16 fiber/mL (100 fibers counted), then the mean fiber count by a group of laboratories (of which the compliance laboratory might be one) has a 95% chance of being less than 0.5 fibers/mL; i.e., $0.16 + 2.13 \times 0.16 = 0.5$.

It can be seen from Figure 1 that the Poisson component of the variability is not very important unless the number of fibers counted is small. Therefore, a further approximation is to simply use +213% and −49% as the upper and lower confidence values of the mean for a 100-fiber count.

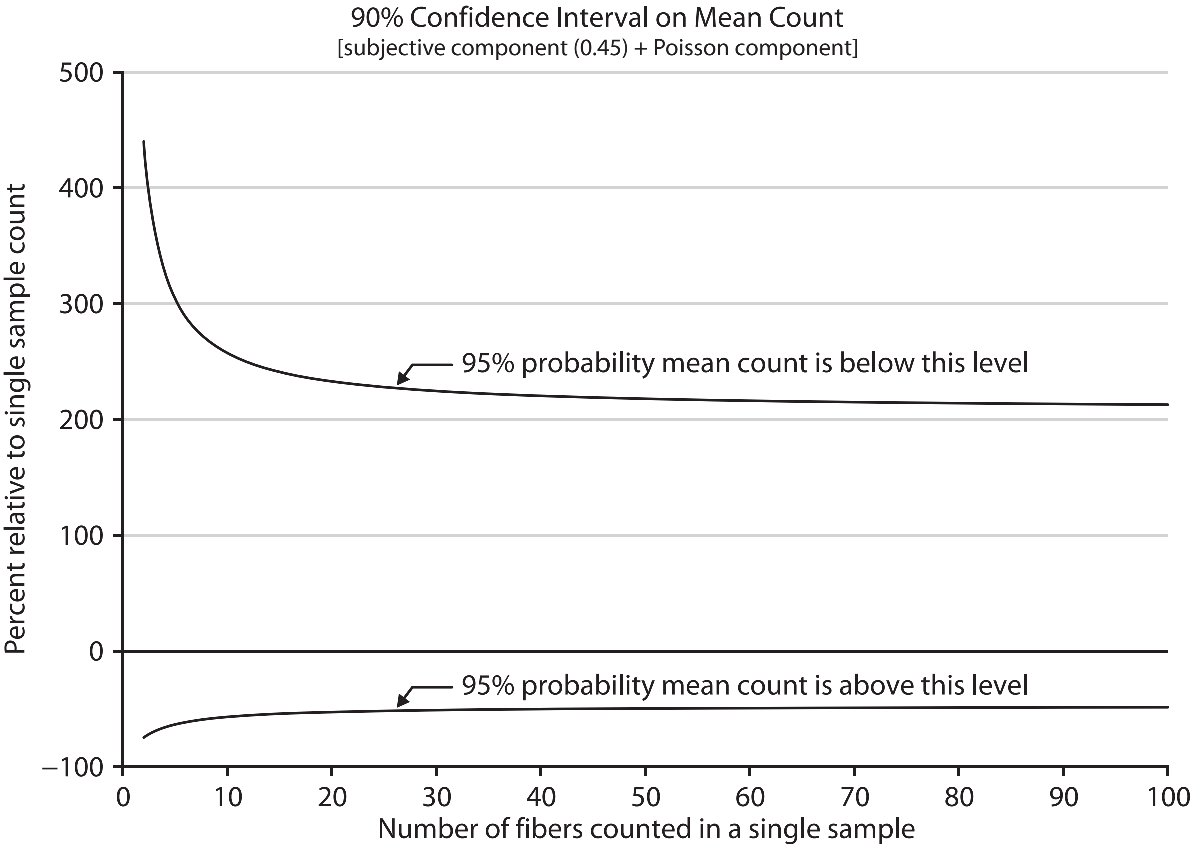


Figure 1. Interlaboratory precision of fiber counts.

The curves in Figure 1 are defined by the following equations:

$$U_{\mathrm{CL}} = \frac{2X + 2.25 + [(2.25 + 2X)^2 - 4(1 - 2.25S_r^2)X^2]^{\frac{1}{2}}}{2(1 - 2.25S_r^2)} \text{ and}$$

$$L_{\mathrm{CL}} = \frac{2X + 4 - [(4 + 2X)^2 - 4(1 - 4S_r^2)X^2]^{\frac{1}{2}}}{2(1 - 4S_r^2)},$$

where S_r = subjective interlaboratory relative standard deviation, which is close to the total interlaboratory S_r when approximately 100 fibers are counted,
X = total fibers counted on sample,
L_{CL} = lower 95% confidence limit, and
U_{CL} = upper 95% confidence limit.
Note that the range between these two limits represents 90% of the total range.

REFERENCES:

[1] Leidel, N. A., S. G. Bayer, R. D. Zumwalde, and K. A. Busch. USPHS/NIOSH Membrane Filter Method for Evaluating Airborne Asbestos Fibers, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 79-127 (1979).

[2] Baron, P. A. and G. C. Pickford. "An Asbestos Sample Filter Clearing Procedure," *Appl. Ind. Hyg., 1*, 169–171, 199 (1986).

[3] Occupational Safety and Health Administration, U.S. Department of Labor, Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite Asbestos; Final Rules, 29 CFR Part 1910.1001 Amended June 20, 1986.

[4] Rooker, S. J., N. P. Vaughn, and J. M. LeGuen. "On the Visibility of Fibers by Phase Contrast Microscopy," *Amer. Ind. Hyg. Assoc. J., 43*, 505–515 (1982).

[5] Baron, P. and G. Deye, "Electrostatic Effects in Asbestos Sampling," Parts I and II, *Amer. Ind. Hyg. Assoc. J., 51*, 51–69 (1990).

[6] Johnston, A. M., A. D. Jones, and J. H. Vincent. "The Influence of External Aerodynamic Factors on the Measurement of the Airborne Concentration of Asbestos Fibers by the Membrane Filter Method," *Ann. Occup. Hyg., 25*, 309–316 (1982).

[7] Beckett, S.T., "The Effects of Sampling Practice on the Measured Concentration of Airborne Asbestos," *Ann. Occup. Hyg., 21*, 259–272 (1980).

[8] Jankovic, J. T., W. Jones, and J. Clere. "Field Techniques for Clearing Cellulose Ester Filters Used in Asbestos Sampling," *Appl. Ind. Hyg., 1*, 145–147 (1986).

[9] Crawford, N. P., H. L. Thorpe, and W. Alexander. "A Comparison of the Effects of Different Counting Rules and Aspect Ratios on the Level and Reproducibility of Asbestos Fiber Counts," Part I: Effects on Level (Report No. TM/82/23), Part II: Effects on Reproducibility (Report No. TM/82/24), Institute of Occupational Medicine, Edinburgh, Scotland (December, 1982).

[10] NIOSH Manual of Analytical Methods, 2nd ed., Vol. 1., P&CAM 239, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-157-A (1977).

[11] Revised Recommended Asbestos Standard, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-169 (1976); as amended in NIOSH statement at OSHA Public Hearing, June 21, 1984.

[12] Asbestos International Association, AIA Health and Safety Recommended Technical Method #1 (RTMI). "Airborne Asbestos Fiber Concentrations at Workplaces by Light Microscopy" (Membrane Filter Method), London (1979).

[13] Abell, M., S. Shulman and P. Baron. "The Quality of Fiber Count Data," *Appl. Ind. Hyg., 4*, 273–285 (1989).

[14] "A Study of the Empirical Precision of Airborne Asbestos Concentration Measurements in the Workplace by the Membrane Filter Method," Asbestos Information Association, Air Monitoring Committee Report, Arlington, VA (June, 1983).

[15] McCrone, W., L. McCrone and J. Delly, "Polarized Light Microscopy," Ann Arbor Science (1978).

[16] Ogden, T. L. "The Reproducibility of Fiber Counts," Health and Safety Executive Research Paper 18 (1982).

[17] Schlecht, P. C. and S. A. Schulman. "Performance of Asbestos Fiber Counting Laboratories in the NIOSH Proficiency Analytical Testing (PAT) Program," *Am. Ind. Hyg. Assoc. J., 47*, 259–266 (1986).

[18] Chatfield, E. J. Measurement of Asbestos Fiber Concentrations in Workplace Atmospheres, Royal Commission on Matters of Health and Safety Arising from the Use of Asbestos in Ontario, Study No. 9, 180 Dundas Street West, 22nd Floor, Toronto, Ontario, CANADA M5G 1Z8.

[19] Walton, W. H. "The Nature, Hazards, and Assessment of Occupational Exposure to Airborne Asbestos Dust: A Review," *Ann. Occup. Hyg., 25*, 115–247 (1982).

[20] Cherrie, J., A.D. Jones, and A.M. Johnston. "The Influence of Fiber Density on the Assessment of Fiber Concentration Using the membrane filter Method." *Am. Ind. Hyg. Assoc. J., 47*(8), 465–74 (1986).

[21] Baron, P. A. and S. Shulman. "Evaluation of the Magiscan Image Analyzer for Asbestos Fiber Counting." *Am. Ind. Hyg. Assoc. J.*, (in press).

[22] Taylor, D. G., P. A. Baron, S. A. Shulman and J. W. Carter. "Identification and Counting of Asbestos Fibers," *Am. Ind. Hyg. Assoc. J. 45*(2), 84–88 (1984).

[23] "Potential Health Hazards of Video Display Terminals," NIOSH Research Report, June 1981.

[24] "Reference Methods for Measuring Airborne Man-Made Mineral Fibers (MMMF)," WHO/EURO Technical Committee for Monitoring an Evaluating Airborne MMMF, World Health Organization, Copenhagen (1985).

[25] Criteria for a Recommended Standard…Occupational Exposure to Fibrous Glass, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-152 (1977).

METHOD WRITTEN BY:

Paul A. Baron, Ph.D., NIOSH/DPSE.

APPENDIX A. CALIBRATION OF THE WALTON-BECKETT GRATICULE

Before ordering the Walton-Beckett graticule, the following calibration must be done to obtain a counting area (D) 100 µm in diameter at the image plane. The diameter, d_c (mm), of the circular counting area and the disc diameter must be specified when ordering the graticule.

1. Insert any available graticule into the eyepiece and focus so that the graticule lines are sharp and clear.
2. Set the appropriate interpupillary distance and, if applicable, reset the binocular head adjustment so that the magnification remains constant.
3. Install the 40 to 45× phase objective.
4. Place a stage micrometer on the microscope object stage and focus the microscope on the graduated lines.
5. Measure the magnified grid length of the graticule, L_o (µm), using the stage micrometer.
6. Remove the graticule from the microscope and measure its actual grid length, L_a (mm). This can best be accomplished by using a stage fitted with verniers.
7. Calculate the circle diameter, d_c (mm), for the Walton-Beckett graticule:

$$d_c = \frac{L_a}{L_o} \times D.$$

   Example: If $L_o = 112$ µm, $L_a = 4.5$ mm, and $D = 100$ µm, then $d_c = 4.02$ mm.

8. Check the field diameter, D (acceptable range 100 µm ± 2 µm) with a stage micrometer upon receipt of the graticule from the manufacturer. Determine field area (acceptable range 0.00754 mm^2 to 0.00817 mm^2).

APPENDIX B. COMPARISON OF COUNTING RULES

Figure 2 shows a Walton-Beckett graticule as seen through the microscope. The rules will be discussed as they apply to the labeled objects in the figure.

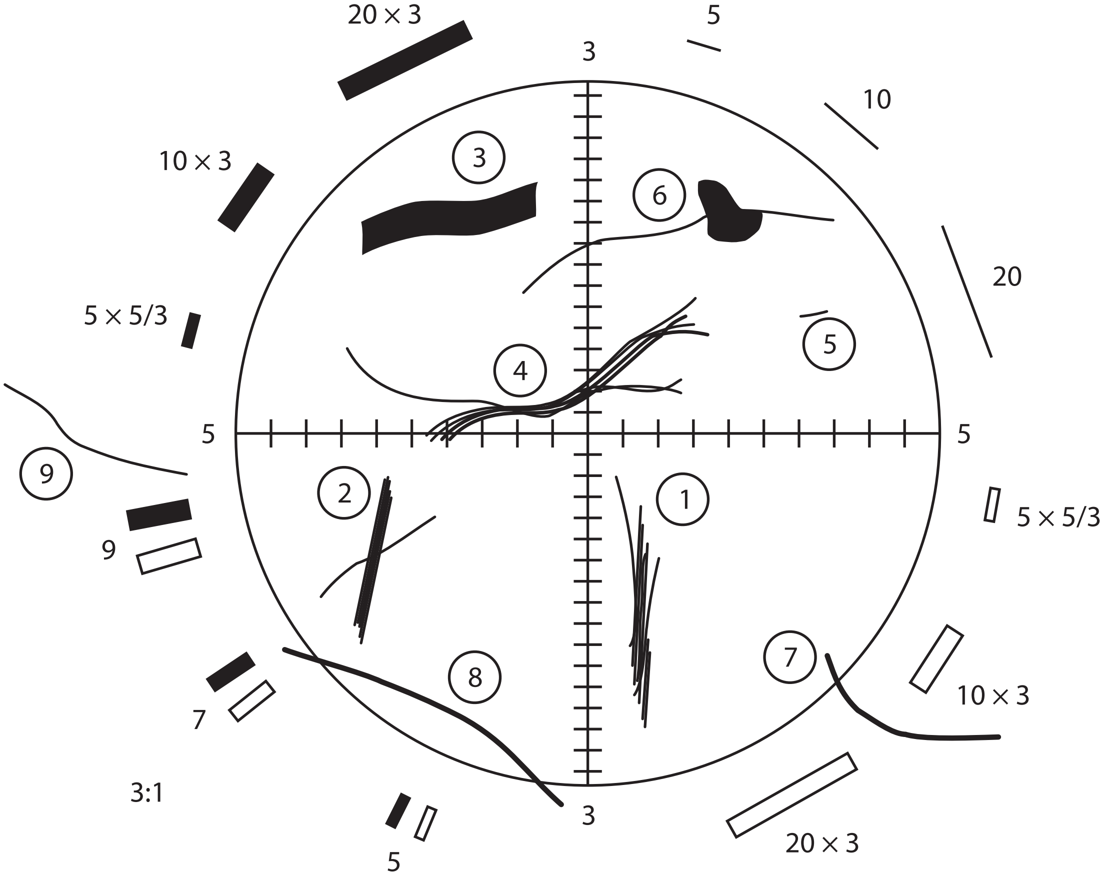


Figure 2. Walton-Beckett graticule with fibers.

These rules are sometimes referred to as the "A" rules:

Object	Count	Discussion
1	1 fiber	Optically observable asbestos fibers are actually bundles of fine fibrils. If the fibrils seem to be from the same bundle, the object is counted as a single fiber. Note, however, that all objects meeting length and aspect ratio criteria are counted whether or not they appear to be asbestos.
2	2 fibers	If fibers meeting the length and aspect ratio criteria (length >5 µm and length-to-width ratio > 3 to 1) overlap, but do not seem to be part of the same bundle, they are counted as separate fibers.
3	1 fiber	Although the object has a relatively large diameter (>3 µm), it is counted as fiber under the rules. There is no upper limit on the fiber diameter in the counting rules. Note that fiber width is measured at the widest compact section of the object.
4	1 fiber	Although long fine fibrils may extend from the body of a fiber, these fibrils are considered part of the fiber if they seem to have originally been part of the bundle.
5	Do not count	If the object is ≤ 5 µm long, it is not counted.
6	1 fiber	A fiber partially obscured by a particle is counted as one fiber. If the fiber ends emanating from a particle do not seem to be from the same fiber and each end meets the length and aspect ratio criteria, they are counted as separate fibers.
7	½ fiber	A fiber which crosses into the graticule area one time is counted as ½ fiber.
8	Do not count	Ignore fibers that cross the graticulate boundary more than once.
9	Do not count	Ignore fibers that lie outside the graticule boundary.

APPENDIX C. ALTERNATE COUNTING RULES FOR NON-ASBESTOS FIBERS

Other counting rules may be more appropriate for measurement of specific non-asbestos fiber types, such as fibrous glass. These include the "B" rules given below (from NIOSH Method 7400, Revision #2, dated 8/15/87), the World Health Organization reference method for man-made mineral fiber [24], and the NIOSH fibrous glass criteria document method [25]. The upper diameter limit in these methods prevents measurements of non-thoracic fibers. It is important to note that the aspect ratio limits included in these methods vary. NIOSH recommends the use of the 3:1 aspect ratio in counting fibers.

It is emphasized that hybridization of different sets of counting rules is not permitted. Report specifically which set of counting rules are used with the analytical results.

"B" Counting Rules

1. Count only *ends* of fibers. Each fiber must be longer than 5 µm and less than 3 µm diameter.
2. Count only ends of fibers with a length-to-width ratio equal to or greater than 5:1.
3. Count each fiber end which falls within the graticule area as one end, provided that the fiber meets rules 1 and 2 above. Add split ends to the count as appropriate if the split fiber segment also meets the criteria of rules 1 and 2 above.
4. Count visibly free ends which meet rules 1 and 2 above when the fiber appears to be attached to another particle, regardless of the size of the other particle. Count the end of a fiber obscured by another particle if the particle covering the fiber end is less than 3 µm in diameter.

5. Count free ends of fibers emanating from large clumps and bundles up to a maximum of 10 ends (5 fibers), provided that each segment meets rules 1 and 2 above.
6. Count enough graticule fields to yield 200 ends. Count a minimum of 20 graticule fields. Stop at 100 graticule fields, regardless of count.
7. Divide total end count by 2 to yield fiber count.

APPENDIX D. EQUIVALENT LIMITS OF DETECTION AND QUANTITATION

Fiber density on filter*			Fiber concentration in air, f/cc	
	Fibers per 100 fields	Fibers/mm^2	400-L air sample	1000-L air sample
	200	255	0.25	0.10
	100	127	0.125	0.05
LOQ	80.0	102	0.10	0.04
	50	64	0.0625	0.025
	25	32	0.03	0.0125
	20	25	0.025	0.010
	10	12.7	0.0125	0.005
	8	10.2	0.010	0.004
LOD	5.5	7	0.00675	0.0027

*Assumes 385 mm^2 effective filter collection area, and field area = 0.00785 mm^2, for relatively “clean” (little particulate aside from fibers) filters.

CATES LABORATORIES

Statement of Quality Assurance

Quality Program Statement

CONFIDENTIAL & PROPRIETARY

Cates Laboratories (CatesLab) is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) and licensed by the State of Texas and State of Arizona as an Asbestos Laboratory for polarized light microscopy (PLM) Bulk Sample Analysis and phase contrast microscopy (PCM) Air Sample Analysis. CatesLab is also licensed as a Mold Analysis Laboratory by the State of Texas.

The asbestos laboratory testing procedures of CatesLab are performed in general accordance with the current NVLAP requirements for bulk asbestos analysis by PLM. All analysts have received the necessary in-house and extramural training to perform analysis of bulk samples by PLM for the presence or absence of asbestos. Each analyst or reviewer has completed the McCrone Research Institute short course on the identification of asbestos, or the equivalent approved by the Laboratory Director, and has successfully completed in-house training. The Asbestos Laboratory Manager has received a university degree including college level classroom and laboratory course work in optical mineralogy.

At least 10 percent of laboratory production is randomly selected for re-analysis by a qualified analyst as a crosscheck (inter-analyst replicate analyses) or self-check (intra-analyst replicate analyses) for in-house laboratory quality control. All analysts are required to participate in interlaboratory testing rounds which include, at a minimum, NVLAP proficiency testing and “round robin” interlaboratory tests. Calibrations pertaining to laboratory equipment, microscopes and sample mounting media are performed in general accordance with NVLAP requirements.

CatesLab is currently enrolled, maintaining a Proficient rating, in the American Industrial Hygiene Association Proficiency Analytical Testing (AIHA PAT) program for asbestos air sample analysis and AIHA EMPAT Direct Exam program for mold spores.

John R. Cates, P.G.
Laboratory Director

Issued 09/09/2020

AF52017-04

8.3 APPENDIX C - TANK CLOSURE GUIDANCE

UNDERGROUND STORAGE TANK CLOSURE GUIDANCE

Iowa Department of Natural Resources
Underground Storage Tank Section
502 East 9th Street
Des Moines, IA 50319-0034 (515-725-8200)
www.iowadnr.gov/ust

May 2021

TABLE OF CONTENTS

Websites used throughout this document

Iowa DNR Land Farming: http://www.iowadnr.gov/Environmental-Protection/Land-Quality/Solid-Waste/Solid-Waste-Permitting/Land-Farming
Iowa DNR UST: www.iowadnr.gov/ust
Iowa Legislative Code: https://www.legis.iowa.gov/docs/iac/rule/567.135.15.pdf
Iowa One Call: www.iowaonecall.com
OSHA: www.osha.gov
OSHA, Trenching: www.osha.gov/trenching
OSHA, Confined Spaces: www.osha.gov/confinedspaces
The Engineering ToolBox: http://www.engineeringtoolbox.com/explosive-concentration-limits-d_423.html

The Iowa Department of Natural Resources (DNR) has provided the following document as guidance to owners and operators, and to UST Professionals to summarize procedures necessary to permanently close an UST system. It does not provide a full account of federal and state regulations, nor is it to be substituted for local government codes and requirements. It is the owner and operator's responsibility to familiarize themselves with all rules and regulations pertaining to the property on which the UST system(s) is to be permanently closed. DNR strongly recommends contacting local fire and building code officials prior to proceeding with tank closure. Furthermore, it is the owner and operator's responsibility to hire an Iowa Licensed UST Tank Remover to review and follow standard safety practices when permanently closing a petroleum or hazardous substance UST system.

Iowa rules pertaining to UST closures can be viewed on the Iowa Legislative Code Website.

How removal used to be conducted. The tank is perilously suspended by this track-mounted crane. The operator is on the other side of the fence. Let's just say everyone involved is very lucky to have walked away unharmed.

STEPS TO SUCCESSFUL UST CLOSURE
UNDERGROUND STORAGE TANK (UST) AND PIPING CLOSURE CHECKLIST

STEP 1 - Notification of Intended UST Closure Activity

- ✓ Send DNR Form 542-1308 "Notification of Closure/Change-in-Service" to the UST Section of the DNR 30 days before the tank closure is scheduled to take place. The form must be filled out completely, accurately and signed by the owner or Responsible Party. **NOTE: It is imperative that you check with your local fire authority for any local requirements (permits, site inspections during excavation, etc.) prior to removal.**

STEP 2 - Preparatory Activities

- ✓ Confirm the availability of those contractors you may be using on the anticipated closure date (tank removers, tank cleaners, excavators, certified groundwater professionals). UST permanent closure must be conducted by an Iowa licensed remover. Notify DNR of any changes to the date of closure for your UST system.
- ✓ You must be a Certified Groundwater Professional in order to conduct or supervise closure sampling. Notify the Iowa Certified Lab of your choice of the types of samples you will need, and request the necessary sample containers. Testing for petroleum products shall be conducted by Iowa Methods OA-1 and OA-2 (if there have been low volatile fuels stored). Copies of these methods are available from the DNR.
- ✓ Obtain the necessary sampling equipment and packing materials to store the samples at approximately 40 degrees Fahrenheit after collection and during shipment. Samples must be received by the laboratory within 72 hours of collection.
- ✓ To avoid a potential accident caused by an excavation, have the location of all underground utilities marked before excavating by hand or with equipment. To comply with Iowa Code Chapter 480, Underground Facilities Information and begin the locating and marking process, you must contact Iowa One Call at 811 or 800-292-8989 a minimum of 48 hours (excluding Saturday, Sunday and legal holidays) before excavation commences. This is a free service.

STEP 3 - Oral Confirmation of Closure Date

- ✓ Contact (telephone) the DNR field office at least 24 hours prior to actual closure to confirm the removal date. This phone call must be made weekdays between the hours of 8:00 am and 4:30 pm. See field office locations and phone numbers on page 4.

STEP 4 - UST Closure Activities

Sampling Procedures *and* ***Tank Removal*** *are explained in greater detail on the following pages.*

- ✓ Drain and flush piping into the tank, and disconnect piping from the tank. Remove product piping.
- ✓ Empty the tank and purge all combustible vapors by inerting or venting through the vent line.
- ✓ Monitor the tank for combustibility with a combustible gas meter until the tank atmosphere is less than 10% of the lower flammable or explosive limit LFL/LEL.
- ✓ Remove tank appurtenances (gauge pipes, fill pipes, turbines, etc.) Leave vent line connected until the tank is purged.
- ✓ Plug the openings and remove the tank from the excavation. Place it on a level surface and block it, or fill the tank to 100 percent capacity with an inert material.
- ✓ Clean and remove the tank according to industry standards:
  a. API RP 1604, Removal and Disposal of Used Underground Petroleum Storage Tanks,
  b. API Publication 2015, Cleaning Petroleum Storage Tanks;
  c. API RP 1631, Interior Lining of Underground Storage Tanks,
  d. The National Institute for Occupational Safety and Health (NIOSH) *Criteria for a Recommended Standard…Working in Confined Space* may be used as a guidance for conducting safe closure procedures at some hazardous substance tanks.
  e. NFPA 326: Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair

f. NFPA 30: Flammable and Combustible Liquids Code, 30-93.

- ✓ An Iowa Certified Groundwater Professional must supervise the collection of soil and groundwater samples, and send them to a certified lab for analysis within 72 hours of collection.

If contamination is discovered during soil or groundwater sampling, you must contact the DNR and report the contamination. To report a release, phone 515-725-8200 or fax to 515-725-8202**.** Forms for reporting a release are found on the UST Section website.

STEP 5 - Closure Report

- ✓ Within 45 days of the tank or piping removal, submit a copy of the DNR's closure report form and the tank registration tags to the DNR. A copy of all reports and drawings must be maintained by the owner/ operator for at least three (3) years.
- ✓ Written confirmation of receipt of the closure report will be mailed to the owner after all these items have been received and reviewed by the department.

Photo below:

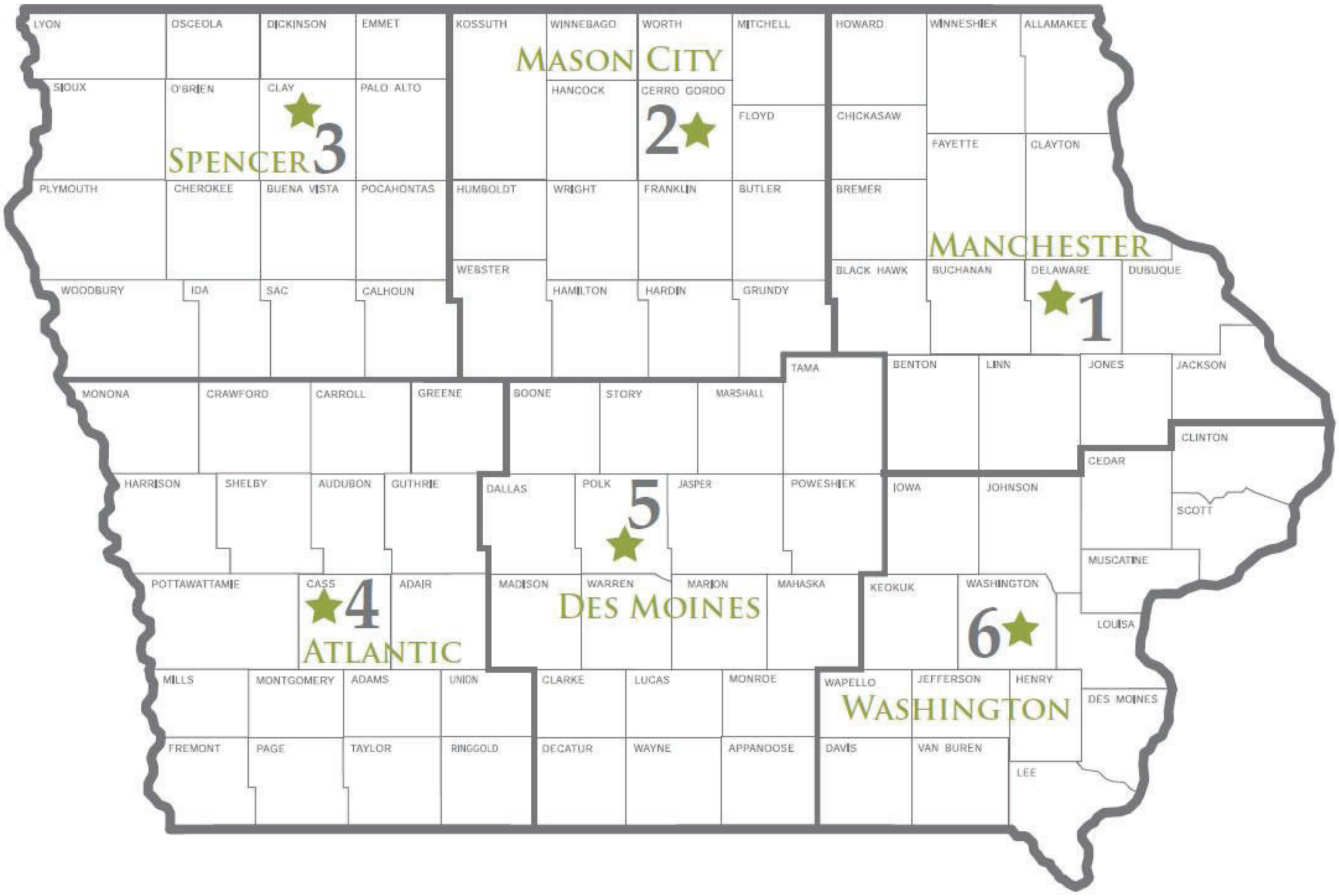
12000 gallon double wall Xerxes fiberglass tank removed in May 2014 at QuikTrip, 6th and University Avenue, Des Moines.

Address all correspondence and questions to:

IOWA DEPARTMENT OF NATURAL RESOURCES
UNDERGROUND STORAGE TANK SECTION
502 E 9TH ST
DES MOINES IA 50319-0034
Phone: 515-725-8200

Iowa Department of Natural Resources
ENVIRONMENTAL SERVICES DIVISION FIELD OFFICE MAP

There are six (6) DNR Field Offices that oversee UST permanent closures throughout Iowa. Phone the field office in the region where the UST closure will occur at least 24 hours in advance to inform them of the date of closure. This phone call must be made weekdays between the hours of 8:00 am and 4:30 pm.



Field Office 1:
1101 Commercial Ct Ste 10
Manchester, IA 52057
Phone: 563-927-2640

Field Office 2:
2300 15th St SW
Mason City, IA 50401
Phone: 641-424-4073

Field Office 3:
1900 N Grand Ave Ste E17
Spencer, IA 51301
Phone: 712-262-4177

Field Office 4:
1401 Sunnyside Ln
Atlantic, IA 50022
Phone: 712-243-1934

Field Office 5:
502 E 9th St
Des Moines, IA 50319
Phone: 515-725-0268

Field Office 6:
1004 W Madison
Washington, IA 52353
Phone: 319-653-2135

IOWA DEPARTMENT OF NATURAL RESOURCES
UNDERGROUND STORAGE TANK (UST) SYSTEM CLOSURE GUIDANCE DOCUMENT

INTRODUCTION

The purpose of this guidebook is to encourage safe UST removal. When regulated USTs are no longer needed they must be properly closed to avoid future safety and environmental hazards. Because these tanks contained flammable or combustible or hazardous liquids, UST removers must exercise the highest safety standards and practices. Accidents at UST removal sites are almost always avoidable. Safe work practices and an awareness of the potential hazards at the UST site will keep workers, the public, and the environment safe. This is merely a guidance document, and should be used for instructional purposes only. This document is not intended to be an in-depth explanation of the rules governing UST systems. You must also follow all the applicable Iowa rules and reference documents.

REFERENCES

The following publications are referenced in Chapter 567--135 Iowa Administrative Code (IAC) “Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks” or have been cited in this document and should be used as guides for further assistance in the permanent closure process.

- API RP 1604 Removal and Disposal of Used Underground Petroleum Storage Tanks
- API Publication 2015, Cleaning Petroleum Storage Tanks
- API RP 1631, Interior Lining of Underground Storage Tanks
- API RP 2219, Safe Operation of Vacuum Trucks in Petroleum Service
- The National Institute for Occupational Safety and Health (NIOSH) *Criteria for a Recommended Standard…Working in confined Space* may be used as a guidance for conducting safe closure procedures at some hazardous substance tanks
- NFPA 326: Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair
- NFPA 30: Flammable and Combustible Liquids Code, 30-93
- Occupational Safety and Health Administration (OSHA)—has rules that you must be familiar with. In one way or another, UST removal will be covered by OSHA. Under certain circumstances, OSHA Standard 1910.120 applies. This is the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard of 29 CFR
- *Tank Closure Without Tears*, New England Interstate Water Pollution Control Commission, 85 Merrimac Street, Boston, Massachusetts 02114, May 1988

SECTION I: HEALTH AND SAFETY CONSIDERATIONS

Owners and operators, and all UST Professionals must adhere to federal, state and local requirements as it pertains to health and safety. Iowa operates an OSHA-approved State Plan and has adopted all Federal OSHA standards, however for questions on applicable regulations, contact Iowa OSHA Consultation at IowaOSHA.gov or (515) 281-7269.

Inhaling high concentrations of petroleum vapors can have effects that range from dizziness to unconsciousness.

High occupational exposures to benzene have been associated with various human blood disorders, including an increased risk of leukemia. Very high levels have also been known to affect the central nervous system. Benzene is rapidly absorbed through the skin.[1]

Benzene and tetraethyl lead are known cancer-causing agents. Although lead has not been used in gasoline since the mid-80s, lead residues may still be present in older tanks and in the soil around the tanks. To minimize exposure to hazardous substances:

- Avoid skin contact and inhaling the vapors.
- Keep petroleum liquids and hazardous substances away from your eyes, skin and mouth.
- Use soap and water or waterless hand cleaner to remove any petroleum product that comes in contact with your skin. Do not use gasoline or other solvents to remove oil and grease from your hands.
- Promptly wash petroleum-soaked clothing and properly dispose of rags.
- Keep work areas clean and well ventilated.
- Clean up spills promptly.

Flammable and/or combustible vapors will be present in the work area. These vapors could reach the explosive range before venting is complete and a safe atmosphere is reached. Make these precautions part of your daily routine during UST projects:

- Eliminate all potential sources of ignition from the area. Some examples of ignition sources at an UST site are smoking materials, non-explosion-proof tools, hot surfaces, static electricity, electrical equipment, and internal combustion equipment.
- Prevent a discharge of static electricity during venting of USTs. Be sure that all equipment used during venting is grounded. It is good practice to ground to the tank and to the earth.
- Prevent vapors from accumulating at ground level. Keep all tanks vented at least 12 feet above ground surface until ready to remove them from the excavation. Also, check weather conditions before beginning a project. Humid weather and calm winds can be especially dangerous.

Gasoline vapors are heavier than air and will tend to stay close to the ground surface unless other forces, such as wind, are helping to disperse them. This is especially critical during tank removals on a calm day. You should consider using construction-size portable fans to help disperse vapors on these days.

Plan ahead. Visit the site before removal takes place. Leave yourself enough room to work safely. Look at the whole site, and determine where and how each activity will take place. Are there overhead obstructions, such as power lines, utility poles or a canopy? Make sure all underground utilities are located before excavating takes place.

Will any nearby buildings interfere with the excavation? The same formula for installing an UST near a building foundation applies to the removal excavation:

- Maintain a minimum distance of 5 feet from the edge of the excavation to the bottom of the building foundation.
- Then, the 45 degree line should strike the lower quadrant of the tank

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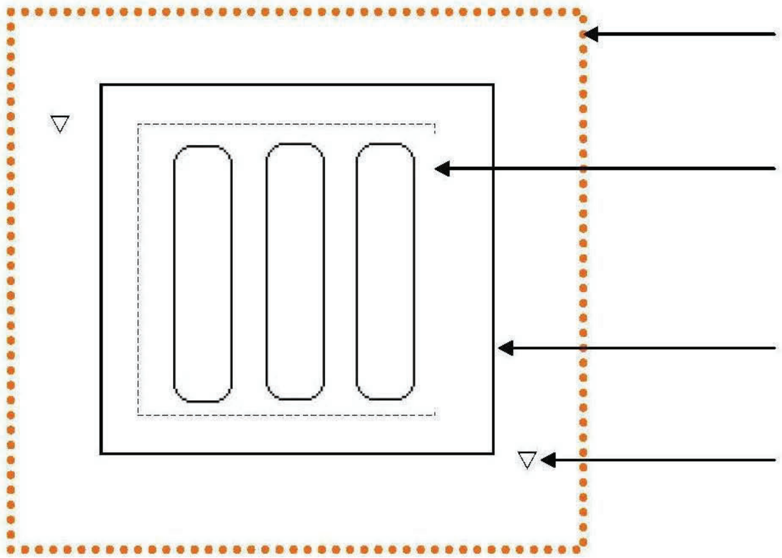
[1] Closure of Underground Petroleum Storage Tanks, API Recommended Practice 1604, 3rd Edition, March 1996, Reaffirmed, November 2001. Page 1.3.1.1

Lay out the project on paper:



API recommends 50 feet of secured, barricaded space from the edge of the excavation.

Edge of excavation - Allow 3 feet at side and ends for a one- yard excavator bucket.

NFPA/NEC Class I Division 2 classified area extends 10 feet in all directions around each possible source of vapor.

Dry powder fire extinguishers - minimum of 2.

Barricades

- Erect and maintain barricades. Barricade as large an area as possible; API recommends 50 feet in all directions. Brightly colored barricade mesh fencing may be more expensive, but it is more effective. A- frames must be spaced close together to be effective in restricting passersby.
- Tank removals often take place at busy locations, including those open for business. Arrange your barricades so customers see where they are supposed to go, as well as where they are not supposed to go.

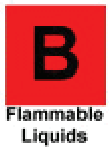
Fire Extinguishers

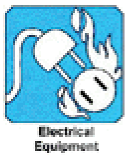
- Fire extinguishers are your first priority at all UST removals. Class B dry chemical extinguishers should be used on gasoline fires. The numerical rating of a fire extinguisher states the approximate number of square feet of a flammable liquid fire a non-expert person can expect to extinguish. A 40B extinguisher should extinguish 40 square feet of a flammable liquid fire. The Fire Marshal Division recommends a minimum of two 40BC fire extinguishers. Locate them at opposite corners of the project so they can be reached quickly. Check them every day to be sure they have not been tampered with, and are fully charged. Train your personnel in their proper use.

Fire Extinguisher Ratings

Class A Extinguishers will put out fires in ordinary combustibles, such as wood and paper. The numerical rating for this class of fire extinguisher refers to the amount of water the fire extinguisher holds and the amount of fire it will extinguish.

Class B Extinguishers should be used on fires involving flammable liquids, such as grease, gasoline, oil, etc. The numerical rating for this class of fire extinguisher states the approximate number of square feet of a flammable liquid fire that a non-expert person can expect to extinguish.





Class C Extinguishers are suitable for use on electrically energized fires. This class of fire extinguishers does not have a numerical rating. The presence of the letter "C" indicates that the extinguishing agent is non-conductive.

Class D Extinguishers are designed for use on flammable metals and are often specific for the type of metal in question. There is no picture designator for Class D extinguishers. These extinguishers generally have no rating nor are they given a multi-purpose rating for use on other types of fires.

Multi-Class Ratings

Many extinguishers available today can be used on different types of fires and will be labeled with more than one designator, e.g. A-B, B-C, or A-B-C. Make sure that if you have a multi-purpose extinguisher it is properly labeled.

This is the old style of labeling indicating suitability for use on Class A, B, and C fires.

This is the new style of labeling that shows this extinguisher may be used on Ordinary Combustibles, Flammable Liquids, or Electrical Equipment fires. This is the new labeling style with a diagonal red line drawn through the picture to indicate what type of fire this extinguisher is **NOT** suitable for. In this example, the fire extinguisher could be used on Ordinary Combustibles and Flammable Liquids fires, but not for Electrical Equipment fires.

Types of Fire Extinguishers

Dry Chemical extinguishers are usually rated for multiple purpose use. They contain an extinguishing agent and use a compressed, non-flammable gas as a propellant.

Halon extinguishers contain a gas that interrupts the chemical reaction that takes place when fuels burn. These types of extinguishers are often used to protect valuable electrical equipment since they leave no residue to clean up. Halon extinguishers have a limited range, usually 4 to 6 feet. The initial application of Halon should be made at the base of the fire, even after the flames have been extinguished.

Water These extinguishers contain water and compressed gas and should only be used on Class A (ordinary combustibles) fires.

Carbon Dioxide (CO2) extinguishers are most effective on Class B and C (liquids and electrical) fires. Since the gas disperses quickly, these extinguishers are only effective from 3 to 8 feet. The carbon dioxide is stored as a compressed liquid in the extinguisher; as it expands, it cools the surrounding air. The cooling will often cause ice to form around the "horn" where the gas is expelled from the extinguisher. Since the fire could re-ignite, continue to apply the agent even after the fire appears to be out.[2]

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[2] Information provided from the Hanford Fire Department, operated by Fluor Hanford, Inc. for the US Department of Energy, Richland Operations Office, Document Number: INTERNET-1053.

How to Use a Fire Extinguisher

Even though extinguishers come in a number of shapes and sizes, they all operate in a similar manner. Here's an easy acronym for fire extinguisher use:

P A S S -- **P**ull, **A**im, **S**queeze, and **S**weep

Pull the pin at the top of the extinguisher that keeps the handle from being accidentally pressed.

Aim the nozzle toward the base of the fire.

Stand approximately 8 feet away from the fire and **squeeze** the handle to discharge the extinguisher. If you release the handle, the discharge will stop.

Sweep the nozzle back and forth at the base of the fire. After the fire appears to be out, watch it carefully since it may re-ignite!

Success!

Flash Point and Fire Point

The **flash point** is the lowest temperature at which a liquid gives off vapor to form an ignitable mixture with the air, near the surface of the liquid.[3] At this temperature the vapor may cease to burn (flash) when the source of ignition is removed. The **fire point** is a slightly higher temperature at which the vapor continues to burn after being ignited.[4] A liquid that has a flash point at or below ambient temperature is easy to ignite and will burn quickly, e.g., gasoline. A low flash point can indicate highly volatile material and presents a greater risk of fire.

A liquid with a flash point above ambient temperature is more difficult to ignite and presents less risk because it does not give off sufficient vapors, e.g., home heating oil or Fuel Oil No. 2. Liquids with flash points above ambient temperature have to be heated to generate enough vapor to be ignitable.

The **fire point** of a liquid is the temperature at which ignition of vapors will result in continued burning. The fire point is used to assess the risk of a materials ability to support combustion or continue to burn. Both values affect how the material or liquids may be shipped, stored and discarded.[5]

For our purposes, the flash point is a useful characteristic of liquid fuel, indicating at which temperature it will ignite or burn when a source of ignition is applied (flame, spark). The flash point helps us appreciate and understand the risks involved and the safety measures required in working around flammable/combustible liquids. Contact the Iowa Department of Transportation regarding questions about transportation of flammable and combustible liquids.

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[3] NFPA, 2021 Flammable and Combustible Liquids Handbook, 4.2.4.

[4] See 49 CFR-Chapter 1-Part 173.120. See also NFPA 30, 1.7.2.2.

[5] Northern Technology & Testing Website, http://www.nttworldwide.com/tech2212.htm.

Examples of Flash Points

Fuel	Flash Point
Ethanol	55 °F (12.8 °C)
Gasoline	−40 °F (<−40 °C)
Diesel (1-D, 2-D and 4-D)	143 °F (>62 °C)
Jet Fuel	100 °F (>38 °C)
Kerosene (paraffin oil)	100-162 °F (>38-72 °C)
Vegetable Oil (canola)	3620 °F (27 °C)[1]
Biodiesel	266 °F (>130 °C)

Classification of Flammable and Combustible Liquids

The classification of liquids is based on flash points. A flammable liquid is any liquid that has a flash point below 100 °F (37.8 °C). Flammable liquids are classified as Class I with sub-classifications (see table below).

Flammable liquids, in other words, ignite easily and burn rapidly. A combustible liquid is any liquid that has a flash point at or above 100 °F.[6] Combustible liquids are classified as Class II or Class III.

Classification of Flammable Liquids (NFPA 30)[7]

Classification	Flash Point	Example
Class I Liquid	Below 100 °F (37.8 °C)	
Class IA	Below 73 °F (22.8 °C) and boiling points below 100 °F (37.8 °C)	Ethanol, Pentane
Class IB	Below 73 °F and boiling points above 100 °F (37.8 °C)	Gasoline, Isopropyl alcohol, Ethyl alcohol, Acetone, Toluene, Benzene
Class IC	73-100 °F	Turpentine, Xylene, Styrene, Butyl alcohol, Diethyl glycol

Classification of Combustible Liquids (NFPA 30)[8]

Classification	Flash Point	Example
Class II	101-140 °F	Kerosene, Diesel fuels, Pine tar, Stoddard solvent, Jet fuel, Fuel Oil 1, 2, 4 and 5
Class IIIA	141-199 °F	Fuel Oil No. 1
Class IIIB	200 °F or above	Fuel Oil No. 6, Ethylene Glycol, Motor Oil

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[6] NFPA 30, See 3.3.30.1 and 3.3.30.2 also 4.2.2 and 4.2.3.

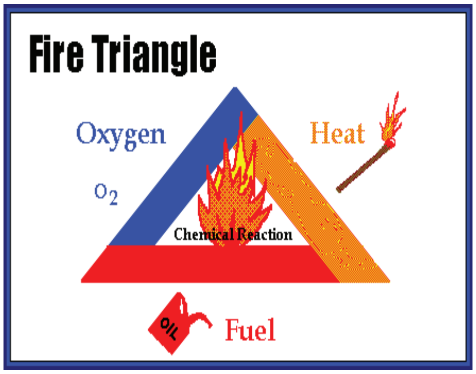
[7] Ibid. 3.3.30.1

[8] Ibid.

The Fire Triangle/Tetrahedron

Four ingredients must exist at the same time in order to produce a fire:

1) Enough Oxygen to sustain combustion,
2) Enough heat to raise the material to its ignition temperature (ignition source),
3) A combustible material (petroleum), and
4) The chemical reaction that is fire.



The *Fire Triangle* might more appropriately be called the *Fire Tetrahedron.* Add in the fourth ingredient, chemical reaction, and you have a fire tetrahedron. The important thing to remember is remove any one of these ingredients, and you will not have a fire or the fire will be extinguished. For example, fire extinguishers put out fire by removing one or more ingredients of a fire triangle or tetrahedron.

Health and Safety Plan

- Prepare a site-specific Health and Safety Plan (HASP), and keep it onsite. The HASP must address the safety and health hazards of each phase of the project. The HASP must provide for pre-entry briefings before beginning any site activity, and at any other time it becomes necessary to keep employees aware of conditions. The plan must designate a site safety and health supervisor, and the safety supervisor must have the authority to shut the project down if personnel health or safety is jeopardized. The plan should also include a communications system, which can be hand signals if they are clearly understood. An emergency communications system, such as sounding a motor vehicle horn an established number of times, must be clearly understood. The HASP should be evaluated at least daily, and must be updated if changing conditions warrant.
- Employees must be advised of the chemical, physical and toxicological properties of each substance that is known or expected to be present on the site.
- Entering the excavation should not be an option. Besides the added cost of sloping and shoring, employees would be put at risk. Consider an approach that does not require your employees to enter the excavation.

Excavations are one of the most hazardous activities in the construction industry. The primary accident at an excavation site is cave-in. According to OSHA statistics, someone is usually killed in a cave-in. Excavations do not have to be deep, such as a tank pit, to be dangerous. Workers have been killed in trench cave-ins; you do not have to be buried to be killed. Trench cave-ins often result in massive lung and liver injuries; you can be crushed to death.

OSHA requires that employees in an excavation be protected from cave-ins. For information on excavation safety, visit OSHA's Safety and Health Topics webpage on trenching and excavation.

Confined Space

Not only is it more expensive to slope or shore an excavation than to plan your removal project so no one has to enter the tank pit, you are putting your employees into a Confined Space situation. Iowa OSHA requires specific training for employees who must work in a Confined Space situation. Plan the UST closure so that no employees have to enter the excavation.

A Confined Space is a space with limited ventilation, the potential to accumulate or contain a hazardous atmosphere, exits that are not readily accessible, and not meant for continuous human occupancy. This includes excavations and trenches. There are many hazards associated with working in a Confined Space. Among them: ladder tip-over, buried utilities, falling equipment or material, and unplanned rescues. Instinctively rushing in to help someone who has become trapped in a Confined Space too often makes an already bad situation worse. Citing OSHA statistics again, half of all workers who die in Confined Space accidents are trying to rescue others.

Working in a Confined Space requires training; performing a rescue from a Confined Space takes more training. If employees absolutely must work in an excavation, train them in safety and self-rescue. Comply with all Iowa OSHA rules for Confined Space entry and activity; it is someone's life.

You must provide ladders, ramps or other safe means of exit in all trenches that are 4 feet deep or more. The means of exit must be within 25 lateral feet of workers. An earthen ramp can only be used if a worker can walk it in an upright position, and only if a competent person has evaluated it.

For additional information on confined space requirements, visit OSHA's webpage on confined spaces in the construction industry at.

Regulatory Requirements

- An Iowa licensed tank remover must be on site during removal to conduct the closure process.
- Soil and groundwater sampling are required for all UST permanent closure and must be conducted or supervised by an Iowa Certified Groundwater Professional (CGWP). Make sure you have a CGWP scheduled to conduct sampling.
- At least 30 days before the tank removal, a Notification of Closure form must be completed and submitted to the department.
- Determine what receptors exist in the area of the tank removal. Is the site an active LUST site? Are there active groundwater monitoring wells on site? Will any of the wells interfere with UST permanent closure? Talk to the LUST project manager to discuss options.
- This is also the time to notify the fire prevention bureau of the local fire department and to begin the permitting process through all the local authorities.

A Des Moines May 2014 tank removal of three 12000 gallon fiberglass tanks.

Some careful excavating was required in order to spare the driveway to a next door residence.

SECTION II: PRE-TANK REMOVAL PROCEDURES

Because of the nature of the flammable or combustible liquids that are stored in USTs, hazardous conditions are likely to exist in the tank removal area. All personnel involved in the closure operation should be familiar with the potential hazards and be aware of the appropriate health and safety measures needed to ensure a safe working environment.

During inerting, purging, and removal procedures, all necessary precautions to prevent ignition in the area must be taken, including but not limited to: grounding and bonding of equipment, using explosion-proof or intrinsically safe equipment, monitoring for vapors in the surrounding area, and controlling pedestrian and traffic flow.

Keep the following in mind when planning a storage system closure:

- It is imperative that you check with your local fire authority for any local requirements (permits, site inspections during excavation, etc.) prior to removal.
- Go out to the site and conduct an inspection of the area where you will be working. Determine what equipment you will need, and obstacles that you will need to remove or work around. Are there wells in the area such as private drinking water wells, public water wells, or groundwater monitoring wells that may require special attention with regard to evaluating the site for contamination or special precautions with regard to spillage of product?
- Review American Petroleum Institute (API) Publication 1604 *Closure of Underground Petroleum Storage Tanks*, the New England Interstate Water Pollution Control Commission (NEIWPCC) CD and booklet, *Tank Closure Without Tears*, NFPA 326 Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning or Repair, and NFPA 30 & 30 A Flammable and Combustible Liquids Code Handbook which complement this guidance document and will help you accomplish a safe tank removal. OSHA has prepared an excavation guidance manual which you should also be familiar with.
- Tank removal operations are likely to generate significant quantities of flammable vapors. Evaluate weather and ambient atmospheric conditions such as wind velocity, wind direction, and humidity prior to beginning the tank removal operation to ensure that vapors will be adequately dissipated.
- Understand and abide by all safety precautions. They are good for you and the environment.

Iowa One Call

- Contact Iowa One Call. The toll free number is 800-292-8989 or through their website. The Iowa One Call center is open 24/7 365 days a year. When you call, be ready to provide detailed location information, including the name of the property owner, the specific location of the excavation (9-1-1 address), and directions to the site. Ask for a “Joint Locate” where you meet the Iowa One Call locator on site. This is the best way to get accurate answers to your questions about subsurface utilities.
- OSHA requires that you determine the location of any underground utilities that reasonably may be expected to be encountered before you open the excavation.
- Local and state laws require that you determine the exact location of a utility before you excavate. Remember that utility locators only have to mark within three (3) feet on either side of a utility to have done their job. It is your responsibility to ensure that utilities are not damaged.

The same state law that requires utility owners to register their utilities and you, the contractor, to notify before excavating, also requires the following colors be used to identify the utility locations.

Underground Utility Markings

Operator and Type of Product:	Identifying Color
Electric Power Lines, Cables, Conduit and Lighting Cables	Red
Gas, Oil, Steam, Petroleum or Gaseous Materials	Yellow
Communication, Alarm or Signal Lines, Cables or Conduit	Orange
Water, Irrigation and Slurry Lines	Blue
Sewers and Drain Lines	Green
Temporary Survey Markings	Pink
Proposed Excavation	White
Reclaimed Water	Purple

Electrical Safety

Disconnect all electrical service going into, under, or through the UST area. Turning off wall switches is not enough. You must use circuit breakers to de-energize the circuits. Use lockout/tag out procedures to ensure that power is not accidently restored. Use your voltmeter or voltage sensor to confirm that electrical circuits are de-energized; don't take chances. Electrical work, including de-energizing circuits, may need to be done by a licensed electrician. Check with local authorities to determine who can perform electrical work.

Drainage of Product

Drain product piping back into the tank. If the piping system is pressurized, you will have to remove or open fully the STP check valve and open the shear valve test ports at each dispenser island to drain the piping. If the system is suction and has a check valve at the tank-top, you will need to excavate to the tank top and remove the check valve to drain the piping. Keep in mind when actually removing the piping that some product may remain in the piping. Take precautions not to spill any remaining product.

Pour enough water/cleaner solution into the piping at each dispenser island to ensure a triple rinse of the piping volume. Pump or vacuum the solution out of the tank. You can also use nitrogen (in place of a triple rinse) to flush fuel out of the product piping. Nitrogen is more expensive, but generates less waste that will have to be properly disposed of. The flow rate of the nitrogen must be high enough to flush as much fuel as possible into the tank. Be sure the tank is appropriately vented so that vapors will dissipate and the pressure in the tank remains below 5 psi. Avoid spilling fuel in the excavation area.

Remove all liquids and residue from the tank. Use explosion-proof or air-operated pumps or a vacuum truck. If you rinse the tank with water, you will be able to remove more of the residue. You may have to use a hand pump to remove the last few inches of liquid from the tank bottom.

Be careful while pumping, especially when using a vacuum truck on a gasoline tank. Fresh air will enter the underground tank and may bring the atmosphere inside the tank into the flammable range. Bond and ground all pump motors and suction hoses to prevent a buildup of static electricity.

If you use a vacuum truck, the area around the truck must be kept as vapor-free as possible. Locate the truck upwind of the tank. The suction hose must be grounded. The vacuum pump exhaust gases must be vented through a line of adequate size. The exhaust vent of the vacuum truck should be located downwind of the truck and tank area and be at least 12 feet above the ground surface.

Excavating

Remove the concrete/asphalt surface over the tank. It is a good idea to separate this material from the backfill material that may need special handling due to contamination. Select your on-site storage area for excavated materials carefully so it will not interfere with subsequent activities. All excavated material must be kept at least two (2) feet from the edge of the excavation, or it must be secured to keep it from falling into the tank pit or causing a cave-in.

Excavate to the top of the tank and remove all tank-top equipment. This includes the fill pipe and drop tube unless you will be using an eductor to purge the tank. Remove all tank risers and product piping and conduit that are accessible and uncovered. Do NOT disconnect the vent line.

The vent line must remain connected until the tank is purged. Plug all other tank openings as you remove the tank top equipment and risers. This will keep vapors in the tank and out of the work area.

The objective at this stage of the project is to access and remove everything possible while the excavation is still shallow. This will avoid having personnel work in, over, or around a deeper, potentially more dangerous excavation at later stages of the tank removal.

Contaminated backfill must be separated from clean backfill during excavation. This can be accomplished by visual observation and by field screening the material as it is excavated. Report obvious contamination to the department.

Purging and Inerting

Once a tank is empty of liquid fuel, the atmosphere inside the tank is a potentially explosive mix of fuel vapors and air. Keep all potential ignition sources a safe distance away. These include smoking materials, tools that can cause a spark, electrical equipment that is not explosion-proof, and internal combustion engines.

Whether you are purging or inerting, you are removing one of the ingredients in the fire triangle (either fuel or oxygen) in order to control the atmosphere inside the tank and avoid an explosion. Where possible, the safest way to avoid an explosion is to eliminate both the oxygen and fuel components of the fire triangle. You should ALWAYS minimize ignition sources when working around tanks.

Purging

Purging is the removal of flammable vapors from a tank either by drawing the vapors out using an eductor, or blowing the vapors out using a diffused air blower. Purging eliminates the fuel ingredient of the fire triangle. A combustible gas indicator (CGI), which is also called an explosimeter, is a device used to measure the concentration of combustible gases. A CGI will only operate properly in the presence of sufficient oxygen. Use an oxygen meter in conjunction with a CGI to monitor the progress of the purging operation. Remember that fuel vapors can regenerate inside the tank. Continue purging as long as possible and monitor the tank atmosphere often.

Inerting

Inerting is the removal or displacement of Oxygen from a tank using a non-reactive or inert gas. Dry ice (which is frozen carbon dioxide or CO_2) or Nitrogen (N_2) are the gases that are commonly used for inerting. Inerting eliminates the oxygen ingredient of the fire triangle. An oxygen meter is used to monitor the progress of the inerting process. Be sure to use an oxygen meter that will work properly in the presence of the gas you are using to inert the tank. Inerting is often the procedure of choice when tank removal takes place in a densely populated urban area because the volume of petroleum vapors generated by inerting is much less than the volume of vapors generated by purging.

Purging and inerting are very different procedures and have very different monitoring requirements. Whether you are purging, inerting, or both, be sure you understand exactly what you are doing. If conducting both purging and inerting procedures, be sure to do the purging first.

Safety concerns do not end once the tanks are purged or inerted. Tanks must be removed from the ground, loaded onto a truck, transported safely, and stored securely while they are waiting to be destroyed. Tanks can regenerate explosive vapors regardless of how well they are cleaned. A used tank will never be safe as long as it remains a tank.

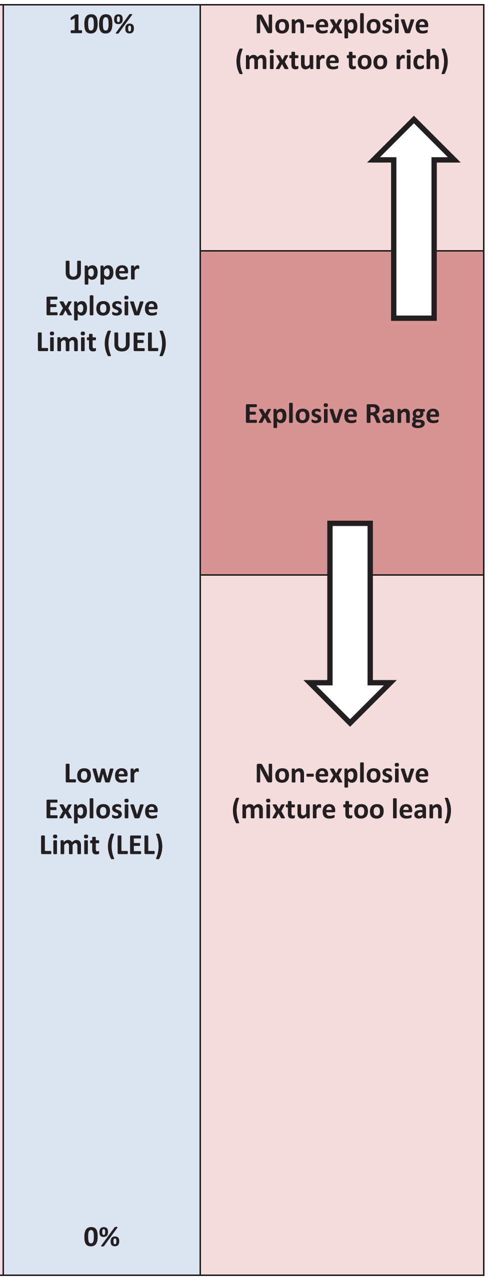
Lower and Upper Explosive Limits

In order for gases or vapors to become flammable/explosive, the concentration of vapors must be within a certain range, called the explosive or flammable range. See the diagram on the right. See Appendix E for a list of the flammable ranges of various vapors.

For example, the lower end of this range (the Lower Explosive Limit or LEL) of gasoline vapor is 1.4% and the upper end of this range (the upper explosive limit or UEL) is 7.6%. This means that below its LEL of 1.4% the gasoline/air mixture is too lean to explode (not enough fuel) and above 7.6% it is too rich to explode (not enough oxygen). If the gasoline vapor concentration is anywhere in between the range of 1.4% and 7.6% the mixture of vapor and air is explosive. When a CGI reads 100%, it is indicating that the vapor concentration has reached the LEL, or 1.4%. The ideal goal of purging is to get the CGI to measure 0%, which would mean that no vapors were present.

Usually, a CGI reading of 10% which indicates that the vapor concentration is 10 percent of the LEL (0.14%) is considered safe.

Again, the goal of purging is to control the vapor concentration in the tank in order to create and maintain an atmosphere that is well below the LEL The only way to know you are achieving this goal is by constant monitoring of the tank atmosphere.



Purging: Monitoring Vapor Levels

When purging a tank, use a CGI to measure the vapor concentration inside the tank. Take readings from openings at both ends and the middle of the tank and from the bottom, middle, and the upper levels of the tank at each opening. All of these readings should be below 10% of the LEL. Most CGI's require normal levels of oxygen to operate properly. Use an oxygen meter to ensure that adequate levels of oxygen are present to allow the CGI to give correct readings.

For double wall tanks, check the interstice for vapors as well. If the primary wall was breached, there could be hazardous levels of vapors in the interstice.

Carefully follow the CGI manufacturer's instructions for calibration, operation, and maintenance of the instrument at all times. Your life depends on the measurements made by the CGI.

Continue monitoring the tank atmosphere until the tank has been loaded for transport and is ready to leave the site. The tank atmosphere must be safe when the tank leaves the site.

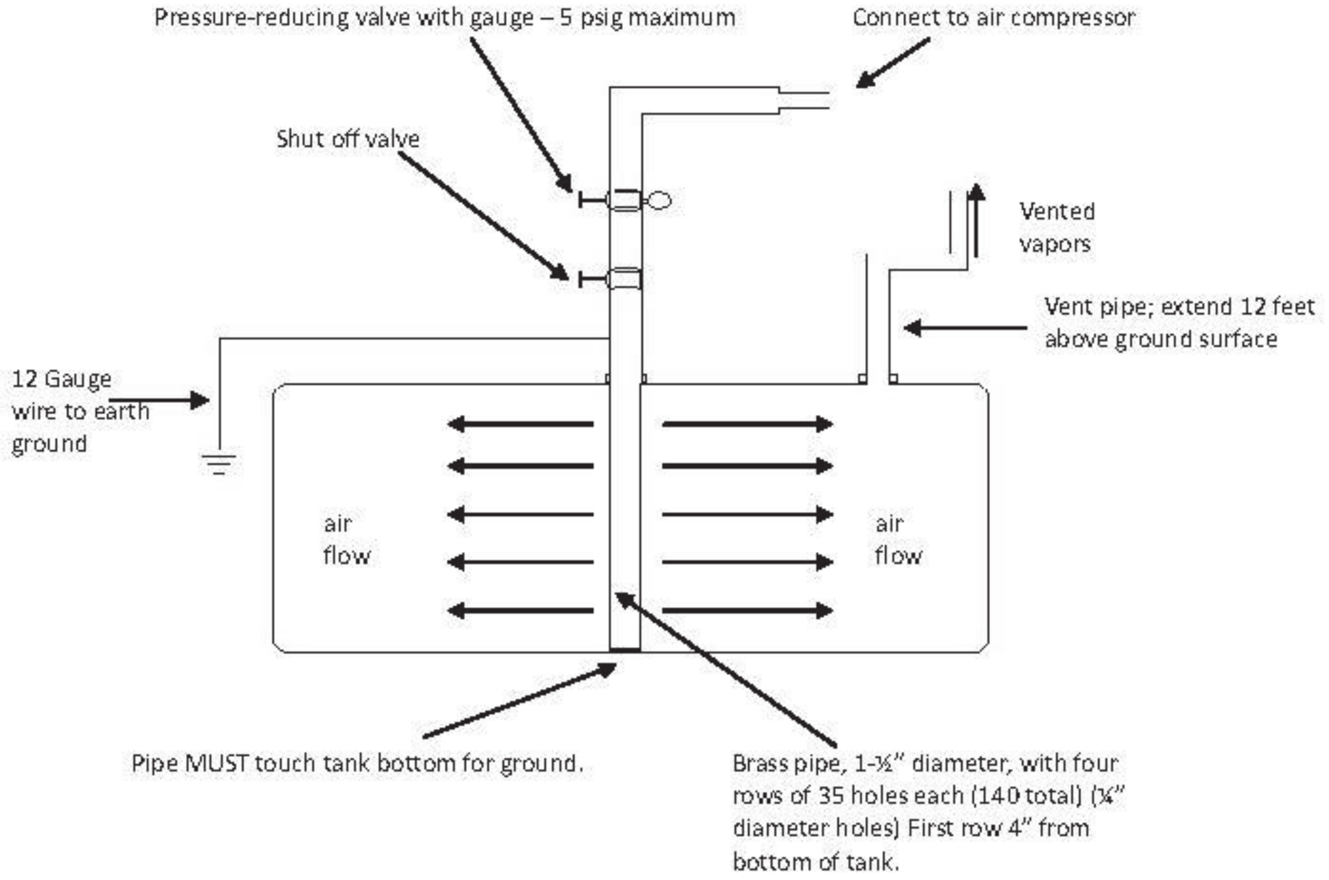
Caution! Keep the following in mind when purging a tank:

- Immediately before beginning work on the tank or in the tank area, check the vapor concentrations in the tank with a CGI.
- Gasoline vapors are heavier than air and may sink to low areas. Check vapor levels in low spots on the work site where vapors can accumulate.
- Even after purging, a tank can regenerate flammable vapors. Check vapor levels often.
- Purging causes large volumes of flammable vapors to be expelled from the tank. Vent all vapors at least 12 feet above grade and 3 feet above any adjacent roof lines.
- Keep the work area free of all sources of ignition.
- Ground and bond the tank and all equipment used for purging to prevent the buildup of static electricity.
- Be sure that personnel using monitoring equipment are thoroughly trained in the use of the instruments and how to interpret the readings.
- When introducing compressed air into a tank, make sure the tank is properly vented so that it does not over-pressurize.

Purging: Using a Diffused Air Blower

When using a diffused air blower, fresh air is circulated through the tank from an air compressor, forcing the explosive vapors out of the tank through the vent. The vent opening must be at least 12 feet above the ground. All other tank openings must be plugged. The drop tube and all other in tank equipment must be removed. The diffuser must be bonded to the tank and grounded to the earth. The flow of air into the tank must be controlled so that the pressure inside the tank never exceeds 5 psig. Always work with a dependable pressure gauge, and check it often during the purging process. Continue purging as long as possible up to the time the tank is removed from the excavation.

A Positive Pressure or Diffused Air Blower

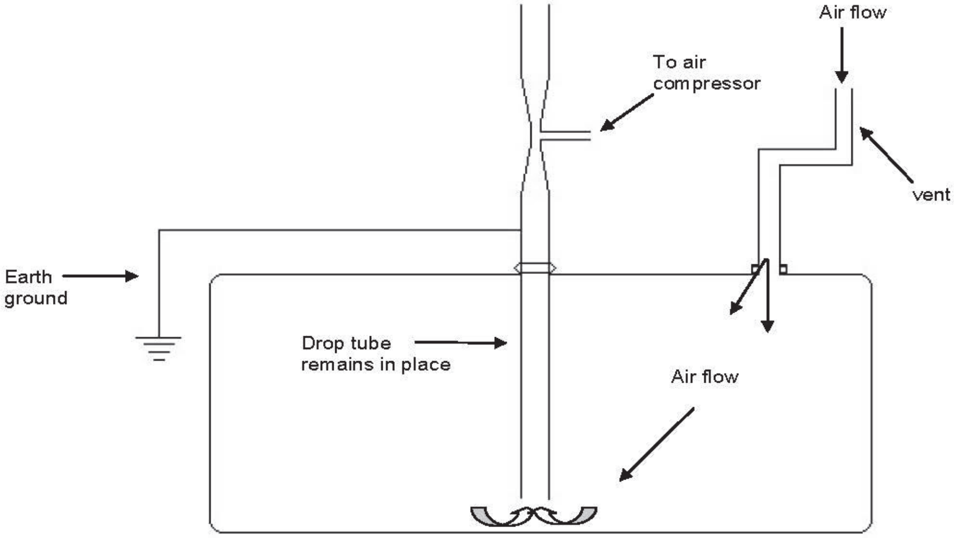


Purging: Using an Eductor-Type Air Mover

When using an eductor, air is pumped through the eductor from an air compressor. The venturi construction of the eductor draws additional air from the tank through the base of the eductor. The air from the compressor and the air/vapors from the tank are both discharged through the top of the educator. Fresh air is drawn into the tank through the vent. The top of the eductor must be at least 12 feet above the ground surface. The eductor is attached to the fill pipe and the drop tube is left in place for this method so that vapors will be drawn from the bottom of the tank. All other tank openings except the vent must be plugged. The eductor should be bonded to the tank and grounded to the earth. Continue purging as long as possible up to the time the tank removed from the excavation.

Photo of eductor in operation at a Des Moines tank removal. Purging should continue as long as possible to keep vapors from regenerating in the tank.

A diagram of an eductor type air mover.



Inerting

Inerting addresses the oxygen component of the fire triangle by replacing the oxygen in the tank with a non- reactive gas. One of the most-widely used methods of inerting a tank is by adding dry ice, which is carbon dioxide in solid (frozen) form. Nitrogen gas is also commonly used to inert tanks. Inerting may be preferable to purging when removing tanks in densely populated urban areas because inerting generally releases a smaller volume of flammable vapors into the atmosphere than purging.

When using dry ice to inert a tank, the API and the NFPA recommend adding 1½ to 2 pounds of dry ice per 100 gallons of tank capacity. The dry ice should be shaved or crushed and distributed evenly over the greatest possible area of the tank's interior. Insert the dry ice through each available tank opening, resealing each tank opening as soon as the addition of the dry ice is completed. As the dry ice warms, it vaporizes and releases carbon dioxide gas, which is heavier than air and settles to the bottom of the tank. As the level of carbon dioxide gas increases, the vapors, oxygen, and air in the tank are pushed out of the tank vent. It generally takes longer to inert with dry ice than it does with nitrogen.

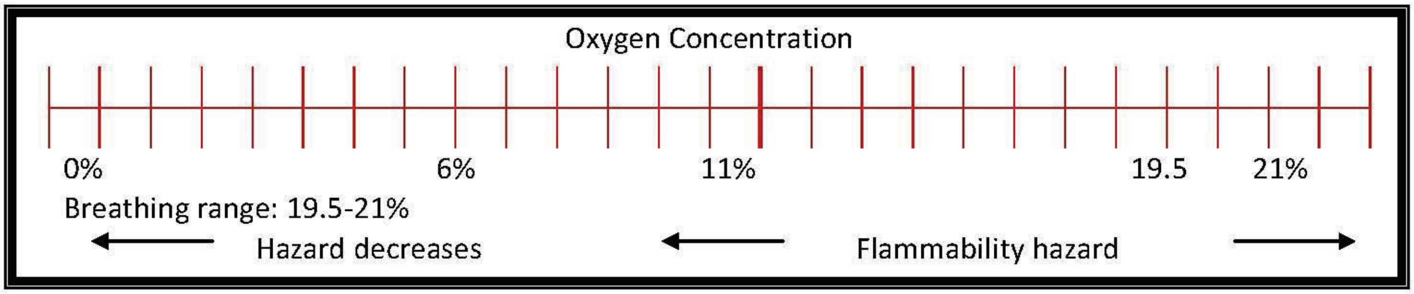
Caution: The temperature of dry ice is -109.3°F (-78.5°C). Skin contact with dry ice can cause severe damage to the skin. Some tips on handling dry ice:

- Dry ice does not melt, it sublimates. Sublimation is the process of going directly from a solid to a gas. Dry ice bypasses the liquid state, giving it its name *dry ice.*
- Dry ice will sublimate at a rate of 10 pounds every 24 hours in a standard insulated container. Be sure to allow for loss of dry ice during transit to the work site.
- Plan to pick up your dry ice as close as possible to the time when you plan to use it. Avoid opening and closing the container as much as possible.
- If you remove only a portion of the dry ice from a container, fill the empty space with wadded newspaper. Dead air space will cause the dry ice to sublimate faster.
- Do not store dry ice in an airtight container. The accumulation of carbon dioxide gas can cause an airtight container to burst.

Nitrogen is introduced into a tank as compressed gas from cylinders. Cylinders of compressed carbon dioxide could also be used rather than dry ice. Because compressed gas cylinders contain gas under high pressure, controlling the pressure is very important when introducing the gas into a tank. Introduce compressed gases through a supply line near the bottom of the tank and at the opposite end from the vent. Use a low flow rate to minimize the generation of static electricity. Use bonding and grounding measures to minimize the accumulation of static charges.

Never discharge a CO_2 fire extinguisher into a tank. Static electricity produced by discharging a CO_2 fire extinguisher can ignite flammable vapors and cause an explosion.

A tank that has been inerted does not contain enough oxygen to support combustion. This means that there is also not enough oxygen to support life. Do not enter a tank that has been inerted!! Only tanks that have been properly purged can be entered! Always follow confined space entry procedures when entering a tank.



Inerting lowers the oxygen concentration in the tank to a level below which combustion will not occur. Combustion should not occur below 11%, but to play it safe make sure the oxygen is 6% or lower.

Inerting: Monitoring Oxygen Levels

Air is roughly 21% oxygen and 79% nitrogen by volume. The safe breathing range for oxygen is 19.5-21%. Most petroleum products need a minimum of 11.5-14% oxygen to support ignition or combustion. To provide a margin of safety, the oxygen concentration should be reduced to 50% of the lowest level of oxygen necessary to support combustion, or about 6-7% oxygen.

Use an oxygen meter to measure the oxygen level inside the tank. Take readings from openings at both ends and the middle of the tank and from the bottom, middle, and the upper levels of the tank at each opening. Do not take readings through a drop tube. All readings should indicate that the oxygen level is 6 percent or less.
Continue monitoring the tank atmosphere until the tank has been loaded for transport and is ready to leave the site. The tank atmosphere must be safe when the tank leaves the site.

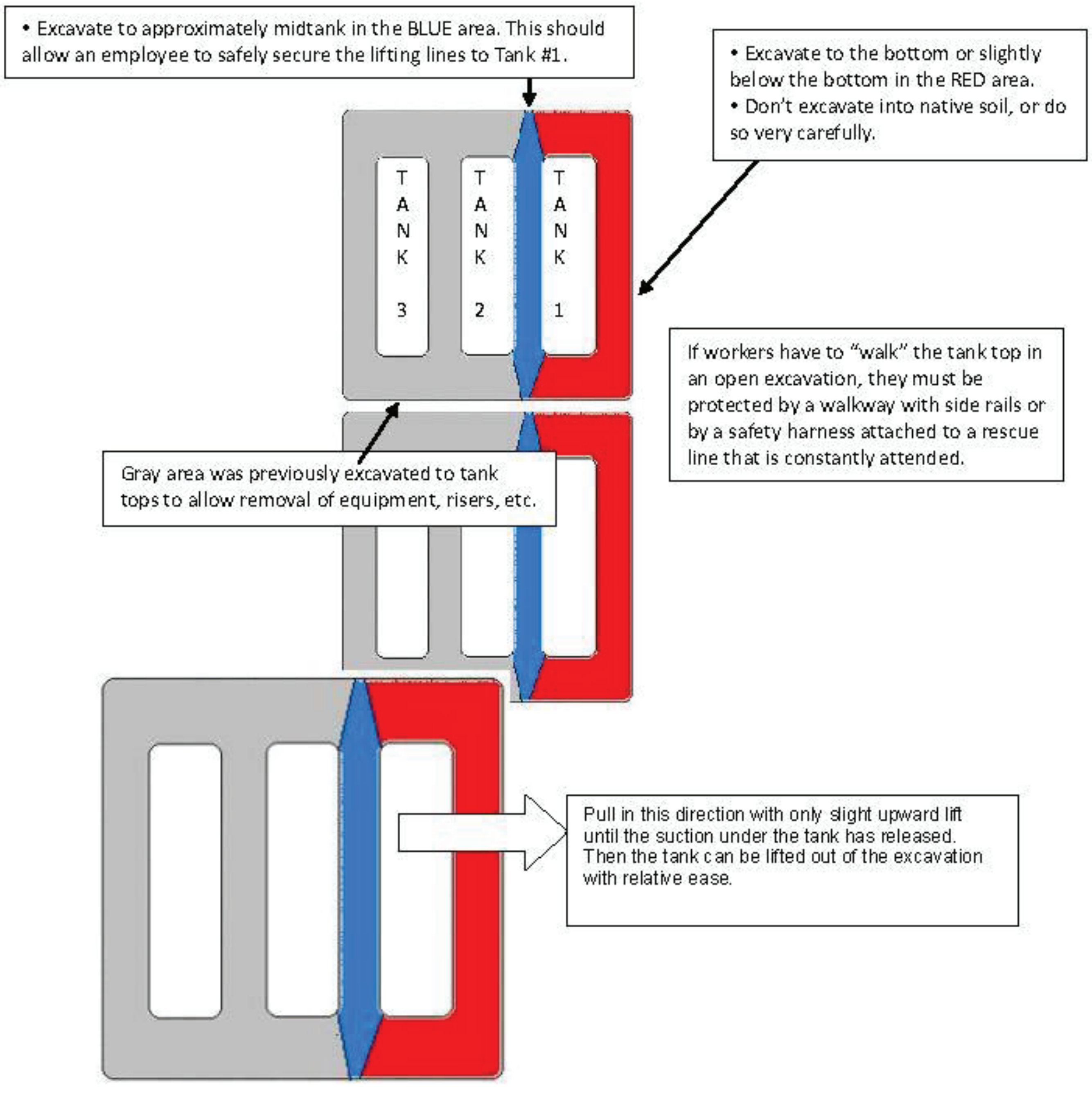
During inerting, flammable vapors will be exiting the tank vent. Monitor the excavation area and any other nearby low spots for the presence of flammable or combustible vapors using a CGI.

SECTION III: REMOVING THE TANK FROM THE EXCAVATION

The tank is ready to be removed from the excavation only after it has been successfully purged or inerted.

After the tank atmosphere has been made safe, but before removing the tank from the excavation, remove the vent pipe and install a plug or cap with a ¼" hole. This hole will prevent the tank from becoming over- pressurized due to temperature changes. The tank should always be positioned with this vent plug on top, including during subsequent transport and storage. All of the other tank openings should already have been plugged and should remain plugged.

If there are multiple tanks in an excavation, plan on removing one of the end tanks first and working your way across the excavation. Excavate around three sides of one tank to finish uncovering it and to prepare it for removal. See the diagram below.



- Excavate to approximately midtank in the BLUE area. This should allow an employee to safely secure the lifting lines to Tank #1.

- Excavate to the bottom or slightly below the bottom in the RED area.
- Don't excavate into native soil, or do so very carefully.

If workers have to "walk" the tank top in an open excavation, they must be protected by a walkway with side rails or by a safety harness attached to a rescue line that is constantly attended.

Gray area was previously excavated to tank tops to allow removal of equipment, risers, etc.

Pull in this direction with only slight upward lift until the suction under the tank has released. Then the tank can be lifted out of the excavation with relative ease.

Rock & Roll

Rocking or rolling the tank toward the fully excavated area will free the tank from the backfill, and allow relatively easy lifting of the tank.

When removing the tank, remember that**:**

- All excavated material must be kept at least two (2) feet from the edge of the excavation, or it must be secured to keep it from falling into the hole or causing a cave-in.
- You must use equipment capable of safely lifting the tank. The tank should not be dragged.
- Place the tank on a level surface and block it to prevent it from rolling.

Removing Sludge and Cleaning the Tank

Iowa DNR regulations prohibit the discharge of liquid waste into the environment. Contract with a licensed hazardous/non-hazardous waste transporter who can properly document on a hazardous/non-hazardous waste manifest the generator, transport and proper disposal/treatment of the hazardous/non-hazardous waste. A list of tank cleaners/vacuum services is provided on the DNR UST website. Drumming petroleum contaminated liquid and sludge and leaving it on site is not proper disposal, nor is transporting it to a Publicly Owned Treatment Works (POTW). Always-contract with a licensed hazardous/non-hazardous waste transporter.

If there is not sufficient room above grade at the site to safely clean the tank, it is possible to remove the sludge while the tank is still in the excavation. Tip the tank toward one end and then wash the sludge to the low end where it can be pumped out. When deciding whether to clean the tank in or out of the excavation, consider the space available to do the work, the ability to restrict sources of ignition from adjacent traffic and people passing by, the likelihood that flammable vapors may accumulate on site, and any other site specific factors that could endanger personnel working on the site or the general public. Check local requirements to see if there are restrictions on how or where cleaning activities can be conducted.

If the tank is to be entered to manually remove sludge from the bottom of the tank or scale buildup from the tank walls, be sure to follow all confined space entry requirements and continue to purge the tank. Removing the sludge from the tank and triple rinsing the inside of the tank will reduce the possibility of vapors regenerating.

After the tank has been cleaned, make sure you receive a signed certificate from the tank cleaning company certifying the cleanliness of the tank. Document the cleaning of tanks with photographs and include them with the closure report.

Labeling the Tank

Before transporting the tank from the site, it must be properly labeled. Lettering must be large and legible from a distance and include a warning against reuse of the tank. The API recommends that the following information be included in the label:

- TANK HAS CONTAINED____________________(gasoline, diesel, kerosene, etc., as appropriate)
- NOT VAPOR-FREE
- NOT SUITABLE FOR STORAGE OF FOOD OR LIQUIDS INTENDED FOR HUMAN OR ANIMAL CONSUMPTION
- MONTH/DAY/YEAR the tank was removed

If the tank has held leaded gasoline, or if the history of the tank is unknown, it should be clearly labeled with the following information:

- TANK HAS CONTAINED LEADED GASOLINE
- TOXIC LEAD VAPORS MAY BE RELEASED IF HEAT IS APPLIED TO THE TANK SHELL

Entering a tank is a confined space procedure.

The atmosphere inside the tank (above) is being purged using an educator while the person is inside cleaning the tank.

A supplied air respirator is not used because the oxygen level is within the breathing range, however, an air purifying half mask is essential because toxic levels of vapors are likely to be present.

The sludge the technician above is removing.

Disposing of Waste Materials

The licensed tank remover is responsible for proper disposal of all waste materials generated during the tank removal process. This includes, but is not limited to, excavated material, non-salvageable storage system components, the tank itself, any fuel or sludge in the tank, and the water used to clean the tank. Waste material must be transported and disposed of using transporters and disposal facilities which possess all required federal, state and local licenses or permits. Submit manifests certifying the proper transport, receipt, and disposal of waste materials with the closure report.

Transporting the Tank

Keep the following in mind when preparing to transport the tank off site:

- The tank should be removed from the site as soon as possible after removal. Fiberglass tanks may be crushed on site. Check local requirements before destroying tanks on site.
- If a tank remains on-site overnight or longer, vapors may regenerate from residues remaining in the tank. Always monitor the tank atmosphere to be sure the tank is properly purged (below 10 percent LEL) or inerted (below 6 percent oxygen) immediately before the tank leaves the site.
- Plug any holes in the tank walls that would allow any residues to leak out during transport.
- Scrape off any chunks of dirt or clay that could fall from the tank during transport.
- Be sure the tank is properly secured before transporting, and that the 1/4-inch vent hole is located at the uppermost point on the tank.
- The transporter is subject to all local, state and federal transportation laws.

Tank being secured for transport.

Tank removal in Waukon. Planning a tank removal must take into account overhead power lines and canopies that can present risks for removers. Please note, the person standing close to the excavation is not wearing safety equipment and the excavation is not barricaded.

A documented release. This is the same tank as above. Note the two quarter-size perforations.

The photo below shows a tank installed in the 1960s that was later internally lined. Boiler plugs were used to repair holes in the tank before it was lined. This photo provides documentation that a release likely occurred at this site before the tank was lined.

Accurately describing the condition of the tank in the closure report is important for determining whether contamination that is present may be due to a new or an old release.

Storing Used Tanks

If a tank is placed in storage, make sure it has been cleaned and residues removed to minimize the regeneration of vapors. Only the ¼-inch vent hole should be left open. Always store used tanks in a secure area where access is restricted to personnel who understand the hazards that are present.

Reusing Tanks

Removed tanks may not be reused for storing petroleum products or other regulated substances unless they are recertified by the manufacturer. Otherwise, removed tanks are not suitable for reuse for any purpose and therefore must be rendered unusable.

- If you transfer ownership of the tank to another party, such as a scrap iron dealer or salvage yard, prepare a Bill of Sale to officially transfer ownership of the tank. The Bill of Sale should include the purchaser’s acknowledgement that the purchaser assumes all liability for the tank. The Bill of Sale should include warning language similar to the warning label applied to the tank:
- TANK HAS CONTAINED_____________________(gasoline, diesel, kerosene, etc., as appropriate)
- NOT VAPOR-FREE
- NOT SUITABLE FOR STORAGE OF FOOD OR LIQUIDS INTENDED FOR HUMAN OR ANIMAL CONSUMPTION

Tanks must be rendered unfit for future use, not put up for sale. The owner of these tanks was told to remove them to a landfill or salvage yard. Tanks can regenerate vapors and are a hazard to public safety unless they are in a secure area

Piping

The tank removal procedure should include removal of all the associated piping. Use care when excavating the piping. It can be very useful if you can identify corrosion holes, defects, improper installation or loose fittings that may have contributed to contamination at the site. Dispose of the piping in the same manner as the tank.

SECTION IV: SAMPLING FOR CONTAMINATION AT TANK REMOVAL

Iowa *Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks* [567—135.15(3)] govern soil and groundwater sampling requirements at tank removals. Proper soil and groundwater sampling procedures must be followed in order to obtain meaningful results. To ensure that sampling procedures are properly followed, tank owners and operators must contract with an Iowa Certified Groundwater Professional (CGWP) to conduct or supervise soil and groundwater sampling.

Visual Inspection

The purpose of an assessment at tank closure is to determine whether a release had occurred from any part of the UST system at any time during its active life. It is important for the tank remover and CGWP to investigate each storage system component for the presence of perforations, cracks, loose fittings or connections, or damage of any kind which may have caused a release.

During the removal process be alert for any evidence of a petroleum release including stained or petroleum saturated soils, strong petroleum odors, or a rainbow sheen on any water that might be present. These are all indicators that a petroleum release has occurred and must be reported to the Iowa DNR.

Samples must be discreet samples, that is, representative of the conditions at one location, such as in line with a spill bucket beneath a tank, and not composite samples. Samples should be collected promptly (during the removal procedures) and collected from freshly exposed native soil. There should be no reason to enter the tank pit to collect soil samples. This would require adherence to applicable OSHA regulations. Grab samples from a backhoe bucket are preferable to workers entering a tank pit.

If samples are to be collected by drilling, split spoon, hollow stem and continuous core are acceptable sampling devices. Grab samples from drill cuttings are not acceptable. Drilling and sample collection should be conducted in accordance with Tier 1 Guidance.

Soil Sampling Equipment

Consult with the Iowa certified lab of your choice for information on recommended sampling equipment and containers. In general, there are two basic types: a brass sampling tube with acetate liner and a glass jar with a Teflon septa lid.

If samples are to be collected by drilling, hollow stem, split spoon and continuous core are acceptable sampling devices (see Tier 1 Guidance). Direct push (DP) equipment with a continuous soil core may be used for soil sampling for closure. Core diameters vary depending on the size of the DP equipment used, but a soil core of at least one and one-eighth inch is preferred.

When hand-sampling or manual sampling, a soil sampling tube is a convenient way to collect a sample from the bottom of an excavation. A rigid acetate liner is inserted into the brass soil sampling tube and the tube is pushed at least two-thirds of the way into the soil. The sample can be collected directly from the bottom of the excavation (e.g., a shallow pipe trench that is safe to enter) or from a backhoe bucket of soil retrieved from the bottom of a tank excavation.

Use only clean jars obtained from the laboratory that will conduct the analyses. Always compact the soil into the container tightly and fill the container completely. No void spaces should be visible in the container. Secure the lid tightly. Use a container that is large enough so that the entire quantity of soil required for each sample can fit into a single container. Sample containers should be clearly labeled and promptly sealed and placed on ice for transport to the Iowa Certified Lab. Do not allow samples to be held so that the maximum holding time of 72 hours is violated.

Use a site drawing to indicate the sample locations along with a description of the sample. Label each sample container exactly as it is identified on the site drawing. The sample label should also indicate the facility name, tank owner, date, and the substance stored in the underground tank. Immediately place the samples in a cooler to maintain them at approximately 40 degrees Fahrenheit. Do not allow the samples to freeze.

Photos courtesy of South Dakota Petroleum Release Compensation Fund

Removers, excavators and CGPs must look for obvious signs of contamination. In these photos contamination is not from overfills, but from damaged, leaking spill buckets. This is why we sample beneath the tank in line with the spill bucket or fill port and STP sump.

The top photo shows a damaged spill bucket that obviously leaked into the backfill and around the tank. The photo on the left shows a piece of 2 inch Ameron pipe that was pressurized and soap tested after removal. This site was part of an autopsy study conducted by the South Dakota Petroleum Contamination Fund. There are several leak locations, one located where the elbow and pipe connect.

Photos courtesy of South Dakota Petroleum Release Compensation Fund

Release Reporting

When there is evidence indicating there has been a release to the environment, the storage system owner must notify the Iowa DNR within 24 hours of discovery under normal circumstances or within six hours if a hazardous condition exists. As the contractor doing the work, you will likely be the first one to identify a release. You must notify the tank owner as soon as you discover the evidence of a release so that the tank owner can meet this reporting requirement. To file a report, the owner should call 515-725-8200 Monday - Friday 8:00 am - 4:30 pm or send a fax to 515-725-8202 ATTN: Underground Storage Tank Section.

In addition to the telephone report filed by the tank owner which must be received within 24 hours, UST professionals must report releases to the Iowa DNR within 7 days of discovery on a special form. This form is available on the Iowa DNR UST website.

When the contamination poses an immediate threat to life or health such as explosive conditions or contamination of public or private drinking water supplies report it immediately to the Iowa DNR's 24 Hour Environmental Emergency Response Hotline 515-725-8694. This is an environmental-related emergency phone number and is only to be used when an immediate threat to life or health is present. Upon receiving the report, DNR personnel will provide further direction.

An example of a hazardous condition is product floating on the groundwater in the tank pit or in a monitoring well; a sheen of product on a lake, in a stream or a river; product discovered in a sump, a monitoring well, or in the UDC; more than 25 gallons of product overfilling or spilling onto the ground; vapors or product present in a building, sewer or utility line. In any of these situations, imminent or potential danger exists to the public or the environment and must be reported immediately

Releases of petroleum from non-regulated systems must be reported to the department.

Below are some examples indicative of a release:

1. Vapor or product is detected in vapor monitoring or groundwater monitoring wells used for leak detection.
2. Unexplained presence of water in the tank or sump
3. Internal tank inspection results reveal perforations, corrosion holes, weld failures, or other similar defects.
4. Soil or groundwater sample analytical results for any petroleum constituent exceed the DNR's action levels [567—135.14].
5. There is a spill or overfill from the UST system.
6. There is an affected receptor (e.g., petroleum discovered in a utility trench, which can be attributed to the UST facility or the UST facility cannot be ruled out as a source).
7. Drinking water supplies are contaminated, which can be attributed to the UST facility or the UST facility cannot be ruled out as a source.
8. Vapors are observed in buildings or structures which can be attributed to the UST facility or the UST facility cannot be ruled out as a source.
9. Free product is observed in the environment or in monitoring well used for release detection or LUST monitoring.
10. Stained soil is observed.
11. A sheen is observed on surface water

Sampling for UST Closure

Soil Sampling for Tank Closure (Removal)

Following the tank removal, inspect the excavation (floor and sidewalls) for evidence of contamination provided the sidewalls are stable and water is not present in the tank bed. Collect samples from any areas where contamination is observed. Figure 1 shows contamination near the fill port and suggested sample locations. Sample at one foot (minimum) to two feet (maximum) (1-2 feet) into native soil. If there is no obvious contamination, the number of samples will be determined by the size of the tank. Refer to Table 2 Soil Sample Locations Summary - Tanks Removed.

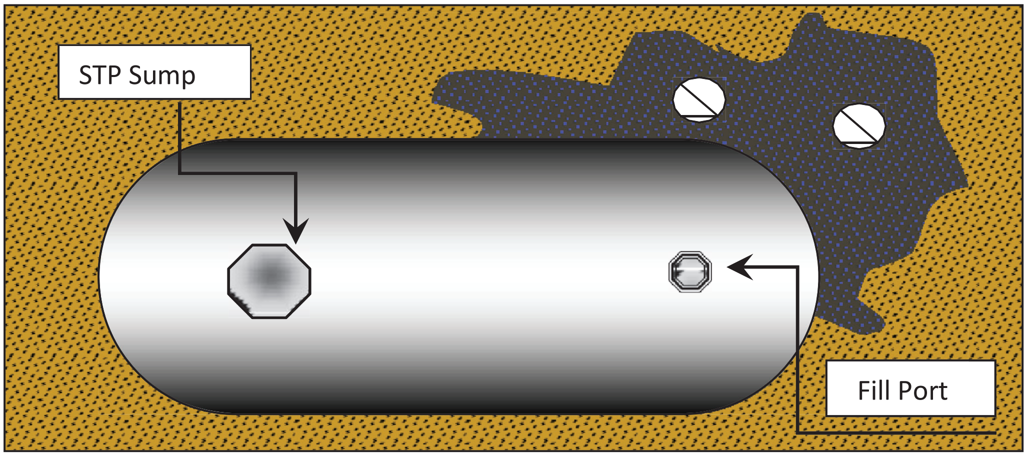


Figure 1

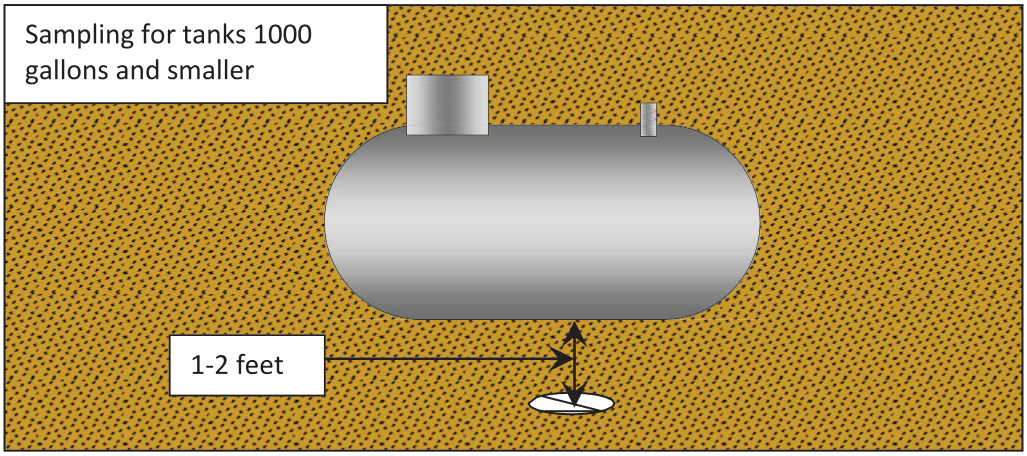


Figure 2

In addition to obvious contamination, collect the standard number of samples according to tank size. Figure 2 shows where to collect a sample for a tank 1000 gallons or smaller capacity. Collect the sample at a depth of at 1-2 feet into native soil.

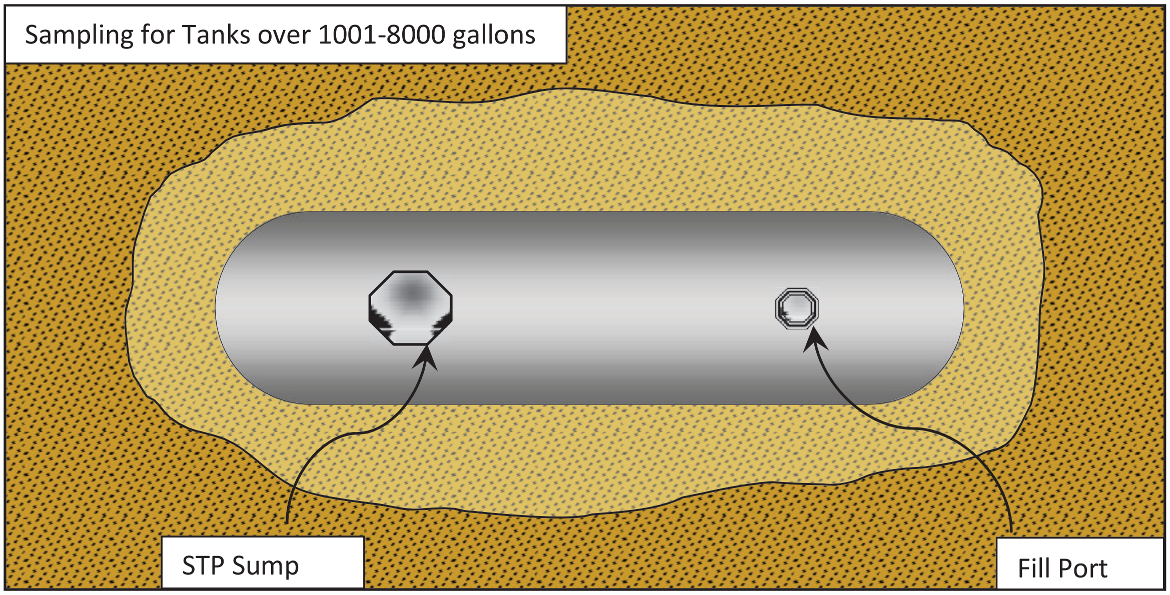


Figure 3

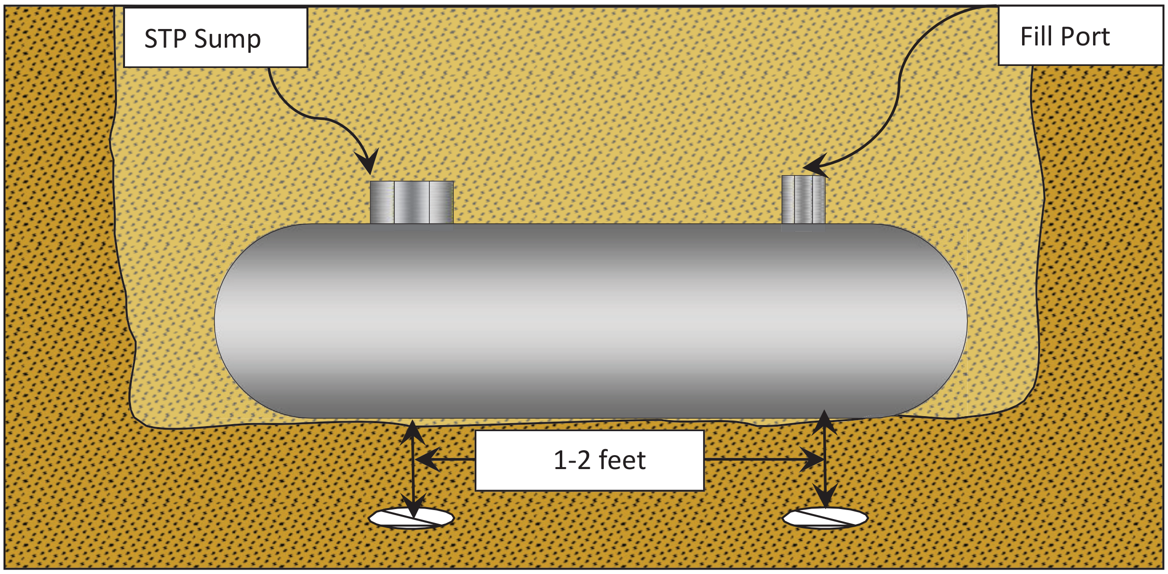


Figure 4

For tanks 1001 to 8000 gallons capacity (if evidence of contamination is not observed), collect two confirmatory samples from areas where leaks are most likely to occur and migrate - in line with the spill containment or fill port, and in line with the submersible turbine pump (STP) and piping connections. Collect samples 1-2 feet into native soil.

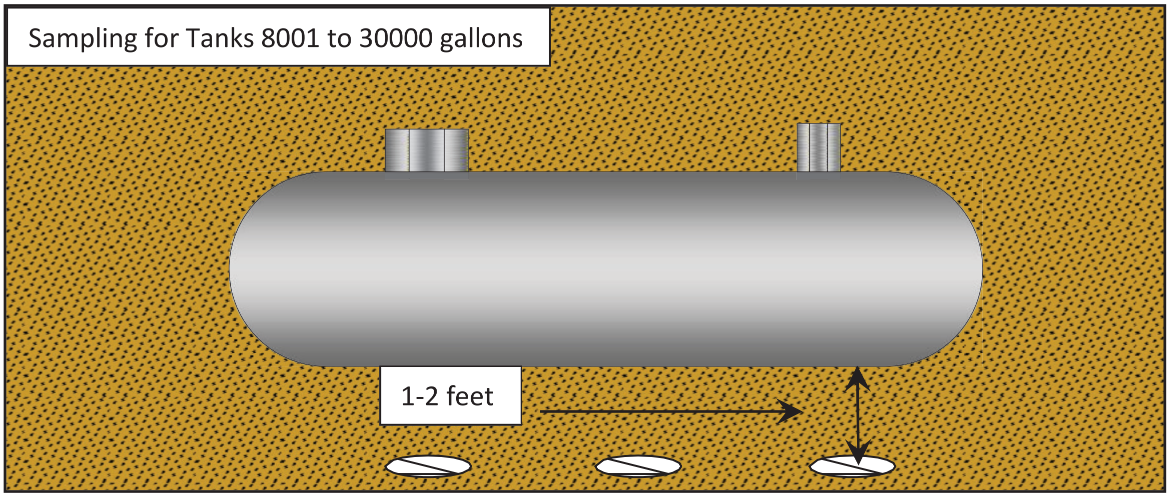


Figure 5

For tanks 8001 to 30000 gallons capacity (if evidence of contamination is not observed), collect two confirmatory samples in line with the spill containment or fill port, and in line with the STP and piping connections and a third sample in the middle of the tank. Collect samples 1-2 feet into native soil.

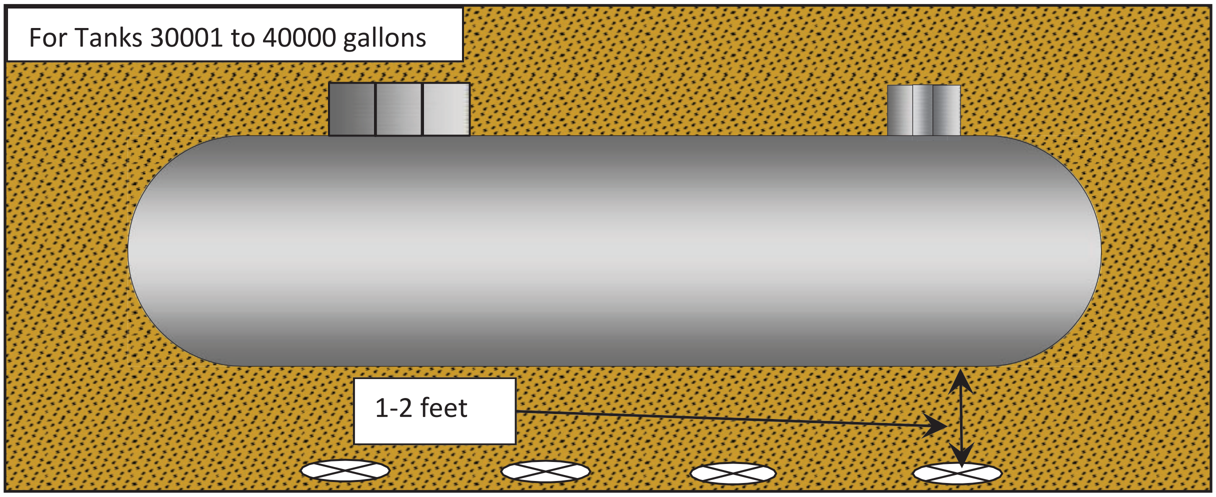


Figure 6

For tanks 30001 to 40000 gallons capacity (if evidence of contamination is not observed), collect confirmatory samples in line with the STP sump and spill containment or fill port and one sample 5 feet from each end (towards the center of the tank) for a total of four samples beneath the tank. Collect samples 1-2 feet into native soil.

For tanks 40001 or greater, collect samples in line with the STP sump and the spill containment, 5 feet from each end (towards the center of the tank) and at center for a total of five samples.

Tank Bed Sampling When Bedrock is Present

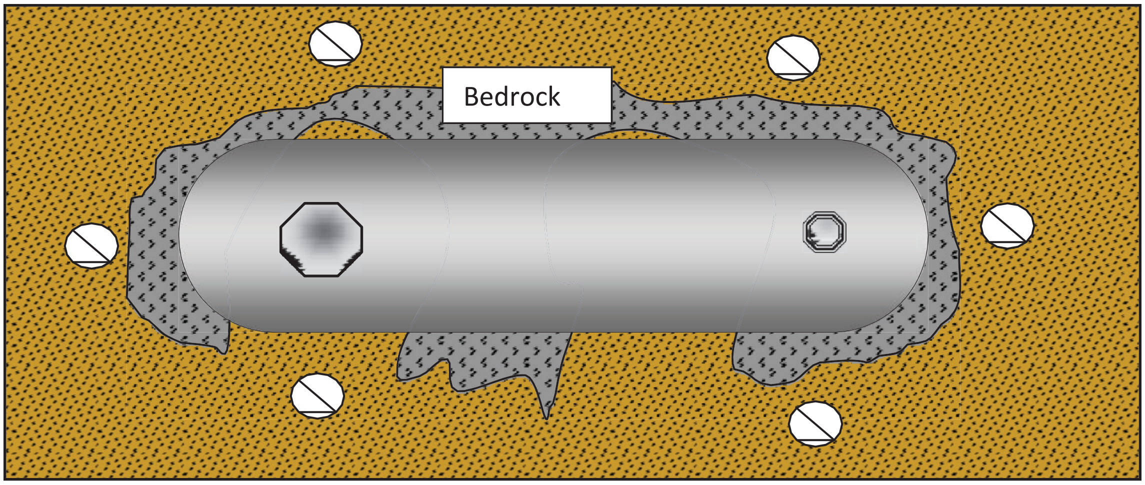


Figure 7

When bedrock is present, collect samples from the tank floor if and where sufficient (i.e., enough to fill a sample jar) native soil is present. Figure 7 above shows possible sample locations if native soil directly beneath the tank is not sufficient. If there is insufficient native soil on the tank bed floor, collect samples according to fill in place procedures or for soil sampling with a concrete pad. The number of samples collected will depend on the capacity of the tank.

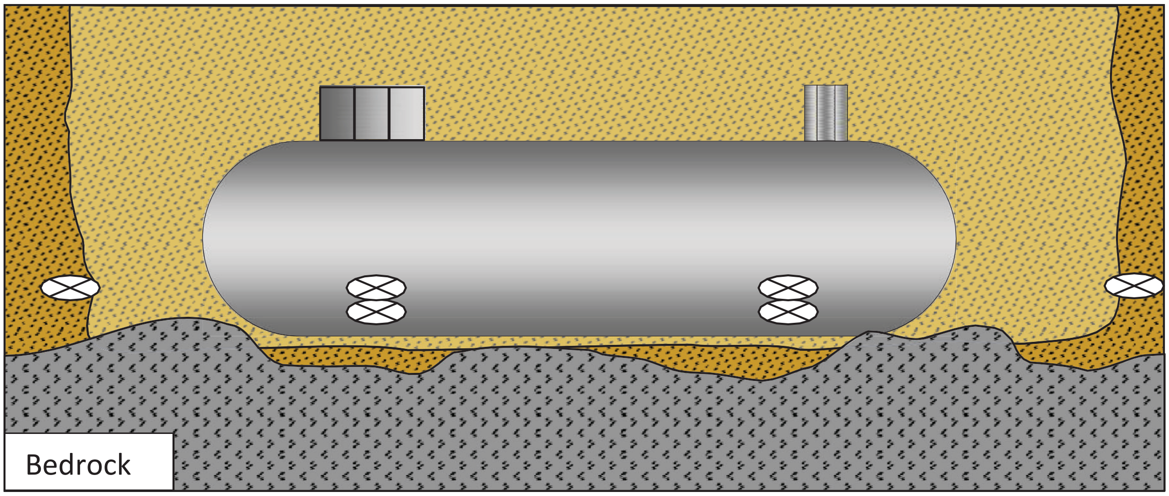


Figure 8

Figure 8 above shows tank bed sampling when bedrock is present, side view.

Tank Bed Sampling with Bedrock Present, Multiple Tanks

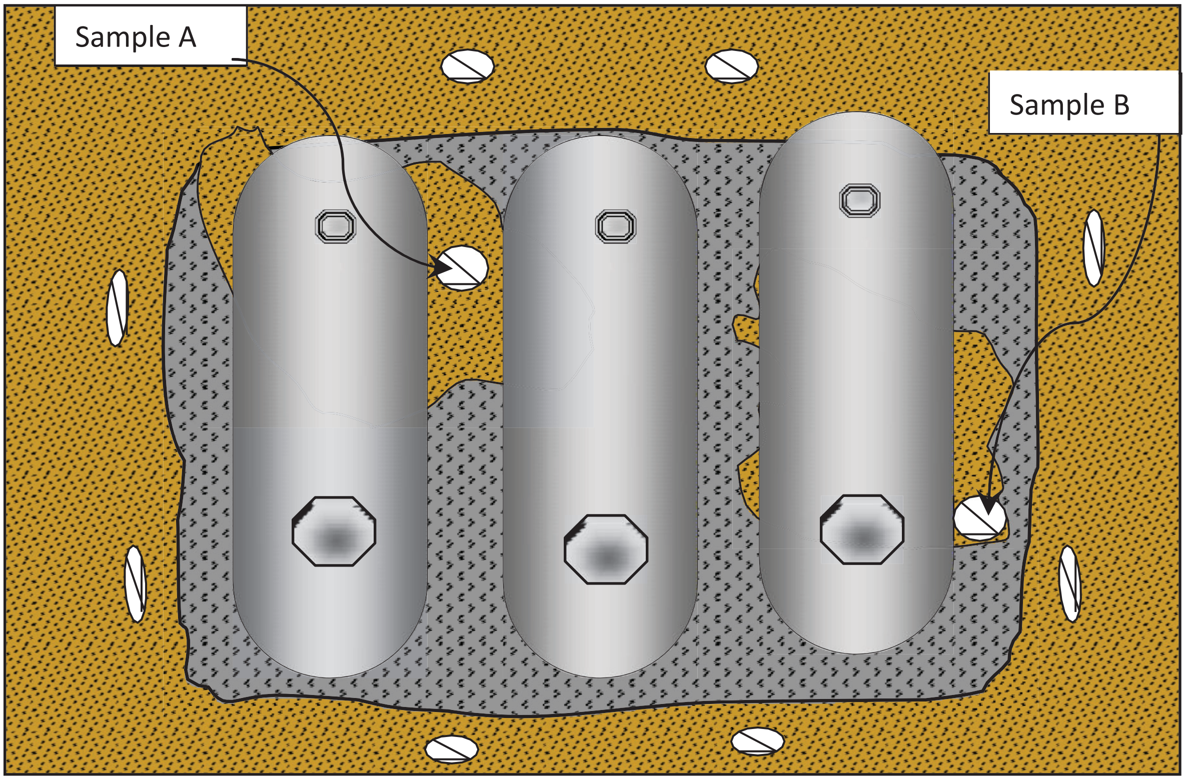


Figure 9

For tank bed soil sampling in bedrock, collect the soil samples from native soils if and where sufficient native soil is present. Figure 9 illustrates where samples should be collected if there is sufficient native soil in the tank bed (i.e. sufficient to fill a sample container). Sample A is collected near the fill port and Sample B is collected near the STP sump. In this example, where native soil is present in the tank bed, forego two of the sidewall samples nearest the floor samples collected. If there is no native soil present beneath the tanks, collect the samples from the sidewalls just above the soil bedrock interface, and in line with fill port and STP sump. Document with photos the tank bed soil conditions and material.

Tank Bed Sampling with Concrete Pad Present

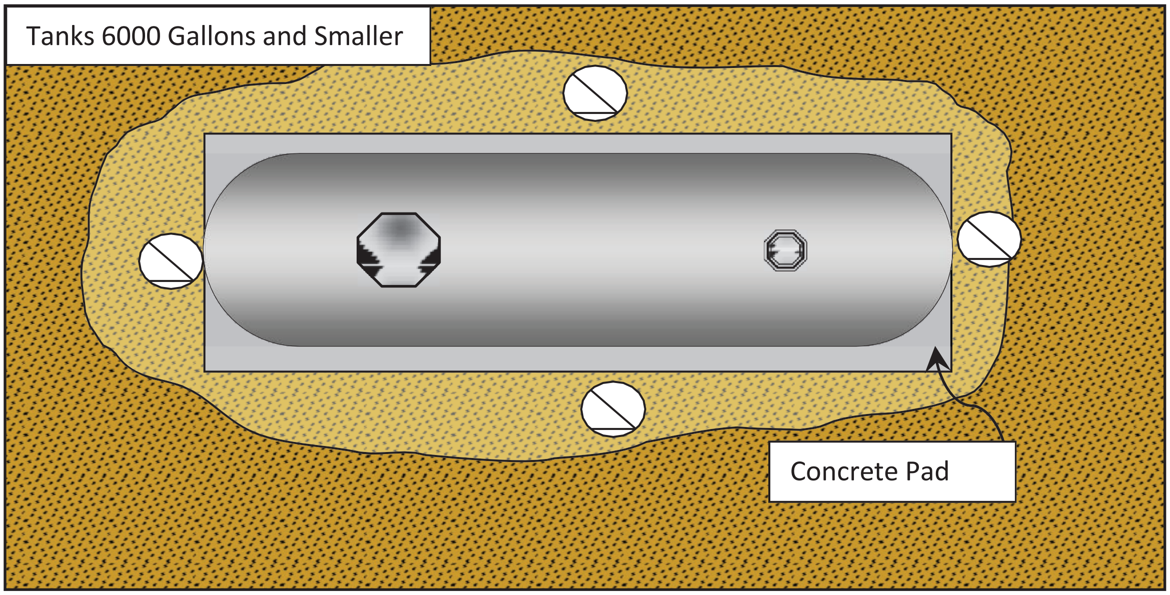


Figure 10

When a concrete pad interferes with sampling directly beneath the tank, collect samples around the side per fill-in-place procedures. Sampling in Figure 10 is for tanks 6000 gallons or smaller capacity. Collect samples as close as possible to the pad, 1-2 feet into native soil.

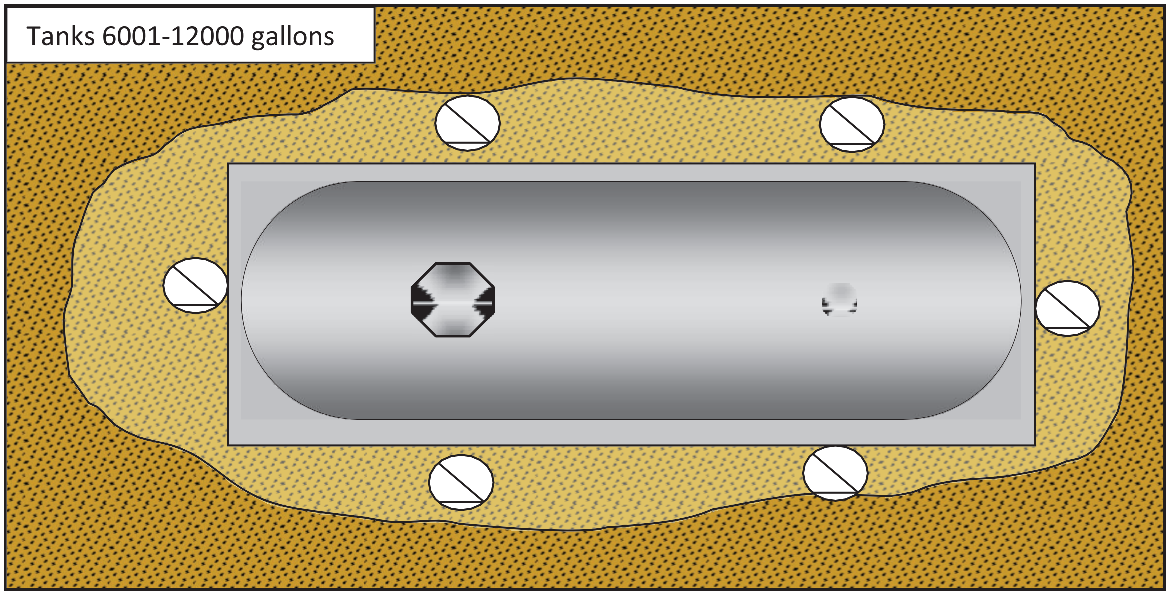


Figure 11

Figure 11 above shows the number of samples for a tank between 6001 and 12000 gallons capacity. Collect samples as close as possible to the pad in line with the spill containment and the STP sump, 1-2 feet into native soil. Collect one sample from each end.

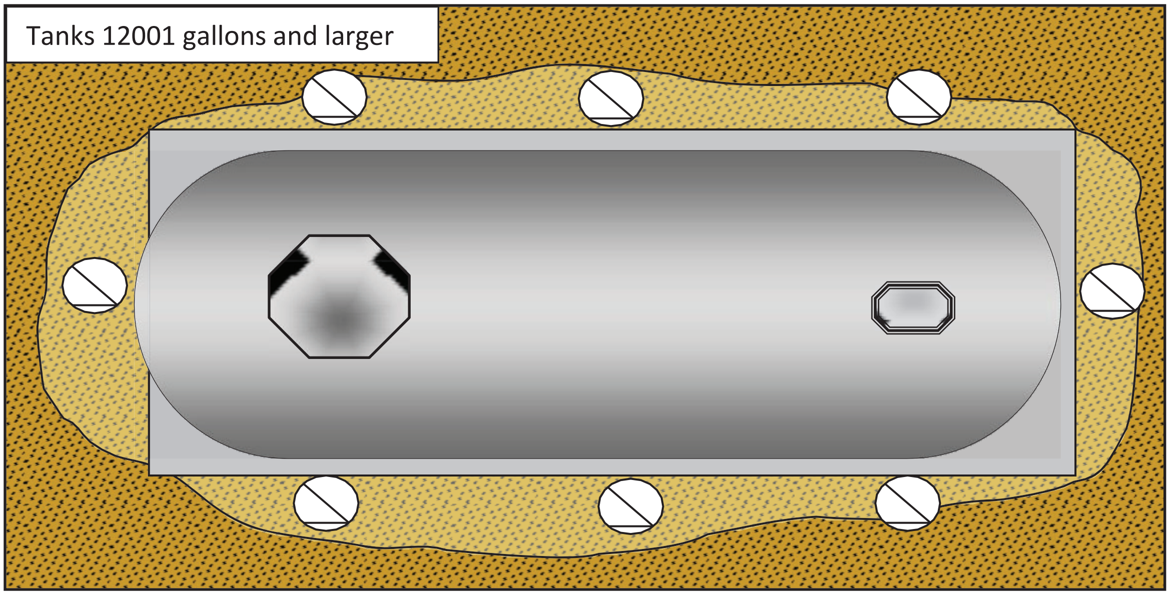


Figure 12

Figure 12 above shows the number of samples for a tank 12001 gallons and larger. Collect samples as close as possible to the pad in line with the spill containment and STP sump and one in the center, 1-2 feet into native soil. Collect a sample from each end.

Tank Bed Sampling with Multiple Tanks and Concrete Pad

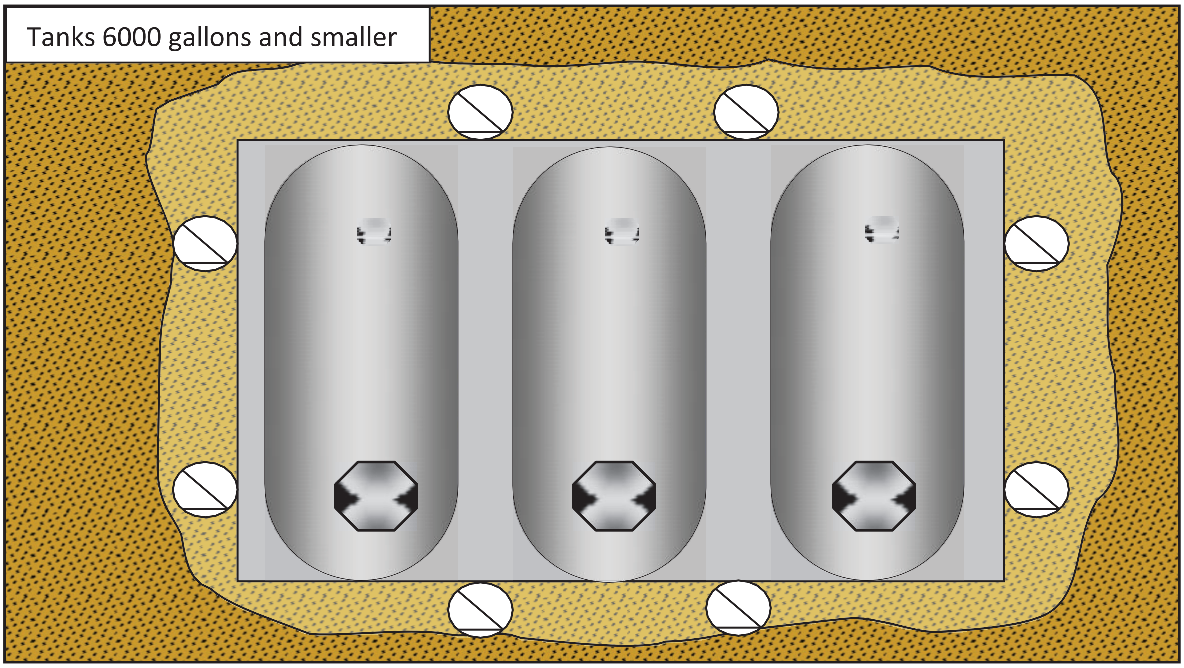


Figure 13

If a concrete pad was installed under a bed of tanks for anchoring, sampling locations depend on the presence of apparent contamination and staining around the perimeter of the pad. If there is no apparent contamination, collect soil samples as in Figure 13.

For tanks between 6001 and 12000 gallons capacity, collect two soil samples from the sides as in Figure 14, below the tank and in line with the STP sump and fill port. Collect one sample between the tanks at the ends as close as possible to the concrete pad, 1-2 feet into native soil.

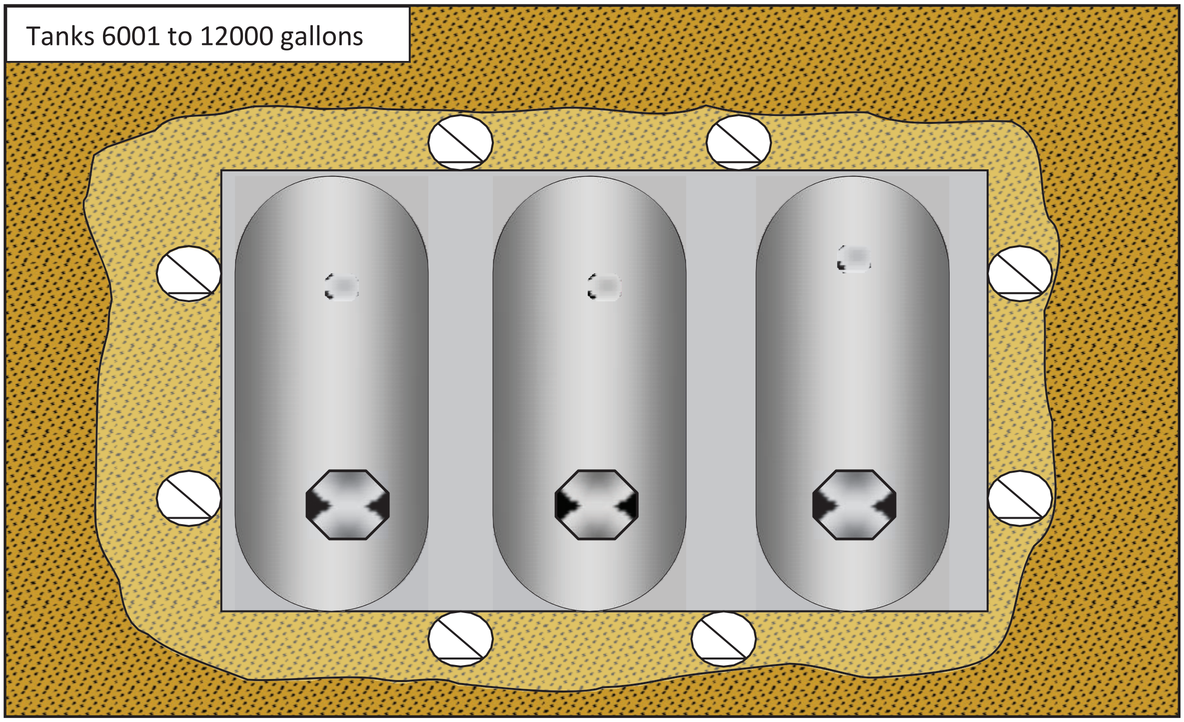


Figure 14

For multiple tanks greater than 12000 gallons in a tank bed with a concrete pad, collect an additional soil sample in the middle of the outer tanks as close as possible to the concrete pad as in Figure 15 below. If the ends of the two outer tanks are intact (no staining, no cracks, deep pitting or perforations), forego soil samples at those locations and sample between the tanks.

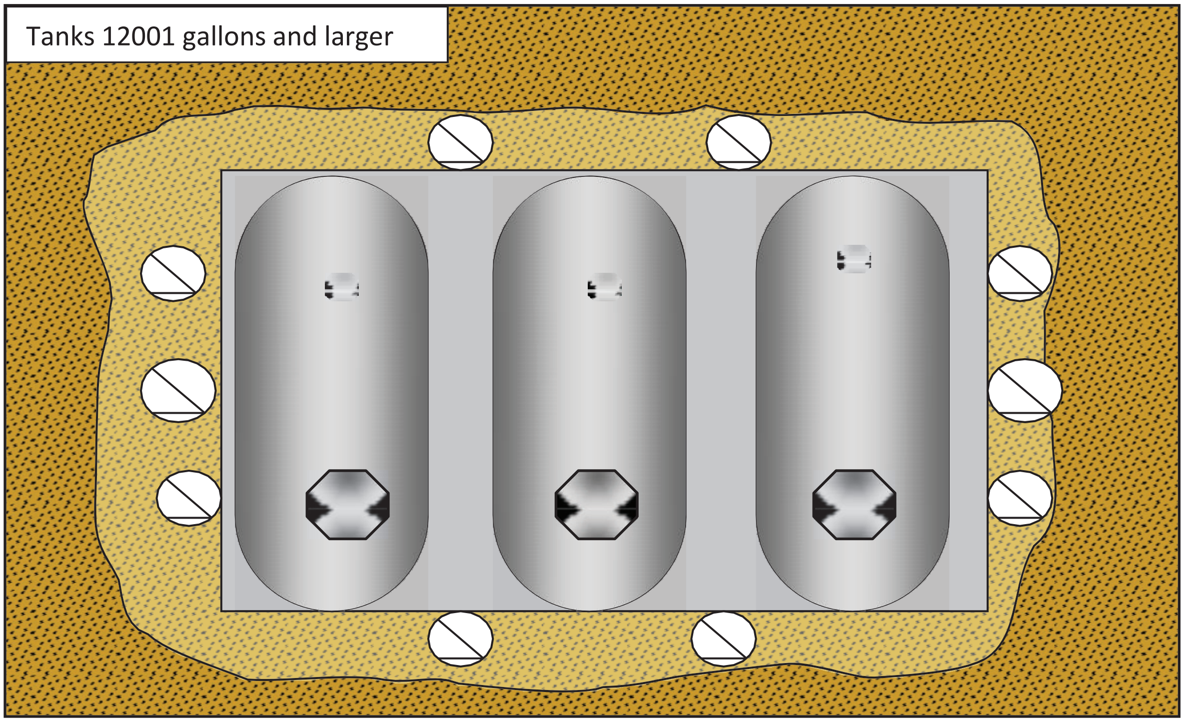


Figure 15

When Groundwater Interferes with Soil Sampling

In cases where water is present in the tank basin, the groundwater professional must determine if the presence of water prevents soil sampling beneath the tank along the tank's centerline; if unable to collect soil samples from the open basin, samples should be collected via a boring placed through the tank fill at the proper location unless alternate sampling is approved by the DNR.

Soil Sampling for Tank Closure (Fill-in-Place)

Prior to closing tanks in place, soil sampling must be completed to determine if contamination is present. Soil samples must be collected in the native soil within 5 feet of the sides and ends of each tank cluster at a depth of 2 to 4 feet below the base of the tank at equal intervals around the tank system. The number of samples will be determined by the size of the tank. Refer to Table 3 Soil Sample Locations Summary for Filling in Place or a Concrete Pad for additional information. Soil samples must also be taken along the piping runs; follow the piping sampling procedures for closed trench sampling as noted in this guidance.

Soil Sampling for Product Piping Closure

The following guidelines are for soil sampling beneath product piping during closure. Piping includes the product line and remote fill piping. All confirmatory soil samples must be discrete samples collected in the native soil 1-2 feet below the product piping.

In cases where water is present in the piping trench, the groundwater professional must determine if the presence of water prevents soil sampling beneath the product piping; if unable to collect soil samples from the open trench, sample according to the closed trench and abandonment procedures unless alternate sampling is approved by the DNR.

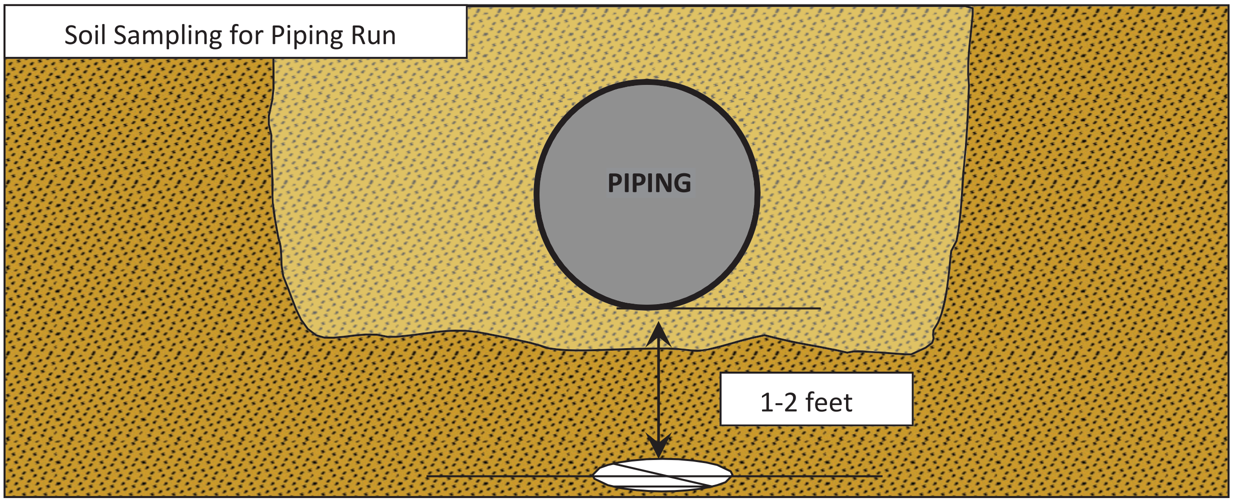


Figure 16

For a single product line in an open trench, collect a sample in the middle of the product line. Collect each soil sample along the product piping from a depth of one foot below the piping into native soil as shown in Figure 16 above.

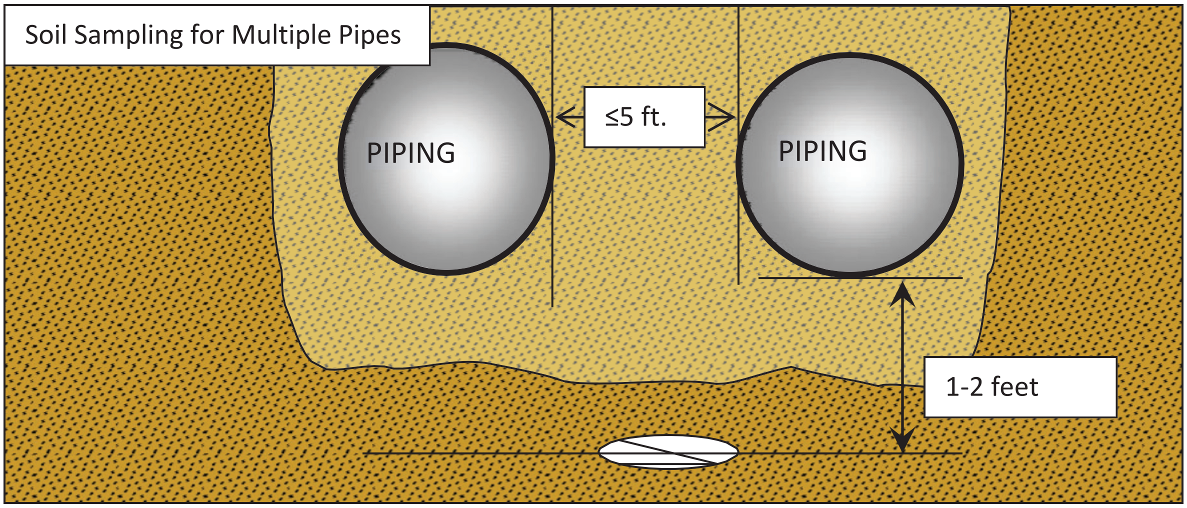


Figure 17

When the distance between two or more piping runs in an open trench is five feet or less, collect one sample in the middle of the piping run, 1-2 feet into native soil as shown in Figure 17.

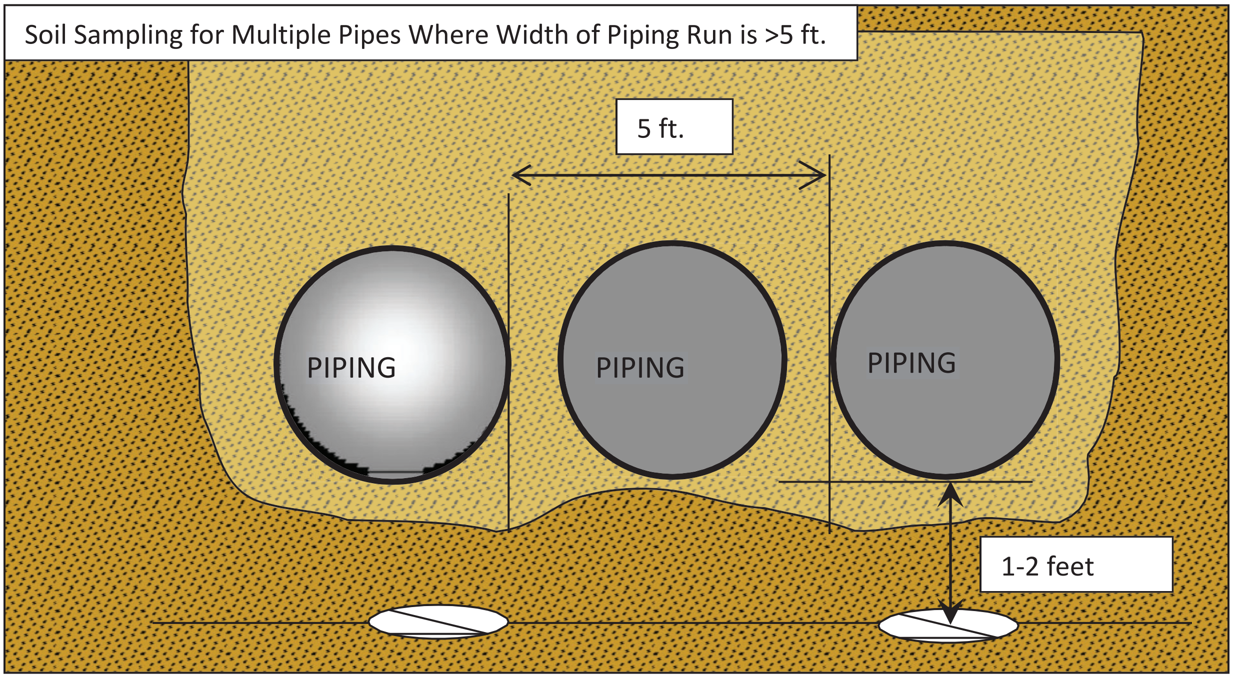


Figure 18

If the width of multiple pipe runs is greater than five feet, collect two samples in line with each other and with a five foot separation distance. Collect each soil sample along the product piping from a depth of one foot below the piping into native soil as shown in Figure 18.

Closed Trench and Abandonment of Piping (Single and Double Wall)

Piping closure in place does not allow for a thorough inspection and visual evaluation of soil conditions in the piping trench. Follow these guidelines for taking soil samples from a closed piping trench.

- Collect a confirmatory soil sample below each connection (swing joint, flex connector, pipe elbow) as they are known to exist and every 10 feet along the piping. Collect the sample(s) one foot below the piping into the native soil. If two or more product lines are known to run parallel and within five feet of each other, collect one sample in the middle of the piping run. Where the product line is less than 10 feet in length, one sample is still required.

- Piping sampling is required in all cases where piping is removed or abandoned in place. For example, piping replaced through a chase would require sampling.

Open Trench and Removal of Piping (Single Wall)

Photos courtesy of SD Petroleum Release Compensation Fund

Follow these guidelines for taking soil samples from along single wall piping when the piping trench is exposed (excavated) and the piping to be removed is available for inspection.

- Collect one confirmatory sample into native soil directly below any connection (swing joint, flex connector, union, tee and pipe elbow), and every 10 feet along the piping run. Confirmatory soil samples should be collected at 1-2 feet below the product piping.
- In addition, examine the piping for damage (structural, physical or mechanical weakness or perforation). Thoroughly inspect and evaluate the soil conditions at the point of any apparent weakness in the piping. Collect a sample into native soil at any point of apparent damage and/or release.
- Inspect the open trench for any areas where there are indications that a release may have occurred. If evidence of contamination is observed, collect a soil sample from the contaminated area for analysis. Make sure the sample is collected from native soil and not backfill.
- If the trench is not fully exposed, or the piping is not available for inspection at closure, follow the guidelines for closed trench and abandonment of piping.

Open Trench and Removal of Piping (Double Wall)

- Examine the piping for damage (structural, physical or mechanical weakness or perforation) and inspect and evaluate the soil conditions at the point of any apparent weakness in the piping. Collect a soil sample along the product piping wherever there is obvious staining or indications a release may have occurred. If piping is not damaged, and contamination is not apparent, collect soil samples every 20 feet and beneath each transition sump (if one exists), 1-2 feet in native soil.

Piping Run Sampling (Double Wall)

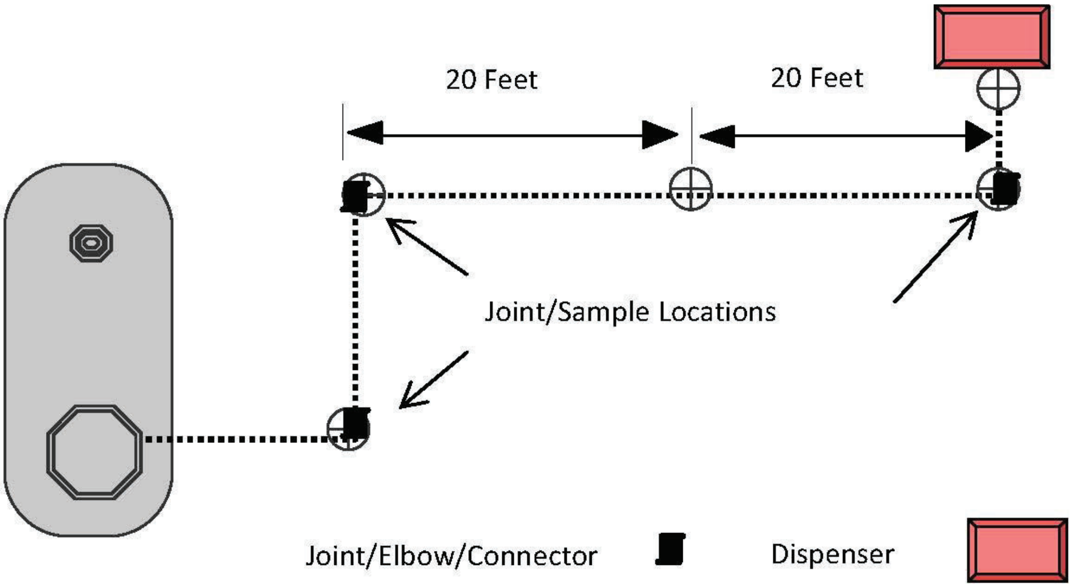


Figure 19

Illustrated above are sampling locations for double wall piping in open trench. A sample is collected at each joint and/or every 20 feet. In Figure 19, soil samples are collected at three joints and in the middle of a 40 foot run of piping. Another sample is collected as close as possible to the dispenser for a total of five samples.

If product piping is taken permanently out-of-service and is located in a common trench with other piping that will remain in service, sample per closed trench guidance.

Soil Sampling Beneath the Dispenser (With and Without Containment)

During UST system closure or piping only closure, collect a soil sample beneath or as close as possible to each dispenser 1-2 feet below the sump into native soil.

If it is not possible to sample directly beneath the dispenser, place the boring no more than 5 feet from the dispenser in the apparent downgradient direction. The boring should be advanced 1-2 feet into native soil below the depth of the dispenser sump. If there are 5 or fewer feet separating the dispensers, collect one sample between them instead of one beneath each each one.

If the product dispensers and piping are within the tank basin, samples are not required.

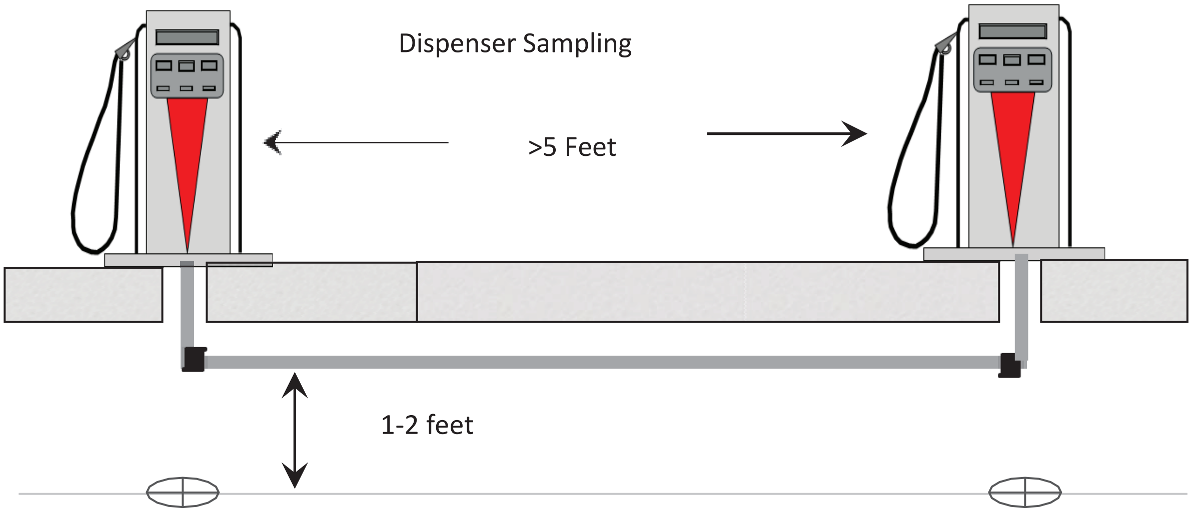


Figure 20

Soil Sampling Beneath the Remote Fill Containment, Piping, and Satellite Dispensers

If the fill port (spill containment) is located 5 or more feet from the tank pit, collect one sample 2 feet into native soil below the fill opening as shown below in Figure 21.

The remote fill line is considered product piping; sample in accordance with requirements for product line closure.

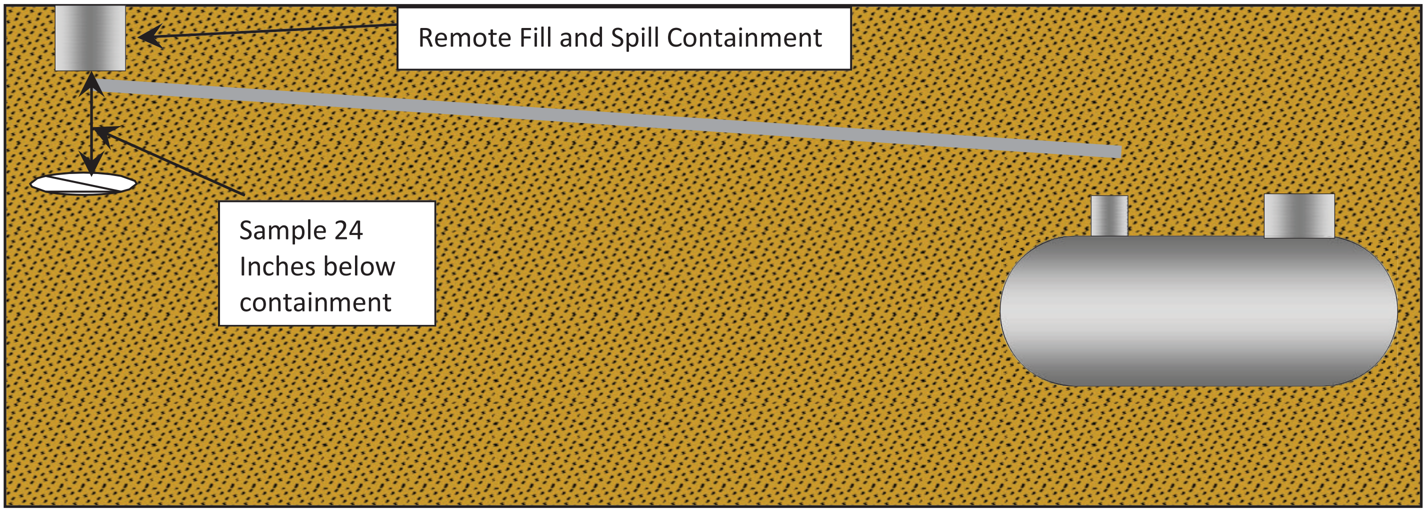


Figure 21

Collect soil samples under the primary and satellite dispenser and along the piping as shown in Figure 22.

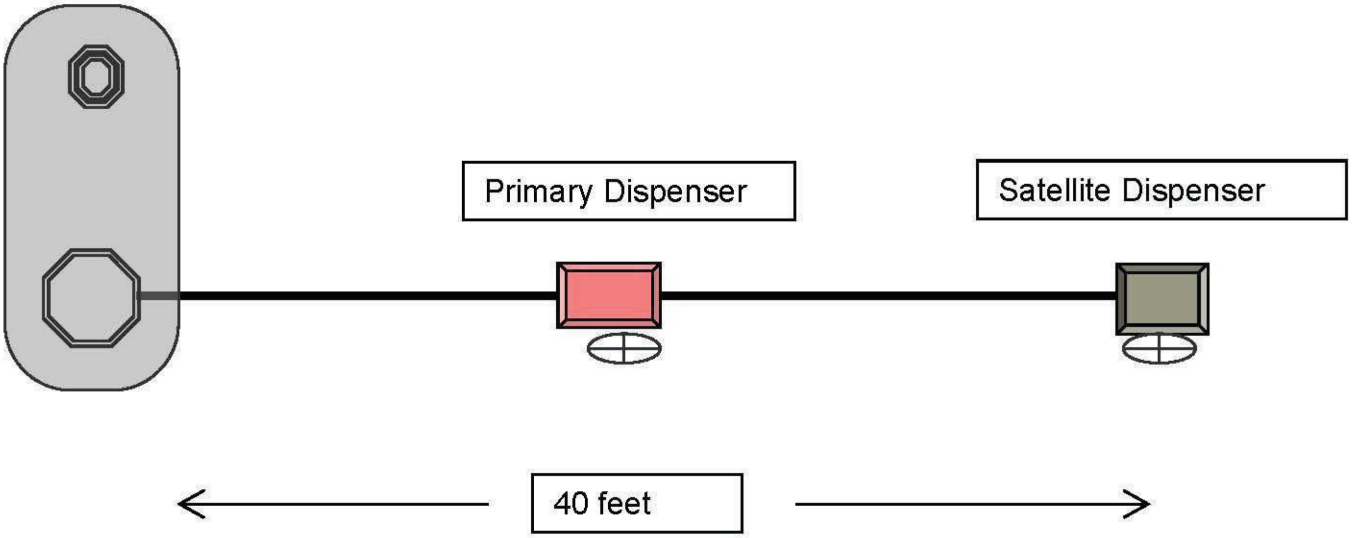


Figure 22

Groundwater Sampling for Tank Closure

Collecting water from the bottom of a tank excavation and placing it in a bottle does NOT meet groundwater sampling requirements. Groundwater samples must be taken from a monitoring well located OUTSIDE the tank excavation. The monitoring well must be located within 20 feet of the presumed downgradient direction. That is, the well must be located so that it would sample any contaminated groundwater flowing away from the storage system. The downgradient direction is determined by local surface topography where assessment reports with groundwater flow direction do not exist. In the closure report, explain how groundwater flow direction was determined.

Groundwater monitoring wells must also be able to detect contamination from the piping and dispensers as well as the tanks, so more than one monitoring well may be required.

When they are no longer needed, monitoring wells must be properly abandoned in accordance with IAC 567- Chapter 39 to prevent possible surface contamination from flowing down the well directly into groundwater.

Procedure for Groundwater Sampling

1. When there is only one tank or there are several tanks in a single tank basin, the monitoring well should be installed in the downgradient direction. If the tanks are in a cluster where the tanks are not in the same basin but the tanks are 10 feet or less apart, they may be treated for groundwater sampling purposes as a single basin. If the tanks are more than 10 feet apart, more than one monitoring well may be required.
2. Monitoring wells must be purged of stagnant water in the casing prior to collecting a sample for analysis. Purging must continue until water quality measurements have stabilized. Once the well has been sufficiently purged, groundwater should be allowed to recharge to the original measured static water level before a sample is collected.
3. Collect a sample of the water by lowering a bailer into the monitoring well until the top of the bailer is just above the surface of the groundwater. Retrieve the bailer, and check for the presence of free product or a sheen floating on the sample's surface. If no sheen or free product is observed, fill the sampling container provided by the laboratory with water from the bailer. If sheen or free product is observed, contact the DNR at 515-725-8200 immediately. The DNR will determine if closure sampling is needed or Risk Based Corrective Action (RBCA) assessment will be conducted.
4. Label the sample according to the well labeling that you used in drawing the map of the well locations, and include on the label the date, facility name, tank owner's name, and substance stored in the tanks. Fill each container so that there is no air space, but do not overfill. Secure the lid on each container after filling. Repeat the sampling procedures above for each monitor well. If the same bailer is to be used to sample more than one well, the bailer must be thoroughly cleaned with soap and detergent, and rinsed with distilled water prior to sampling each additional well.
5. Prepare the samples for delivery to the Iowa certified laboratory by placing the containers into an iced cooler or chest maintained at approximately 40 degrees Fahrenheit. Samples must be shipped so that they will arrive at the laboratory within 72 hours of collection. The Iowa certified laboratory listing may be found on the DNR’s UST website.

Groundwater Sampling Placement Requirements

Due to the size and layout of some UST sites, more than one groundwater monitoring well may be necessary. Figure 23, below, shows a UST site with a 40 foot long 20000 gallon UST and two 10000 gallon USTs. The layout is roughly 80 feet wide. Downgradient flow is to the south. One monitoring well located in the middle and to the south of the site is insufficient to capture a release from any part of this UST layout. A more accurate approach would be to split the site in the middle at 40 feet and locate a well in the middle of each 40 foot section. Wells must be outside the tank basin, but within 20 feet of the tank system.

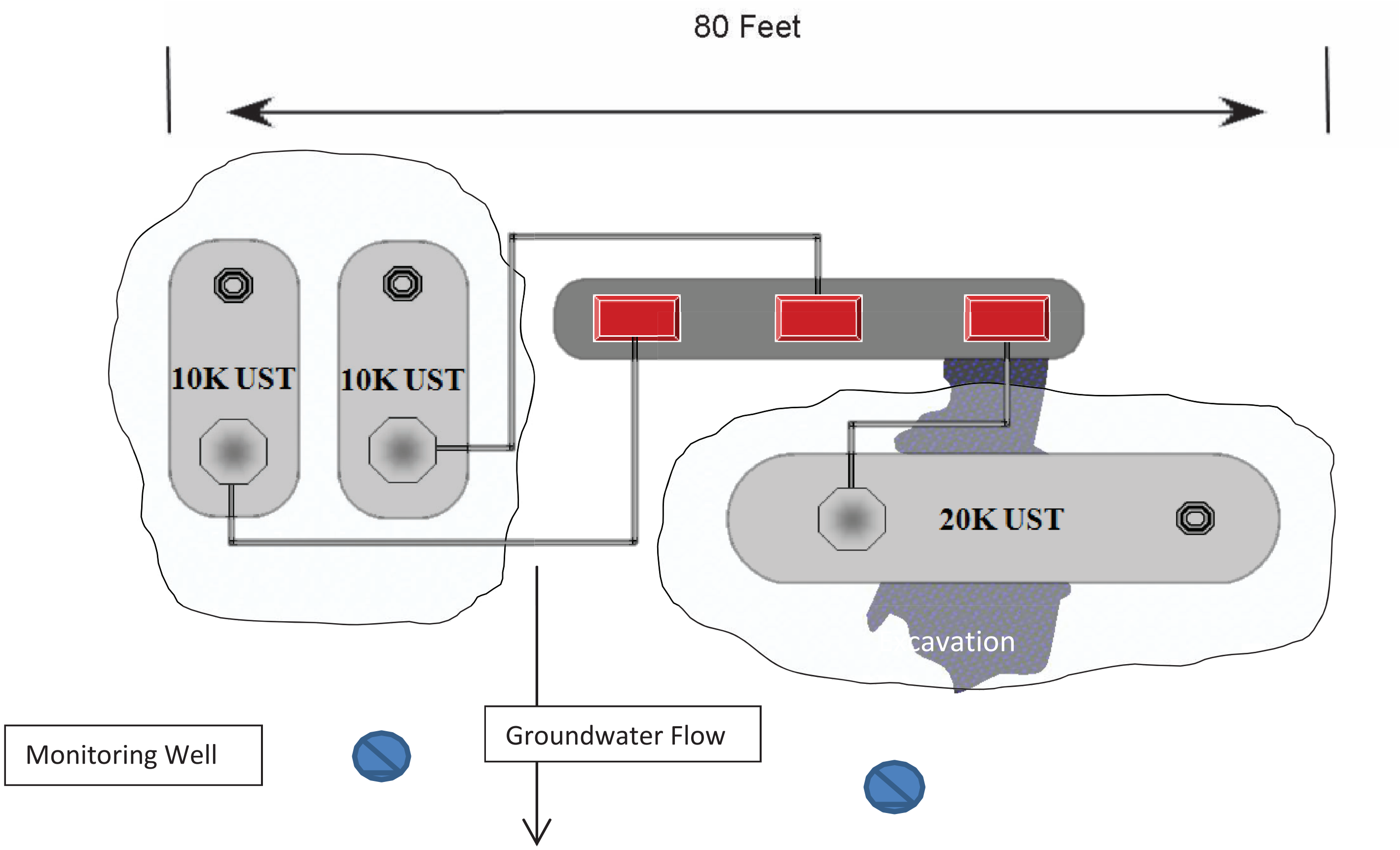


Figure 23

There are so many varied UST layouts that not all can be depicted in a diagram. There are often obstructions and limited space, which may make well location difficult to determine. This is why the DNR relies on the professional judgement of the CGP to determine the groundwater flow, number and placement of the monitoring wells. Any variations in sampling must be explained.

In Figure 24, groundwater flow is to the northeast. Two monitoring wells again should be sufficient to capture a release from any part of the UST system. The monitoring well on the left is outside the tank pit, but within 20 feet of the tank system. The monitoring well on the right will capture a release from the dispenser island and the 20000 gallon tank.

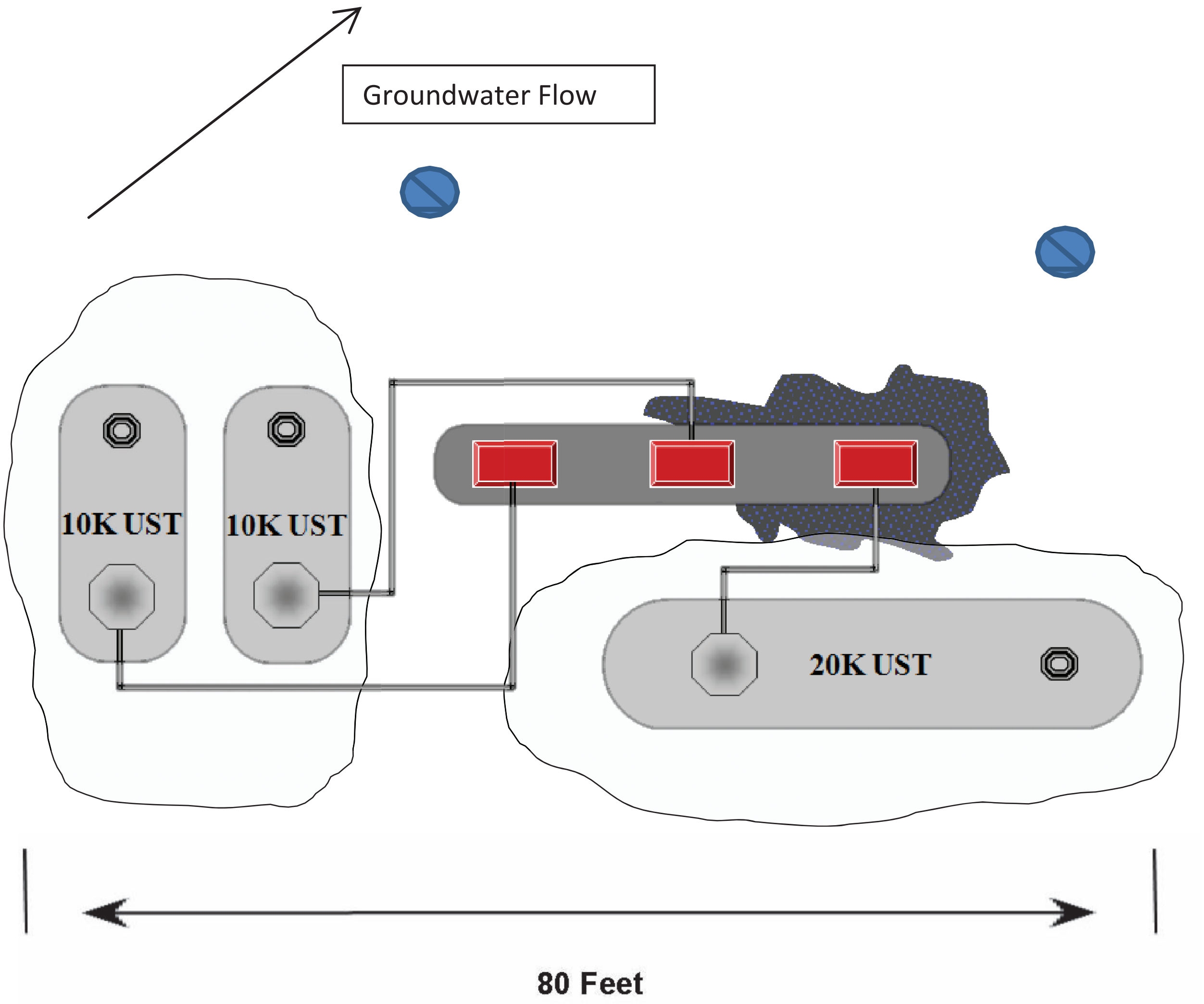


Figure 24

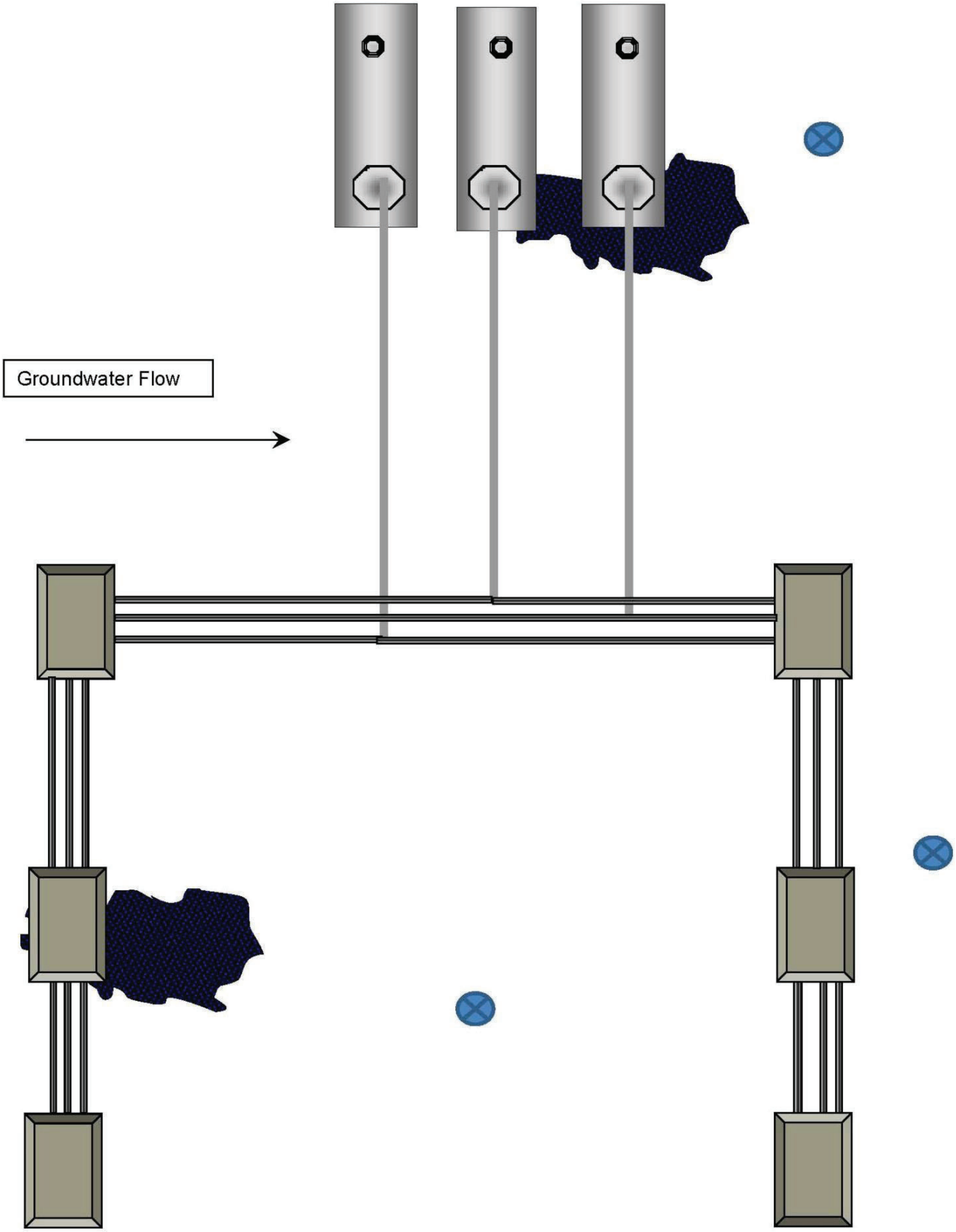


Figure 25

This is a large dispensing area with groundwater flow to the east. Obviously, one monitoring well is not sufficient to cover a release from the tank bed and the dispensing area. Three monitoring wells would be preferred.

Thank you to the Wisconsin DNR for providing the diagrams used in the graphics in Figure 1 - Figure 22.

Laboratory Procedures for Testing Soil and Groundwater Samples

Regardless of the product stored in the tank, soil and groundwater samples must be analyzed for volatile petroleum compounds (gasoline) with concentrations of benzene, toluene, ethylbenzene, and xylene (BTEX) reported separately using analytical Method OA-1. In addition to this analysis, if any liquid other than gasoline (for example, diesel, kerosene, fuel oil, mineral spirits, used oil), or if it is unknown whether any liquid other than gasoline was stored at the site, soil and groundwater samples must also be analyzed for Total Extractable Hydrocarbons (diesel and waste oil) using Method OA-2. For tanks containing non-petroleum regulated substances, the laboratory analysis must be suitable for detecting the substance stored and its breakdown constituents using the appropriate EPA and DNR approved analytical methods.

Contaminant Action Levels

Soil and groundwater samples with contaminant concentrations exceeding the action levels in the Table 1 may require further investigation and/or corrective action. The owner/operator, will be notified in a letter if there are additional requirements.

Table 1. Contaminant Action Levels

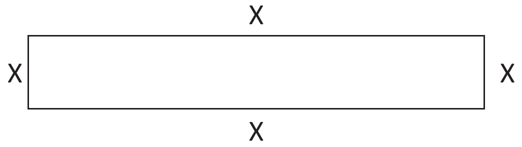
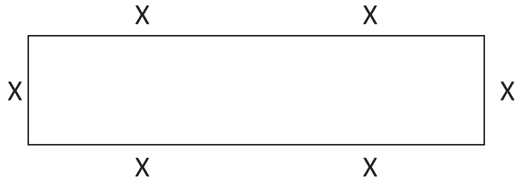
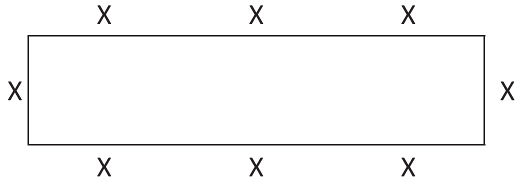
Volatile Hydrocarbons	Soil Action Level (mg/kg) ppm	Groundwater Action Level (ug/L) ppb
Benzene	0.54	5
Toluene	3.2	1000
Ethylbenzene	15	700
Xylene	52	10000
Low Volatility Hydrocarbons		
Waste Oil	No Limit	400
Diesel	3800	1200

Soil Sample Locations

Table 2. Soil Sample Locations Summery - UST Removal

TANK CAPACITY (Gallons)	# OF SAMPLES	LOCATION
1,000 or less	1	Center of Tank
1,001 to 8,000	2	In line with STP sump and Fill Port
8,001 to 30,000	3	In line with STP Sump, Fill Port and at Center
30,001 to 40,000	4	In line with STP Sump, Fill Port, and 5 feet from each end (toward the center of the tank)
40,001 or greater	5	In line with STP sump, spill bucket, center and 5 feet from each end (toward the center of the tank)
Product Dispensers	1	Take one sample directly beneath dispenser 1-2 feet below sump into native soil
Product Lines		Collect samples at a minimum depth of 1-2 feet into native soil
Remote Fill	1	1-2 feet below spill bucket into native soil

Table 3. Soil Sample Locations Summary - Filling in Place or When Concrete Pad is Present

TANK CAPACITY (Gallons)	# OF SAMPLES	LOCATION	EXAMPLE (“X” = Location of Sample)
6,000 or fewer	4	One from each end and one from each side	
6,001 to 12,000	6	One from each end and two from each side in line with spill and STP sump	
12,001 or greater	8	One from each end and three from each side at center and in line with spill bucket and STP sump	

Sampling Exceptions

Soil and groundwater sampling must be conducted at every tank and piping closure. If DNR approved external leak detection (e.g., ground water or soil vapor monitoring) which has operated in accordance with the IAC rule prior to closure, analysis of soil samples for contamination may not be required. To qualify for this exception, the leak detection equipment must be operational, the required monitoring must have been conducted, and proper records must have been maintained.

If these external leak detection requirements have been met, the soil and groundwater sampling requirements may be satisfied by submitting to the department:

1) Form 542-1308 (Notice of Closure or Change-in-Service)
2) A description of the monitoring method used,
3) A complete record of the monitoring results for at least the previous 90 days,
4) The specifications of the monitoring equipment,
5) A notarized statement from the owner verifying that no release to the environment has occurred.

If contaminated soils, contaminated groundwater, or free product as a liquid or vapor is discovered during the site assessment or by any other manner, contact the department in accordance with 135.6(1). Normal closure procedures no longer apply. Owners and operators must begin corrective action in accordance with rules 567—135.7(455B) to 567—135.12(455B).

Tank closure requirements do not pertain to non-regulated tanks. If uncertain if the tank is regulated or non-regulated contact the DNR. If contamination is observed during tank closure activities, the DNR must be notified.

Excavation Backfill

Clean tank backfill can be used to fill the excavation or as backfill for new tanks if it meets the tank manufacturer’s backfill requirements. Contaminated backfill must be disposed of properly.

For more information visit the Land Farming page of the DNR’s website.

Heavily contaminated backfill is often easy to identify based on staining and odor. Lesser levels of contamination may be less obvious and it may be difficult to distinguish “clean” from “contaminated” backfill. To determine whether soil is clean or contaminated, contamination levels should be determined using PID or FID instruments. PID or FID readings less than 10 ppm generally indicate that backfill is clean enough to remain onsite. Laboratory analysis of soil samples provides a more definitive assessment of soil contamination levels than field screening tools such as a PID or FID. Laboratory tests indicating that contaminant levels are less than Tier 1 screening values indicate that the backfill is clean enough to remain onsite. Tier 1 values are available for review in the Contaminant Corrective Action Levels section of the Closure Guidance.

If contaminated soils are discovered at the time of closure, the tank basin may be overexcavated up to one (1) foot in the native soils to remove contamination without triggering corrective action regulations. If contamination is limited and localized, it may be practical and economical to remove this additional one foot of native soil. Confirmation samples taken after the one foot of soil has been removed should be collected from the areas showing the greatest contamination to determine whether further remediation will be required. If this limited excavation of contaminated native soil has been conducted, it must be reported to the DNR before the excavation is backfilled.

Contaminated soil removal beyond one foot of the boundaries of the tank excavation is considered *expedited corrective action*, and must be conducted according to DNR regulations (see 135.12(11)).

Tank Fill in Place

When removal is hazardous due to utilities or other barriers or when it compromises another structure, filling in place may be the only option.

The tank owner must submit the Notification of Closure Form (indicate *Fill in Place* on the form) 30 days before the tank fill-in-place procedures are to begin.

Excavate to the top of the tank if necessary. Drain and flush piping contents back to tank. Remove all tank top equipment and piping.

Remove liquids and residues from the tank and clean[9]

Purge the tank and surrounding area of all vapors, and monitor with a CGI continuously during the procedure. Keep the atmosphere in the tank below 10% of the LEL and/or 6-7% Oxygen (see Purging and Inerting).

Examine the tank for two openings, one at each end of the tank. One opening must be large enough to accept the fill material. Openings at the top of the tank may be too small and/or too few to introduce the inert material and to fill the tank to 100% capacity. The other opening is an observation hole to ensure the tank is filled to capacity. If sufficient openings do not exist, excavate to the top of the tank and make the openings. Use explosion proof, non-sparking tools to increase or enlarge the number of openings (you are still monitoring the atmosphere). Cap or plug all other openings.

Clean the tank according to the procedures explained above (see API #2015, *Cleaning Petroleum Storage Tanks*).

To proceed with fill in place, flowable mortar, clean sand or other fill material approved by the DNR may be used to completely fill the underground tank to 100% of capacity.

Sand is generally available, will flow readily, and is a suitable material if it is clean and free of rocks (which would prevent leveling out in the tank). The sand should be introduced dry. As it nears the top of the tank, the sand can be washed into the tank with NOMINAL amounts of water and puddled causing it to flow to the ends. Use of large amounts of water is prohibited as it will cause the tank to be filled with water before it is filled with sand.

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[9] See American Petroleum Institute publications 2015 and 2219 for safety precautions during removal and fill in place and for vacuum truck operating and safety practices.

Fill the tanks using concrete, sand or flowable mortar or other approved material until the inert material flows out of the observation hole. Piping that is to be permanently closed in place must be purged and capped.

Submit a closure report to the DNR within 45 days of the closure. Use DNR form 542-1303 which is available on the DNR UST website.

CLOSURE REPORT FORMS

Within 45 days of UST and / or piping closure, the DNR closure report is due. The UST owner and operator is responsible to submit the report. The form is available on the DNR UST website.

Complete all sections of the closure report form and attach the information in the appendices as described on page 5 of the closure report form. The closure report covers all the required information needed in order to properly close the UST system. The UST Section will formally respond to the closure report. If the site is an active LUST site, the report will be forwarded to the LUST project manager.

APPENDIX A: QUALIFICATIONS FOR EXCLUDING GROUNDWATER SAMPLES FOR UST CLOSURES

If groundwater is encountered within ten feet (10’) below the lowest level of the tank excavation, a groundwater sample is required. If groundwater is not encountered within ten feet (10’) below the lowest level of the tank excavation, but sands or highly permeable soils are encountered, or there are other indications of potential for groundwater contamination, a groundwater sample or samples are required (see Section II, Part 2 of this guidance document).

Conditions for Exclusion

If sands or highly permeable soils are not present in a boring located within 20 feet (20’) downgradient from the tank excavation and groundwater is not encountered within ten feet (10’) below the lowest level of the tank excavation, the certified well contractor’s log and the results of a hydraulic conductivity test must be submitted with the closure report to the DNR. The hydraulic conductivity test must be conducted by a person knowledgeable in the performance and interpretation of such testing. The results of the test must indicate a conductivity rate less than 0.3 meter per day in order to exclude the groundwater sample requirement.

A hydraulic conductivity test, using a Guelph permeameter or an equivalent in situ constant head permeameter in a boring which terminates above the water table and ten feet (10’) below the lowest level of the tank excavation is acceptable. If laboratory methods are used, collect undisturbed soil samples using a thin-walled tube sampler in accordance with the American Society of Testing and Materials (ASTM) Standard D1587. Samples shall be clearly marked, preserved and transported to the laboratory. The laboratory shall measure hydraulic conductivity using a constant-head permeameter in accordance with ASTM Standard D2434 or a falling-head permeameter in accordance with acceptable methodology.

Definition of Highly Permeable Soils

1) Sands and highly permeable soils for the purposes of UST closures are defined as:
2) Soil materials classified by the Iowa Geological Survey Bureau as follows:
    a. **(CGg)** clean well sorted gravel greater than 0.25 inches in diameter
    b. **(CGs)** gravel with minor amounts of sand
    c. **(CGc)** clean sand
    d. **(CGp)** sand with minor amounts of pebbles or gravel

3) Vulnerable bedrock
4) Any soils having a hydraulic conductivity rate greater than 0.3 meter per day

APPENDIX B: ENCOUNTERING BEDROCK DURING GROUNDWATER SAMPLING FOR TANK CLOSURE

Certified Well Driller and Groundwater Professional Required

For all tank closures, a groundwater sample is required from the first saturated groundwater zone. The monitoring well must be positioned downgradient, outside of the tank pit, and not farther than 20 feet from the UST system. If the top of the water table is suspected to be within bedrock or if bedrock is encountered before groundwater during drilling activity, a certified well contractor must conduct the drilling and a certified groundwater professional must conduct the assessment and sampling activity.

Shallow Bedrock Assessment

Before drilling for a groundwater sample, the groundwater professional must determine if there is a potential to encounter bedrock before groundwater. These potential areas include (1) areas where karst features or outcrops exist within one mile of the site and (2) areas with bedrock less than 50 feet from the surface. The purpose of this determination is to prevent drilling through contaminated subsurface areas thereby creating a preferential pathway to a bedrock aquifer.

Field Screening for Contamination

The groundwater professional must first identify the presence of petroleum contamination in the soil (overburden) through the use of field screening methods (e.g., PID, FID) in order to reduce the risk of spreading contamination to the bedrock aquifer and to determine an appropriate drilling method and monitoring well construction technique. If field screening indicates contamination in the overburden, the most contaminated soil should be determined and selected for lab analysis.

When Bedrock Contamination is Suspected

If the use of field screening indicates the presence of contamination in the overburden, the overburden must be isolated from the bedrock by installing a permanent casing before continuing drilling, sealing all the casing string with grout seal and seating the casing in the bedrock. Installation of a grout seal around all of the casing in the overburden and seating the casing in the bedrock should ensure the well will remain free of petroleum contamination. The casing should be set and all equipment removed and cleaned before continuing to drill to water.

The bedrock cuttings should be continuously screened for the presence of contamination. The bedrock boring may be cased or uncased depending on the friability of the bedrock material. After the first saturated groundwater zone is encountered, a monitoring well will be installed and a water sample collected for lab analysis.

Contamination in the Overburden with a Confining Unit

While drilling into bedrock, if a substantial confining layer of material (e.g., shale) is encountered before groundwater, drilling should cease. The confining layer should trap groundwater as well as contamination from a release in the UST system. Construct a monitoring well above the confining unit to collect a groundwater sample for lab analysis.

USTs Set in Bedrock

If the UST is resting on bedrock, examine the tank pit for petroleum staining. If petroleum staining is present, remove all backfill material. If the base of the tank pit is bedrock, but the sidewalls are not bedrock and staining is present in the UST pit, collect a soil sample from each of the sidewalls (nearest the bedrock surface). Use field screening methods to locate the presence of contamination in the tank pit.

Plugging Monitoring Wells

All monitoring wells and borings that access groundwater must be plugged according to 567-Chapter 39. DNR Form 542-1226, Abandoned Water Well Plugging Record, must be completed and submitted to the department. The Abandoned Water Well Plugging Record form 542-1226 is available on the DNR's UST website.

APPENDIX C: EXEMPT PRE 1974 TANKS

Affidavit for owners and operators or other interested parties requesting acknowledgment by the DNR that underground storage tanks are exempt from closure provisions in accordance with Iowa Administrative Code 567-135.15(7) can be found on the DNR's UST website DNR Form 542-0986.

APPENDIX D: MONITORING RECORDS USED IN LIEU OF SOIL & WATER SAMPLING

Reserved May 2021

APPENDIX E: EXPLOSIVE LIMITS OF GASES

Explosive Limits of Gases

Fuel Gas	"Lower Explosive or Flammable Limit" (LEL/LFL) *(%)*	"Upper Explosive or Flammable Limit" (UEL/UFL) *(%)*
Acetaldehyde	4	60
Acetone	2.6	12.8
Acetylene	2.5	81
Ammonia	15	28
Arsine	5.1	78
Benzene	1.35	6.65
n-Butane	1.86	8.41
iso-Butane	1.80	8.44
isobutene	1.8	9.0
Butylene	1.98	9.65
Carbon Disulfide	1.3	50
Carbon Monoxide	12	75
Cyclohexane	1.3	8
Cyclopropane	2.4	10.4
Diesel Fuel	1.3	6
Diethyl Ether	1.9	36
Ethane	3	12.4
Ethylene	2.75	28.6
Ethyl Alcohol	3.3	19
Ethyl Chloride	3.8	15.4
Fuel Oil No.1	0.7	5
Fuel Oil No. 6	1	5
Hydrogen	4	75
Isobutane	1.8	9.6

Fuel Gas	"Lower Explosive or Flammable Limit" (LEL/LFL) *(%)*	"Upper Explosive or Flammable Limit" (UEL/UFL) *(%)*
Isopropyl Alcohol	2	12
Gasoline	1.4	7.6
Kerosene	0.7	5
Methane	5	15
Methyl Alcohol	6.7	36
Methyl Chloride	10.7	17.4
Methyl Ethyl Ketone	1.8	10
Naphthalene	0.9	5.9
n-Heptane	1.0	6.0
n-Hexane	1.25	7.0
n-Pentene	1.65	7.7
Neopentane	1.38	7.22
Neohexane	1.19	7.58
n-Octane	0.95	3.20
iso-Octane	0.79	5.94
n-Pentane	1.4	7.8
iso-Pentane	1.32	9.16
Propane	2.1	10.1
Propylene	2.0	11.1
Silane	1.5	98
Styrene	1.1	6.1
Toluene	1.27	6.75
Triptane	1.08	6.69
p-Xylene	1.0	6.0

Note! The limits indicated are for gas and air at 68 °F (*20 °C)* and atmospheric pressure.[10]

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[10] The Engineering ToolBox Website

APPENDIX F: REPORTING PETROLEUM RELEASES FROM UST SYSTEMS

Reserved May 2021

8.4 APPENDIX D – HEALTH AND SAFETY PLAN

SITE-SPECIFIC HEALTH AND SAFETY PLAN

Project No. 3563 **Date** October 16, 2023
Client: City of Clinton
Address 1000, 1002, 1004, 1006 – 1008, and 1010 - 1012 South 4th Street, Clinton, Iowa

Site Contact Tammy Johnson **Office/Cell Phone No.** (563) 594-6730
Job Location 1000, 1002, 1004, 1006 – 1008, and 1010 - 1012 South 4th Street, Clinton, Iowa
Work Objectives Asbestos Remediation and possible UST excavation and removal

Key Individuals: Project Manager Krista Brodersen
Site Health and Safety Megan Ostrand
Prepared by Krista Brodersen **Reviewer/Approver** Lindsay E. James
Hospital/Clinic MercyOne Clinton Medical Center
Phone No. (563) 244-5555
Address: 1410 North 4th Street, Clinton, Iowa

Paramedic 911 **Fire Dept.** 911 **Police Dept.** 911

Emergency/Contingency Plans: In the event of an emergency, dial 911. Provide first aid, transport to hospital or request ambulance, depending on severity of injury. Also notify Krista Brodersen or Megan Ostrand.

15 Minute Eyewash ______ **Fire Extinguisher** required **First Aid Kit** required

Site Control Measures for Asbestos Activities: Wear full body protective clothing (including head, body, and foot coverings) consisting of material impenetrable by asbestos fibers (Tyvek or equivalent) and air purifying respirators with dual HEPA filters. Mark work zone with safety triangles/cones.

Site Control Measures for UST Removal Activities: Wear reflective vests and mark work zone with safety triangles/cones. Blackstone anticipates performing fieldwork in a USEPA Level D work uniform consisting of hard hats, safety glasses, protective gloves, and steel-toed boots.

Personal Decontamination Procedures for Asbestos Activities: The following procedures should be followed during asbestos work:

- Workers and authorized personnel shall enter the regulated area through the worker decontamination enclosure system. Workers shall not eat, chew, or smoke once they have entered the work area. Eating may take place just outside the clean room. Smoking, at any time during the project, is not recommended, but, if need be, smoking may take place outside the fence.
- Personnel who enter the work area must sign the entry log, located in the clean room, upon entry and exit.

- Personnel, before entering the work area, shall read and be familiar with posted regulations, personal protection requirements (including workplace entry and exit procedures) and emergency procedures. A sign-off sheet shall be used to acknowledge that these procedures have been reviewed and understood by personnel prior to entry.
- Personnel shall proceed first to the clean room, remove street clothes and appropriately don respiratory protection and launderable and/or disposable coveralls, head covering, and foot covering. Hard hats, eye protection, and gloves shall also be utilized.
- Personnel wearing designated personal protective equipment shall proceed from the clean room through the shower room and equipment room to the main work area.
- Before leaving the work area, personnel shall remove gross contamination from the outside of respirators and protective clothing by brushing and/or wet wiping procedures. Each person shall clean bottoms of protective footwear in the walk off pan just prior to entering the equipment room.
- Personnel shall proceed to the equipment room where they remove protective equipment except respirators. Deposit disposable and/or launderable clothing into appropriately labeled containers for disposal and/or laundering.
- A drum lined with a labeled 6 mil polyethylene bag for collection of disposable clothing shall be in this room. Contaminated footwear (e.g., rubber boots, other reusable footwear) shall be stored in this area for reuse the following workday.
- Reusable, contaminated footwear shall be stored in the equipment room when not in use in the work area. Upon completion of abatement, it shall be disposed of as asbestos contaminated waste. Rubber/steel toed boots may be decontaminated at the completion of the abatement project for reuse.
- Still wearing respirators, personnel shall proceed to the shower area, clean the outside of the respirators and the exposed face area under running water prior to removal of respirator, and shower and shampoo to remove residual asbestos contamination. Various types of respirators will require slight modification of these procedures.
- After showering and drying off, proceed to the clean room and don clean disposable and/or launderable clothing if there will be later reentry into the work area or street clothes if it is the end of the work shift.

Personal Decontamination Procedures for UST Removal Activities: If needed, soap and water cleaning on non-disposable personal protective equipment (PPE) and clothing. Proper disposal of other PPE, such as sampling gloves.

Sampling Equipment Decontamination Procedures for Asbestos Activities: The equipment room shall be used for storage of equipment and tools at the end of a shift after they have been decontaminated using a HEPA filtered vacuum and/or wet cleaning techniques as appropriate. Replacement filters (in sealed containers until used) for HEPA vacuums and negative pressure ventilation equipment, extra tools, containers of surfactant and other materials, and equipment that may be required during the abatement may also be stored here as needed.

Sampling Equipment Decontamination Procedures for UST Removal Activities: Sampling equipment will be decontaminated before use during the UST excavation activities and between each sampling location using a non-phosphate soap wash followed by a potable water rinse.

EMERGENCY CONTACT INFORMATION

911

LOCAL LAW ENFORCEMENT

Name: Clinton Police Department
Address: 113 6th Avenue South
City: Clinton State: Iowa
Telephone: (563) 243-1458

LOCAL FIRE DEPARTMENT

Name: Clinton Fire Department
Address: 340 3rd Avenue South
City: Clinton State: Iowa
Telephone: (563) 242-0125

NEAREST HOSPITAL or MEDICAL FACILITY

Name: MercyOne Clinton Medical Center
Address: 1410 North 4th Street, Clinton, Iowa
City: Clinton State: Iowa
Telephone: (563) 244-5555

MAP with DIRECTIONS is attached

HAZ MAT

1-800-424-8802

POISON CONTROL

1-800-955-9119

OSHA (In case of emergency call)

1-800-321-OSHA

CLIENT CONTACT

Name: Tammy Johnson **Phone #: (563) 594-6730**

BLACKSTONE PROJECT MANAGER

Name: Krista Brodersen **Phone #: (309) 581-5095**

BLACKSTONE FIELD MANAGER/SITE HEALTH AND SAFETY

Name: Krista Brodersen **Phone #: (309) 581-5095**

Job Safety Analysis and PPE Assessment
Complete a "hazard assessment" of the workplace to identify and control chemical, physical, biological, and other health hazards.

<table>
<tr><th colspan="5">Job Safety Analysis and PPE Assessment Form</th></tr>
<tr><td rowspan="3">Task Type (Check all that apply)</td><td rowspan="3">Engineering Services</td><td rowspan="3">Task Description (include estimate of task duration in hours/day)
Asbestos Remediation
UST Removal
Advance soil boring/install temporary groundwater well</td><td colspan="2">Location or Project: 1000, 1002, 1004, 1006-1008, and 1010 - 1012 South 4th Street, Clinton, Iowa</td></tr>
<tr><td colspan="2">Date: October 16, 2023</td></tr>
<tr><td colspan="2">Project #: 3563</td></tr>
<tr><td colspan="2">Analysis Team Member</td><td>Position Title</td><td>Reviewed by</td><td>Position Title</td></tr>
<tr><td colspan="2">Krista Brodersen</td><td>Senior Project Manager</td><td rowspan="2">Lindsay E. James</td><td rowspan="2">Senior Project Manager</td></tr>
<tr><td colspan="2">Mick Day</td><td>ACM Abatement Supervisor</td></tr>
<tr><td colspan="2">Special Training Required
HAZWOPER 40-hour
Asbestos Certification
Certified Groundwater Professional
Certified UST Remover</td><td colspan="3"></td></tr>
</table>

Job Task Step	Potential Environmental and Personal Hazards	Critical Actions	PPE Required
1. Pre-Mobilization	Standard office protocols for COVID-19 **Review Blackstone Asbestos Program**	-Review Blackstone COVID-19 Protocol. -Determine if additional state or local protocols are applicable	Mask, gloves, disinfectant, hand sanitizer, as appropriate

Job Task Step	Potential Environmental and Personal Hazards	Critical Actions	PPE Required
		-Stay up to date on COVID-19 infection rates/situation for area where project is located -Contact parties involved to ensure adherence to strict COVID-19 protocols. -Gather appropriate PPE for project including additional PPE for COVID-19 protection.	
2. Mobilization	Standard Blackstone travel protocols for COVID-19	-If using a shared vehicle, follow protocols for disinfecting vehicle prior to use. -Wear masks if more than one Blackstone team member or if with clients traveling to project site.	Mask, gloves, disinfectant, hand sanitizer, as appropriate sunglasses
3. Asbestos Remediation	Slip/trip/fall Heavy equipment Heat/cold stress Chemical exposure – inhalation of asbestos	-Survey work area for hazards. -Maintain fluids/sunblock/wear appropriate clothing/take breaks. -Wear protective clothing and NIOSH-approved respirator while collecting asbestos samples for laboratory analysis.	Head: Hard hat Body: Tyvek suit Foot: Steel-toed boots Hand: Nitrile gloves for sampling Eyes: Safety glasses Respiratory: Half-face respirator with HEPA filter
4. UST Removal	Slip/trip/fall Heavy equipment Heat/cold stress	-Survey work area for hazards. -Maintain fluids/sunblock/wear appropriate clothing/take breaks.	Head: Hard hat Body: Work clothes and High-Vis Vest

Job Task Step	Potential Environmental and Personal Hazards	Critical Actions	PPE Required
	Chemical exposure	-Wear Level D protective clothing.	Foot: Steel-toed boots Hand: Nitrile gloves for sampling Eyes: Safety glasses
5. Soil/Groundwater Sampling	Slip/trip/fall Heat/Cold stress Chemical exposure (petroleum hydrocarbons, direct contact with soil or inhalation)	Survey work area for hazards Maintain fluids/sunblock/wear appropriate clothing/take breaks. Use monitoring equipment. Wear protective clothing. Keep arms close to body when lifting.	Head: Hard hat Eyes: Safety glasses Body: Level D Foot: Steel-toed boots Hand: NItrile gloves Respiratory: None. PID will be used. Hearing: Ear plugs
6. Unpack lab equipment, check inventory, review laboratory instructions.	Sample bottles may contain acid preservatives. Any free liquid encountered in a cooler should be considered to be an acid.	Check for leaking containers.	Head: None Body: Hi-vis shirt or vest Foot: Steel-toe boots Hand: Nitrile gloves Respiratory: None Hearing: None Eye/face: Safety glasses
7. Prepare samples to be shipped to lab.	Take care in handling samples.	Follow proper guidelines for shipping samples.	Head: None Foot: Steel-toe boots Hand: Nitrile gloves Respiratory: None Hearing: None Eye/face: Safety glasses

CHEMICAL HAZARDS

Chemical	Exposure Routes	PEL/ TLV	Hazard
Dust and particulates	inhalation, skin and/or eye contact	PEL: TWA 15 mg/m^3 (total) TWA 5 mg/m^3 (resp)	Irritation eyes, skin, throat, upper respiratory system. Avoid visible emissions.
Asbestos	Inhalation	TWA 0.1 fiber/m^3 (8 hours) EL 1.0 fiber/m^3 (30 min)	Long-term exposure to asbestos can cause lung cancer and mesothelioma, asbestosis, Pleural disease.
Total Petroleum Hydrocarbons	Skin eye, ingestion, inhalation	NA	Irritation eyes, skin, throat, upper respiratory system; headache, dizziness

PHYSICAL HAZARDS

X Heat
X Cold
X Wet

X Noise
X Other Traffic near roadways

X Slip, Trip, Fall
____ Electrical Hazards
X Underground Hazards

____ Overhead Hazards

X Excavations/Trench
X Moving Equipment
____ Confined Space

PERSONAL PROTECTIVE EQUIPMENT - ASBESTOS

R = Required A = As Needed

R Hard Hat
R Safety Boots
R Reflective Vest
R Hearing Protection
R Tyvek Coveralls
____ 5 Minute Escape Respirator

R Safety Eye gear: glasses w/ side protection
R Respirator (Type): Full-face ____ Half-face X
____ Filter Type: Organic vapor _ Acid gas _ HEPA __
R Gloves (Type): Neoprene ___ PVC ___ [✓ Nitrile]
R Other Mobile phone

PERSONAL PROTECTIVE EQUIPMENT - UST

R = Required A = As Needed

R Hard Hat
R Safety Boots
R Reflective Vest
R Hearing Protection
____ Tyvek Coveralls
____ 5 Minute Escape Respirator

R Safety Eye gear: glasses w/ side protection
____ Respirator (Type): Full-face ____ Half-face ____
____ Filter Type: Organic vapor _ Acid gas _ HEPA __
R Gloves (Type): Neoprene ___ PVC ___ [✓ Nitrile]
R Other Mobile phone

In general, if PID air monitoring readings in workers' breathing zone exceed 10 ppm for 60 seconds or longer, upgrade to Level C (respirator, etc.) or vacate the immediate area.

Hearing protection is required during drilling activities.

MONITORING/SAMPLING EQUIPMENT

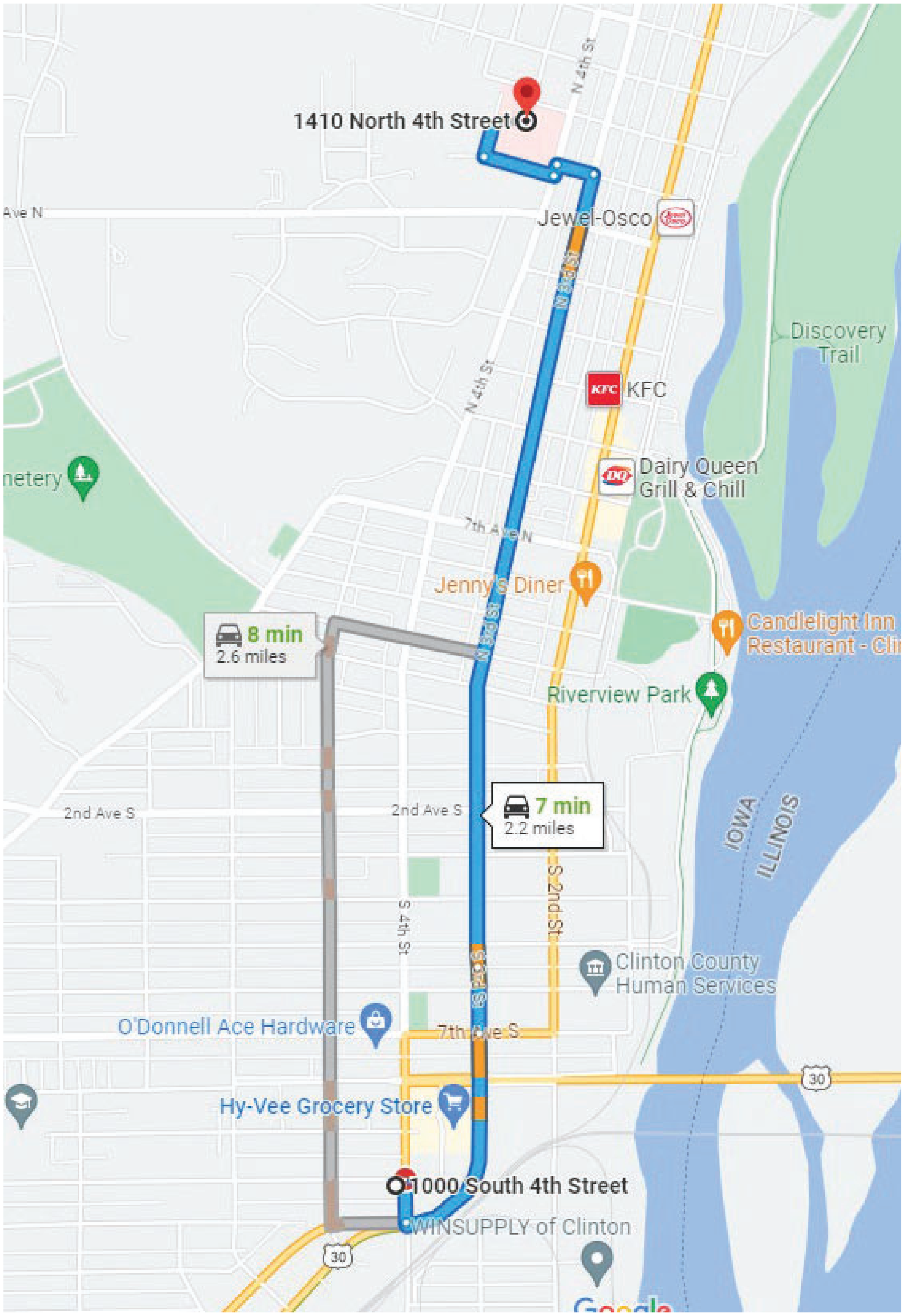
__________ Organic Vapor Analyzer (FID)
__________ Oxygen Meter
__________ Combustible Gas Meter
__________ H_2S Meter
___X___ PID with lamp of ____10.2 eV________________
_______ Detector Tube (specify)____________________
_______ Passive Dosimeter
___X___ Air Sampling Pump
_______ Olympus Delta Hand-Held XRF
_______ Filter Media

BIOLOGICAL HAZARDS

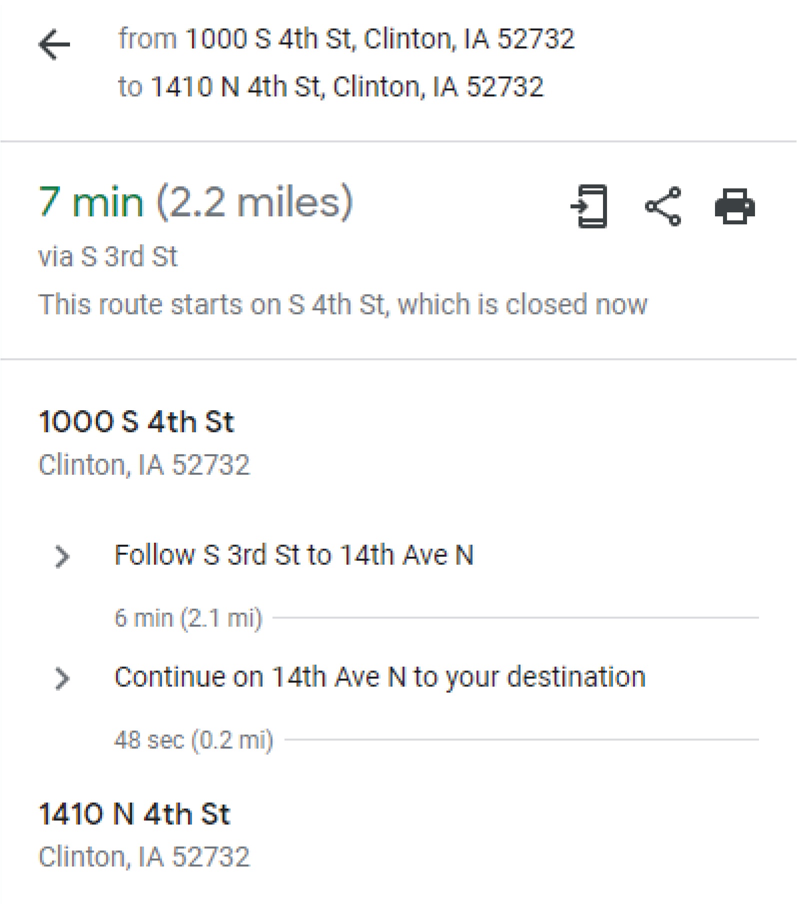
________ Insects (e.g., mosquitos, chiggers, spiders, bees, wasps)
________ Poisonous Plants (e.g., poison ivy, poison oak)
________ Animals (e.g., rabid animals, dogs)
___X___ Other _____COVID-19___________________________

REVIEW PROTOCOLS INCLUDED IN THE APPENDICES

Map to Hospital



DIRECTIONS



from 1000 S 4th St, Clinton, IA 52732
to 1410 N 4th St, Clinton, IA 52732

7 min (2.2 miles)
via S 3rd St
This route starts on S 4th St, which is closed now

1000 S 4th St
Clinton, IA 52732

Follow S 3rd St to 14th Ave N

6 min (2.1 mi)

Continue on 14th Ave N to your destination

48 sec (0.2 mi)

1410 N 4th St
Clinton, IA 52732

1000, 1002, 1004, 1006-1008, and 1010 - 1012 SOUTH 4TH STREET, CLINTON IOWA
ASBESTOS REMEDIATION AND UST REMOVAL
ONSITE SAFETY MEETING ATTENDEES

Signature	Name (Printed)/Title	Date

APPENDIX A
ASBESTOS PROTOCOLS

I. INTRODUCTION

Asbestos is a naturally occurring mineral found throughout the world. The mineral is concentrated in a few areas in the world and was mined in those areas extensively. Asbestos and asbestos containing materials (ACM) have excellent insulation properties, sound absorbing properties and heat resistant properties. Asbestos has been used for thousands of years but its use greatly increased with the advent of the industrial revolution. The most common forms of asbestos are:

1. Chrysotile, a serpentine form
2. Amosite, an amphibole form
3. Crocidolite, an amphibole form

Three other forms of asbestos are Anthophollyte, Actinolite, and Tremolite. All three of these forms are of the Amphibole form.

Asbestos was processed into many forms and uses. Asbestos materials and ACM can be found in hundreds of applications including building insulation, fireproofing materials, gaskets, fire blankets, electrical wiring, caulk, and cementitious materials such as siding. In this society and after decades of removal efforts, asbestos and ACM are still present and occupational exposure is always a potential health threat. Each person must be aware of the uses of asbestos and if they suspect ACM is present, do not disturb the material and notify your supervisor.

II. TYPES OF ACM

ACM is categorized as friable and non-friable. Friable ACM can be easily crushed by the hand. This form generates thousands of fibers and can result in elevated exposure to the person breathing the air with the fibers. Non-friable ACM cannot be crushed easily with the hand. Cementitious materials, floor tile and mastic are examples of non-friable ACM. Friable ACM will release fibers when disturbed. A disturbance can be by gravity, wind, vibration and physical contact. As friable ACM ages, it becomes more friable and releases more fibers over time.

III. EXPOSURE AND HEALTH THREATS

Asbestos fibers are very small and can easily enter the body by inhalation. Currently, the greatest health threat is by inhalation with a small threat by ingestion. Asbestos fibers are known to cause asbestosis, lung cancer and mesothelioma, another form of cancer. Asbestos fibers can also cause pleural plaque which is a scarred tissue on the lining of the lung. These diseases can have a latency period of 30-50 years. A person can be exposed to asbestos fibers and the disease can set in 30-50 years after the exposure.

IV. SAFEGUARDS FOR HANDLING ACM

It is important to handle ACM properly to prevent fiber release. In order for personnel to handle ACM properly, there are several training topics to be covered. Among these are:

Health Impacts
Routes of Exposure
Personal Protective Equipment
Proper handling
Exposure monitoring
Respiratory protection and selection
Abatement procedures
Transportation procedures
Regulatory Requirements

V. TRAINING

Training must be conducted to educate personnel on recognition, handling, and avoidance of ACM. Management must learn the regulatory requirements and ensure that employees meet the requirements. For employees that may encounter ACM, the minimum training will be a two-hour session on awareness of the hazards of asbestos, avoidance of ACM and reporting of suspect or known ACM as well as the topic listed above in Section IV. For employees who will participate in assessing the presence of asbestos (commonly referred to as an inspection) or removal of ACM (commonly called abatement), the training will meet the EPA and State requirements. Asbestos related training will be given before an employee begins field work. The awareness training will be provided annually.

VI. EXPOSURE MONITORING

Exposure monitoring is the process in which the potential exposure to asbestos fibers in the work area is determined. Exposure monitoring is conducted with battery operated pumps and a filter type cassette. The sampling is normally conducted over a full shift of 8 hours. The results of the personnel exposure monitoring will be conducted with the current OSHA Permissible Exposure Level (PEL) which is 0.1 fibers per cubic centimeter (f/cc) time-weighted-averaged over 8 hours in year 2015. Air monitoring procedures will meet OSHA Method ID-160 or NIOSH Method 7400 or 7402.

For short term exposure the excursion value of 1 f/cc time-weight-averaged over 30 minutes will be used for regulatory comparison.

Air monitoring records shall be kept and not destroyed for the lifetime of the company.

VII. PERSONAL PROTECTIVE EQUIPMENT

Personal protective Equipment (PPE) refers to clothing and safety equipment and respirators.

Respirator protection consisting of a half face or full-face air purifying respirator will be used when exposure to asbestos is possible. Type 100 cartridges will be used. If an employee uses a respirator, the company must have a written respiratory protection program, the employee must be involved in a medical surveillance program and annual fit testing and training must be completed.

The company will comply with the respiratory regulation 29 CFR 1910.134 or 29 CFR 1926.1101.

If the employee may be in contact with ACM, the employee shall wear protective clothing consisting of 1) a woven suit or a polycoated suit, 2) boots and 3) gloves. The suit and gloves will be disposable. If protective clothing is used, decontamination shall be implemented.

VIII. DECONTAMINATION

If PPE is used, then decontamination must occur. The decontamination process depends on the PPE used. Decontamination may range from disposal of a suit, gloves, and washing the boots and respirator to a full decontamination process. Before any person enters a controlled area where ACM is suspected or known to be present, a decontamination line must be created and built. The factors affecting a decontamination line creation are given in the applicable regulations.

IX. MEDICAL SURVEILLANCE

All employees who will be working with suspected or known ACM must participate in a medical surveillance program. The medical examinations shall be provided to the employees at no cost to the employee. Medical examinations will be provided annually. A licensed physician shall guide the examination and may provide the examination. An examination shall be provided at the beginning of employment which may involve exposure to ACM, periodically during employment and at the end of employment of exposure to ACM. The physician and company health and safety officer shall determine the medical test to be completed. Medical tests required by the regulations shall be completed. These tests may include medical tests of the respiratory system, cardiovascular system, digestive tract, chest x-ray, and a pulmonary function test. A medical questionnaire will be completed by the employee for the physician’s evaluation.

The company will provide the physician with information about the employee’s job tasks, the potential exposure to ACM, and the PPE worn by the employee.

The physician shall provide a written, signed opinion regarding the examination including at least 1) the employee’s ability to perform the job tasks, 2) any limitations on the employee, and 3) the employee’s use of a respirator. The written opinion must state that the employee has been informed of the results of the examination by the physician. The written opinion may not disclose any medical condition. Medical records must be kept until 30 years after the start of employment.

APPENDIX B

HEAT STRESS AND COLD STRESS PROCEDURES

I. PURPOSE

This section describes recommended methods to recognize, prevent, and measure heat and cold stress in the field, and engineering controls and work practices to avoid and prevent heat and cold stress. This procedure will also cover other weather-related hazards such as thunderstorms, tornados, and hurricanes. This discussion applies to all employees exposed to weather.

II. HEAT STRESS

Hazards of Heat Stress

The Table below outlines the causes, symptoms and treatment methods for heat stress hazards encountered in hot environments.

Heat Stress Hazards - Symptoms and Treatment

Heat Stress Hazard	Causes and Symptoms	Treatment
Sunburn	Mild sunburn is identified when exposed skin turns light pink. This can occur in a short period of time (as little as 15 minutes) in high UV conditions. As sunburn progresses, skin turns a deeper pink to bright red and is hot and painful to touch. Blisters can occur in very severe cases.	Cover exposed skin to protect it from exposure from the sun. Wear a broad brimmed hat, ANSI approved sunglasses and work under cover when possible. Sunscreen that provides adequate protection against both UVA and UVB rays should be used. Sunscreen should be applied about a half hour before sun exposure, and again just before working in the sun. Studies have shown that most people apply far too little sunscreen. The SPF of sunscreen is reduced when it is applied too thinly. Personnel should reapply sunscreen periodically especially if you perspire a great deal.

Heat Stress Hazard	Causes and Symptoms	Treatment
Heat Rash	Excessive sweating results in sweat ducts been plugged and resulting in skin inflammation. Symptoms include a prickly rash which can become infected.	• Rest in a cool area • Wash the skin • Allow skin to dry • Seek medical attention, if infected • Regularly bathe and dry skin
Fainting	Non-acclimated employee stands in heat for long periods of time that causes pooling of blood in lower extremities, which results in less blood flowing to the brain. The symptom includes sudden loss of consciousness.	• Rest in cool, shaded area for 5 minutes • Gradually adjust to working in heat • Move around to circulate blood
Heat Cramps	Occurs in tired muscles when the worker sweats profusely and drinks large quantities of water. Low salt level causes spasms, while high salt level causes cramps. Symptoms include painful cramping and spasms in the muscles.	• Rest in cool, shaded area for 5 minutes • Drink small quantities of water frequently • Drink up to 4 cups per hour • Avoid caffeinated beverages or alcohol
Heat Exhaustion	Large amounts of fluid lost by sweating Symptoms resemble early heat stroke – Physically weak, fatigued, or faint – Giddy, irritable, or mentally confused – Nauseous – Headache, dizziness, and/or lightheadedness – Person continues to sweat and body temperature is normal – Skin is moist and clammy – Person may vomit or lose consciousness	• Rest in shade or air-conditioned vehicle or room for 15 minutes minimum • Drink plenty of fluids (at least 5-7 ounces per 15-20 minutes) • Seek medical attention, if severe • Use cooling vest or wet clothing if required

Heat Stress Hazard	Causes and Symptoms	Treatment
Heat Stroke	This is a life-threatening condition in which the body's temperature regulatory system fails and sweating becomes inadequate. Symptoms include the following: – Person's skin is hot and dry – Skin appears red in color – Body temperature is 103°F or higher – Person is mentally confused or delirious – Person can have convulsions or become unconscious	• Call 911 or your local emergency number immediately. • Move the person to a cooler place. Quickly cool the body. Immerse the victim in a cool bath or briefly wrap wet sheets around the body and fan it. Wrapping the patient in wet towels or cloths can actually act as insulation and increase the body temperature, so avoid keeping them wrapped for prolonged periods. • Do not apply ice or very cold water to the victim's skin as this can cause vasoconstriction in the skin, preventing heat from escaping the body core. • Watch for signals of breathing problems. Keep the person lying down and continue to cool the body any way you can. If the victim refuses water or is vomiting or there are changes in the level of consciousness, do not give anything to eat or drink.

III. Preventive Measures

The following preventive measures and engineering controls shall be implemented when temperature exceeds 85 degrees Fahrenheit, or when the temperature exceeds 80 degrees Fahrenheit with relative humidity of 85 percent or more:

- Provide adequate supply of cool or iced water or sport drinks for each employee working in the hot environment. The amount of water or sports drinks available onsite should be adequate to provide each employee at least 24 to 32 ounces per hour.

- Supervisor/designated person will monitor water containers every hour, and employees are encouraged to report to supervisor/designated person low levels or dirty water.
- The supervisor will provide frequent reminders to employees to drink frequently, and more water breaks will be provided.
- Every morning there will be short tailgate meetings to remind workers about the importance of frequent consumption of water throughout the shift.
- Employees working in extreme heat conditions should avoid alcohol, caffeine, and heavy meals.
- Place water containers as close as possible to the workers, not away from them.
- Take frequent breaks in cool or shaded areas such as trees, air-conditioned vehicles, buildings, canopies, lean-tos, or other partial and/or temporary structures that are either ventilated or open to air movement. Employees suffering from heat illness or believing a preventative recovery period is needed shall be provided access to an area with shade that is either open to the air or provided with ventilation or cooling for a period of no less than five minutes. Such access to shade shall be permitted at all times.

To determine whether the frequency of breaks is adequate, one or more of the following heat stress monitoring methods should be performed, especially when wearing Personal Protective Equipment that limits the evaporation of sweat:

- **Heart rate-** count your heart beats for 30 seconds as soon as you stop working. If your number of heart beats exceeds 110 beats per minute, increase your rest period by 1/3. If your number of heart beats continues to exceed 100 beats per minute in the next rest period, stop work for at least one hour.
- **Oral temperature-** Put a thermometer underneath your tongue for 3 minutes, if your temperature exceeds 99.6 degrees Fahrenheit; increase your rest period by 1/3. If your temperature exceeds 100.6 degrees Fahrenheit, rest for at least one hour.
- **Body Water Loss-** Measure body weight during the day. If your weight loss has exceeded 1.5% of your body weight at the start of the day, increase your rest period and drink additional fluids.

Whenever possible, provide air-conditioned cabs for equipment operators, which will prevent heat stress and allow the operators to work for longer periods of time. When the temperature exceeds 100 °F (or if the temperature exceeds 90 °F with relative humidity over 70 percent), consider the use of PPE such as cooling vests, water cooled garments or wet clothing such as headbands or bandanas.

A. Acclimating to Heat

People need time for their bodies to adjust to working in the heat. This truth applies to employees (1) returning to work after a prolonged absence, (2) moving from a cool to a hot climate, or (3) working during the beginning stages of a heat wave. Just because you used to be able to work 10 hours in hot weather does not mean you still can if you have been out for a while. Help your body acclimate to the heat—you may have to reduce your hours or increase your breaks for a few days.

B. Risk Factors

Each employee and work task has unique characteristics that affect the susceptibility to Heat Related Illness. The following factors should be considered when evaluating the risk of Heat Related Illness.

Personal Factors:

- Age (very young and elderly are more affected)
- Personal Health/Fitness/Obesity and other Health Conditions
- Personal Stress
- Dehydration
- Alcohol Use
- Certain Drugs, Medications, or Supplements (Be particularly cautious if taking antihistamines, cold or cough medicines, blood pressure/heart medication, diet pills, seizure medication, laxatives, thyroid pills, diuretics, etc. Check with your health care provider to determine whether your medications will have any effects on your exposure to heat.)
- Lack of Acclimatization to Hot Weather or Hot Weather Work

Environmental Risk Factors (job related):

- Duration of Activity
- Metabolic Load (how strenuous the work is)
- Wearing Heavy Attire or Protective Clothing (PPE)

Environmental Risk Factors (environmentally related):

- Temperature
- Humidity
- Air Velocity
- Radiant Heat Sources (sunlight, reflection, etc.)

C. Training

All Employees

Employees who work in hot environments (exceeding 85° F, or exceeding 80° F with relative humidity of 85 percent or more) should be trained in heat stress recognition, measurement and prevention measures at least once every two years, to include the following elements:

- Signs, symptoms and treatment of various heat related illnesses.
- Procedures for acclimating.

- The need to drink water frequently.
- The need to take breaks out of the heat.
- How to contact emergency services and how to effectively report the work location to 911.
- The importance of choosing water instead of soda or other caffeinated beverages and avoiding alcoholic beverages all together during high heat.
- Methods to measure heat stress such as heart rate, oral temperature, or weight loss; and
- PPE is available to alleviate heat stress.

Supervisors

Supervisors must be trained in Blackstone's Heat Stress Procedures prior to supervising employees working in heat including a thorough understanding of procedures related to prevention, emergency response, and personal risk factors. Supervisors must evaluate personal risk factors of each employee under their supervision prior to assigning a task where heat related illness is a possibility.

III. COLD STRESS

When we work in cold temperatures; there is a potential for cold related illness to occur. There are several types of cold related illnesses and injury. These include frostbite and hypothermia. A description of each is listed below, along with basic first aid procedures that can be utilized for each illness.

A. Frostbite

Frostbite is literally the freezing of body tissue (usually skin). Fingers, toes, ears, and the nose are the most vulnerable to frostbite.

There are three degrees of frostbite, including:

- Frostnip, which usually affects the face, ears, or fingertips. While the skin may feel numb, frostnip does not lead to permanent tissue damage.
- Superficial frostbite, in which the outer skin is affected.
- Deep frostbite, in which the skin and underlying tissue freezes. Permanent damage is possible, depending on how long and how deeply the tissue is frozen.

Frostbite is caused by either prolonged exposure to cold temperatures or shorter exposure to very cold temperatures.

Many people with frostnip or frostbite experience numbness. “Pins and needles” sensations, severe pain, itching and burning are all common when the affected area is warmed, and blood starts flowing again. Skin may look white, grayish-yellow, or even black (with severe frostbite), and it may feel hard, waxy, and numb. Blistering is also common.

Treatment and First Aid: Get out of the cold, get out of wet clothing as soon as possible, and remove all constrictive jewelry and clothing. Then immerse the affected area in warm, but not hot, water. If water is not available, warm the tissue with body heat. For example, warm your hands

by tucking them into your armpits and warm your nose, ears, or face by covering them with dry hands.
Do not:

- Thaw the frostbitten tissue if there is a chance that it will refreeze before you get medical attention, as this increases the likelihood of permanent damage.
- Rub or massage frostbitten skin or disturb blisters, which can further damage tissue.
- Use direct dry heat, like heating pads or a campfire to thaw frostbitten tissue.

Many people with frostbite may also be experiencing hypothermia (body temperature that is too low), which can be deadly as described below. This is why it is so important to seek medical attention immediately.

B. Hypothermia
Hypothermia can occur in cold work environments. Prolonged exposure to cold temperatures can cause the body's core temperature to drop. Blood flow to the outer limbs is reduced as the body attempts to keep the core warm.

Treatment and First Aid: Treatment and First Aid for Hypothermia include the following:

- The patient should be removed from the cold environment and placed in a warm shelter away from the wind. Wet clothing should be removed and replaced with a warm, dry covering including head covering.
- Emergency medical services should be activated (call 911 if available) as soon as possible.
- The patient's breathing should be monitored, and if it becomes dangerously slow or stops, CPR should be initiated.
- Rough handling or jerking of the patient should be minimized if the person is lethargic or unconscious. This may cause an irritable heart to develop abnormalities (e.g., a heart attack).
- Rewarming should be started by applying warm compresses to the chest, neck, and groin. Hot water should not be used. Because there may be associated frostbite, direct heat should not be applied to the body. Instead, warm blankets and body to body contact may be needed as a first aid measure.
- The severity of hypothermia and the patient's mental status and ability to function will determine what further treatment is necessary. Passive rewarming with warm clothing in a warm environment may be all that is required for a conscious person who is shivering.
- Active rewarming may be considered for those who are colder or show signs of confusion. Warmed intravenous fluids, warming blankets, and warmed humidified air may be provided in the hospital.

C. Preventive Measures

The following measures should be taken to prevent cold stress ailments:

- Wear appropriate clothing for the weather. When appropriate, wear insulated coveralls with a hat.

- Prepare for the worst when performing outdoor tasks if cold weather is a possibility.
- Wear mittens or protective gloves, or wear mittens alone if protective gloves are not required. Wearing two pairs of socks is advised, with wool recommended for the outer layer.
- Move your body or perform warm-up exercises. Increasing physical activity will help your body stay warm. Wiggle fingers and toes if they start to feel numb.
- Don't smoke. Smoking constricts blood vessels and increases the risk for frostbite.

D. Training

Employees who work in cold environments should be trained in the recognition, treatment and prevention of cold stress. Anyone familiar with cold stress symptoms, first aid and prevention can lead the training, which can be conducted as a part of a project tailgate safety session (e.g., when cold weather is expected).

IV. OTHER WEATHER-RELATED SAFETY ISSUES

Weather-related safety issues can arise from thunderstorms, lightning, tornados, high winds, and floods. The following precautions should be followed when thunderstorms, lightning, heavy winds or flooding are encountered.

A. Thunderstorms and Lightning

- **Postpone activities**. Before working outdoors, check the forecast for thunderstorms. Consider postponing activities to avoid being caught in a dangerous situation.
- **Monitor the weather**. Look for signs of a developing thunderstorm such as darkening skies, flashes of lightning or increasing wind.
- **Get to a safe place**. If you hear thunder, even a distant rumble, immediately move to a safe place. When thunder roars, go indoors! REMEMBER, IF YOU CAN HEAR THUNDER, YOU CAN BE STRUCK BY LIGHTNING! Fully enclosed buildings with wiring and plumbing provide the best protection. Sheds, picnic shelters, tents or covered porches do not protect you from lightning. If a sturdy building is not nearby, get into a hard-topped metal vehicle and close all the windows. Stay inside until 30 minutes after the last rumble of thunder.
- **Keep away from electrical equipment, wiring and water pipes.** Sensitive electronics should be unplugged well in advance of thunderstorms.
- If you are caught outdoors during a thunderstorm, adhere to the following rules:
  - **Avoid open areas and stay away from isolated tall trees, towers, or utility poles**. Do not be the tallest object in the area. Lightning tends to strike the taller objects in the area. If you are stuck in a thunderstorm, crouch with feet together and hands on knees.
  - **Stay away from metal conductors such as wires or fences.** Ungrounded metal does not attract lightning, but lightning can travel long distances through it.

B. Tornadoes and High Winds

- The safest place to be is an underground shelter, basement, or safe room.
- If no underground shelter or safe room is available, a small, windowless interior room or hallway on the lowest level of a sturdy building is the safest alternative.

- Mobile trailers are not safe during tornadoes. Abandon mobile trailers and go to the nearest sturdy building or shelter immediately.
- If you are caught outdoors, seek shelter in a basement, shelter or sturdy building. If you cannot quickly walk to a shelter:
  - Immediately get into a vehicle, buckle your seat belt and try to drive to the closest sturdy shelter.
  - If flying debris occurs while you are driving, pull over and park. Now you have the following options as a last resort:
    - Stay in the car with the seat belt on. Put your head down below the windows, covering with your hands and a blanket if possible.
    - If you can safely get noticeably lower than the level of the roadway, exit your car, and lie in that area, covering your head with your hands.
- Drilling activities and the use of manlifts (subcontractors) shall not be conducted when sustained wind speeds exceed 25 miles per hour, or when wind gusts threaten stability of the equipment.

C. Flash Floods

- Avoid driving, walking, or swimming in flood waters.
- Stay away from water, storm drains, ditches, ravines, or culverts during flash flood warnings. Moving water only six inches deep can knock you off your feet.
- If you come upon flood waters, turn around and travel to higher ground or find an alternative route.

REVIEW OSHA QUICK CARDS IN THE APPENDICES

APPENDIX C
COVID-19 PROTOCOL

I. INTRODUCTION

Coronavirus disease (COVID-19) is an infectious disease caused by a new virus. The disease causes respiratory illness with symptoms such as a cough, fever, and in more severe cases, difficulty breathing. Coronavirus spreads primarily through contact with an infected person when they cough or sneeze. It also spreads when a person touches a surface or object that has the virus on it, then touches their eyes, nose, or mouth. You can protect yourself by washing your hands frequently, avoiding touching your face, and avoiding close contact (6 feet) with people. Subsequent strains of the virus have had similar symptoms and behavior.

Blackstone has developed and implemented this protocol to limit the exposure of employees, clients, and contractors, and to prevent the further spread of the disease. This plan will be re-evaluated and updated as new information becomes available and as business conditions change. Please note, that although this protocol has been written specifically for the COVID-19 pandemic, these practices are applicable and will be implemented during any global pandemic. Training will be completed on the contents of this protocol and subsequent updates whenever updates are made related to COVID-19 or if there is a development of a new disease or pandemic situation. The Plan will also be periodically evaluated for effectiveness and protocols will be updated/changed as necessary to address potential deficiencies or overly burdensome/inefficient requirements. Updates will include corrective actions taken as a result of lessons learned in the implementation of the Plan.

Additionally, training and information will be provided as necessary to ensure that Blackstone employees are informed on health issues of pertinent diseases including prevention of illness, initial disease symptoms, preventing the spread of the disease, and when it is appropriate to return to work after illness. The Blackstone Health and Safety Officer is responsible for Plan development, updates, implementation, and training and will coordinate with local health departments and health care providers as necessary to appropriately care for Blackstone personnel who may become ill as a result of exposure to COVID-19 or another pandemic disease.

II. CDC BEST PRACTICES

Blackstone staff will generally follow CDC best practices for COVID-19. As these practices are updated frequently, please visit the link below to review the most up to date guidance related to vaccines, masks, travel, etc. Blackstone may implement more stringent protocols to protect business conditions and improve workplace safety.
https://www.cdc.gov/coronavirus/2019-ncov/index.html

III. SAFETY PROTOCOLS

A. Centers for Disease Control (CDC) Best Practices

Blackstone employees will follow the CDC best practices for hygiene:

- Wash your hands often with soap and water for at least 20 seconds, especially after going to the bathroom; before eating; and after blowing your nose, coughing, or sneezing.
- If soap and water are not readily available, use an alcohol-based hand sanitizer with at least 70% alcohol. Always wash hands with soap and water if hands are visibly dirty.
- Avoid touching your eyes, nose, and mouth with unwashed hands.
- Avoid close contact with people who are sick.
- Stay home when you are sick.
- Cover your cough or sneeze with a tissue, then throw the tissue in the trash.
- Clean and disinfect frequently touched objects and surfaces using a regular household cleaning spray or wipe.

B. Blackstone General Protocols

1. First and foremost, Blackstone wants our employees to stay safe. Please practice personal hygiene techniques as outlined by the CDC (See Section A). **Face masks are currently not required at Blackstone. This protocol will be updated as necessary based on changes in CDC guidance. Disposable face masks are available in the kitchen area with disinfecting solutions.**
2. If a Blackstone employee suspects they have COVID-19, has been diagnosed with COVID-19, has been tested for the virus and awaiting results, or has been exposed to someone who has COVID-19, please notify your supervisor who will coordinate with the Blackstone Health and Safety Officer and HR Coordinator. Do not come to work - minimizing direct contact with others prevents the spread.
3. Blackstone employees, regardless of vaccination status, which have tested positive for COVID-19, have COVID-19 symptoms, or reside with someone who has tested positive and cannot isolate should follow the protocol outlined below for returning to work. With positive test result regardless of vaccination status the CDC recommends: staying home for at least five days, isolating from other in your home, wearing a well-fitting mask if you must be around others in your home, and not traveling. Day 1 is defined as the first full day after your symptoms developed or test specimen was collected.
    a. After 5 days, If you are fever free for 24 hours (without the use of fever-reducing medication) and symptoms are improving another healthcare provided covid test can be taken. If a negative result is received, you can come back to in person work. If a positive test result is received continue to isolate.
    b. After 10 days, you can return to in-person work without an additional test result, if symptoms have improved and you have been fever free for 24 hours (without the use of fever-reducing medication).
4. Blackstone recommends consultation with a health professional before returning to work, especially if symptoms were severe and you have underlying health conditions.
5. If you are not comfortable in your job task/conditions, please let your supervisor know as soon as possible. Employees may continue to follow work from home if they are not comfortable returning to the office. Additionally, employees may request a different seating

arrangement during office work hours, if they feel their workstation is in too close proximity to others.

6. Field projects which are still going will be staffed as normal as long as conditions are safe. Field staff will be in and out of the office as they need to be to accomplish their job tasks. People in the field should practice person to person distancing. Most of our sites are in remote environments, which is helpful.
7. All client work will continue according to Blackstone protocols and client-specific protocols, if implemented
8. Although it is highly unlikely that an outbreak of COVID-19 within Blackstone will lead to a disruption in our ability to provide services to our clients, each client manager will be responsible for notifying their client if a disruption of service will occur and when it is anticipated that services will resume. In the event that an individual client manager is not able to perform these duties, their supervisor will facilitate client contact.
9. Living through a pandemic is stressful. If you are feeling isolated or stressed, please reach out to your supervisor, coworker, friend, family member, or mental health professional.
10. Blackstone encourages workers to obtain appropriate immunizations now that a safe and effective vaccine has been developed for COVID-19.

C. Overland Park Office Cleaning and Disinfecting Procedures – Note: implementation of these procedures is not currently warranted but they can be implemented if future conditions warrant.

1. Follow CDC guidelines outlined in Section A.
2. Wash or sanitize hands before or immediately upon entering facility.
3. Hand washing facilities, hand sanitizers, tissues, no touch trash cans, hand soap, and disposable towels are provided in the men’s and women’s restrooms and in the kitchen breakroom area.
4. Minimize the use of any shared equipment such as computers, desks, etc. and disinfect appropriately before and after use if common use cannot be avoided.
5. Minimize the circulation of “hard” items such as papers and other materials among other staff.
6. Limit use of common spaces such as the conference room and kitchen areas. No more than 10 people will be allowed at a time in common areas, and social distancing of at least 6 feet should be maintained at all times while in proximity to others.
7. Each employee will be responsible for disinfecting tables, counters, light switches, doorknobs, handles, and faucets after each use. Spray bottles of Pine-sol are available in the bathrooms and kitchen area for spraying down counters, faucets, and bathroom fixtures. Spray bottles of at least 70% alcohol are also available for spraying down doorknobs, handles, light switches, and microwave and copier controls, etc.
8. The entry door and copier should be disinfected several times a day using a paper towel and alcohol spray. (Do not spray directly on copier controls, rather spray paper towel, then wipe)

9. If an item is dirty, wash first with soap and water or another general cleaner and then use a disinfectant to kill germs.
10. It is recommended that personal phones and other electronics such as computer keyboards and mice be disinfected at least once per day. Follow the manufacturer's instructions for cleaning and disinfecting. If there are no instructions, use alcohol-based wipes or spray a paper towel with 70% alcohol and dry the surface thoroughly.
11. If a Blackstone employee becomes infected with COVID-19 and has recently been in the office, more extensive disinfecting procedures will be implemented:
    a. If possible, close off areas visited by the infected employee. Use ventilating fans to increase air circulation in the area.
    b. Wait 24 hours or as long as practical before beginning cleaning and disinfection.
    c. Clean and disinfect all areas such as offices, bathrooms, common areas, shared electronic equipment (like tablets, touch screens, keyboards, copier, microwave, etc.) used by the infected employee, focusing especially on frequently touched surfaces.
    d. Gloves and facemasks should be worn while cleaning and disinfecting.
    e. If it has been more than 7 days since the person with suspected/confirmed COVID-19 was in the office, additional cleaning and disinfection is not necessary.
12. Additional information regarding approved disinfectants is included in Section D below.

D. Appropriate Disinfectants

For disinfection, diluted household bleach solutions (see below), alcohol solutions with at least 70% alcohol, and most common EPA-registered household disinfectants should be effective.

- Diluted household bleach solutions can be used if appropriate for the surface. Follow manufacturer's instructions for application and proper ventilation. Check to ensure the product is not past its expiration date. Never mix household bleach with ammonia or any other cleanser. Unexpired household bleach will be effective against coronaviruses when properly diluted.
  - Prepare a bleach solution by mixing:
    - 5 tablespoons (1/3rd cup) bleach per gallon of water or
    - 4 teaspoons bleach per quart of water
- Products with the EPA-approved emerging viral pathogens claims icon (https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2) are expected to be effective against COVID-19 based on data for harder to kill viruses. Follow the manufacturer's instructions for all cleaning and disinfection products (e.g., concentration, application method and contact time, etc.).

E. State Specific-Guidelines and Requirements

Most states have removed specific guidelines, requirements and travel restrictions. Blackstone will continue to follow CDC guidelines and requirements if state specific requirements are not in place. It is recommended to confirm there are no travel restrictions and know your requirements before you travel.

IV. CLIENT SPECIFIC PROTOCOLS

Client specific protocols as related to variants of COVID-19 will be provided if implemented. At this time no clients have asked us to institute a more specific protocol than what we have currently implemented.

V. HELPFUL RESOURCES AND LINKS

Below are helpful resources to keep up to date on the ever-changing new information related to Coronavirus. Information is included for each state agency in which Blackstone has an office.

https://www.cdc.gov/coronavirus/2019-ncov/index.html (CDC)
https://www.osha.gov/coronavirus/safework (OSHA)
https://www.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6
- John's Hopkins GIS tracker
https://www.who.int/emergencies/diseases/novel-coronavirus-2019 (World Health Organization)
https://www.coronavirus.kdheks.gov/ (Kansas info)
https://www.jocogov.org/coronavirus-covid-19-update (JOCO info)
https://health.mo.gov/living/healthcondiseases/communicable/novel-coronavirus/
(Missouri info)
https://www.jacksongov.org/Residents/Health-Services/COVID-19-Information
(Jackson County, MO info)
https://idph.iowa.gov/Emerging-Health-Issues/Novel-Coronavirus (Iowa info)
https://dph.illinois.gov/covid19.html (Illinois info)
https://dhhs.ne.gov/Pages/Coronavirus.aspx (Nebraska info)

TIPS FOR WORKING REMOTELY

I. HOME OFFICE DESIGN

- Create a separate office space, if possible
- Avoid setting up your workspace in front of the tv or on your bed (captain obvious, I know)
- If you need a change of scenery, move around to different places in your home/apartment
- Try to avoid awkward/static positions that can cause stress and pain on your body

II. TIME MANAGEMENT

- Establish routines
    - Try to stick somewhat closely to your regular sleep/waking hours (can be tough!)
    - Create a morning routine – even if it is just making a cup of coffee before you go to your work area. Other ideas include meditation, exercise, taking a shower and get dressed, creating a special time with your kiddos

  - Set regular work hours and stick to them. Many of us are not going to be able to work "regular business hours" due to family responsibilities, but we can plan to work similar hours each day
  - Create an end of workday routine – take the dog for a walk, exercise, start working on making dinner, read a book…make it something you look forward to so you will step away from work
- Create a to-do list for the day – set goals for what you hope to accomplish.
- End your day by starting a to-do list for the next day, and don't beat yourself up if you weren't able to accomplish everything on your to do list for that day.
- Use time management apps (yes there are apps for everything!) like Harvest, Rescue Time, Toggl, MyLifeOrganized and many others. I have not used any of these – some are work focused and some have a more personal focus.
- If necessary, set some ground rules with family members so that they don't bother you with every little detail of life. This isn't possible with little ones, but hopefully can work with elementary/teenage kids and spouses/significant others.
- Understand that distractions may be unavoidable if you have children and other family members in your home! Use breaks to address distractions/deal with family issues and cut yourself some slack.

III. HEALTH AND WELLNESS

- Take frequent short breaks (every hour or so)
  - Stretch and take deep breaths – my apple watch reminds me to stand every hour and I set the breathe app to remind me to breathe four times a day.
  - Go outside for fresh air
- Make sure you are getting enough exercise. Many folks regularly went to the gym and participated in other activities that are not currently available. Take walks, run, use fitness apps, YouTube videos, etc. to stay active.
- Eat Healthy Meals and Snacks (caveat…it is harder to get out and get fresh fruits and vegetables…but being at home makes it easier to binge on a bag of chips or other similar items).
- Create small rewards for yourself when you accomplish various tasks such as getting a healthy snack after making a work call, taking a short walk after finishing a section of a report, etc.
- Make a list of the things you would like to do/accomplish during the time when you would be meeting with friends, watching sports, attending events etc. such as getting to that book you've been wanting to read, calling friends/family members you rarely talk to but miss, trying new recipes, cleaning out some closets, starting a new creative project (writing, art, crafting, building something, etc.). If you want to get really into it, assign a point total to each thing and work to get a certain number of points per week.
- Use your PTO if you need a mental health day or are sick – this is obvious if you have COVID-19 symptoms, but things like migraines, colds, flu, allergies etc. aren't going away

just because we have a new virus to contend with. Sometimes it seems like we should keep working since we can work at home, even when we feel awful and would be better off taking some time to stay in bed.
- Make a list of things for which you are grateful - practice gratitude
- Refer back to the mental health tips in Section VI.

IV. COMMUNICATION WITH COWORKERS AND PERSONAL GROWTH

- Check in with each other often!
    - supervisors make sure you are regularly communicating with your team members to set goals expectations for task/project completion schedules and to make sure they are doing ok
    - team members communicate with your supervisors if you have questions, concerns, etc. Let them know if there is something you need to make your work from home or work from the field time more efficient/effective. Also, make sure they are doing ok too!
    - Keep your calendar updated and stay in contact with PMs to make sure
- Online training courses and webinars – there are a lot of great online training courses and webinars – many of them are free. If there is something you are interested in, check with your supervisor about participating.

- Having trouble thinking clearly and concentrating
- Having difficulty making decisions

On the emotional side you might be:
- Anxious or fearful
- Feeling depressed
- Feeling guilty
- Feeling angry
- Feeling heroic, euphoric or invulnerable
- Not caring about anything
- Feeling overwhelmed by sadness

To combat these feelings the CDC recommends these actions to support yourself during these trying times:
- Take breaks from watching, reading, or listening to news stories, including social media. Hearing about the pandemic repeatedly can be upsetting.
- Take care of your body. Take deep breaths, stretch, or meditate. Try to eat healthy, well-balanced meals, exercise regularly, get plenty of sleep, and avoid alcohol and drugs.
- Make time to unwind. Try to do some other activities you enjoy.
- Connect with others. Talk with people you trust about your concerns and how you are feeling.

For those facing a variety of issues personally and helping others in a variety of circumstances, the National Alliance on Mental Illness has an excellent document with ideas and resources (link provided in Section VI). If you fall outside of the serious mental health issue status but are filled with anxiety and worry, try to find some joy. Reading stories about how people are going out of their way to help others, is a wonderful source of joy. And laughter always heals the soul – find ways to laugh each day…at least a little!

MENTAL HEALTH TIPS

I. MENTAL HEALTH TIPS

As part of the Blackstone Health and Safety/Health and Wellness Program, we will be sharing helpful resources to provide support, encouragement, and information. We will each deal with the uncertainty and stress of these unprecedented times in our own way, but there are some feelings/behaviors that we should be aware of and looking out for in ourselves, friends, family, coworkers, etc. The tips below provide info we can refer back to during these challenging times. Understanding how you are feeling and how you can mitigate your circumstances helps in dealing with this crisis. Advice from the Substance Abuse and Mental Health Administration offers a practical way to evaluate your behavior, thinking and emotional state.

For behavior, these are some things you must be experiencing:

- An increase or decrease in your energy and activity levels
- An increase in irritability, with outbursts of anger and frequent arguing
- Trouble relaxing or sleeping
- Frequent crying
- Excessive worrying
- Wanting to be alone most of the time
- Blaming other people for everything
- Difficulty communicating or listening
- Difficulty giving or accepting help
- An inability to feel pleasure or have fun

With regard to your thinking you may be:

- Having trouble remembering things
- Feeling confused
- Having trouble thinking clearly and concentrating
- Having difficulty making decisions

On the emotional side you might be:

- Anxious or fearful
- Feeling depressed
- Feeling guilty
- Feeling angry
- Feeling heroic, euphoric or invulnerable
- Not caring about anything
- Feeling overwhelmed by sadness

To combat these feelings the CDC recommends these actions to support yourself during these trying times:

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- Make time to unwind. Try to do some other activities you enjoy.
- Connect with others. Talk with people you trust about your concerns and how you are feeling.

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APPENDIX D

FIRST AID PROGRAM

I. FIRST AID

First aid is emergency care provided for injury or sudden illness before emergency medical treatment is available. The first-aid provider in the workplace is someone who is trained in the delivery of initial medical emergency procedures, using a limited amount of equipment to perform a primary assessment and intervention while awaiting arrival of emergency medical service (EMS) personnel.

OSHA's First Aid standard (29 CFR 1910.151) requires trained first-aid providers at all workplaces of any size in the absence of an infirmary, clinic, hospital, or physician, that is reasonably accessible in terms of time and distance to the worksite, which is available for the treatment of injured employees. A person who has a valid certificate in first aid shall be available at the worksite to render first aid.

A workplace first-aid program is part of a comprehensive safety and health management system that includes essential elements.

- The elements of a first aid program begin with identifying and assessing the workplace risks that have potential to cause worker injury or illness;

- The first aid program should include:

    - Methods to minimize the outcome of accidents or exposures,
    - Comply with OSHA requirements relating to first aid,
    - Include sufficient quantities of appropriate and readily accessible first-aid supplies and first-aid equipment, such as bandages and automated external defibrillators,
    - Assign and train first-aid providers who receive first-aid training suitable to the specific workplace and receive periodic refresher courses on first-aid skills and knowledge,
    - Instruct all workers about the first-aid program, including what workers should do if a coworker is injured or ill,
    - Put the policies and program in writing, and
    - Provide for scheduled evaluation and changing of the first-aid program to keep the program current and applicable to emerging risks in the workplace, including regular assessment of the adequacy of the first-aid training course.

- Additionally, if an employee is expected to render first aid as part of his or her job duties, the employee is covered by the requirements of the Occupational Exposure to Bloodborne Pathogens standard (29 CFR1910.1030). This standard includes specific training requirements.

II. FIRST AID SUPPLY REQUIREMENTS

The safety officer has the responsibility for choosing the types and amounts of first-aid supplies and for maintaining these supplies. The supplies must be adequate, should reflect the kinds of injuries that occur, and must be stored in an area where they are readily available for emergency access. First aid kits will consist of appropriate items for the environment in which they are used. For example, in a work area where the eyes or body of a person may be exposed to injurious corrosive materials, suitable facilities and supplies will be provided for quick drenching or flushing of eyes and body parts in the event of exposure. The safety officer will periodically assess the contents of first aid kits to ensure the availability of adequate first aid supplies.

Employees will have access to either a personal, company, or rented vehicle at each work site, in the event that an injured person requires transportation to a physician or hospital. In the event that an injury is more serious and requires emergency services, Blackstone personnel carry cell phones to contact ambulance services.
A specific example of the minimal contents of a workplace first-aid kit is described in American National Standards Institute ANSI Z308.1 – 2003. The kits described are suitable for small businesses. For large operations, employers should determine how many first-aid kits are needed, and if it is appropriate to augment the kits with additional first-aid equipment and supplies.

III. TRAINING AND CERTIFICATION

Blackstone will select employees to receive first aid training. A valid certificate in first aid training will be obtained from the U.S. Bureau of Mines, the American Red Cross, or equivalent training that can be verified by documentary evidence. Retraining shall occur every two years.

IV. WHAT IS FIRST AID?

For the purposes of Part 1904 of OSHA, "first aid" means the following:

- Using a non-prescription medication at nonprescription strength (for medications available in both prescription and non-prescription form, a recommendation by a physician or other licensed health care professional to use a non-prescription medication at prescription strength is considered medical treatment for recordkeeping purposes).

- Administering tetanus immunizations (other immunizations, such as Hepatitis B vaccine or rabies vaccine, are considered medical treatment).

- Cleaning, flushing or soaking wounds on the surface of the skin.

- Using wound coverings such as bandages, Band-Aids™, gauze pads, etc.; or using butterfly bandages or Steri-Strips™ (other wound closing devices such as sutures, staples, etc., are considered medical treatment).

- Using hot or cold therapy.

- Using any non-rigid means of support, such as elastic bandages, wraps, non-rigid back belts, etc. (devices with rigid stays or other systems designed to immobilize parts of the body are considered medical treatment for recordkeeping purposes).

- Using temporary immobilization devices while transporting an accident victim (e.g., splints, slings, neck collars, back boards, etc.).

- Drilling of a fingernail or toenail to relieve pressure or draining fluid from a blister.

- Using eye patches.

- Removing foreign bodies from the eye using only irrigation or a cotton swab.

- Removing splinters or foreign material from areas other than the eye by irrigation, tweezers, cotton swabs or other simple means.

- Using finger guards.

- Using massages (physical therapy or chiropractic treatment are considered medical treatment for recordkeeping purposes); or

- Drinking fluids for relief of heat stress.

VII. RECORDKEEPING

A. First Aid Log

In the event that first aid treatment as outlined above is required for a Blackstone employee either at the office, in the field, or at another setting while the employee is working for Blackstone, the first aid treatment should be recorded on the Blackstone First Aid Log. A copy of the Blackstone First Aid Log is attached.

B. Incident Report

In the event of an illness or injury, an Incident Report form is completed by the person providing first aid or other treatment and includes:

- Date and time of illness or incident.
- Name of person with illness or injury.
- Description of symptoms.
- Treatment provided.
- Referral arrangements (e.g., ambulance, hospital, medical service); and

- Name of person completing Incident Report form (if different than person providing first aid).

A copy of the incident report form is attached. The original copy of the Incident Report form is retained securely in the Blackstone office.

FIRST AID LOG
INCIDENT REPORT FORM

BLACKSTONE
ENVIRONMENTAL

Blackstone Incident Reporting Form

Use this form to report any workplace accident, injury, incident, close call or illness.
Return completed form to the Corporate Health and Safety Officer

This is documenting a(n):

☐ Lost Time/Injury
☐ First Aid
☐ Incident
☐ Close Call
☐ Observation

Details of person injured or involved (to be filled in by person injured / involved if possible)
Person Completing Report:______________________ Date:_____________________
Person(s) Involved:____________________________
Equipment or Truck ID:_________________________

Event Details
Date of Event:______________________ Location of Event:______________________
Time of Event:______________________ Witnesses:____________________________

Description of Events (Describe tasks being performed and sequence of events):
____
____
____
____
____

*If more space is required, please use the <u>back</u> of this sheet

Was event / injury caused by an unsafe act (activity or movement) or an unsafe condition (machinery or weather)? Please explain:
____
____

TO BE COMPLETED ONLY IF LOST TIME/INJURY OR FIRST AID WAS REQUIRED	
Type of injury sustained:	
Cause of lost time/ injury or first aid:	
Was medical treatment necessary?	Yes_____ No_____ If yes, name of hospital or physician:

Signature of Employee:______________________________ Date:___________________
Signature of Supervisor:_____________________________ Date:________

OSHA® FactSheet

Asbestos

Asbestos is a naturally occurring mineral fiber. It was used in numerous building materials and vehicle products for its strength and ability to resist heat and corrosion before its dangerous health effects were discovered. Individual asbestos fibers cannot be seen by the naked eye, which puts workers at an increased risk. The Occupational Safety and Health Administration (OSHA) has regulations to protect workers from the hazards of asbestos.

What is the hazard?

Asbestos fibers are released into the air during activities that disturb asbestos-containing materials.

The asbestos fibers can then be inhaled without knowing and trapped in the lungs. If swallowed, they can become embedded into the digestive tract as well.

Asbestos is a known human carcinogen and can cause chronic lung disease as well as lung and other cancers. Symptoms and/or cancer may take many years to develop following exposure.

Where is the hazard?

The hazard may occur during manufacturing of asbestos-containing products; performing brake or clutch repairs; renovating or demolishing buildings or ships; or cleanup from those activities; contact with deteriorating asbestos-containing materials and during cleanup after natural disasters.

Some materials are presumed to contain asbestos if installed before 1981. Examples of these materials, as well as other presumed asbestos-containing materials are:

- Thermal system insulation
- Roofing and siding shingles
- Vinyl floor tiles
- Plaster, cement, putties and caulk
- Ceiling tiles and spray-on coatings
- Industrial pipe wrapping
- Heat-resistant textiles
- Automobile brake linings and clutch pads

OSHA Standards

OSHA has three standards to protect workers from the hazards of asbestos depending on the type of workplace. For complete information on all of the requirements, see the standard specific to your type of workplace:

General Industry: 29 CFR 1910.1001 covers work in general industry, such as exposure during brake and clutch repair, maintenance work, and manufacture of asbestos-containing products.

Shipyards: 29 CFR 1915.1001 covers construction, alteration, repair, maintenance, renovation and demolition of structures containing asbestos during work in shipyards.

Construction: 29 CFR 1926.1101 covers construction, alteration, repair, maintenance, or renovation and demolition of structures containing asbestos.

What protections exist in the Standards?

- **Permissible Exposure Limit (PEL)** for asbestos is 0.1 fiber per cubic centimeter of air as an eight-hour time-weighted average (TWA), with an excursion limit (EL) of 1.0 asbestos fibers per cubic centimeter over a 30-minute period. The employer must ensure that no one is exposed above these limits.
- **Assessment** of workplaces covered by the standards must be completed to determine if asbestos is present and if the work will generate airborne fibers by a specific method under each standard.
- **Monitoring** necessary to detect if asbestos exposure is at or above the PEL or EL for workers who are, or may be expected to be exposed to asbestos. Frequency depends on work classification and exposure. The construction and shipyard standards require assessment and monitoring by a competent person.

- If the exposure has the potential to be above the PEL or EL, employers must use proper **engineering controls and work practices** to the extent feasible to keep it at or below the PEL and EL. Where feasible engineering controls and work practices do not ensure worker protection at the exposure limits, employers must reduce the exposures to the lowest level achievable and then supplement with proper **respiratory protection** to meet the PEL. The construction and shipyard standards contain specific control methods depending on work classification, and the general industry standard has specific controls for brake and clutch repair work.
- **Proper hazard communication and demarcation** with warning signs containing specified language in areas that have exposures above the PEL or EL is necessary. No smoking, eating, or drinking should occur in these areas and proper PPE must be provided and used to prevent exposure.
- **Separate decontamination and lunch areas** with proper hygiene practices must be provided to workers exposed above the PEL to avoid contamination.
- **Training** requirements depend on the workplace exposure and classification. Training must be provided to all workers exposed at or above the PEL before work begins and yearly thereafter. All training must be conducted in a manner and language in which the worker is able to understand. Workers who perform housekeeping operations in buildings with presumed asbestos-containing materials but not at the PEL must also be provided asbestos awareness training.
- **Medical surveillance** requirements are different depending on the industry. Medical surveillance must be provided for workers who engage in certain classifications of work, or experience exposures at or above the PEL in construction and shipyards. In general industry, medical examinations must be provided for workers who experience exposure at or above the PEL.
- **Records** must be kept on exposure monitoring for asbestos for at least 30 years, and worker medical surveillance records retained for the duration of employment plus 30 years. Training records must be kept for at least 1 year beyond the last date of employment.

Contact OSHA

For more information on this and other health-related issues impacting workers, to report an emergency, fatality or catastrophe, to order publications, to file a confidential complaint, or to request OSHA's free on-site consultation service, contact your nearest OSHA office, visit www.osha.gov, or call OSHA at 1-800-321-OSHA (6742), TTY 1-877-889-5627.

Worker Rights

Workers have the right to:

- Working conditions that do not pose a risk of serious harm.
- Receive information and training (in a language and vocabulary the worker understands) about workplace hazards, methods to prevent them, and the OSHA standards that apply to their workplace.
- Review records of work-related injuries and illnesses.
- Get copies of test results that find and measure hazards.
- File a complaint asking OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA's rules.
- OSHA will keep all identities confidential.
- Exercise their rights under the law without retaliation or discrimination.

For more information, see OSHA's workers page.

For assistance, contact us. We can help. It's confidential.

OSHA®
Occupational
Safety and Health
Administration

U.S. Department of Labor
www.osha.gov (800) 321-OSHA (6742)

OSHA® QUICK CARD™

Protecting Workers from Cold Stress

Cold temperatures and increased wind speed (wind chill) cause heat to leave the body more quickly, putting workers at risk of cold stress. Anyone working in the cold may be at risk, e.g., workers in freezers, outdoor agriculture and construction.

Common Types of Cold Stress

Hypothermia

- Normal body temperature (98.6°F) drops to 95°F or less.
- **Mild Symptoms:** alert but shivering.
- **Moderate to Severe Symptoms:** shivering stops; confusion; slurred speech; heart rate/breathing slow; loss of consciousness; death.

Frostbite

- Body tissues freeze, e.g., hands and feet. Can occur at temperatures above freezing, due to wind chill. May result in amputation.
- **Symptoms:** numbness, reddened skin develops gray/white patches, feels firm/hard, and may blister.

Trench Foot (also known as Immersion Foot)

- Non-freezing injury to the foot, caused by lengthy exposure to wet and cold environment. Can occur at air temperature as high as 60°F, if feet are constantly wet.
- **Symptoms:** redness, swelling, numbness, and blisters.

Risk Factors

- Dressing improperly, wet clothing/skin, and exhaustion.

For Prevention, Your Employer Should:

- Train you on cold stress hazards and prevention.
- Provide engineering controls, e.g., radiant heaters.
- Gradually introduce workers to the cold; monitor workers; schedule breaks in warm areas.

For more information:

OSHA® **Occupational Safety and Health Administration**

U.S. Department of Labor
www.osha.gov (800) 321-OSHA (6742)

OSHA 3156-02R 2014

OSHA® QUICK CARD™

How to Protect Yourself and Others

- Know the symptoms; monitor yourself and co-workers.
- Drink warm, sweetened fluids (no alcohol).
- Dress properly:
  - Layers of loose-fitting, insulating clothes
  - Insulated jacket, gloves, and a hat (waterproof, if necessary)
  - Insulated and waterproof boots

What to Do When a Worker Suffers from Cold Stress

For Hypothermia:

- Call 911 immediately in an emergency.
- To prevent further heat loss:
  - Move the worker to a warm place.
  - Change to dry clothes.
  - Cover the body (including the head and neck) with blankets, and with something to block the cold (e.g., tarp, garbage bag). Do **not** cover the face.
- If medical help is more than 30 minutes away:
  - Give warm, sweetened drinks if alert (no alcohol).
  - Apply heat packs to the armpits, sides of chest, neck, and groin. Call 911 for additional rewarming instructions.

For Frostbite:

- Follow the recommendations "**For Hypothermia**".
- Do not rub the frostbitten area.
- Avoid walking on frostbitten feet.
- Do not apply snow/water. Do not break blisters.
- Loosely cover and protect the area from contact.
- Do not try to rewarm the area unless directed by medical personnel.

For Trench (Immersion) Foot:

- Remove wet shoes/socks; air dry (in warm area); keep affected feet elevated and avoid walking. Get medical attention.

For more information:

OSHA®
Occupational
Safety and Health
Administration

U.S. Department of Labor
www.osha.gov (800) 321-OSHA (6742)

8.5 APPENDIX D – FIELD DOCUMENTATION AND EQUIPMENT

1000 Block of South 4th Street Sampling Data Form

Person collecting sample:	Date:
Sample location:	Sample ID:
Duplicate or field blank:	Sampling pump ID:
Site conditions:	Sampling pump calibration (yes/no)
Sample start time:	Sample stop time:
Demolition Equipment present:	
Water application (yes/no):	
Hose diameter:	Nozzle diameter:
Water counter start:	Water counter end:
Description of photographs taken:	
Notes:	

Gilian BDX-II

Air Sampling Pump

Operation Manual

SENSIDYNE®

1000 112TH Circle N, Suite 100 • St. Petersburg, Florida 33716 USA
(800) 451-9444 • (727) 530-3602 • (727) 539-0550 [FAX] • www.sensidyne.com

REF 360-0136-01 (Rev E)

PACKING LIST

The items listed below are shipped with the Gilian BDXII Abatement Air Sampler:

- *BDXII Abatement Air Sampler*
- *Tool Kit*
- *Tubing*
- *Operation and Service Manual*

ALWAYS check to make certain
You have received all of the items listed above.

If you have any questions or need assistance, contact your
Sales Representative, or call

(800) 451-9444

OR

(727) 530-3602

PROPRIETARY NOTICE

This manual was prepared exclusively for the owner of the Gilian BDXII Abatement Air Sampler. The material within this manual is proprietary information and is to be used only to understand, operate, and service the instrument. By receiving this document, the recipient agrees that neither this document nor the information disclosed within nor any part thereof shall be reproduced or transferred, physically, electronically or in any other form, or used or disclosed to others for manufacturing or for any other purpose except as specifically authorized in writing by Sensidyne, LP.

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DISCLAIMER

THE SELLER ASSUMES NO RESPONSIBILITY WHATSOEVER, TO ANY PARTY WHOSOEVER, FOR ANY PROPERTY DAMAGE, PERSONAL INJURY, OR DEATH RECEIVED BY OR RESULTING FROM, IN WHOLE, OR IN PART, THE IMPROPER USE, INSTALLATION, OR STORAGE OF THIS PRODUCT BY THE USER, PERSON, FIRM, ENTITY, CORPORATION OR PARTY NOT ADHERING TO THE INSTRUCTIONS AND WARNINGS IN THIS MANUAL, OR OTHERWISE PROVIDED BY THE SELLER OR FROM NOT ADHERING TO ALL FEDERAL, STATE, AND LOCAL ENVIRONMENTAL AND OCCUPATIONAL HEALTH AND SAFETY LAWS AND REGULATIONS.

THE SELLER SHALL NOT BE LIABLE FOR DIRECT, INDIRECT, CONSEQUENTIAL, INCIDENTAL OR OTHER DAMAGES RESULTING FROM THE SALE AND USE OF ANY GOODS AND SELLERS' LIABIL- ITY HEREUNDER SHALL BE LIMITED TO REPAIR OR REPLACEMENT OF ANY GOODS FOUND DEFECTIVE. THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR USE OR FOR A PARTICULAR PURPOSE WHICH ARE EXPRESSLY DISCLAIMED.

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WARNINGS

READ AND UNDERSTAND ALL WARNINGS AND INSTRUCTIONS BEFORE USE

This product is intended for use in abatement air sampling for asbestos or lead removal projects. It is not designed for use with low flow modules, and it is not recommended for use with cyclones or impactors that require constant flow control.

Read and understand **ALL** warnings before using this product. Failure to read, understand, and comply with **ALL** warnings could result in property damage, severe personal injury, or death.

Read and understand **ALL** applicable Federal, State, and Local environmental health and safety laws and regulations, including OSHA. Ensure complete compliance with **ALL** applicable laws and regulations before and during use of this product.

UNDER NO CIRCUMSTANCES should this product be used except by qualified, trained, technically competent personnel and not until the warnings, Operation and Service Manual, labels, and other literature accompanying this product have been read and understood.

The Operation and Service Manual must be read and understood by each user before operating this product or using its accessories, in order to ensure proper and safe use and installation of this product and to ensure familiarity with the proper treatment and safety procedures in the event of an accident.

DO NOT remove, cover, or alter any label or tag on this product, its accessories, or related products.

DO NOT operate this product should it malfunction or require repair. Operation of a malfunctioning product, or a product requiring repair may result in serious personal injury or death. **DO NOT** attempt to repair or modify the instrument, except as specified in the Operation and Service Manual. Contact the Service Department to arrange for a Returned Material Authorization (RMA).

Use **ONLY** genuine Sensidyne replacement parts when performing any maintenance procedures described in this manual. Failure to do so may seriously impair instrument performance. Repair or alteration of the product beyond the scope of these maintenance instructions, or by anyone other than an authorized service person, could cause the product to fail to perform as designed and persons who rely on this product for their safety could sustain severe personal injury or death.

DO NOT operate in excessive chemical or water vapor atmospheres. Failure to follow instructions may cause permanent damage to the equipment.

The BDXII Abatement Air Sampling Pump employs rechargeable Nickel-Cadmium or Nickel-Metal-Hydride batteries. **ALWAYS** fully charge the battery pack before starting the pump.

DO NOT operate the unit with improperly maintained batteries. This can cause pump failure or faulting.

DO NOT operate the unit with a dirty or blocked inlet filter. This can cause pump failure or faulting.

DO NOT drop, crush, or roughly handle the unit, and **NEVER** submerge the unit in water. This can cause pump failure or faulting.

DO NOT run the pump beyond its recommended specifications.

SECTION ONE
Introduction

1.1 OVERVIEW

IMPORTANT

You must read this manual in its entirety to ensure proper operation of your unit.

This manual contains basic information for operating and maintaining the Gilian BDXII Abatement Air Sampler. The BDXII is capable of delivering up to 3.0 LPM of sample air for periods exceeding 8 hours, with a nominal head restriction of up to 20” of water. Primary application for the Abatement Air Sampler is asbestos sampling, though sampling for emissions, dusts, fumes, and mists is also possible.

The BDXII is designed for maximum utility, simplicity of operation, long service life, and extreme ease of maintenance. Features of the BDXII Abatement Air Sampler include:

- Long life, rechargeable battery pack
- Battery pack rechargeable while attached to unit, or separately
- Belt clip for portability and convenience
- High impact Lexan plastic case for durability
- Light weight construction for comfort when unit is attached to belt
- Built-in, easily readable flowmeter
- Small, long life pump

1.2 GENERAL DESCRIPTION

The BDXII Abatement Air Sampler consists of a pump contained in a Lexan plastic case, electronic flow control system, a pneumatic system, and a rechargeable battery pack. The BDXII is shown in Figure 1.1 and Figure 1.2.

The BDXII sampler is equipped with a basic control board, which contains the flow control circuitry. The board also contains the On/Off switch, and the flow control potentiometer.

The pump will normally maintain set flow within 5%, with no more than two (2) readjustments needed over an 8-hour period. However, heavy filter media loading may make more frequent readjustments necessary.

The internal/external vent control is located on the top of the sampling pump. You may select the venting control as desired, using the screwdriver provided with the pump. Selecting the open circle position will vent the pump’s discharge external to the sampler’s case (recommended for moist or corrosive sampling environments). Selecting the closed circle will vent the pump’s discharge internally (recommended for dust laden environments).

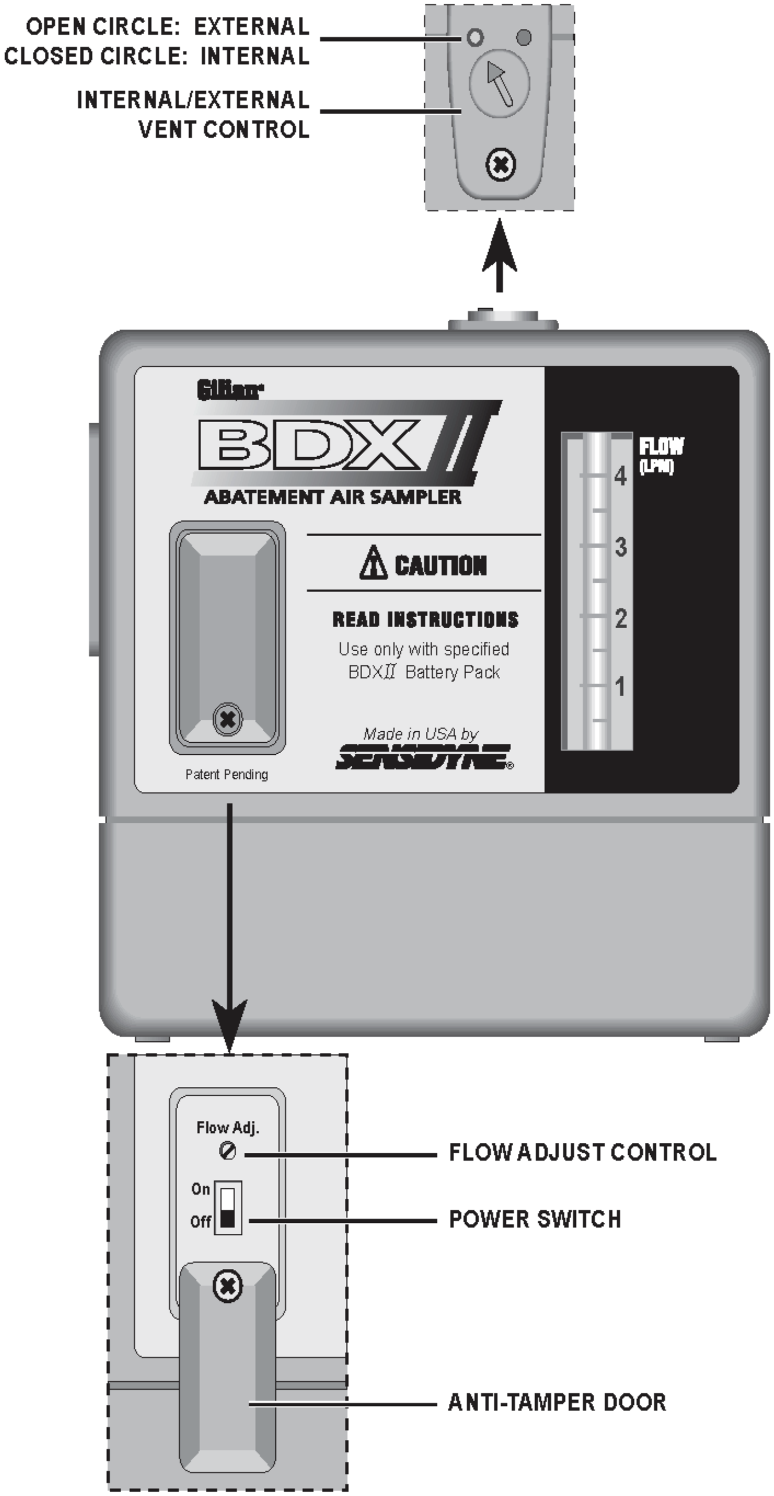


Figure 1.1

BDXII Abatement Air Sampler (Front view)

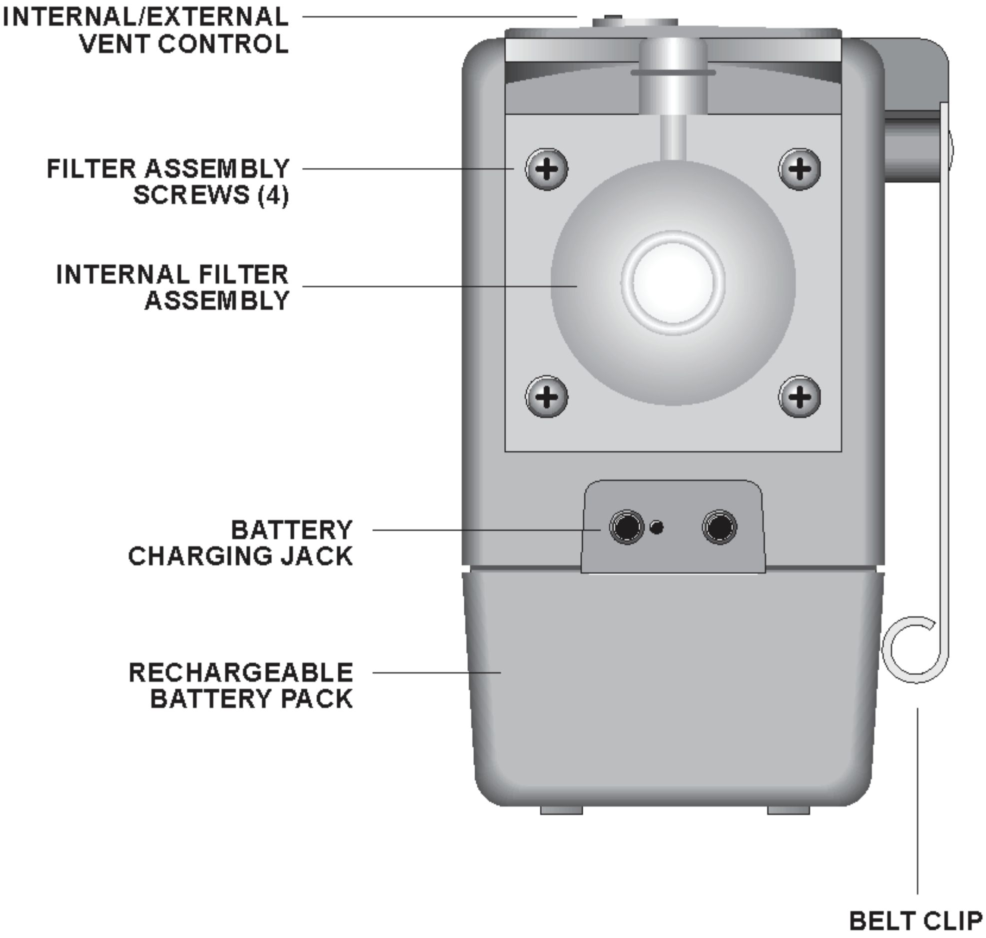


Figure 1.2
BDXII Abatement Air Sampler (Side view)

SECTION TWO
Operation

2.1 INTRODUCTION

Before using the BDXII for sampling, the unit must be properly prepared. This includes charging and calibrating the unit for proper flow rate.

When charging the unit make certain that the unit is fully charged. This provides the unit with enough charge to complete a full period of sampling. Follow the general instruction provided in Section Three, as well as the specific instructions provided with the particular charging device used.

CAUTION
When charging the device, make certain the AC outlet is nearby and readily accessible.

The BDXII should be calibrated before and after each day of sampling. Calibration should be performed using either an electronic bubble meter (e.g., Gilibrator-2), or a precision rotameter that has been calibrated against an electronic bubble meter.

When a sampling train requires the use of an unusual combination of sampling media (such as a glass fiber filter preceding an impinger), these sampling media should be installed in-line during calibration.

2.2 CALIBRATION (FLOW ADJUST)

To ensure proper operation of the BDXII Abatement Air Sampling Pump, the unit should be properly calibrated prior to sampling.

The calibration (flow adjust) is recommended using a Gilibrator-2 precision electronic flowmeter. If you use a precision bubble meter other than the Gilibrator-2, make certain you follow the instructions that came with your device.

Refer to Figure 2.1 and calibrate the pump as follows:

1) Make certain the unit is properly charged.

2) Using a small Phillips screwdriver, back out the holding screw just enough so the anti tamper cover plate can be rotated 180. This exposes the On/Off switch and the flow adjust screw (See Figure 1.1).

3) Assemble the cassette filter holder for the sampling media. Use the appropriate filter for the sampling method. Compress the cassette by using a mechanical press or other means of applying pressure. Use shrink tape around the cassette to cover joints and prevent leakage. If a cassette adapter is used, make certain it does not come in contact with the backup pad.

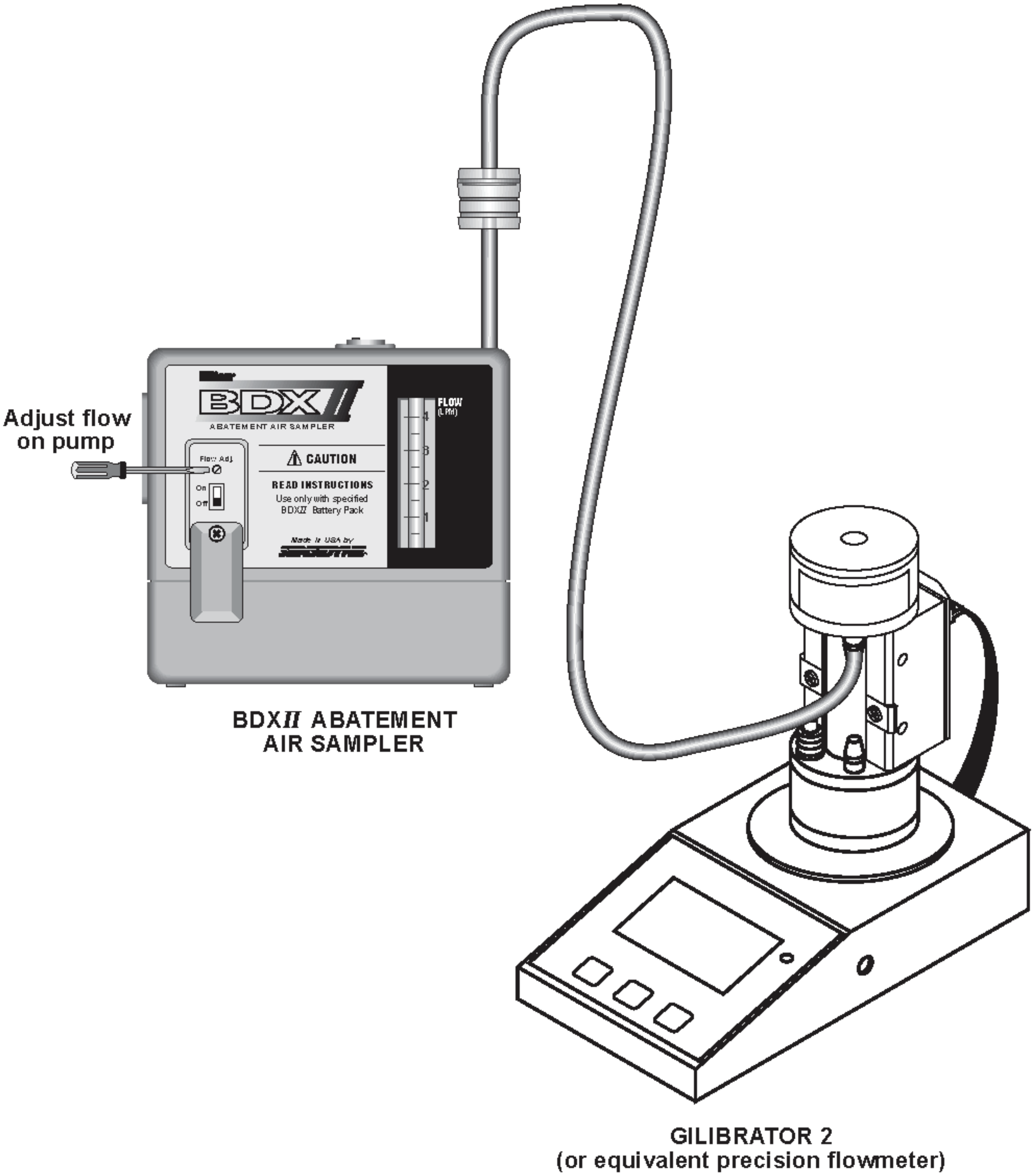


Figure 2.1
BDXII Pump Calibration (Flow Adjust)

4) Move the On/Off switch to the On position.

5) Set the pump flow rate by turning the flow adjust screw (clockwise for increased flow and counterclockwise for decreased flow).

6) Use the built-in rotameter on the BDX*II* as a flow indicator only. Accurate flow adjustment settings must be made by using a Gilibrator-2, or equivalent flow calibration device, for calibration measurements.

7) When calibrating the sampler for flow, the sample collection (i.e. a filter cassette) should be in-line.

8) When the desired flow rate has been attained, move the On/Off switch to the Off position. The unit is now ready for sample collection.

2.3 OPERATION

Begin the sample run by switching the On/Off switch to the On position. Secure the front anti-tamper cover. The pump will operate at the flow rate set at the last calibration (flow adjustment). The sampling run is terminated by moving the On/Off switch to the Off position.

NOTE

It may be necessary to readjust the flow rate at least 2 times during the sampling period in order to maintain flow within 5% of the set flow rate.

After sampling, remove the filter cassette and prepare the cassette filter for analysis. Replace the cassette filter with a clean fresh filter.

Fully charge the battery pack (preferably overnight) to ensure enough power to complete the entire next sampling period. The actual time to achieve a fully charged battery pack depends on the charging device used (see Section Three).

3.1 GENERAL MAINTENANCE

The BDXII Abatement Air Sampling Pump is relatively maintenance free. Most maintenance involves periodic inspection of the unit, battery maintenance, and filter maintenance.

General inspection involves checking the unit for blockage and pump capacity as follows:

1) Examine the unit for physical damage. Make certain that all case components and connections are tight.

2) Turn on the pump and check the flowmeter.

3) If there is no flow, check all tubing for blockage.

4) Check for gross contamination with dust, mud, etc. If contaminated or excessively dirty, replace the internal filter.

5) Also, check the Troubleshooting Guide (Appendix C) and make any corrective action. If the problem still exists, return the unit for repair (see Appendix D for obtaining a Returned Material Authorization).

3.2 BATTERY MAINTENANCE

The Gilian BDXII Abatement Air Sampler uses rechargeable Nickel-Metal-Hydride batteries. The battery packs must be fully charged and maintained properly to achieve maximum pump run time. The battery pack has an output of 4.8 Vdc and a capacity of 1.8 ampere-hours. It is incumbent upon the pump user to ensure that the battery pack has enough charge to complete the intended run time. The BDXII battery pack is charged through a built-in jack. The jack is located on the side of the unit, below the internal filter assembly. Note that the charging plug is polarized to prevent improper insertion.

CAUTION

Do not short the battery terminals or the charging jack. Shorting will result in irreversible damage to the battery pack.

The battery pack may be charged while attached to the unit or charged separately. Figure 3.1 shows how to remove the battery pack for battery pack replacement or for charging the pack separately from the unit.

NOTE

The BMS Multi-Station Charger has a single and double discharge mode (Single Evaluation and Double Evaluation) designed to enhance the performance of Nickel-Cadmium batteries. Excessive use of these discharge/charge features will needlessly shorten battery life. We recommend use of the Double Evaluation mode for maintenance only (maximum once monthly) for use with Nickel-Cadmium batteries. These modes offer no advantage with Nickel-Metal-Hydride batteries.

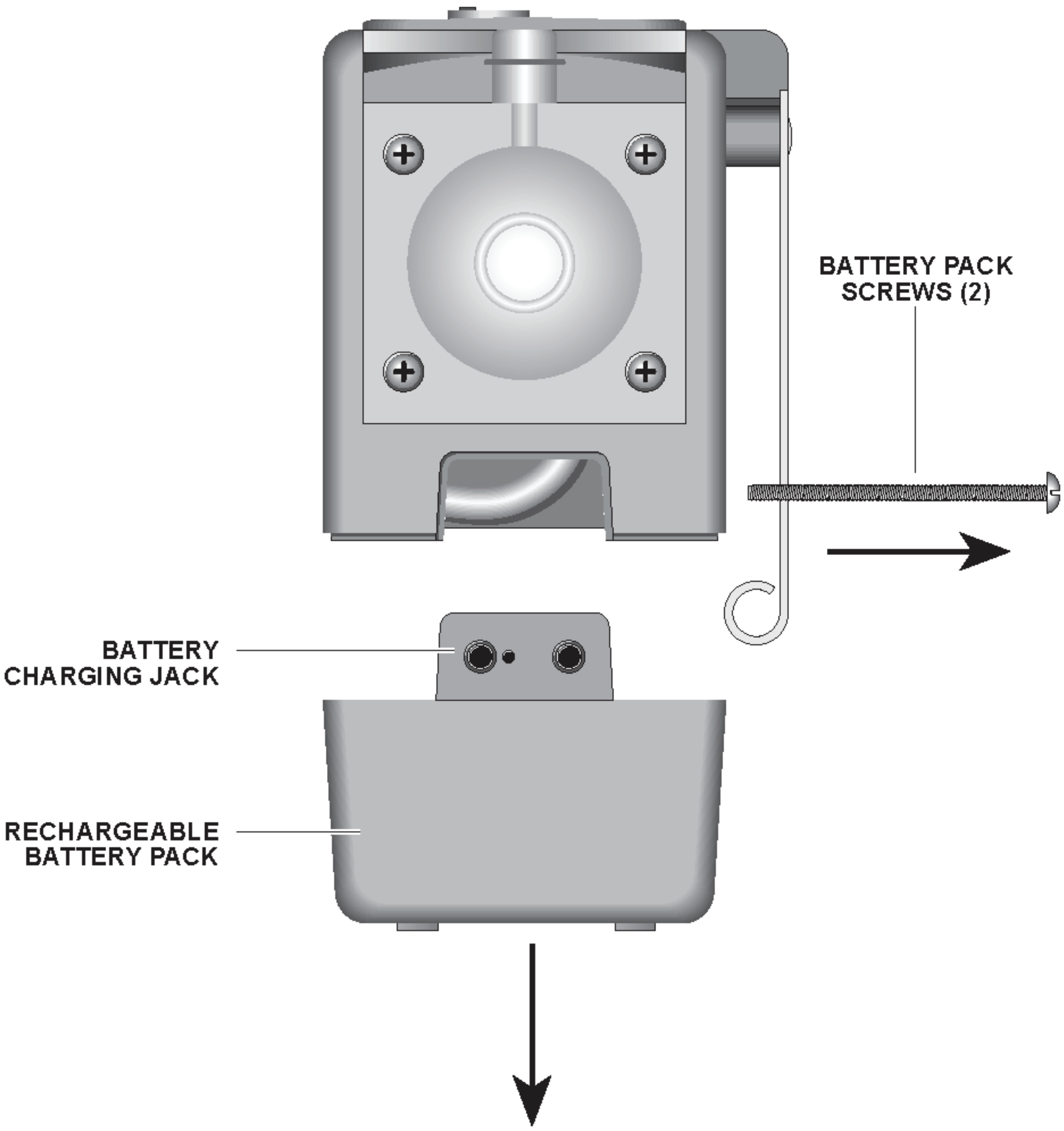


Figure 3.1
Battery Pack Removal

3.2.1 Battery Charging

- ***Battery Life***

Battery life is usually measured in charge/ discharge cycles. Gilian battery packs are capable of providing 300–500 charging cycles. Since this is very difficult to track over the life of the battery, Table 3.1 will help you to anticipate how long the battery should last. The estimated battery life is based on proper battery maintenance.

- ***Leakage Current***

Nickel-Metal-Hydride batteries always have a small internal leakage current. If the battery pack has been removed from the charger for more than two days with-out use, it will require additional charging to restore it to full capacity. This process can be repeated 2–3 times without causing signs of memory effect.

3.2.2 Available Battery Chargers

- ***Single-Unit Charger***

Single unit chargers provide a constant-rate charge of 194 mA and can fully charge a BDXII battery pack in 16 hours.

- ***Universal Multi-Station Charger***

The Multi-Station Charger can charge up to 5 battery packs simultaneously. These chargers provide a timed, constant-rate charge of 180 mA and can fully charge a battery pack in 15 hours. The unit automatically switches to trickle charge (41mA) as each battery pack becomes fully charged.

- ***BMS Multi-Station Charger System***

The BMS Multi-Station Charger & Diagnostic System can charge up to 5 battery packs simultaneously. The BMS offers timed charging that switches to a pulsed charge when the battery pack reaches full charge capacity. Batteries can be charged in under 14 hours. The diagnostic programs provide accurate test data regarding battery voltage under load and battery capacity.

WARNING

DO NOT use the BMS-200 charger to charge Ni-MH battery version pumps.
Use ONLY the BMS II-100CE model with
Ni-MH battery models to prevent permanent damage to the batteries

Pump Usage		Weekly Use		Es. Battery Life†
High Medium		40-60 hours		1-1.5 years
Low		20-39 hours		1.5-2.5 years
		< 20 hours		over 2.5 years

† Inactivity for extended periods may shorten battery life.

Table 3.1
Estimated Battery Life

3.3 FILTER MAINTENANCE

The BDXII internal filter should be changed whenever it becomes clogged or dirty. The condition of the internal filter is visible through the clear window on the filter assembly.

To change the BDXII filter, refer to Figure 3.2 and follow the steps below.

1) Make certain the pump is turned off.

2) Remove any tubing attached to the pump.

3) Remove the 4 housing screws on the filter housing. Remove the filter housing from the unit.

4) Remove the filter O-ring from the filter housing. Remove and discard the old filter.

5) Insert a new filter in the filter housing. Make certain the filter is properly centered and flat.

6) Insert the filter O-ring in the filter housing. Make certain the O-ring is properly seated.

7) Reinstall the center O-ring (orange) in its place on the pump. Make certain it is properly seated.

8) Reinstall the filter assembly back on the unit.

9) Insert and tighten the 4 screws.

Repeat this procedure on a periodic basis or whenever the filter becomes clogged or dirty.

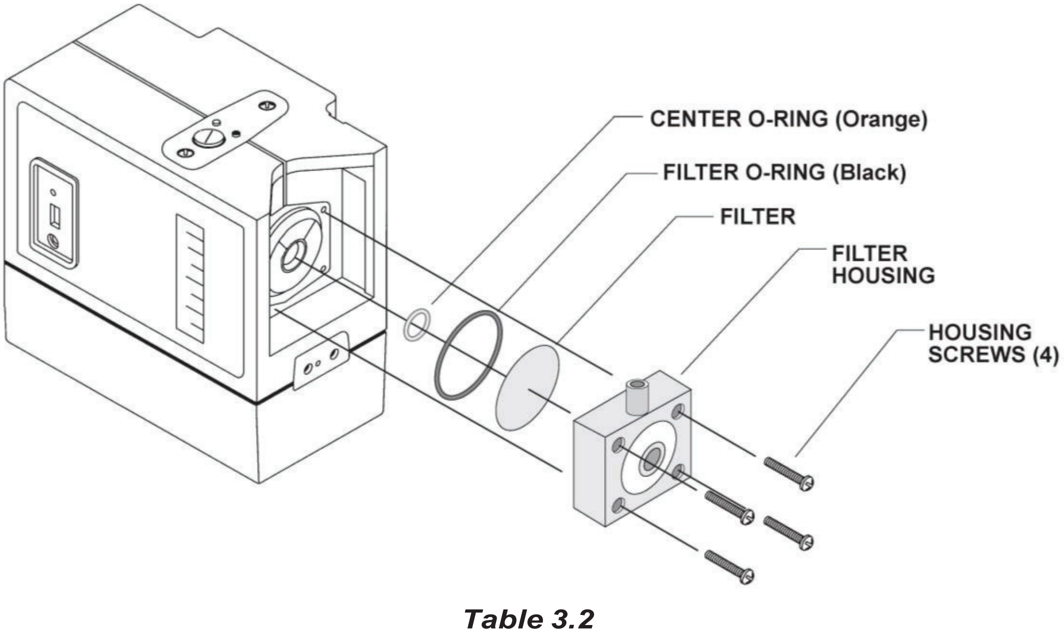


Table 3.2
Internal Filter Maintenance

APPENDIX A
PARTS LIST

Part No.	Description
801863-7	Abatement Air Sampler (pump only) with Ni-MH Battery Pack **
783-0008-04	Rechargeable Battery Pack (Ni-MH) **
911-0601-US-R	Single Unit Charger (120V @ 50/60 Hz), Output: 194 mA
911-0601-EU-R	Single Unit Charger (230V @ 50/60 Hz), Output: 194 mA
811-9919-US	Universal Multi-Station Charger (115V 50/60 Hz), Output: 180 mA
811-9919-EU	Universal Multi-Station Charger (230 V 50/60 Hz), Output: 180 mA
380-0015-01	Tool Kit
201050-100	Replacement Filters (pkg of 100)
800556	Filter Kit
800142	Clip Assembly (3/8”)
200484	Tubing, 36”, ¼” ID
360-0136-01	Operation & Service Manual

* For further information on spare parts, please contact your Customer Service Representative.

** See Section 3.2.2 regarding use of BMS Chargers with Ni-MH Batteries

APPENDIX B
SPECIFICATIONS

General Specifications

Controls	Power Switch, Flow Control
Flow Indicator	Built-in rotameter, range 500–4000 cc/min, with 500 cc/div @ 20% Full Scale accuracy.
Additional Features	See-through external filter housing, with filter monitoring lens; built-in belt clip.
Dimensions	3.6” (W) x 3.9” (H) x 2.0” (D) 90 mm (W) x 100 mm (H) x 51 mm (D)
Weight	21 oz. (595 g)

Power Supply

Battery Pack	4.8 volt, 1.8 amp hour
Battery Type	Rechargeable Nickel-Metal-Hydride
Battery Charge Time	14–16 hours
Expected Battery Life †	300–500 charge/recharge cycles
Estimated Battery Life †	2.5 years (< 20 hours weekly use) 1.5–2.5 years (20–39 hours weekly use) 1–1.5 years (40–60 hours weekly use)

† Inactivity for extended periods may shorten nickel-cadmium battery life. Battery life estimates are based on proper battery maintenance.

Operating Specifications

Operating Range	500–3000 cc/min (0.5–3.0 LPM)
Flow Control	5% of set point over an 8-hour period, with no more than two (2) readjustments when operating at 2.0 LPM.
Operating Duration (Full Charge)	10 hours at 2.0 LPM, with an inlet pressure of up to 20” of water at 21 C (70 F)
Operating Temperature	-20 C to 45 C (-4 F to 113 F)
Storage Temperature	-40 C to 45 C (-40 F to 113 F)
Charging Temperature	5 C to 45 C (41 F to 113 F)

Certifications

Intrinsic Safety - UL 17G9
Class 1, Div 1, Groups A,B,C,D
Temp Code T3C

APPENDIX C

TROUBLESHOOTING GUIDE

Cause	Remedy
• Pump is running but no flow (or reduced flow).	
Internal filter may be clogged	Remove obstruction or replace filter.
• Unable to adjust flow rate to desired setting.	
Sampling filter cassette is clogged.	Remove cassette. If flow is now adjustable, replace filter cassette.
System may have leaks.	Check for leaks in tubing, assemblies, and internal filter. Repair leaks or replace assemblies, as necessary.
Improperly seated or damaged valves or diaphragm	Return unit to factory for repair.
Pump motor is worn or damaged	Return unit to factory for repair.
• Flowmeter float appears to be “stuck”.	
System may have leaks.	If float is stuck at bottom of flowmeter, identify other symptoms (low or no flow with pump running, etc.) and follow direction accordingly.
Float is stuck.	Return unit to factory for repair.
• Pump will not run for the specified battery charge life.	
Battery pack not properly installed.	Disconnect battery pack and re-install it properly.
Battery pack may be damaged or discharged	Charge or replace battery pack, as needed.
Batteries may be exhibiting “memory.”	Allow battery pack to fully discharge. FULLY recharge battery pack.
Pump motor is worn.	Return unit to factory for repair.

APPENDIX D
RETURN MATERIAL AUTHORIZATION

Sensidyne maintains an instrument service facility at the factory to provide its customers with both warranty and non-warranty repair service. Sensidyne assumes no liability for service performed by personnel other than Sensidyne personnel. To facilitate the repair process, please contact the Sensidyne Service Department in advance for assistance with a problem which cannot be remedied and/or re- quires the return of the product to the factory. All returned products require a Returned Material Authorization (RMA) number. Sensidyne Service Department personnel may be reached at:

Sensidyne
1000 112th Circle N, Suite 100
St. Petersburg, FL 33716 USA
727-530-3602
727-539-0550 [FAX]

All non-warranty repair orders will have a minimum fee whether the repair is authorized or not. This fee includes handling, administration and technical expenses for inspecting the instrument and providing an estimate. However, the estimate fee is waived if the repair is authorized.

If you wish to set a limit to the authorized repair cost, state a “not to exceed” figure on your purchase order. Please indicate if a price quotation is required before authorization of the repair cost, understanding that this invokes extra cost and handling delay. Sensidyne’s repair policy is to perform all needed repairs to restore the instrument to its full operating condition.

Repairs are handled on a “first in - first out” basis. Your order may be expedited if you authorize an expediting fee. This will place your order next in line behind orders currently in process.

Pack the instrument and its accessories (preferably in their original packing) and enclose your return address, purchase order, shipping and billing information, RMA number, a description of the problem encountered with your instrument and any special instructions. All prices are subject to change without notice.

If this is the first time you are dealing directly with the factory, you will be asked to prepay or to authorize a COD shipment.

Send the instrument, prepaid, to:

Sensidyne
1000 112th Circle N, Suite 100
St. Petersburg, FL 33716 USA
Attention: Service Department
RMA #:_________________

SERVICE OPTIONS

The Sensidyne Service Department offers you a variety of service options which will help increase your user confidence while minimizing costly interruptions and maintenance costs. These options include initial training, on-site technical assistance, and full factory repairs. Sensidyne has developed several programs which will allow you to select just the right options best suited to your applications and needs. For further information, contact the Sensidyne Service Department.

Notes

Manufactured by:

Sensidyne, LP

1000 112th Circle N, Suite 100

St. Petersburg, Florida 33716

USA

800-451-9444 • 727-530-3602 • 727-539-0550 [fax]

www.Sensidyne.com • info@sensidyne.com

Authorized EU Representative

Schauenburg Electronic Technologies GmbH

Weseler Str. 35 · 45478

Mülheim-Ruhr Germany

+49 (0) 208 9 99 10 • +49 (0) 208 5 41 10 [fax]

www.schauenburg.com • international@schauenburg.com

Handheld PID Monitors

User's Guide

Rev. A
November 2018
P/N: 059-4026-000

Handheld PID Monitors User's Guide

Product Registration

Register your product online by visiting:

https://www.raesystems.com/customer-care

By registering your product, you can:

- Receive notification of product upgrades or enhancements
- Be alerted to Training classes in your area
- Take advantage of Honeywell RAE Systems special offers and promotions

Handheld PID Monitors User's Guide

Contents

⚠ WARNINGS ⚠

This Manual must be carefully read by all individuals who have or will have the responsibility of using, maintaining, or servicing this product. The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions. The user should understand how to set the correct parameters and interpret the obtained results.

For safety reasons, this equipment must be operated and serviced by qualified personnel only. Read and understand the instruction manual completely before operating or servicing.

AVERTISSEMENT

Pour des raisons de sécurité, cet équipement doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d'instructions en entier avant d'utiliser, d'entretenir ou de réparer l'équipement.

Read Before Operating

This manual must be carefully read by all individuals who have or will have the responsibility of using, maintaining, or servicing this product. The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions. The user should understand how to set the correct parameters and interpret the obtained results.

CAUTION!

To reduce the risk of electric shock, turn the power off before opening this instrument or performing service. Never operate the instrument when the instrument is open. Service this product only in an area known to be non-hazardous.

ATEX WARNING!

To reduce the risk of electrostatic ignition, do not use the instrument without the rubber boot in place.

WARNINGS

STATIC HAZARD: Clean only with a damp cloth.
For safety reasons, this equipment must be operated and serviced by qualified personnel only. Read and understand instruction manual completely before operating or servicing.

USE ONLY RAE SYSTEMS BATTERY PACKS, PART NUMBERS 059-3051-000, 059-3052-000, AND 059-3054-000. THIS INSTRUMENT HAS NOT BEEN TESTED IN AN EXPLOSIVE GAS/AIR ATMOSPHERE HAVING AN OXYGEN CONCENTRATION GREATER THAN 21%. SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY. RECHARGE BATTERIES ONLY IN NON-HAZARDOUS LOCATIONS.

DO NOT MIX OLD AND NEW BATTERIES OR BATTERIES FROM DIFFERENT MANUFACTURERS.

THE CALIBRATION OF ALL NEWLY PURCHASED RAE SYSTEMS INSTRUMENTS SHOULD BE TESTED BY EXPOSING THE SENSOR(S) TO KNOWN CONCENTRATION CALIBRATION GAS BEFORE THE INSTRUMENT IS PUT INTO SERVICE.

FOR MAXIMUM SAFETY, THE ACCURACY OF THE INSTRUMENT SHOULD BE CHECKED BY EXPOSING IT TO A KNOWN CONCENTRATION CALIBRATION GAS BEFORE EACH DAY’S USE.

DO NOT USE USB/PC COMMUNICATION IN HAZARDOUS LOCATIONS.

AVERTISSIMENT

DANGER RISQUE D'ORIGINE ELECTROSTATIQUE: Nettoyer uniquement avec un chiffon humide.
Pour des raisons de sécurité, cet équipment doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d’instructions en entier avant d’utiliser, d’entretenir ou de réparer l’équipement.
Utiliser seulement l'ensemble de batterie RAE Systems, la reference 059-3051-000 au 059-3052-000 au 059-3054-000. Cet instrument n’a pas été essayé dans une atmosphère de gaz/air explosive ayant une concentration d’oxygène plus élevée que 21%. La substitution de composants peut compromettre la sécurité intrinsique. Ne charger les batteries que dans emplacements désignés non-dangereuse.
Ne pas melanger les anciennes et les nouvelles batteries, ou bien encore les batteries de differents fabriquants.
La calibration de toute instruments de RAE Systems doivent être testé en exposant l’instrument a une concentration de gaz connue par une procédure diétalonnage avant de mettre en service l’instrument pour la première fois.

Pour une securite maximale, la sensibilité du l’instrument doit être verifier en exposant l’instrument a une concentration de gaz connue par une procédure diétalonnage avant chaque utilisation journalière.

Ne pas utiliser de connection USB/PC en zone dangereuse.

Proper Product Disposal At End Of Life

EU Directive 2012/19/EU: Waste Electrical and Electronic Equipment (WEEE)
This symbol indicates that the product must not be disposed of as general industrial or domestic waste. This product should be disposed of through suitable WEEE disposal facilities. For more information about disposal of this product, contact your local authority, distributor, or the manufacturer

Caution

This device complies with Part 15 of the FCC Rules / Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditionssuivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur del'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage estsusceptible d'en compromettre le fonctionnement.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peutfonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

IMPORTANT! BUMP TEST THE MONITOR BEFORE EACH DAY’S USE

Prior to each day’s use, every gas detection monitor should be bump tested to confirm the response of all sensors and activation of all alarms by exposing the monitor to a concentration of target gas that exceeds the low alarm set point. A bump test is also recommended if the monitor has been subjected to physical impact, liquid immersion, an Over Limit alarm event, or custody changes, or anytime the monitor’s performance is in doubt.

To ensure greatest accuracy and safety, only bump test and calibrate in a fresh air environment.
The monitor should be calibrated every time it does not pass a bump test, but no less frequently than every six months, depending on use and exposure to gas and contamination, and its operational mode.

- Calibration intervals and bump test procedures may vary due to national legislation.
- Honeywell recommends using calibration gas cylinders containing the gas that is appropriate to the sensor you are using, and in the correct concentration.

Special Notes

⚠ When the instrument is taken out of the transport case and turned on for the first time, there may be some residual organic or inorganic vapor trapped inside the detector chamber. The initial PID sensor reading may indicate a few ppm. Enter an area known to be free of any organic vapor and turn on the instrument. After running for several minutes, the residual vapor in the detector chamber will be cleared and the reading should return to zero.

⚠ The battery of the instrument discharges slowly even if it is turned off. If the instrument has not been charged for 5 to 7 days, the battery voltage will be low. Therefore, it is a good practice to always charge the instrument before using it. It is also recommended to fully charge the instrument for *at least 10 hours* before first use. Refer to this User Guide’s section on battery charging for more information on battery charging and replacement.

1. Standard Contents

- Instrument
- Calibration Kit
- Charger Stand
- AC/DC Adapter
- Alkaline Battery Adapter
- Data Cable
- CD-ROM With User's Guide, Quick Start Guide, and related materials

2. General Information

The compact instrument is designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It monitors Volatile Organic Compounds (VOC) using a photoionization detector (PID) with a 9.8 eV, 10.6 eV, or 11.7eV gas-discharge lamp. The instrument consists of a PID with associated microcomputer and electronic circuit. The unit is housed in a rugged case with a backlit LCD and 3 keys to provide easy user interface. It also has a built-in flashlight for operational ease in dark locations.

Key Features

Lightweight and Compact
- Compact, lightweight, rugged design
- Built-in sample draw pump

Dependable and Accurate
- Up to 16 hours of continuous monitoring with rechargeable battery pack
- Designed to continuously monitor VOC vapor at parts-per-million (ppm) and/or parts-per-billion (ppb) levels

User-friendly
- Preset alarm thresholds for STEL, TWA, low- and high-level peak values.
- Audio buzzer and flashing LED display are activated when the limits are exceeded.

Datalogging Capabilities
- 260,000-point datalogging storage capacity for data download to PC

3. Physical Description

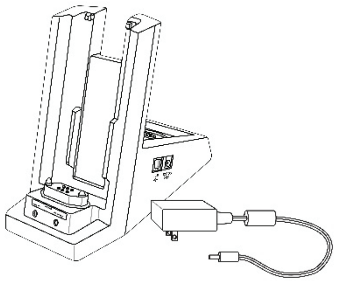
The main components of the portable VOC monitoring instrument include:

- Three keys for user interaction with the instrument: 3 operation/programming keys for normal operation or programming
- LCD display with back light for direct readout and calculated measurements
- Built-in flashlight for illuminating testing points in dark environments
- Buzzer and red LEDs for alarm signaling whenever exposures exceed preset limits
- Charge contacts for plugging directly to its charging station
- Gas entry and exit ports
- USB communication port for PC interface
- Protective rubber cover

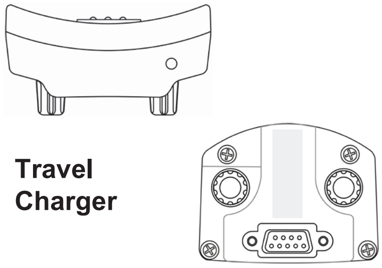
Easy-to-use separation tube holder (UltraRAE 3000+)

4. Charging The Battery

Always fully charge the battery before using the instrument. The instrument's Li-ion battery is charged by attaching the instrument to the Travel Charger (or by placing the instrument in the optional Charger Stand). Contacts on the bottom of the instrument meet the Travel Charger's (or Charger Stand's) contacts, transferring power without other connections.



Charger Stand

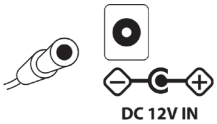


Travel Charger

Note: Before connecting the charger to the instrument, visually inspect the contacts to make sure they are clean. If they are not, wipe them with a soft cloth. Do not use solvents or cleaners.

Follow this procedure to charge the instrument:

1. Plug the AC/DC adapter's barrel connector into the instrument's Charger Stand or Travel Charger.



2. Plug the AC/DC adapter into the wall outlet.
3. Connect the AC/DC adapter to the Travel Charger (or Charger Stand).
4. Place the instrument into the Travel Charger or Charger Stand. The LED in the Travel Charger (or Charger Stand) should glow.

The instrument begins charging automatically. (If the optional Charger Stand is used, the "Primary" LED blinks green to indicate charging.) During charging, the diagonal lines in the battery icon on the instrument's display are animated and you see the message "Charging..."

Note: If the Li-ion battery has been discharged below a certain threshold, the "Charging..." message does not display immediately. The charging LED blinks to indicate that it is charging, and after it has been charging for a while, the "Charging..." message appears.

When the instrument's battery is fully charged, the battery icon is no longer animated and shows a full battery. The message "Fully charged!" is shown. (If the Charger Stand or Travel Charger is used, its LED glows continuously green.)

Note: If you see the "Battery Charging Error" icon (a battery outline with an exclamation mark inside), check that the instrument or rechargeable battery has been properly set into the Travel Charger (or Charger Stand). If you still receive the message, check the Troubleshooting section of this guide.

Note: If the instrument or battery has been charging for more than 10 hours and you see the "Battery Charging Error" icon and a message that says, "Charging Too Long," this indicates that the battery is not reaching a full charge. Try changing the battery and make sure the contacts on the instrument are meeting the Travel Charger's (or Charger Stand's) contacts. If the message is still shown, consult your distributor or RAE Systems Technical Services.

4.1. Charging A Spare Rechargeable Battery

A rechargeable Li-ion battery can be charged when it is not inside the monitor. The Charger Stand is designed to accommodate both types of charging. Contacts on the bottom of the battery meet the contacts on the cradle, transferring power without other connections, and a spring-loaded capture holds the battery in place during charging.

1. Plug the AC/DC adapter into the monitor's cradle.
2. Place the battery into the cradle, with the gold-plated contacts on top of the six matching charging pins.
3. Plug the AC/DC adapter into the wall outlet.

The battery begins charging automatically. During charging, the Secondary LED in the cradle blinks green. When charging is complete, it glows steady green.

Release the battery from the cradle by pulling it back toward the rear of the cradle and tilting it out of its slot.

Note: If you need to replace the Li-ion battery pack, replacements are available from RAE Systems. The part number is 059-3051-000.

Note: An Alkaline Battery Adapter (part number 059-3052-000), which uses four AA alkaline batteries (Duracell MN1500), may be substituted for the Li-Ion battery.

WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge and replace batteries only in areas known to be non-hazardous. Remove and replace batteries only in areas known to be non-hazardous.

4.2. Low Voltage Warning

When the battery's charge falls below a preset voltage, the instrument warns you by beeping once and flashing once every minute, and the "empty battery" icon blinks on and off once per second. You should turn off the instrument within 10 minutes and either recharge the battery by placing the instrument in its cradle, or replace the battery with a fresh one with a full charge.

4.3. Clock Battery

An internal clock battery is mounted on one of the instrument's printed circuit boards. This long-life battery keeps settings in memory from being lost whenever the Li-ion battery or alkaline batteries are removed. This backup battery should last approximately five years, and must be replaced by an authorized Honeywell service technician. It is not user-replaceable.

4.4. Data Protection While Power Is Off

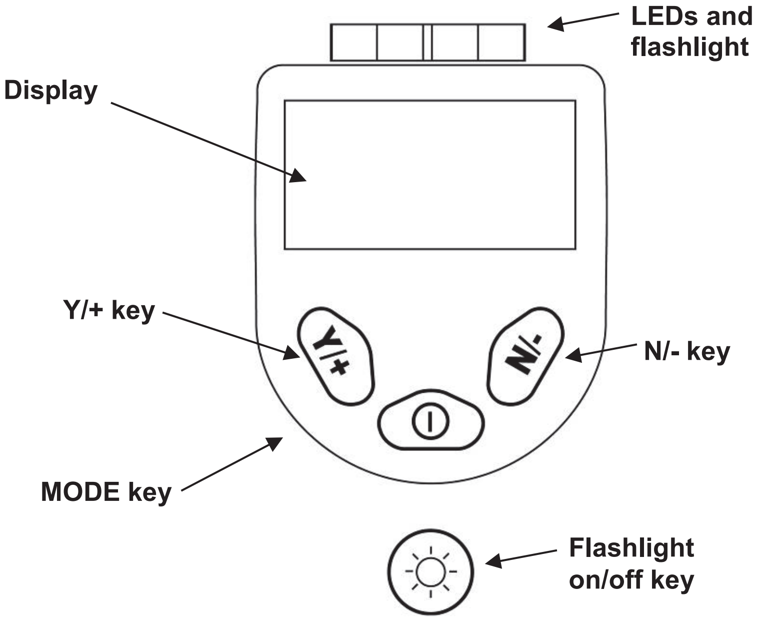
When the instrument is turned off, all the current real-time data including last measured values are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost.

5. User Interface

The instrument’s user interface consists of the display, LEDs, an alarm transducer, and four keys. The keys are:

Y/+
MODE
N/-
Flashlight on/off

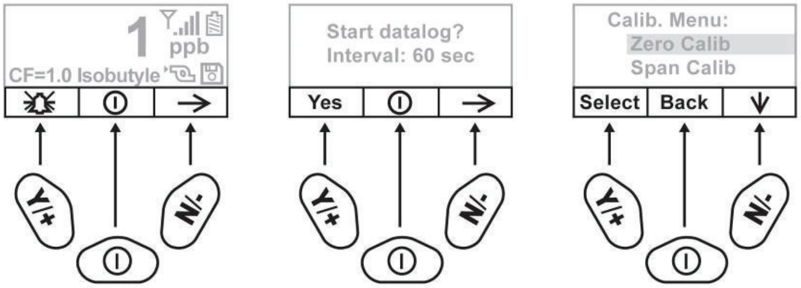
The LCD display provides visual feedback that includes the reading, time, battery condition, and other functions.



In addition to their labeled functions, the keys labeled Y/+, MODE, and N/- act as “soft keys” that control different parameters and make different selections within the instrument’s menus. From menu to menu, each key controls a different parameter or makes a different selection.
Three panes along the bottom of the display are “mapped” to the keys. These change as menus change, but at all times the left pane corresponds to the [Y/+] key, the center pane corresponds to the [MODE] key, and the right pane corresponds to the [N/-] key. Here are three examples of different menus with the relationships of the keys clearly shown:

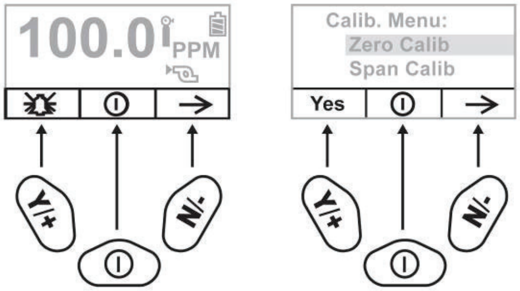
MiniRAE 3000+, ppbRAE 3000+, UltraRAE 3000+

RELATIONSHIP OF BUTTONS TO CONTROL FUNCTIONS



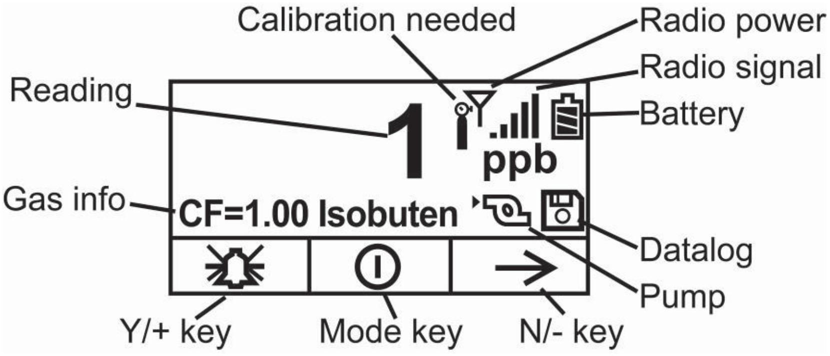
MiniRAE Lite+

RELATIONSHIP OF BUTTONS TO CONTROL FUNCTIONS



6. Display

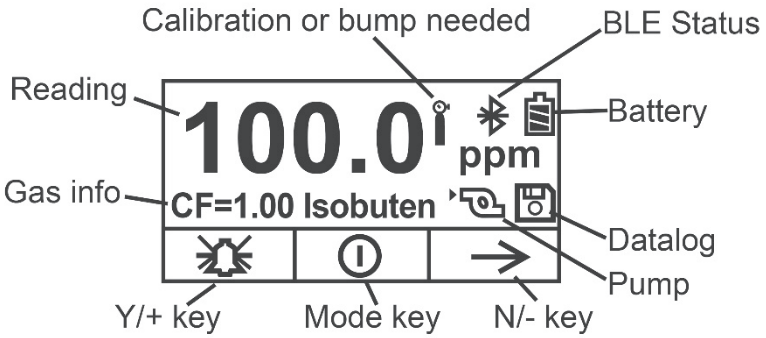
The display shows the following information:



Gas info	Tells the Correction Factor and type of calibration gas
Reading	Concentration of gas as measured by the instrument
Calibration needed	Indicates that calibration should be performed
Calibration (or bump) needed	Dark icon indicates that calibration should be performed; light icon indicates bump should be performed
Radio power	Indicates whether Mesh radio connection is on or off
Radio signal	Indicates signal strength (more bars = greater strength)
Battery	Indicates level in 3 bars
Pump	Indicates that pump is working
Datalog	Indicates whether datalog is on or off
Y/+	Y/+ key's function for this screen
MODE	MODE key's function for this screen
N/-	N/- key's function for this screen

Note: The "Radio power" icon and "Radio signal" icon are only shown if a Mesh radio is installed in the instrument. If the instrument has a BLE radio, the Bluetooth icons shown on the next page are used.

If the instrument is equipped with BLE instead of other wireless, the BLE Status icon is shown:



6.1. Icons

These are the icons shown on the display to indicate functions or status.

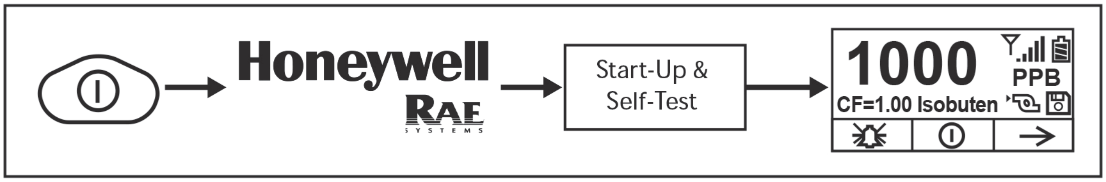
✓	The instrument has been bump tested and calibrated in compliance with the policy settings
🔋 🔋 🔋 🪫	Battery level
!	Charging error
▮	Calibration required
▯	Bump test required
💾	Datalog on
Y	Radio Power
▁ ▁▂ ▁▂▃ ▁▂▃▄	Radio signal
	Pump operational
×	Pump blocked or stalled
ᛒ ᛒ ᛒ×	BLE status: Installed, Connected, Turned Off

7. Operating The Instrument

The instrument is designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It gives real-time measurements and activates alarm signals whenever the exposure exceeds preset limits. Prior to factory shipment, the instrument is preset with default alarm limits and the sensor is pre-calibrated with standard calibration gas. However, you should test the instrument and verify the calibration before the first use. After the instrument is fully charged and calibrated, it is ready for immediate operation.

7.1. Turning The Instrument On

1. With the instrument turned off, press and hold [MODE].
2. When the display turns on, release the [MODE] key.



Note: The main display may show ppb or ppm and other features, depending on the instrument. The Honeywell logo should appear first. (If the logo does not appear, there is likely a problem and you should contact your distributor or Honeywell RAE Systems Technical Support.) The instrument is now operating and performs self tests. If any tests (including sensor and memory tests fail), refer to the Troubleshooting section of this guide.

Once the startup procedure is complete, the instrument shows a numerical reading screen with icons. This indicates that the instrument is fully functional and ready to use.

7.2. Turning The Instrument Off

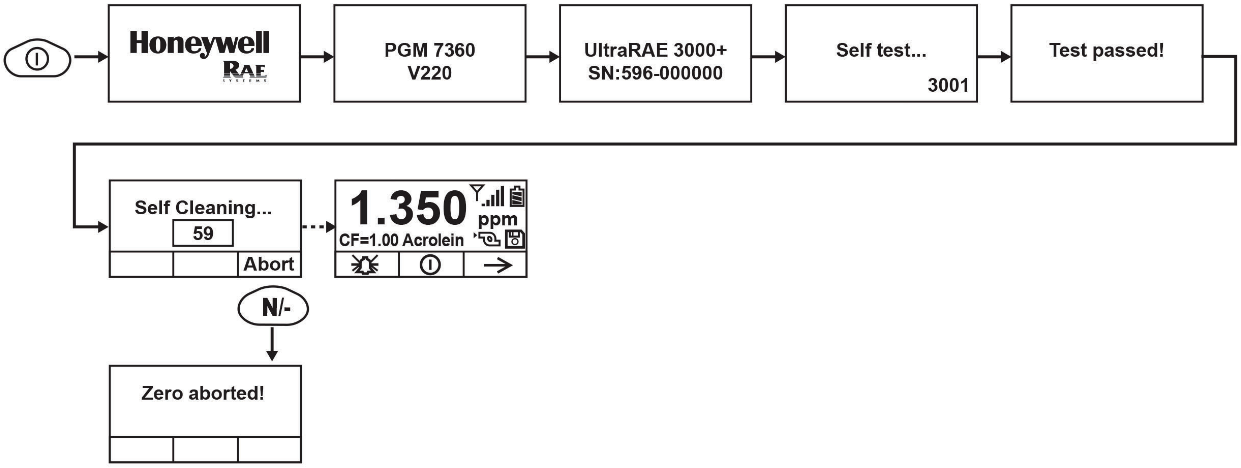
1. Press and hold the Mode key for 3 seconds. A 5-second countdown to shutoff begins.
2. Once the countdown stops, the instrument is off. Release the Mode key.
3. When you see “Unit off...” release your finger from the [MODE] key. The instrument is now off.

Note: You must hold your finger on the key for the entire shutoff process. If you remove your finger from the key during the countdown, the shutoff operation is canceled and the instrument continues normal operation.

7.3. Auto-Zero At Startup Option

Using ProRAE Studio II (version 1.11.4 and above) or Honeywell™ Safety Suite Device Configurator, the instrument can be programmed to automatically perform a zero calibration after self-testing during startup.

Note: The option is disabled by default. If it is disabled, the instrument performs its self-test and then goes directly to reading mode.



The zeroing process can be aborted by pressing the [N/-] key at any time during the process, and the instrument will go directly to normal reading mode.

Notes:

- When a ppbRAE 3000+ is in normal reading mode and is not in system alarm (Low Alarm or High Alarm), zero calibration is triggered in a locked interval (1 hour). If the instrument is in low alarm, Auto Zero is skipped until the alarm clears.
- We do not recommend using this function on the UltraRAE3000+ and ppbRAE3000+.
- We highly recommend that you make sure the instrument is in a clean air environment during startup and zeroing.

7.4. Operating The Built-In Flashlight

The instrument has a built-in flashlight that helps you point the probe in dark places. Press the flashlight key to turn it on. Press it again to turn it off.

☼

Note: Using the flashlight for extended periods shortens the battery's operating time before it needs recharging.

7.5. Pump Status

IMPORTANT!

During operation, make sure the probe inlet and the gas outlet are free of obstructions. Obstructions can cause premature wear on the pump, false readings, or pump stalling. During normal operation, the pump icon alternately shows inflow and outflow as shown here:

During duty cycling (PID lamp cleaning), the display shows these icons in alternation:

If there is a pump failure or obstruction that disrupts the pump, you will see this icon blinking on and off:

If you see this blinking icon, consult the Troubleshooting section of this guide.

7.6. Calibration Status

The instrument displays this icon if it requires calibration:

Calibration is required (and indicated by this icon) if:

- The lamp type has been changed (for example, from 10.6 eV to 9.8 eV).
- The sensor has been replaced.
- It has been 30 days or more since the instrument was last calibrated.
- If you have changed the calibration gas type without recalibrating the instrument.
- If the instrument fails a bump test.

7.7. Bump Status

The instrument displays this icon if it requires a bump test:

A bump test is required (and indicated by this icon) if:

- The defined period between bump tests has been exceeded (bump test overdue).
- The sensor has failed a previous bump test.
- The sensor(s) should be challenged on a periodic basis.

7.8. Glance Mode

Glance Mode allows you to get vital information without turning on the instrument. You can check information such as the instrument's model and serial number, installed sensor types, wireless modules installed, etc., which may help when taking inventory of instruments and their sensors or when working with service or support personnel. Glance Mode can be enabled/disabled via ProRAE Studio II or Honeywell Safety Suite Device Configurator.

7.8.1. Enter Glance Mode

Note: The instrument must be configured so that Glance Mode is turned on (the default mode is "Off"). This can be done in ProRAE Studio II or Honeywell Safety Suite Device Configurator. In ProRAE Studio II or Honeywell Safety Suite Device Configurator, Glance Mode can be enabled or disabled by checking or unchecking the box labeled "Enable Glance Mode." You can also set which screens will be displayed, as well as their order.

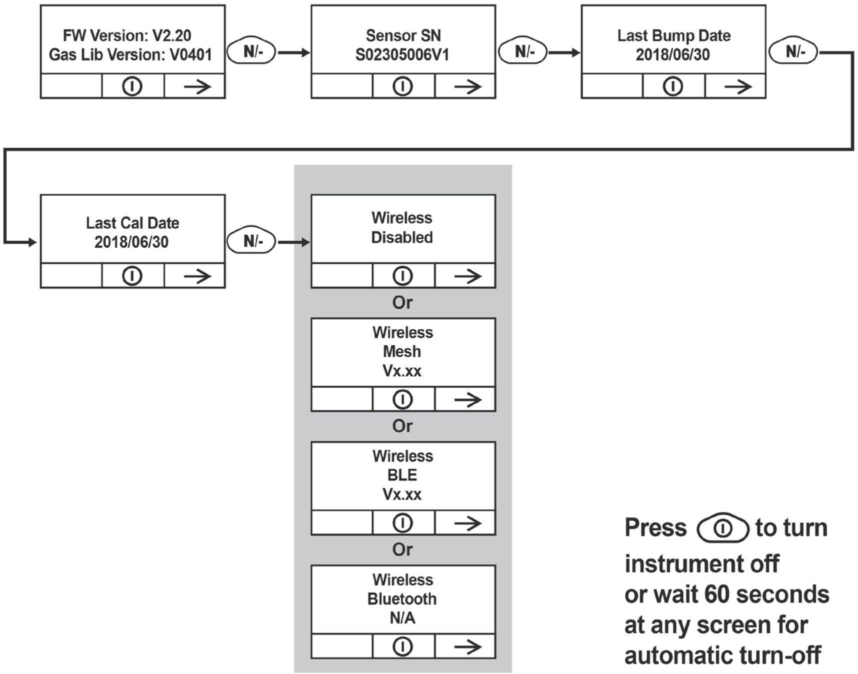
With the instrument turned off, press and hold [MODE] and [N/-] simultaneously for 2 seconds to enter Glance Mode. If you see the message "GLANCE DISABLED," you must configure the instrument to use Glance Mode.

If Glance Mode is enabled, the first screen, with the Honeywell Logo, is displayed. Release the [MODE] and [N/-] keys, and the first screen with information about the instrument is shown.

Note: If there is no information to show, the instrument will display "No Screen Display!" and turn itself off.

7.8.2. Glance Mode Screens

Every screen displayed in sequence as configuration. Press [N/-] to advance to the next screen. If the Wireless modem is turned off, the screen shows "Disabled". Otherwise, the type of wireless is shown. When the last screen is shown, pressing [N/-] "loops" to the first screen.



Press Ⓘ to turn instrument off or wait 60 seconds at any screen for automatic turn-off

7.8.3. Exit Glance Mode

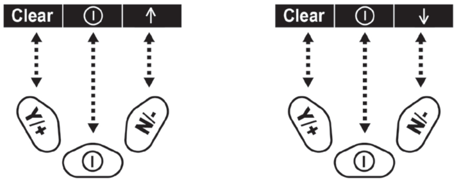
The instrument exits Glance Mode and turns off when you press the [MODE] key. The display shows "Power Off", and after 3 seconds, it turns off. In addition, if you do not press either key in 60 seconds, the instrument automatically exits Glance Mode and shuts off.

7.9. Reverse Direction – Main Navigation

Sometimes you want to go back to a previous screen rather than advance through an entire set of screens before "wrapping around" to that screen again.

To reverse direction:

1. Press and hold [N/-] for 3 seconds.
2. When the arrow changes from pointing up to pointing down, release your finger.



Now when you press [N/-], you step back through the screens.

To change direction again: Press and hold [N/-] for 3 seconds and then release.

Note: Changing direction does not work with all screens. It works primarily in submenus.

7.10. Policy Enforcement

The instrument can be configured to enforce a facility/company's requirements that calibration and/or bump testing be performed at specified intervals, and to explicitly prompt the user that calibration/bump testing is required. Depending on how Policy Enforcement features are configured, the user may be required to perform a bump test or calibration prior to being able to use the instrument. That is, it can be set to not allow normal operation of the instrument unless calibration or bump testing is performed.

If the instrument has been bump tested and calibrated in compliance with the policy settings, a check-mark icon is included along the top of the instrument screen:

✓

If Policy Enforcement is enabled, then after startup the instrument displays a screen that informs the user that the instrument requires either a bump test or a calibration. If both are required, then they are shown in sequence.

Note: Policy enforcement features are disabled by default.

7.10.1. Setting Policy Enforcement

You must use ProRAE Studio II or Honeywell Safety Suite Device Configurator to make changes to Policy Enforcement settings. You must use an AutoRAE 2 Cradle, a Travel Charger, or a Charger Stand. Policy violations are captured in the datalog.

Using The Travel Charger, Charger Stand, or AutoRAE 2 Automatic Test And Calibration System

To program an instrument via an AutoRAE 2, you need ProRAE Studio II Instrument Configuration and Data Management Software, the AutoRAE 2 connected to a power source, and a USB PC communications cable. Here are directions for using ProRAE Studio II. (For Device Configurator, consult its manual.)

1. Connect a USB cable between a PC with ProRAE Studio II and the AutoRAE 2 Cradle, Travel Charger, or Charger Stand.
2. Apply power to the AutoRAE 2 Cradle, Travel Charger, or Charger Stand.
3. Turn off the instrument (or put it into AutoRAE 2 Mode or Communication Mode) and set it in the cradle.
4. Start ProRAE Studio II software on the PC.
5. Select "Administrator" and input the password (the default is "rae").
6. Click "Detect the instruments automatically" (the magnifying glass icon with the letter "A" in it). After a few seconds, the AutoRAE 2 Cradle is found and it is shown, along with its serial number.
7. Click on the icon to highlight it, and then click "Select."
8. In ProRAE Studio II, the instrument or AutoRAE 2 Cradle is shown, including its Serial Number, under "Online."
9. Expand the view to show the instrument or to show the instrument in the AutoRAE 2 Cradle by clicking the "+" to the left of the image of the AutoRAE 2 Cradle.
10. Double-click on the icon representing the instrument
11. Click "Setup."

12. In the menu that now appears on the left side, click “Policy Enforcement.” It is highlighted, and the Policy Enforcement pane is shown. For “Must Calibrate” and “Must Bump,” you have the options of no enforcement or enforcement (including “Can’t Bypass,” and “Can Bypass”).

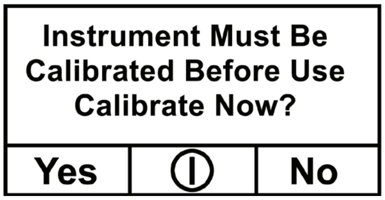
Must Calibrate. The user is prompted to calibrate the instrument when calibration is due (as set by the calibration interval). There are two programmable options:

- **Can’t Bypass.** Unless calibration is performed, the instrument cannot be used, and the only option is to turn off the instrument.
- **Can Bypass.** If calibration is due but the user does not want to perform a calibration, the instrument can still be used. In this case, the instrument records that the user has bypassed the calibration requirement in a Policy Violation report.

Must Bump. The user is prompted to bump test the instrument when a bump test is due (as set by the bump test interval). There are two programmable options:

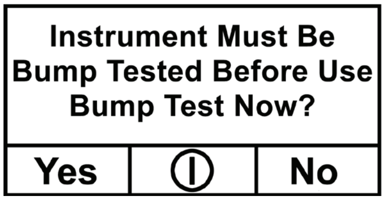
- **Can’t Bypass.** Unless a bump test is performed, the instrument cannot be used, and the only option is to turn off the instrument.
- **Can Bypass.** If a bump test is due but the user does not want to perform one, the instrument can still be used. In this case, the instrument records that the user has bypassed the bump testing requirement in a Policy Violation report.

These are the screens that are shown on the instrument after startup if “Can Bypass” is selected:



Instrument Must Be
Calibrated Before Use
Calibrate Now?

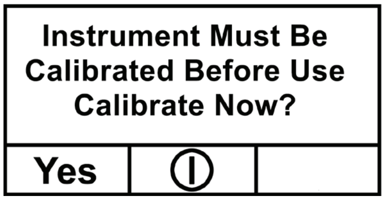
Yes | ⏻ | **No**



Instrument Must Be
Bump Tested Before Use
Bump Test Now?

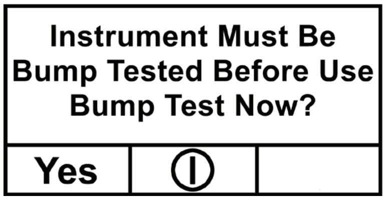
Yes | ⏻ | **No**

If “Can’t Bypass” is selected, the display looks like this, and only allows the options of performing the test or shutting down:



Instrument Must Be
Calibrated Before Use
Calibrate Now?

Yes | ⏻



Instrument Must Be
Bump Tested Before Use
Bump Test Now?

Yes | ⏻

16. Once you have made your selections in ProRAE Studio II, you must upload the changes to the instrument. Click the icon labeled “Upload all settings to the instrument.”

17. A confirmation screen is shown. Click “Yes” to perform the upload, or “No” to abort. Uploading takes a few seconds, and a progress bar is shown. You can abort the upload by clicking “Cancel.”

18. Exit ProRAE Studio II.

19. Press [Y/+] on the instrument to exit Communication Mode.

8. Operating Modes – MiniRAE 3000+ & ppbRAE 3000+

Your instrument operates in different modes, depending on the model and its factory default settings. In some cases, you can change modes using a password and the instrument's navigation. In other cases, you must use ProRAE Studio II or Honeywell Safety Suite Device Configurator software.

The default setting for your instrument is:

User Level: Basic
Operation Mode: Hygiene

This is outlined in detail on page 73.

The other options, covered later in this guide, are:

User Level: Advanced (page 75)
Operation Mode: Hygiene

User Level: Advanced (page 75)
Operation Mode: Search

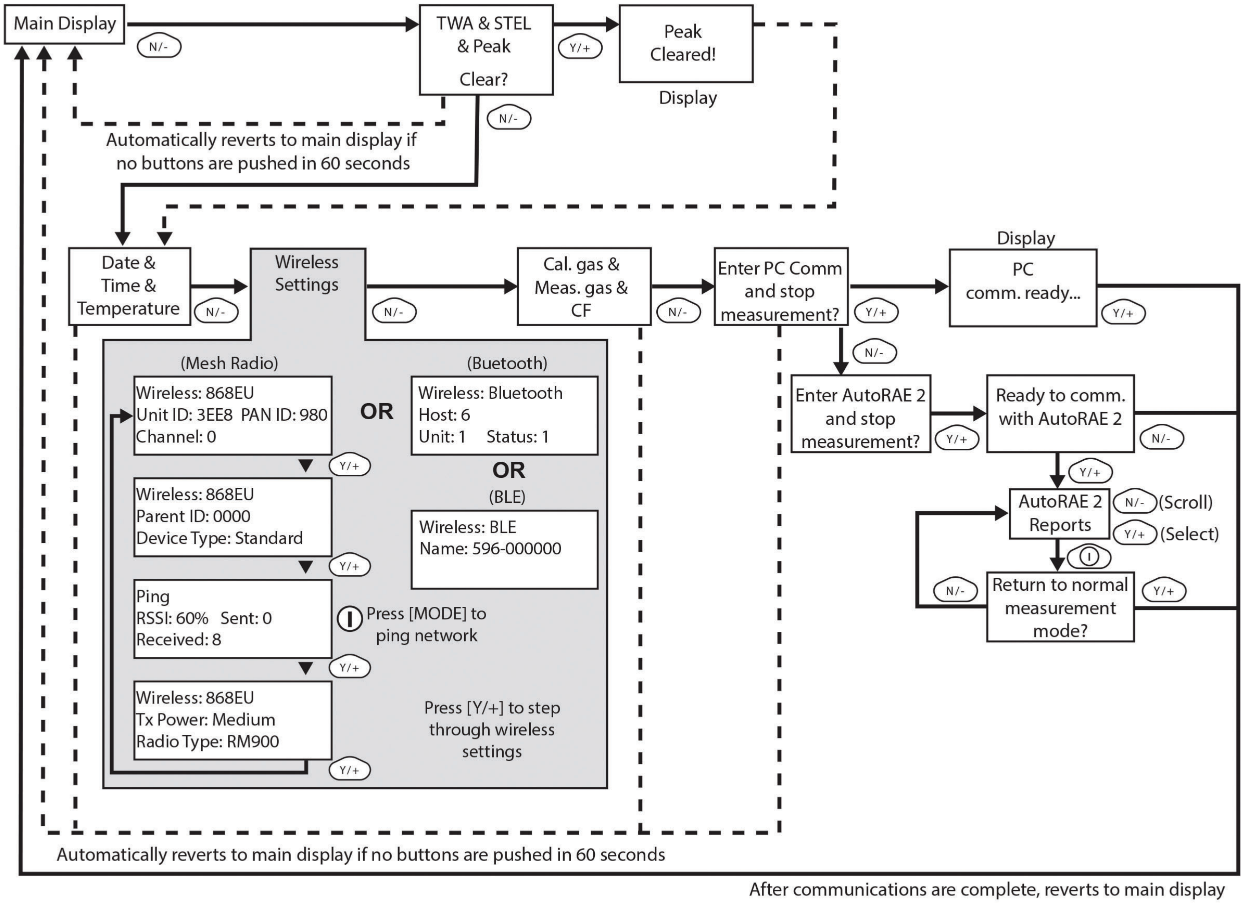
Using ProRAE Studio II or Honeywell Safety Suite Device Configurator allows access to other options. In addition, Diagnostic Mode (page 79) is available for service technicians.

8.1. Basic User Level/Hygiene Mode (Default Settings) – MiniRAE 3000+ & ppbRAE 3000+

The instrument is programmed to operate in Basic User Level/Hygiene Mode as its default. This gives you the most commonly needed features while requiring the fewest parameter adjustments.

Pressing [N/-] steps you from one screen to the next, and eventually return to the main display. If you do not press a key within 60 seconds after entering a display, the instrument reverts to its main display.

Note: While viewing any of these screens, you can shut off your instrument by pressing [MODE].



Note: At the Average & Peak, Date & Time & Temperature, Calibration Gas & Measurement Gas & Correction Factor, and PC Communications screens, the instrument automatically goes to the main display after 60 seconds if you do not push a key to make a selection.

9. Operating Modes – UltraRAE 3000+

The UltraRAE is actually two monitors in one:

- Compound-specific monitor
- VOC monitor

As a compound-specific monitor, it takes timed measurements and uses a separation tube in conjunction with software that enables the UltraRAE 3000+ to give specific readings on one particular type of compound, such as benzene or butadiene.

As a VOC monitor, the UltraRAE 3000+ operates in different modes. In some cases, you can change modes using a password and using the instrument's navigation. In other cases, you must use ProRAE Studio II or Honeywell Safety Suite Device Configurator software.

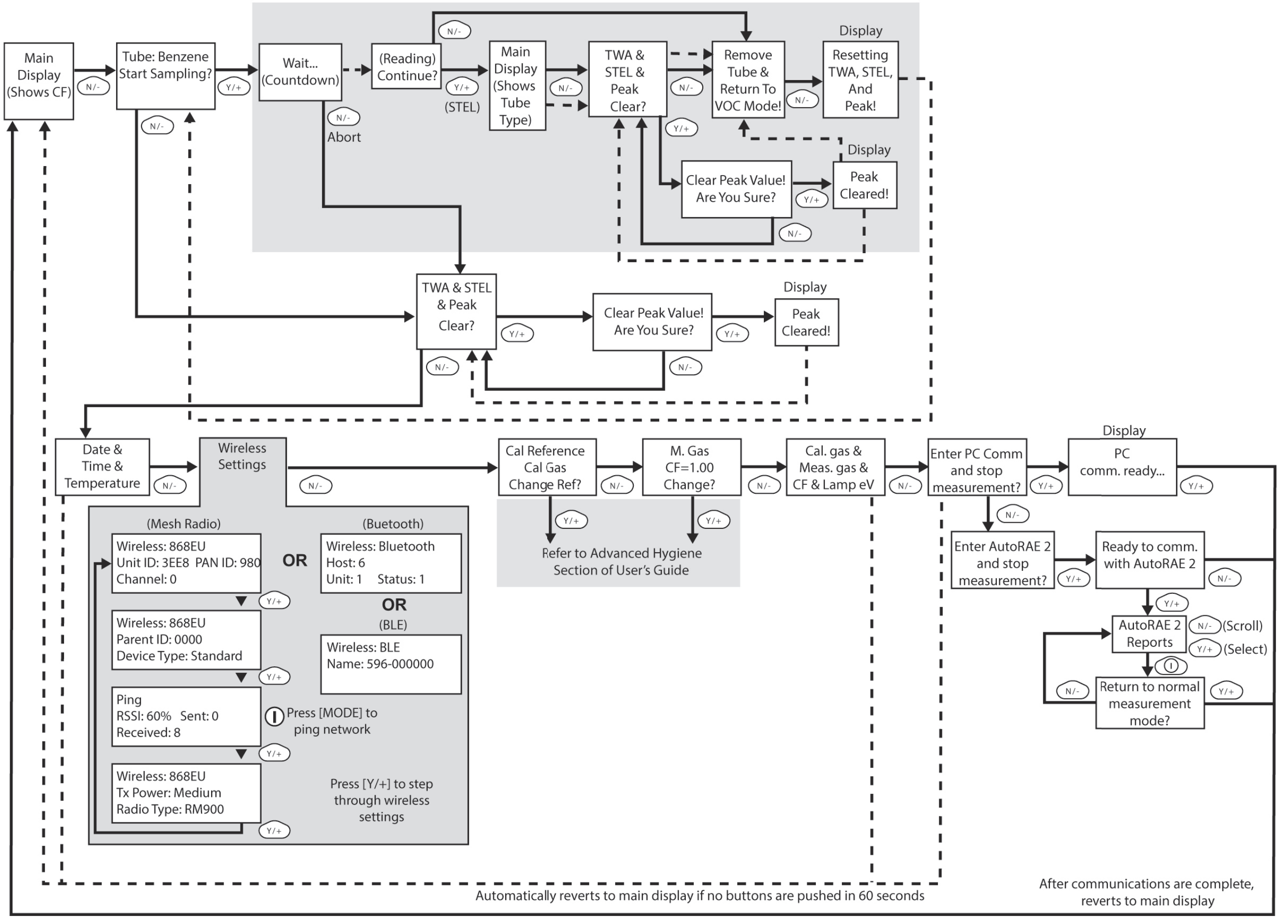
The following two sections cover operation in the two modes.

- Compound Specific, page 29.
- VOC, page 35.

The diagram on the next page shows the basic flow of the UltraRAE 3000+'s functions. The area with the gray field is the compound-specific (tube) mode, while the rest shows VOC mode. Navigate through the steps by using the [Y/+] and [N/-] keys as shown in the diagram.

Note: If you use a password to access Programming Mode (see page 19), then the navigation changes slightly, entering part of Advanced Hygiene Mode's settings, as shown on page 75.

Compound-Specific (Tube)



Note: Dashed line indicates automatic progression.

The default setting for your instrument is:

User Level: Basic
Operation Mode: Hygiene

This is outlined in detail on page 73.

The other options, covered later in this guide, are:

User Level: Advanced (page 75)
Operation Mode: Hygiene

User Level: Advanced (page 75)
Operation Mode: Search

Using ProRAE Studio II or Honeywell Safety Suite Device Configurator allows access to other options. In addition, Diagnostic Mode (page 79) is available for service technicians.

10. Compound-Specific Operation – UltraRAE 3000+

10.1. Compound-Specific Measurement

The UltraRAE 3000+ can perform compound-specific measurement in addition to general VOC measurement. This requires using a RAE-Sep separation tube (butadiene or benzene) and having the UltraRAE 3000+ in Tube Mode, operating with a 9.8eV lamp.

10.2. Measurement Phases

To perform a compound-specific measurement, follow this order:

1. UltraRAE 3000+ is ready for sampling
2. Prepare the separation tube
3. Insert the separation tube
4. Start measurement
5. UltraRAE 3000+ displays and logs measurement
6. Remove the separation tube

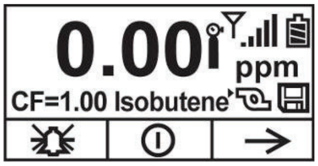
10.3. Performing A Measurement – UltraRAE 3000+

Before performing a compound-specific measurement for Benzene or Butadiene using a RAE-Sep™ separation tube, make sure the UltraRAE 3000+ is in Tube Mode and that the appropriate tube type is selected. The UltraRAE 3000+ only acts as a compound-specific measurement device when it is equipped with a 9.8eV lamp. The UltraRAE 3000+ is designed to auto-sense the lamp type. It can also be manually set to default to a 9.8eV lamp type.

Make sure the UltraRAE 3000+ is set to operate with your selected tube:

1. Enter Programming Mode.
2. Select Measurement.
3. Select Tube Selection.
4. Make a choice of Benzene or Butadiene.
5. Save your choice.

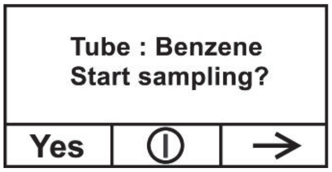
To begin measuring, turn on the UltraRAE 3000+. This screen is shown, which includes the CF (correction factor) and measurement gas type for calibration reference:



0.00i ppm

CF=1.00 Isobutene

Press [N/-] to advance. You will see this screen:



Tube : Benzene

Start sampling?

Do not begin sampling yet!

Before you start sampling, you must insert a RAE-Sep separation tube into the inlet/holder. Follow the Separation Tube Preparation and Placing A Tube Into The UltraRAE 3000+ instructions before pressing any buttons on the UltraRAE 3000+. Once the tube is in place, then proceed to measuring.

IMPORTANT!

Once a tube's ends are broken off, the material inside is exposed. Therefore, use the tube for sampling as soon as possible.

10.4. Separation Tube Preparation

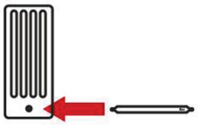
CAUTION!

Wear hand and eye protection when breaking tube tips. Use caution in handling tubes with broken ends. Keep away from children. RAE-Sep tubes should be disposed of according to local regulations. See footnotes of data sheets for disposal information.

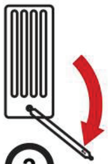
1. Open a package of RAE-Sep separation tubes and remove one.
2. Place the tip in the package's tube tip breaker (the small hole on the front) and snap off the tip.
3. Turn the tube around and snap off the other end.

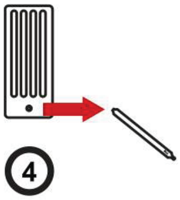
CAUTION!

Only use Honeywell RAE Systems tubes.

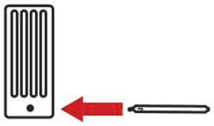

①


②

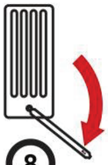

③

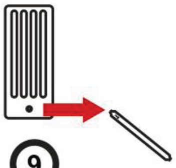

④


⑤


⑥


⑦


⑧

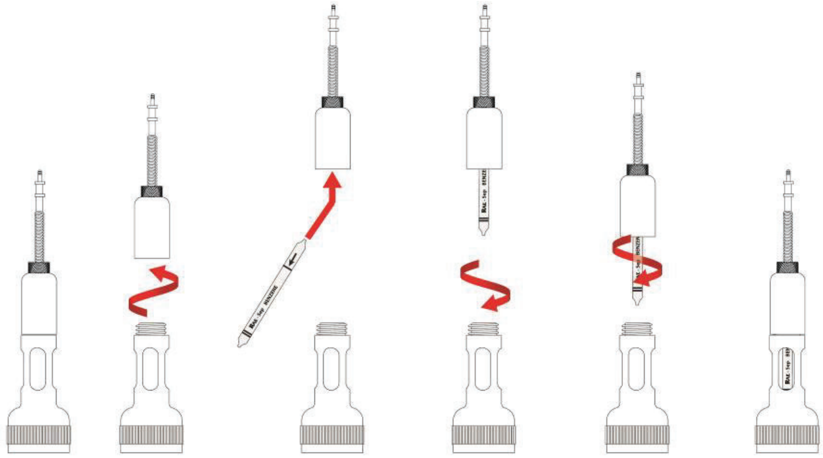

⑨

CAUTION!

Handle tubes with care. Tube ends are sharp after ends are broken off.

10.5. Inserting The Separation Tube

1. Unscrew the front of the sampling probe from the base.
2. Slip the tube into the rubber holder in the front portion. Make sure the arrow on the side of the tube points toward the instrument.
3. Insert the other end of the tube into the middle of the base while turning the front portion to tighten it onto the base’s threads.



IMPORTANT!

Do not overtighten any portion of the sampling assembly.

Note: When the UltraRAE 3000+ is used for VOC monitoring, no tube is inserted.

IMPORTANT!

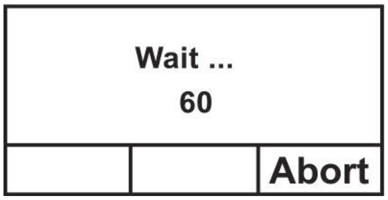
To ensure that there are no leaks, periodically test the seals:

With the UltraRAE 3000+ running, place your finger over the end of the inlet probe. The alarm should sound and the pump-stall icon should flash on the display. This indicates that all seals are good. Stop the alarm by pressing [Y/+]. If the pump does not alarm or show the stalled-pump icon, then check that all inlet parts are tight and inspect the O-ring for damage (replace it if necessary).

10.6. Measuring

Once the tube is in place, begin measuring by pressing [Y/+].

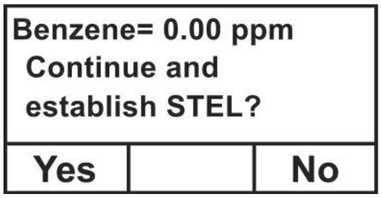
The display shows a countdown (60 seconds is shown here, but sampling time depends on the type of separation tube selected and the temperature):



Wait ...
60

Note: You can abort the sampling by pressing [N/-] at any time.

Once the countdown is complete, the reading is shown:



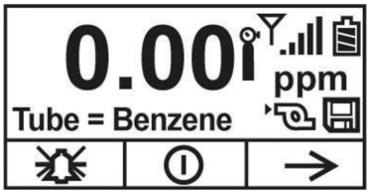
Benzene= 0.00 ppm
Continue and
establish STEL?

Press [Y/+] to continue sampling with the tube for 15 minutes to establish a STEL reading, or press [N/-] to return to the main menu.

WARNING!

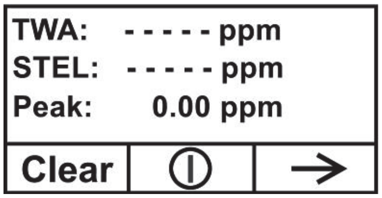
At least 1/4 of the tube should still be yellow-orange at the bottom. If not, the STEL value is not valid. Abort the measurement and change the tube. Then do a snapshot test instead of a STEL test. **Note:** If the STEL is exceeded, the UltraRAE 3000+ goes into alarm.

If you press [N/-] to return to the main menu, which shows the tube type instead of the CF (correction factor):



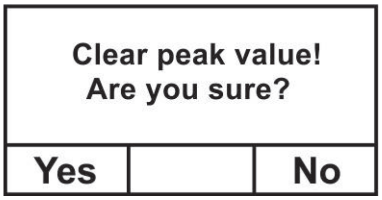
0.00 ppm
Tube = Benzene

Press [N/-] to advance to this screen:



TWA: - - - - - ppm
STEL: - - - - - ppm
Peak: 0.00 ppm

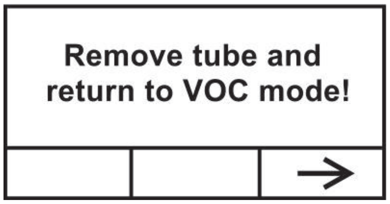
If you press [Y/+], you are asked, "Clear peak value! Are You Sure?" to confirm:



Clear peak value!
Are you sure?

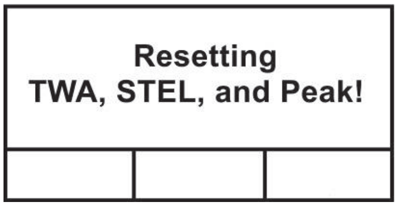
Press [Y/+] to clear the Peak value and exit to VOC operation.

If you press [N/-], this display is shown:



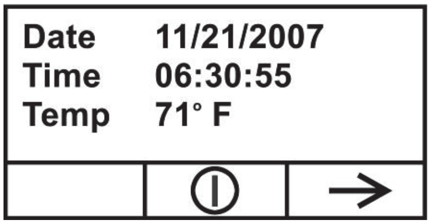
Remove tube and
return to VOC mode!

Remove the tube and put the inlet back together. Then press [N/-]. This display is shown:



Resetting
TWA, STEL, and Peak!

After a few seconds, the UltraRAE 3000+ enters VOC mode and shows this display:



Date 11/21/2007
Time 06:30:55
Temp 71° F

You can step through the rest of the steps by pressing [N/-] repeatedly until you reach the main menu again.

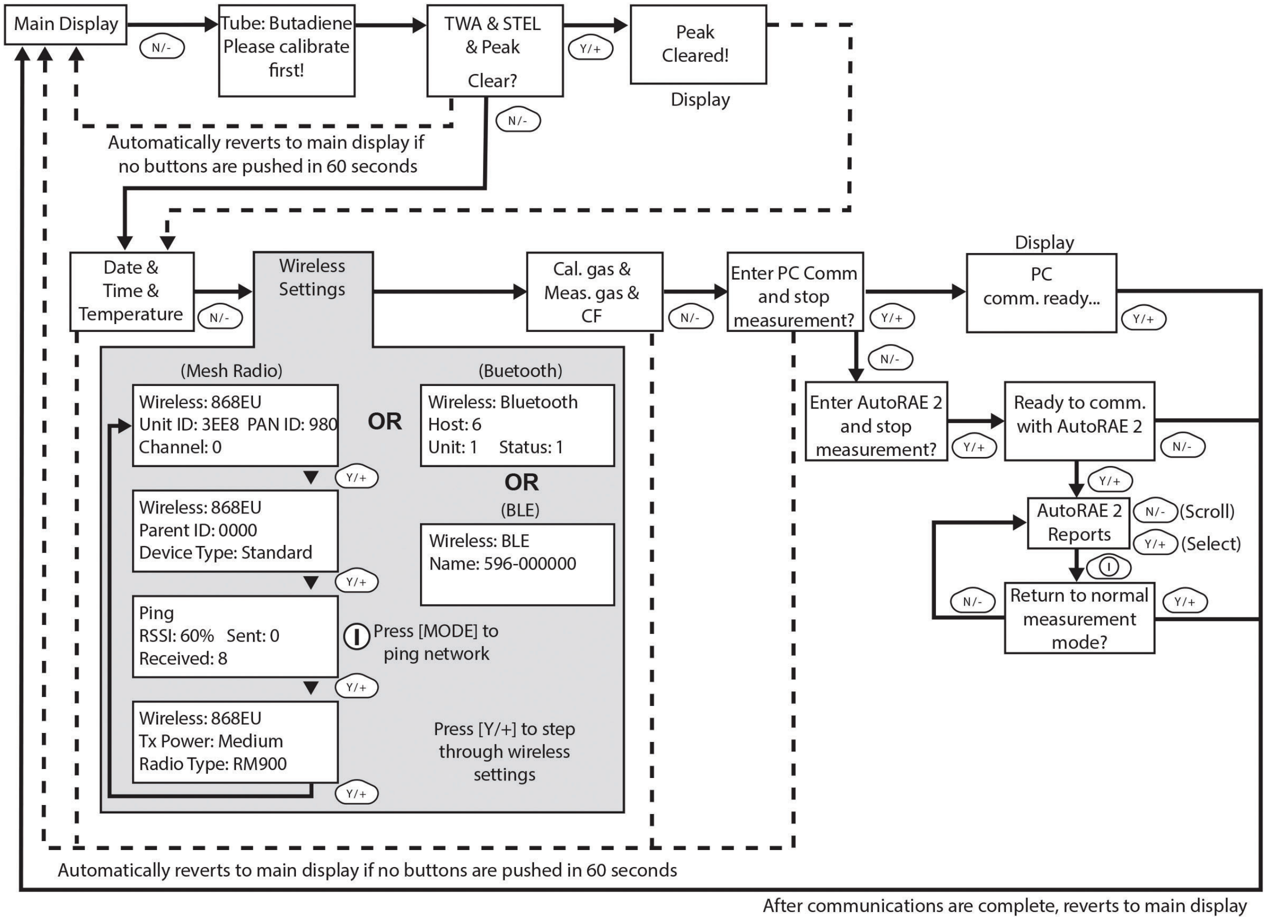
11. VOC Operation – UltraRAE 3000+

11.1. Basic User Level/Hygiene Mode (Default Settings)

The instrument is programmed to operate in Basic User Level/Hygiene Mode as its default. This gives you the most commonly needed features while requiring the fewest parameter adjustments.

Pressing [N/-] steps you from one screen to the next, and eventually return to the main display. If you do not press a key within 60 seconds after entering a display, the instrument reverts to its main display.

Note: While viewing any of these screens, you can shut off your instrument by pressing [MODE].



Note: Dashed line indicates automatic progression.

Note: At the Average & Peak, Date & Time & Temperature, Calibration Gas & Measurement Gas & Correction Factor, and PC Communications screens, the instrument automatically goes to the main display after 60 seconds if you do not push a key to make a selection.

11.2. Basic Operation – MiniRAE 3000+

The instrument is programmed to give you the most commonly needed information quickly.

Pressing [N/-] steps you from one screen to the next, and eventually return to the main display. If you do not press a key within 60 seconds after entering a display, the instrument reverts to its main display.

Note: While viewing any of these screens, you can shut off your instrument by pressing [MODE].

Note: At the Average & Peak, Date & Time & Temperature, Calibration Gas & Measurement Gas & Correction Factor, and PC Communications screens, the instrument automatically goes to the main display after 60 seconds if you do not push a key to make a selection.

12. Alarm Signals

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn you of the alarm condition. In addition, the instrument alarms if one of the following conditions occurs: battery voltage falls below a preset voltage level, failure of the UV lamp, or pump stall.

12.1. Alarm Signal Summary

Message	**Condition**	**Alarm Signal**
HIGH	Gas exceeds "High Alarm" limit	3 beeps/flashes per second*
OVR	Gas exceeds measurement range	3 beeps/flashes per second*
MAX	Gas exceeds electronics' maximum range	3 beeps/flashes per second*
LOW	Gas exceeds "Low Alarm" limit	2 beeps/flashes per second*
TWA	Gas exceeds "TWA" limit	1 Beep/flash per second*
STEL	Gas exceeds "STEL" limit	1 Beep/flash per second*
Pump icon flashes	Pump failure	3 beeps/flashes per second
Lamp	PID lamp failure	3 beeps/flashes per second plus "Lamp" message on display
Battery icon flashes	Low battery	1 flash, 1 beep per minute plus battery icon flashes on display
CAL	Calibration failed, or needs calibration	1 beep/flash per second
NEG	Gas reading measures less than number stored in calibration	1 beep/flash per second

* MiniRAE 3000+, ppbRAE 3000+, and UltraRAE 3000+: Hygiene mode only. In Search mode, the number of beeps per second (1 to 7) depends upon the concentration of the sampled gas. Faster rates indicate higher concentrations.

12.2. Preset Alarm Limits & Calibration

The instrument is factory calibrated with standard calibration gas, and is programmed with default alarm limits. These settings can be changed in Programming Mode to align more precisely with your standards.

MiniRAE Lite+

Cal Gas (Isobutylene)	Cal Span	Unit	Low	High
MiniRAE Lite+	100	ppm	50	100

MiniRAE 3000+

Cal Gas (Isobutylene)	Cal Span	Unit	Low	High	TWA	STEL
MiniRAE 3000+	100	ppm	50	100	10	25

ppbRAE 3000+

Cal Gas (Isobutylene)	Cal Span	Unit	Low	High	TWA	STEL
ppbRAE 3000+	10	ppm	10	25	10	25
MiniRAE 3000+	100	ppm	50	100	10	25
MiniRAE Lite+	100	ppm	50	100	10	25

UltraRAE 3000+

Cal Gas	Cal Span	Unit	Low	High	TWA	STEL
Isobutylene	100	ppm	50	100	10	25
Benzene	5	ppm	2	5	0.5	2.5
Butadiene	10	ppm	5	10	2	5

12.3. Testing The Alarm

You can test the alarm whenever the main (Reading) display is shown. Press [Y/+], and the audible and visible alarms are tested.

12.4. Integrated Sampling Pump

The instrument includes an integrated sampling pump. This diaphragm-type pump that provides a 450 to 550 cc per minute flow rate. Connecting a Teflon or metal tubing with 1/8" inside diameter to the gas inlet port of the instrument, this pump can pull in air samples from 100' (30 m) horizontally or vertically.

Note: In Search Mode, the pump turns on when a sample measurement is started, and turns off when the sample is manually stopped.

If liquid or other objects are pulled into the inlet port filter, the instrument detects the obstruction and immediately shuts down the pump. The alarm is activated and a flashing pump icon is displayed. You should acknowledge the pump shutoff condition by clearing the obstruction and pressing the [Y/**+**] key while in the main reading display to restart the pump.

12.5. Backlight

The LCD display is equipped with an LED backlight to assist in reading the display under poor lighting conditions.

12.6. Datalogging

During datalogging, the instrument displays a disk icon to indicate that datalogging is enabled. The instrument stores the measured gas concentration at the end of every sample period (when data logging is enabled). In addition, the following information is stored: user ID, site ID, serial number, last calibration date, and alarm limits. All data are retained (even after the unit is turned off) in non-volatile memory so that it can be down- loaded later to a PC.

12.6.1. Datalogging event

When Datalogging is enabled, measurement readings are being saved. These data are stored in "groups" or "events." A new event is created and stored each time the instrument is turned on and is set to automatic datalogging, or a configuration parameter is changed, or datalogging is interrupted. The maximum time for one event is 24 hours or 28,800 points. If an event exceeds 24 hours, a new event is automatically created. Information, such as start time, user ID, site ID, gas name, serial number, last calibration date, and alarm limits are recorded.

12.6.2. Datalogging sample

After an event is recorded, the unit records a shorter form of the data. When transferred to a PC running ProRAE Studio II or Honeywell Safety Suite Device Configurator, this data is arranged with a sample number, time, date, gas concentration, and other related information.

12.6.3. Auto/Manual/Snapshot Datalogging

The instrument has three datalog types:

Auto	Default mode. Collects datalog information when the instrument is sampling.
Manual	Datalogging occurs only when the instrument's datalogging is manually started (see page 65 for details).
Snapshot	Datalogs only during snapshot (single-event capture, initiated by pressing [MODE]) sampling. See page 66 for details.

Note: You can only choose one datalog type to be active at a time.

13. Accessories

MiniRAE Lite+

The following accessories are included with the instrument:

- 10.6 eV lamp
- Flex-I-Probe
- External filter
- Green rubber boot
- Alkaline battery adapter
- Lamp cleaning kit
- Tool Kit
- Lithium-Ion (Li-Ion) battery, if specified
- Travel Charger, if specified
- Universal wall adapter, if specified
- Quick Start Guide
- Soft leather carrying case

MiniRAE 3000+ & ppbRAE 3000+

The following accessories are included with the instrument:

- AC Adapter (Battery Charger)
- Alkaline battery adapter
- External Filter

Hard-case kits also include these accessories:

- Calibration adapter
- Calibration regulator and Flow controller

UltraRAE 3000+

The following accessories are included with the instrument:

- AC Adapter (Battery Charger)
- Travel Charger
- Alkaline battery adapter
- External Filter

Hard-case kits also include these accessories:

- Calibration gas, if specified
- Calibration adapter
- Calibration regulator and flow controller
- Charger Stand (instead of Travel Charger)

14. Standard Kit & Accessories

14.1. AC Adapter (Battery Charger)

WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in area known to be non-hazardous.
Ne charger les batteries que dans emplacements designés non-dangereuses.

A battery charging circuit is built into the instrument cradle. It only needs a regular AC to 12 VDC adapter (wall-mount transformer, part number 500-0114-000) to charge the instrument.

To charge the battery inside the instrument:

1. Power off the instrument.
2. Connect the AC adapter to the DC jack on the instrument's cradle. If the instrument is off, it automatically turns on.
3. While charging, the display message shows "Charging." The Primary LED on the cradle flashes green when charging.
4. When the battery is fully charged, the LED changes to glowing green continuously, and the message "Fully charged" appears on the display. If there is a charging error, the LED glows red continuously.

A completely discharged instrument can be charged to full capacity within 8 hours. Batteries drain slowly even if an instrument is off. Therefore, if the instrument has been in storage or has not been charged for several days or longer, check the charge before using it.

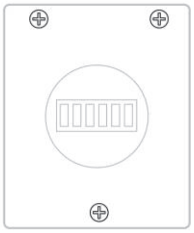
The factory-supplied battery is designed to last for 16 hours of normal operation (no alarm), for a new battery under the optimum circumstances. As the battery becomes older or is subject to adverse conditions (such as cold ambient temperature), its capacity will be significantly reduced.

14.2. Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500) and provides approximately 12 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the Li-ion battery pack.

To insert batteries into the adapter:

1. Remove the three Philips-head screws to open the compartment in the adapter.
2. Insert four fresh AA batteries as indicated by the polarity (+/-) markings.
3. Replace the cover. Replace the three screws.



To install the adapter in the instrument:

1. Remove the Li-ion battery pack from the instrument by sliding the tab and tilting out the battery.
2. Replace it with the alkaline battery adapter
3. Slide the tab back into place to secure the battery adapter.

IMPORTANT!

Alkaline batteries cannot be recharged. The instrument's internal circuit detects alkaline batteries and will not allow recharging. If you place the instrument in its cradle, the alkaline battery will not be recharged. The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the instrument. If you try to charge an alkaline batteries installed in the instrument, the instrument's display will say, "Alkaline Battery," indicating that it will not charge the alkaline batteries.

Note: When replacing alkaline batteries, dispose of old ones properly.

WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge the battery only in areas known to be non-hazardous. Remove and replace the battery only in areas known to be non-hazardous.

14.3. External Filter

WARNING!

Always use an external filter on the instrument. This prevents contaminants and debris from clogging the sample pathway and protects the sensor from damage.

The external filter is made of PTFE (Teflon®) membrane with a 0.45 micron pore size to prevent dust or other particles from being sucked into the sensor manifold, which would cause extensive damage to the instrument. It prolongs the operating life of the sensor. To install the external filter, simply connect it to the instrument's inlet tube.

15. Optional Accessories

15.1. Calibration Adapter

The calibration adapter for the instrument is a simple 6-inch Tygon tubing with a metal adapter on one end. During calibration, simply insert the metal adapter into the regular gas inlet probe of the instrument and the tubing to the gas regulator on the gas bottle.

15.2. Calibration Regulator

The Calibration Regulator is used in the calibration process. It regulates the gas flow rate from the Span gas cylinder into the gas inlet of the instrument during calibration process. The maximum flow rate allowed by the flow controller is about 0.5L/min (500 cc per min.). Alternatively, a demand-flow regulator or a Tedlar gas bag may be used to match the pump flow precisely.

15.3. Organic Vapor Zeroing Kit

The Organic Vapor Zeroing Kit is used for filtering organic air contaminants that may affect the zero calibration reading. To use the Organic Vapor Zeroing Kit, simply connect the filter to the inlet port of the instrument.

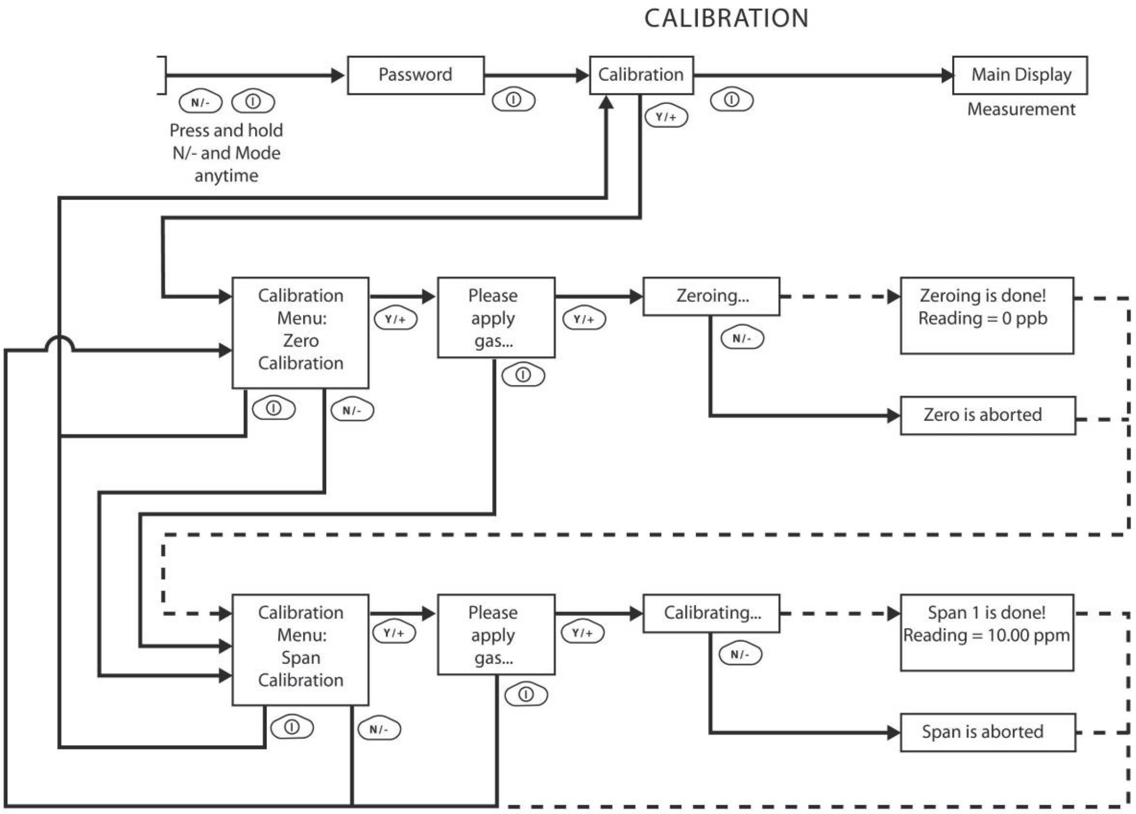
15.4. AutoRAE 2 Automatic Test & Calibration System

The AutoRAE 2 Automatic Test and Calibration System \ portable gas monitors makes compliance with monitor test and calibration requirements as easy as pressing a button. Simply cradle the monitor and the system will take care of all calibration, testing, and recharging.

The AutoRAE 2 is a flexible, modular system that can be configured to meet your calibration requirements effectively and efficiently. An AutoRAE 2 system can be as simple as a single cradle deployed in standalone mode to calibrate one instrument at a time, or as powerful as a networked, controller-based system supporting ten monitors and five distinct calibration gas cylinders.

16. Standard Two-Point Calibration (Zero & Span)

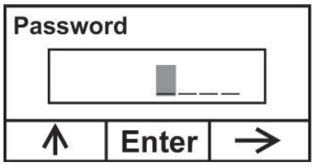
The following diagram shows the instrument's calibrations in Basic/Hygiene mode.



Note: Dashed line indicates automatic progression.

Entering Calibration

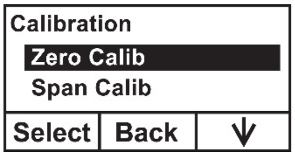
1. Press and hold [MODE] and [N/-] until you see the Password screen.



2. In Basic User Level, you do not need a password to perform calibrations. Instead of inputting a password, enter calibration by pressing [MODE].

   Note: If you inadvertently press [Y/+] and change any of the numbers, simply press [MODE] and you will be directed to the calibration menu.

The Calibration screen is now visible with Zero Calibration highlighted.



These are your options:

- Press [Y/+] to select the highlighted calibration (Zero Calib or Span Calib).
- Press [MODE] to exit calibration and return to the main display and resume measurement.
- Press [N/-] to toggle the highlighted calibration type.

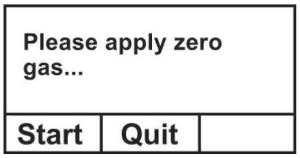
16.1. Zero (Fresh Air) Calibration

This procedure determines the zero point of the sensor calibration curve. To perform a fresh air calibration, use the calibration adapter to connect the instrument to a "fresh" air source such as from a cylinder or Tedlar bag (optional accessory). The "fresh" air is clean, dry air without organic impurities and an oxygen value of 20.9%. If such an air cylinder is not available, any clean ambient air without detectable contaminants or a charcoal filter can be used.

At the Zero Calibration menu, you can proceed to perform a Zero calibration or bypass Zero calibration and perform a Span calibration. You may also go back to the initial Calibration menu if you want to exit calibration.

- Press [Y/+] to start calibration.
- Press [MODE] to quit and return to the main calibration display.

If you have pressed [Y/+] to enter Zero calibration, then you will see this message:



Please apply zero gas...

1. Start the flow of Zero calibration gas.
2. Press [Y/+] to start calibration.

   Note: At this point, you may press [MODE] if you decide that you do not want to initiate calibration. This will take you directly to the Calibration menu, highlighted for Span calibration.

3. Zero calibration starts a 60-second countdown and displays this message:

   Zeroing...

During the zeroing process, the instrument performs the Zero calibration automatically and does not require any action on your part.

Note: To abort the zeroing process at any time and proceed to Span calibration, press [N/-] at any time while zeroing is being performed. You will see a confirmation message that says "Zero aborted!" and then the Span calibration menu appears.

When Zero calibration is complete, you see this message:

Zeroing is done! Or Zeroing is done!
Reading = 0 ppb Reading = 0 ppm

The instrument will then show the Calibration menu on its display, with Span Calib highlighted.

16.1.1. Reflex PID Technology™

All handheld PID monitors after firmware version 2.20 benefit from our patented Reflex PID Technology™. It provides several benefits, including enhanced stability and accuracy, particularly at very low levels. One time each hour, Reflex PID™ Technology adjusts the zero point automatically to ensure greater uniformity in readings, especially when detecting ultra-low levels (ppb range) of VOCs. This one-minute operation is performed automatically, so precise readings are assured without requiring the user to perform zeroing.

Reflex PID technology is automatically enabled during each zero calibration process. For the ppbRAE3000+, it performs a sensor noise level assessment to re-baseline zeroing of the instrument and provide ultimate performance at sub-ppm level.

The instrument’s user can decide to abort this operation by pressing [N/-], should this process need to be interrupted for a measurement.

16.2. Span Calibration

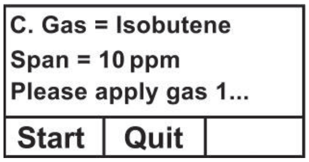
This procedure determines the second point of the sensor calibration curve for the sensor. A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure. Choose the 500 cc/min. regulator only if the flow rate matches or slightly exceeds the flow rate of the instrument pump. Alternatively, the span gas can first be filled into a Tedlar bag or delivered through a demand-flow regulator. Connect the calibration adapter to the inlet port of the instrument, and connect the tubing to the regulator or Tedlar bag.

Another alternative is to use a regulator with >500 cc/min flow but allow the excess flow to escape through a T or an open tube. In the latter method, the span gas flows out through an open tube slightly wider than the probe, and the probe is inserted into the calibration tube.

At the Span Calibration menu, you perform a Span calibration. You may also go back to the Zero calibration menu or to the initial Calibration menu if you want to exit calibration.

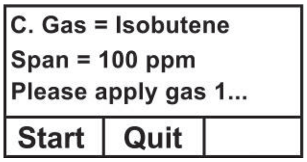
- Press [Y/+] to enter Span calibration.
- Press [N/-] to skip Span calibration and return to Zero calibration.
- Press [MODE] to exit Span calibration and return to the top calibration menu.

If you have pressed [Y/+] to enter Span calibration, then you will see the name of your Span gas (the default is isobutylene) and the span value in parts per million (ppm). You will also see this message that prompts you:



C. Gas = Isobutene
Span = 10 ppm
Please apply gas 1...

MiniRAE 3000+, ppbRAE 3000+, UltraRAE 3000+



C. Gas = Isobutene
Span = 100 ppm
Please apply gas 1...

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1. Turn on your span calibration gas.
2. Press [Y/+] to initiate calibration.

   Note: You may press [MODE] if you decide that you do not want to initiate calibration. This will abort the span calibration and take you directly to the Calibration menu for Zero calibration.

3. Span calibration starts and displays this message:

   Calibrating...

During the Span calibration process, there is a 30-second countdown and the instrument performs the Span calibration automatically. It requires no actions on your part.

Note: If you want to abort the Span calibration process, press [N/-] at any time during the process. You will see a confirmation message that says "Span is aborted!" and then the Zero calibration menu appears. You can then proceed to perform a Zero calibration, perform a Span calibration, or exit to the topmost Calibration menu.

When Span calibration is complete, you see a message similar to this (the value is an example only):

Span 1 is done!
Reading = 10.0 ppm

The instrument then exits Span calibration and shows the Zero calibration menu on its display.

Note: The reading should be very close to the span gas value.

16.3. Exiting Two-Point Calibration In Basic User Level

When you are done performing calibrations, press [MODE], which corresponds with "Back" on the display.

You will see the following message:

Updating settings…

The instrument updates its settings and then returns to the main display. It begins or resumes monitoring.

17. Three-Point Calibration

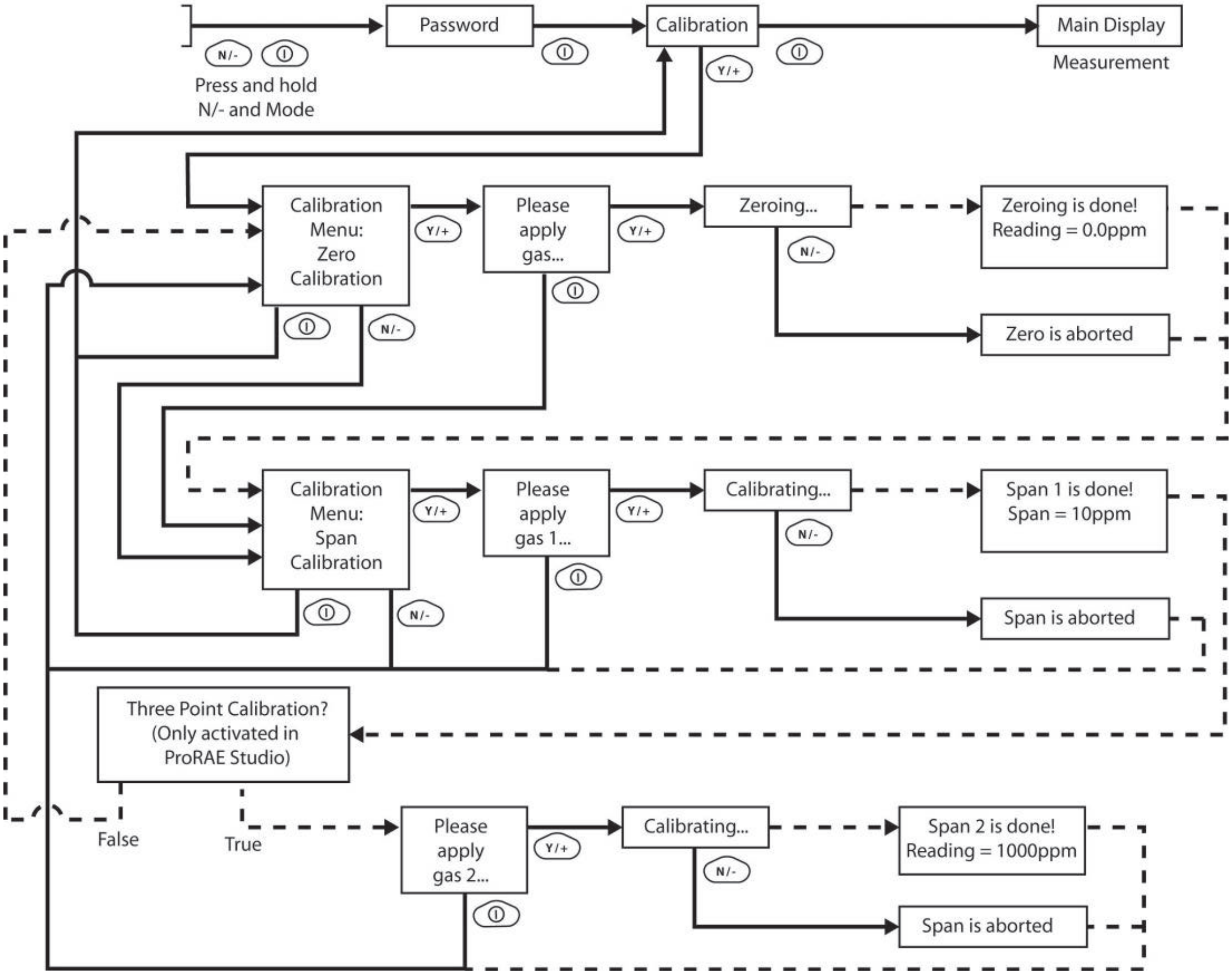
Note: This feature is not available on MiniRAE Lite+.

For enhanced accuracy, it is possible to perform a second Span calibration in addition to the Zero and Span calibrations outlined in the previous section. Your instrument first must be set to allow this third calibration. This requires using ProRAE Studio II or Honeywell Safety Suite Device Configurator software and a PC, as well as a higher concentration of calibration gas. Follow the instructions in the next section.

Note: Once the third calibration is set, you do not need to use ProRAE Studio II or Honeywell Safety Suite Device Configurator to allow future 3-point calibrations. Also, you can only disable 3-point calibration capability by using ProRAE Studio II or Honeywell Safety Suite Device Configurator again.

Perform the Zero and Span calibrations. After the first Span calibration (Span 1) is completed, the display a second Span calibration (Span 2) can be performed. The process is identical to the first calibration. As in the Span 1 calibration, you may exit and return to the Zero calibration screen if you choose not to perform this calibration or to abort it.

Note: If a bump test is available, it appears after the last calibration in the menu. See "Two-Point Calibration," page 43, for details. Also, refer to page 51 for details on how to perform a bump test.



Note: Dashed line indicates automatic progression.

Span 2 Calibration

The minimum value of Span 2 gas should be 1000 ppm. If the primary concern is accuracy at low concentration, only using the 2-point calibration process with Span 1 set to 100 ppm is adequate. The reading error at 10 ppm will be lower. If Span 1 is set to 10 ppm, the reading error under 100 ppm (or over 100ppm to 1000 ppm) will be higher. A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure.

Note: This gas should be of a higher concentration than the gas used for Span 1 calibration.

Choose the 500 cc/min. regulator only if the flow rate matches or slightly exceeds the flow rate of the instrument pump. Alternatively, the span gas can first be filled into a Tedlar bag or delivered through a demand-flow regulator. Connect the calibration adapter to the inlet port of the instrument, and connect the tubing to the regulator or Tedlar bag.

Another alternative is to use a regulator with >500 cc/min flow but allow the excess flow to escape through a T or an open tube. In the latter method, the span gas flows out through an open tube slightly wider than the probe, and the probe is inserted into the calibration tube.

At the Span Calibration menu, you perform a Span calibration. You may also go back to the Zero calibration menu or to the initial Calibration menu if you want to exit calibration.

- Press [Y/+] to enter Span 2 calibration.
- Press [N/-] to skip Span calibration and return to Zero calibration.
- Press [MODE] to exit Span calibration and return to the top calibration menu.

If you have pressed [Y/+] to enter Span calibration, then you will see the name of your Span gas (the default is isobutylene) and the span value in parts per million (ppm). You will also see this message that prompts you:

Please apply gas...

1. Turn on your span calibration gas.
2. Press [Y/+] to initiate calibration.

   Note: You may press [MODE] if you decide that you do not want to initiate calibration. This will take you directly to the Calibration menu for Zero calibration.

3. Span calibration starts a 30-second countdown and displays this message:

   Calibrating...

During the Span calibration process, the instrument performs the Span calibration automatically and does not require any action on your part.

Note: If you want to abort the Span calibration process, press [N/-] at any time during the process. You will see a confirmation message that says “Span is aborted!” and then the Zero calibration menu will appear. You can then proceed to perform a Zero calibration, perform a Span calibration, or exit to the topmost Calibration menu.

When Span calibration is complete, you will see a message similar to this (the value shown here is for example only):

Span 2 is done!
Reading = 1000 ppm

The instrument then exits Span calibration and shows the Zero calibration menu on its display.

Note: The reading should be very close to the span gas value.

17.1. Exiting Three-Point Calibration

When you are done performing calibrations, press [MODE], which corresponds with “Back” on the display. You will see the following message:

Updating settings…

The instrument updates its settings and then returns to the main display. It begins or resumes monitoring.

18. Bump Test

RAE Systems recommends that a bump test be conducted prior to each day’s use. The purpose of a bump test is to ensure that the instrument’s sensors respond to gas and all the alarms are enabled and functional.

- The ppbRAE 3000+ must be calibrated if it does not pass a bump test when a new sensor is installed, after sensor maintenance has been performed, or at least once every 180 days, depending on use and sensor exposure to poisons and contaminants.
- Calibration and bump test intervals and procedures may vary due to national legislation and company policy.

To perform a bump test (functional challenge), follow these steps:

1. Select “Bump.”
2. Install the calibration adapter and connect it to a source of calibration gas.
3. Verify that the displayed calibration value meets the concentration specified on the gas cylinder.
4. Start the flow of calibration gas.
5. Press [Y/+] to start the bump test.
6. You can abort the calibration at any time during the countdown by pressing [N/-].
7. If the calibration is not aborted, the display shows reading and then tells you whether the bump test passed or failed. If the bump test failed, then it automatically advances to the Calibration screen.

A bump test can be performed either manually or using the AutoRAE 2 Automatic Test and Calibration System. When a bump test is done manually, the instrument makes a pass/fail decision based on sensor performance, but the user still has the responsibility to make sure all the alarms are enabled and functional.

Note: Bump testing and calibration can be performed using an AutoRAE 2 Automatic Test & Calibration System. An AutoRAE 2 bump test takes care of both the sensor and alarm tests. Consult the AutoRAE 2 User’s guide for details.

The same gas is used for a bump test as for calibration. The instrument must be connected to a cylinder of calibration gas with supplied tubing.

IMPORTANT!

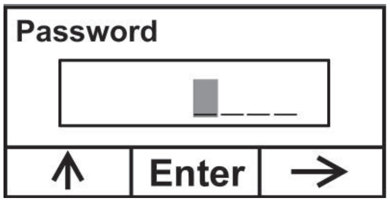
If the instrument does not pass a bump test, perform a full calibration. If calibration also fails, the PID sensor or lamp may require cleaning or replacement. If the instrument repeatedly fails to calibrate, turn it off and refer it for servicing.

19. Programming Mode

On the MiniRAE 3000+, ppbRAE 3000+, or UltraRAE 3000+, Programming Mode can be entered from either Hygiene Mode or Search Mode. If the current user mode is Basic, you must provide a 4-digit password to enter. On the MiniRAE Lite+, there is only one mode.

19.1. Entering Programming Mode

1. Press and hold [MODE] and [N/-] until you see the Password screen.



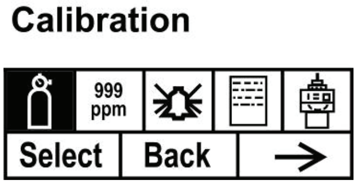
2. Input the 4-digit password:

- Increase the number from 0 through 9 by pressing [Y/+].
- Step from digit to digit using [N/-].
- Press [MODE] when you are done.

If you make a mistake, you can cycle through the digits by pressing [N/-] and then using [Y/+] to change the number in each position.

Note: The default password is 0000.

When you have successfully entered Programming Mode, you see this screen:



Note: The password can only be changed by connecting the instrument to a PC running ProRAE Studio II or Honeywell Safety Suite Device Configurator software. Follow the instructions in ProRAE Studio II or Honeywell Safety Suite Device Configurator to change it.The Calibration label is shown and its icon is highlighted, but you can press [N/-] to step from one programming menu to the next, with the name of the menu shown at the top of the display and the corresponding icon highlighted.

As you repeatedly press [N/-], the selection moves from left to right, and you see these screens:

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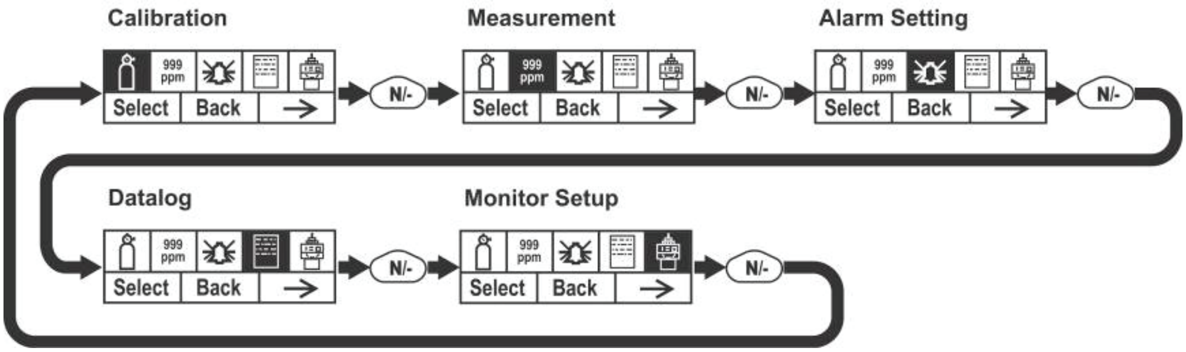
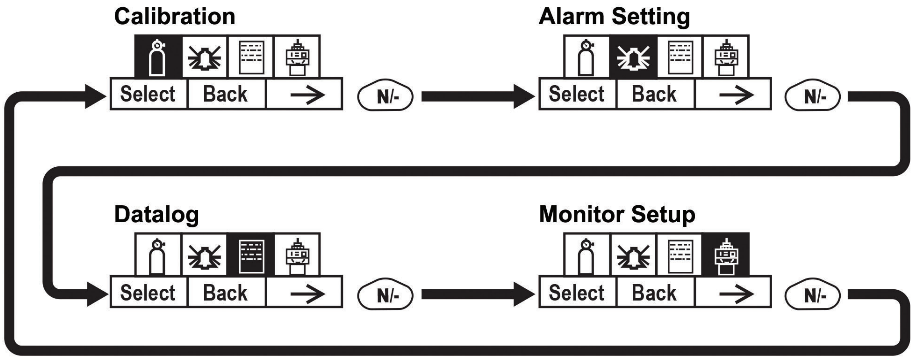


MiniRAE Lite+



Note: When you reach Monitor Setup and press [N/-], the menu cycles back to Calibration.

20. Programming Mode Menus

The Programming Mode allows anyone with the password to change the instrument's settings, calibrate the instrument, modify the sensor configuration, enter user information, etc. Programming Mode has five menus. Each menu includes several sub-menus to perform additional programming functions.

The table on the next shows the menus and sub-menus.

All entries are supported on MiniRAE 3000+, ppbRAE 3000+, and UltraRAE 3000+.

Entries marked with an asterisk (*) are supported on MiniRAE Lite+.

Calibration	**Measurement**	**Alarm Setting**	**Datalog**	**Monitor Setup**
Zero Calibration *	Meas. Gas	High Alarm *	Clear Datalog *	Radio Power*
Span Calibration *	Meas. Unit	Low Alarm *	Interval *	Op Mode
Bump *	Tube Selection	STEL Alarm	Data Selection *	Site ID
		TWA Alarm	Datalog Type *	User ID
		Alarm Mode *		User Mode
		Buzzer & Light *		Date *
				Time *
				Pump Duty Cycle
				Pump Speed
				Temperature Unit
				Language *
				Real Time Protocol
				Power On Zero
				Unit ID
				LCD Contrast
				Lamp ID
				PAN ID
				Mesh Channel
				Mesh Interval

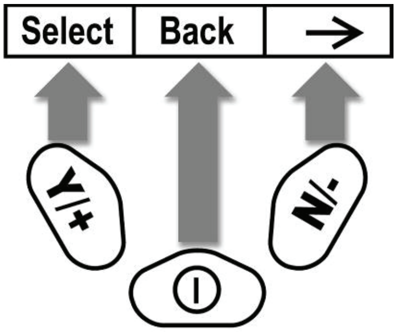
Once you enter Programming Mode, the LCD displays the first menu, Calibration. Each subsequent menu is accessed by pressing [N/-] repeatedly until the desired menu is displayed. To enter a sub-menu of a menu, press [Y/+].

20.1. Exiting Programming Mode

To exit Programming Mode and return to normal operation, press [MODE] once at any of the programming menu displays. You will see "Updating Settings…" as changes are registered and the mode changes.

20.2. Navigating Programming Mode Menus

Navigating through the Programming Mode menus is easy and consistent, using a single interface format of “Select,” “Back” and “Next” at the top level. The three control buttons correspond to these choices as shown:



Note: Pressing [MODE] in the Programming Mode’s top level causes the instrument to exit Programming Mode and return to monitoring.

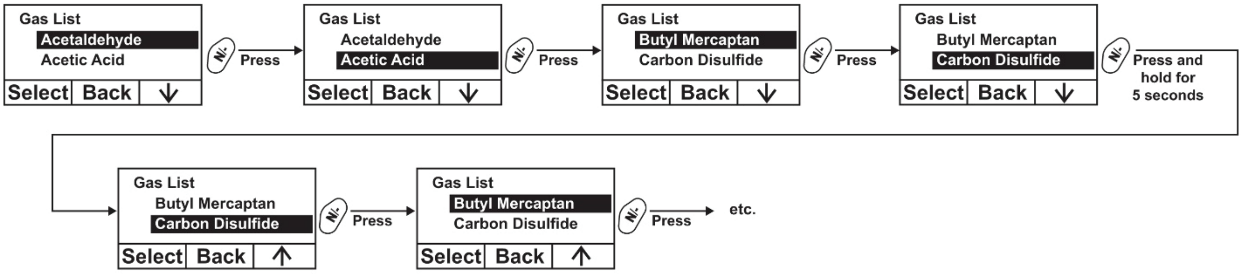
The three keys perform the following functions in Programming Mode:

Key	Function in Programming Mode
[MODE]:	Exit menu when pressed momentarily or exit data entry mode
[Y/+]:	Increase alphanumerical value for data entry or confirm (yes) for a question
[N/-]:	Provides a “no” response to a question

20.3. Reverse Direction – Menu Selection

Lists can be long, so rather than progressing in one direction through every item in the list before “looping” back to the first item, you can change the scrolling direction.

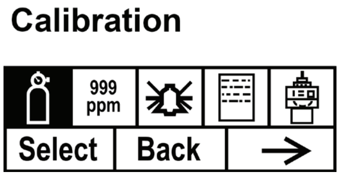
To reverse direction: Press and hold [N/-] for 5 seconds. The direction arrow changes. Now when you press [N/-], the menu items are scrolled through in the other direction.



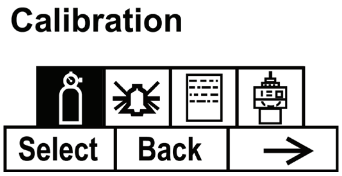
Note: You can change direction anytime by pressing and holding [N/-] for 5 seconds.

20.4. Calibration

Two types of calibration are available: Zero (fresh air) and Span.



MiniRAE 3000+, ppbRAE 3000+, UltraRAE



MiniRAE Lite+

Select Zero or Span Calibration by pressing [N/+]. Once your choice is highlighted, press [Y/+].

20.4.1. Zero Calibration

The procedure for performing a zero calibration is covered on page 45.

Auto Zero can also be performed. Refer to page 19 for details.

20.4.2. Span Calibration

The procedure for performing a basic span calibration is covered on page 4343.

20.4.3. Bump Test

The procedure for performing a bump test is covered on page 51.

A bump test can be performed either manually or using the AutoRAE 2 Automatic Test and Calibration System. When a bump test is done manually, the instrument makes a pass/fail decision based on sensor performance, but the user still has the responsibility to make sure all the alarms are enabled and functional.

Note: Bump testing and calibration can be performed using an AutoRAE 2 Automatic Test & Calibration System. An AutoRAE 2 bump test takes care of both the sensor and alarm tests. Consult the AutoRAE 2 User's guide for details.

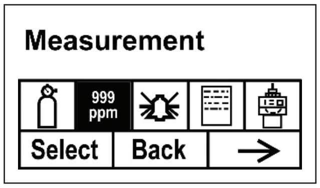
The same gas is used for a bump test as for calibration. The instrument must be connected to a cylinder of calibration gas with supplied tubing.

IMPORTANT!

If the instrument does not pass a bump test, perform a full calibration. If calibration also fails, the PID sensor or lamp may require cleaning or replacement. If the instrument repeatedly fails to calibrate, turn it off and refer it for servicing.

20.5. Measurement

The sub-menus for Measurement are Measurement Gas and Measurement Unit.



20.5.1. Meas. Gas

Measurement gases are organized in four lists:

- My List is a customized list of gases that you create. It contains a maximum of 10 gases and can only be built in ProRAE Studio II or Honeywell Safety Suite Device Configurator on a PC and transferred to the instrument.

  Note: The first gas in the list is always isobutylene (it cannot be removed from the list).

- Last Ten is a list of the last ten gases used by your instrument. The list is built automatically and is only updated if the gas selected from Custom Gases or Library is not already in the Last Ten. This ensures that there is no repetition.
- Gas Library is a library that consists of all the gases found in RAE Systems' Technical Note TN-106 (available online at www.raesystems.com).
- Custom Gases are gases with user-modified parameters. Using ProRAE Studio II or Honeywell Safety Suite Device Configurator, all parameters defining a gas can be modified, including the name, span value(s), correction factor, and default alarm limits.

1. Scroll through each list by pressing [N/-].
2. Press [Y/+] to select one (My List, Last Ten, Gas Library, or Custom Gases).
3. Once you are in one of the categories, press [N/-] to scroll through its list of options and [Y/+] to select one. (If you press [MODE], you exit to the next submenu.)
4. Press [Y/+] to save your choice or [N/-] to undo your selection.

Press [MODE] to leave the sub-menu and return to the Programming Mode menus.

20.5.2. Meas. Unit

Standard available measurement units include:

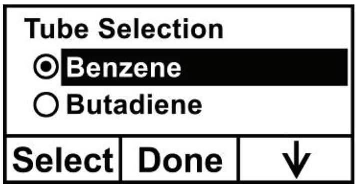
Abbreviation	Unit
ppm	parts per million
ppb	parts per billion
mg/m3	milligrams per cubic meter
ug/m3	micrograms per cubic meter

- Scroll through the list by pressing [N/-].
- Select by pressing [Y/+].
- Save your selection by pressing [Y/+] or undo your selection by pressing [N/-].

Press [MODE] to leave the sub-menu and return to the Programming Mode menus.

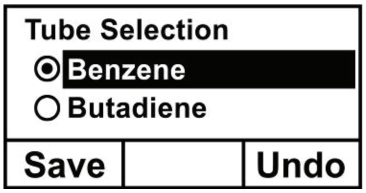
20.5.3. Tube Selection (UltraRAE 3000+ only)

When operating the UltraRAE 3000+ in Compound Specific mode, the internal computer works most effectively when it is told which type of separation tube is being used.



Tube Selection
◉ Benzene
○ Butadiene

1. Scroll through the menu by pressing [N/-].
2. Press [Y/+] to make a selection.
3. Press [MODE] when you are done.
4. Press [Y/+] to save your choice or [N/-] to undo your selection.



Tube Selection
◉ Benzene
○ Butadiene

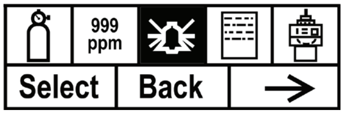
20.5.4. Alarm Setting

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings: Low, High, TWA and STEL). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn of the alarm condition.

An alarm signal summary is shown on page 36.

In this menu, you can change the High and Low alarm limits, the STEL limit, and the TWA. Press [Y/+] to to enter the Alarm Setting menu. **Note:** All settings are shown in ppm (parts per million), or mg/m^3 (milligrams per cubic meter), depending on your setting.

Alarm Setting



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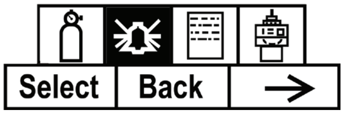
Alarm Setting



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1. Scroll through the Alarm Limit sub-menu using the [N/-] key until the display shows the desired limit to be changed (High Alarm, Low Alarm, STEL Alarm, and TWA Alarm)
2. Press [Y/+] to select one of the alarm types. The display shows a flashing cursor on the left-most digit of the previously stored alarm limit.
3. Press [Y/+] to increase each digit's value.
4. Press [N/-] to advance to the next digit.
5. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.
Press [MODE] when you are done.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

When all alarm types have been changed or bypassed, press [MODE] to exit to the Programming Menu.

20.5.5. High Alarm

You can change the High Alarm limit value. The value is typically set by the instrument to match the value for the current calibration gas. It is expressed in parts per billion (ppb). **Note:** The default value depends on the measurement gas.

To change the High Alarm value:

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

When you have completed your selections, press [MODE]. You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

20.5.6. Low Alarm

You can change the Low Alarm limit value. The value is typically set by the instrument to match the value for the current calibration gas. It is expressed in parts per billion (ppb). Note: The default value depends on the measurement gas.

To change the Low Alarm value:

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

When you have completed your selections, press [MODE]. You will see two choices: Save and Undo. You can register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

20.5.7. STEL Alarm

Note: This feature is not included on MiniRAE Lite+.

You can change the STEL Alarm limit value. The value is typically set by the instrument to match the value for the calibration gas. It is expressed in parts per billion (ppb). **Note:** The default value depends on the measurement gas.

To change the STEL Alarm value:

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

When you have completed your selections, press [MODE]. You will see two choices: Save and Undo. You can register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

20.5.8. TWA Alarm

Note: This feature is not included on MiniRAE Lite+.

You can change the TWA (time-weighted average) Alarm limit value. The value is typically set by the instrument to match the value for the calibration gas. It is expressed in parts per billion (ppb).

Note: The default value depends on the measurement gas.

To change the TWA Alarm value:

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.
When you have completed your selections, press [MODE]. You will see two choices:

- Save
- Undo

You can register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

20.5.9. Alarm Mode

There are two selectable alarm types:

Latched When the alarm is triggered, you can manually stop the alarm.
The latched setting only controls alarms for High Alarm, Low Alarm, STEL Alarm, and TWA alarm.

Note: To clear an alarm when the instrument is set to "Latched," press [Y/+] when the main (Reading) display is shown.

Automatic Reset When the alarm condition is no longer present, the alarm stops and resets itself.

1. Press [N/-] to step from one alarm type to the other.
2. Press [Y/+] to select an alarm type.

When you have completed your selections, press [MODE].

You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

20.5.10. Buzzer & Light

The buzzer and light alarms can be programmed to be on or off individually or in combination. Your choices are:

- Both on
- Light only
- Buzzer only
- Both off

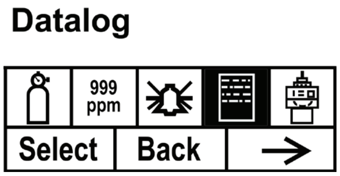
1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates your selection).
3. When you have completed your selections, press [MODE].

You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

20.6. Datalog

The instrument calculates and stores the concentration and ID of each sample taken. In the datalog sub-menu, a user can perform the tasks and functions shown below.



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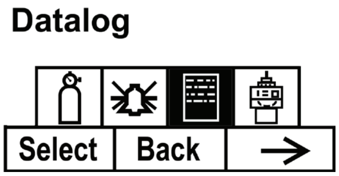

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1. Scroll through the Datalog sub-menu using the [N/-] key until the display shows the desired parameter to be changed:

   Clear Datalog
   Interval
   Data Selection
   Datalog Type

2. Press [Y/+] to make your selection. Exit by pressing [MODE] for Back.

20.6.1. Clear Datalog

This erases all the data stored in the datalog.

Note: Once the datalog is cleared, the data cannot be recovered.

Press [Y/+] to clear the datalog. The display asks, "Are you sure?"

- Press [Y/+] if you want to clear the datalog. When it has been cleared, the display shows "Datalog Cleared!"
- Press [N/-] if you do not want to clear the datalog.

The display changes, and you are taken to the next sub-menu, Interval.

20.6.2. Interval

Intervals are shown in seconds. The default value is 60 seconds. The maximum interval is 3600 seconds.

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.
When you have completed your selections, press [MODE].

You will see two choices: Save and Undo. You can register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

20.6.3. Data Selection

Data Selection allows you to select which types of data are stored and made available when you offload your datalog to a computer via ProRAE Studio II or Honeywell Safety Suite Device Configurator software.

You can choose any or all of three types of data (you must choose at least one):

- Average
- Maximum
- Minimum

1. Press [N/-] to step from one option to the next. The highlighter indicates your choice.
2. Press [Y/+] to toggle your selection on or off (the check box indicates "on" with an "X").
3. When you have completed your selections, press [MODE].

You will see two choices: Save and Undo. You can register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

20.6.4. Datalog Type

The instrument has three datalog types:

Auto	Default mode. Collects datalog information when the instrument is sampling.
Manual	Datalogging occurs only when the instrument's datalogging is manually started (see below for details).
Snapshot	Datalogs only during single-event capture sampling.

Note: You can only choose one datalog type to be active at a time.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].

You will see two choices: Save and Undo. You can register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

20.6.5. Manual Datalog

When the instrument is set to Manual Datalog, you turn datalogging on and off by stepping through the displays from the Main Display, and then pressing the keys to select datalog on/off functions.

- When you reach the screen that says "Start Datalog?" press [Y/+] to start it. You see "Datalog Started," confirming that datalogging is now on.
- When you reach the screen that says "Stop Datalog?" press [Y/+] to stop it. You see "Datalog Stopped," confirming that datalogging is now off.

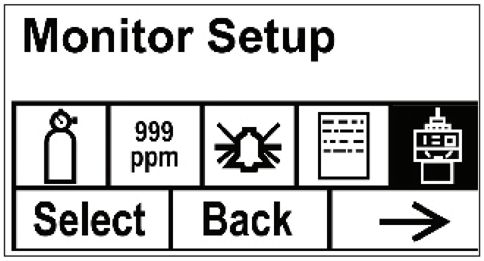
20.6.6. Snapshot Datalog

When the instrument is in Snapshot datalogging mode, it captures a single "snapshot" of the data at the moment of your choosing. Whenever the instrument is on and it is set to Snapshot, all you have to do is press [MODE] each time you want to capture a snapshot of the data at that instant.

When you send the data to a computer using ProRAE Studio II or Honeywell Safety Suite Device Configurator, the data snapshots are uniquely identified by time and other parameters.

20.7. Monitor Setup

Many settings can be accessed in this menu, including setting the date and time and adjusting the pump's on/off duty cycle.



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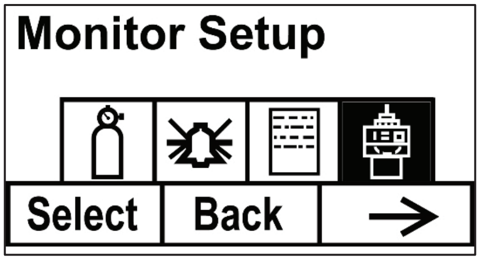

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Radio Power

The radio connection can be turned on or off. (The default value is off.)

1. Press [N/-] to step from one option to the next (on or off).
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates that the option is selected).
3. When you have completed your selection, press [MODE].

- Press [Y/+] to accept the new radio setting (on or off).
- Press [N/-] to discard the change and move to the next sub-menu.

20.7.1. Op Mode

Note: This feature is not included on MiniRAE Lite+.

Under Monitor Setup is "Op Mode."

Press [Y/+] to select.

You see two options (one is highlighted):

Hygiene
Search

The current mode is indicated by a dark circle within the circle in front of either Hygiene or Search.

1. Select Hygiene or Search by pressing [N/-]. The highlighting changes from one to the other each time you press [N/-].
2. Press [Y/+] to select that mode for the instrument.
3. Press [MODE] when you want to register your selection to place the instrument in the selected mode.
4. Press [Y/+] to commit the change and exit to the Monitor Setup screen, or press [N/-] to Undo (exit to the Monitor Setup screen without changing the Mode).

20.7.2. Site ID

Enter an 8-digit alphanumeric/character Site ID in the programming mode. This Site ID is included in the datalog report.

1. Press [Y/+] and the display shows the current site ID. Example: “RAE00001.” Note that the left-most digit flashes to indicate it is the selected one.
2. Press [Y/+] to step through all 26 letters (A to Z) and 10 numerals (0 to 9).

   Note: The last four digits must be numerals.

3. Press [N/-] to advance to the next digit. The next digit to the right flashes.
4. Repeat this process until all eight digits of the new site ID are entered.

Press [MODE] to exit.

If there is any change to the existing site ID, the display shows “Save?” Press [Y/+] to accept the new site ID. Press [N/-] to discard the change and move to the next sub-menu.

20.7.3. User ID

Enter an 8-digit alphanumeric User ID in the programming mode. This User ID is included in the datalog report.

1. Press [Y/+] and the display shows the current User ID. Example: “RAE00001.” Note that the left-most digit flashes to indicate it is the selected one.
2. Press [Y/+] to step through all 26 letters (A to Z) and 10 numerals (0 to 9).
3. Press [N/-] to advance to the next digit. The next digit to the right flashes.
4. Repeat this process until all eight digits of the new User ID are entered.

Press [MODE] to exit.

If there is any change to the existing User ID, the display shows “Save” Press [Y/+] to accept the new site ID. Press [N/-] to discard (undo) the change and move to the next sub-menu.

20.7.4. User Mode

Note: This feature is not included on MiniRAE Lite+.

The instrument has two user modes:

Basic	Basic users can only see and use a basic set of functions.
Advanced	Advanced users can see all screens and perform all available functions.

Note: The default value for User Mode is Basic.

To change the User Mode:

1. Press [N/-] to step from one option to the next. The highlighting changes each time you press [N/-].
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].
4. Press [Y/+] to accept the new User Mode. Press [N/-] to discard the change and move to the next sub-menu.

20.7.5. Date

The Date is expressed as Month/Day/Year, with two digits for each.

1. Press [Y/+] and the display shows the current date. Note that the left-most digit flashes to indicate it is selected.
2. Press [Y/+] to step through all 10 numerals (0 to 9).
3. Press [N/-] to advance to the next digit. The next digit to the right flashes.
4. Repeat this process until all six digits of the new date are entered.
5. Press [MODE] to exit.

- Press [Y/+] to save the new date.
- Press [N/-] to undo the change and move to the next sub-menu.

20.7.6. Time

The Time is expressed as Hours/Minutes/Seconds, with two digits for each. The time is in 24-hour (military) format.

1. Press [Y/+] and the display shows the current time. Note that the left-most digit flashes to indicate it is selected.
2. Press [Y/+] to step through all 10 numerals (0 to 9).
3. Press [N/-] to advance to the next digit. The next digit to the right flashes.
4. Repeat this process until all six digits of the new time are entered.
5. Press [MODE] to exit.

- Press [Y/+] to save the new date.
- Press [N/-] to undo the change and move to the next sub-menu.

20.7.8. Duty Cycle

The pump’s duty cycle is the ratio of its on time to off time. The duty cycle ranges from 50% to 100% (always on). Duty cycling is employed by the instrument to clean the PID. A lower duty cycle has a greater effect on keeping the PID clean than a higher duty cycle.

Important! Pump duty cycling is interrupted when the instrument senses a gas. The pump’s duty cycle is disabled when the measurement is greater than the low-alarm threshold and is re-enabled when the reading falls below the low-alarm threshold. The range is 10 to 300 seconds, and the default value is 30.

1. Press [Y/+] to increase the value.
2. When you have completed your selection, press [MODE].

- Press [Y/+] to save the new duty cycle value.
- Press [N/-] to undo the change and move to the next sub-menu.

20.7.9. Temperature Unit

The temperature display can be switched between Fahrenheit and Celsius units.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the “radio button” indicates “on”).
3. When you have completed your selection, press [MODE].

- Press [Y/+] to save the new temperature unit.
- Press [N/-] to undo the change and move to the next sub-menu.

20.7.10. Pump Speed

The pump can operate at two speeds, high and low. Running at low speed is quieter and conserves a small amount of power. There is almost no difference in sampling accuracy.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the “radio button” indicates “on”).
3. When you have completed your selection, press [MODE].

- Press [Y/+] to save the new temperature unit.
- Press [N/-] to undo the change and move to the next sub-menu.

20.7.11. Language

English is the default language, but other languages can be selected for the instrument.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the “radio button” indicates “on”).
3. When you have completed your selection, press [MODE].

- Press [Y/+] to save your new language choice.
- Press [N/-] to undo it and return to the previous language selection.

20.7.12. Real Time Protocol

Note: This feature is not included on MiniRAE Lite+.

Real Time Protocol is the setting for data transmission.

The choices are:

P2M (cable)	Point to multipoint. Data is transferred from the instrument to multiple locations using a wired connection. Default data rate: 19200 bps.
P2P (cable)	Point to point. Data is transferred only between the instrument and one other location, such as a computer. Default data rate: 9600 bps.
Wireless	Data is transferred wirelessly and can be received by receivers.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the “radio button” indicates “on”).
3. When you have completed your selection, press [MODE].

- Press [Y/+] to save the new real-time communications protocol.
- Press [N/-] to undo the change and move to the next sub-menu.

20.7.13. Power On Zero

Note: This is not recommended for ppbRAE3000+ or UltraRAE3000+.

Always make sure the instrument is turned on in VOC-free environment..When Power On Zero is on, the instrument performs a zero calibration when it is turned on.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the “radio button” indicates your selection).
3. When you have completed your selection, press [MODE].

- Press [Y/+] to save the change.
- Press [N/-] to discard the change and move to the next sub-menu.

20.7.14. Unit ID

This three-digit number keeps data separated by instrument when more than one instrument is used in a network. If multiple sensing units are attempting to communicate with the same Host, then the units must all have a different Unit ID.

1. Press [Y/+] to step through all 10 numerals (0 to 9). If you pass the numeral you want, keep pressing [Y/+]. After it counts up to 9, it starts counting up from 0 again.
2. Press [N/-] to advance to the next digit. The next digit to the right flashes.
3. Repeat this process until all three digits of the Unit ID are entered.
4. Press [MODE] when you are done.

- Press [Y/+] to save the change.
- Press [N/-] to discard the change and move to the next sub-menu

20.7.15. LCD Contrast

The display’s contrast can be increased or decreased from its default setting. You may not need to ever change the default setting, but sometimes you can optimize the display to suit extreme temperature and ambient brightness/darkness conditions.

- The minimum value is 20.
- The maximum value is 60.

1. Press [Y/+] to increase the value or [N/-] to decrease the value.
2. Press [MODE] to save your selection.

- Press [Y/+] to save your new contrast value.
- Press [N/-] to undo it and return to the previous value.

20.7.16. Lamp ID

The instrument does not automatically identify the type of lamp, so you must select a lamp type manually.

1. Scroll through the menu by pressing [N/-].
2. Press [Y/+] to make a selection.
3. Press [MODE] when you are done.
4. Press [Y/+] to save your choice or [N/-] to undo your selection.

20.7.17. PAN ID

The instrument and any other devices that you want to interconnect wirelessly must have the same PAN ID. You can set the PAN ID in the instrument or through ProRAE Studio II or Honeywell Safety Suite Device Configurator.

1. Press [N/-] to advance through the digits from left to right.
2. Press [Y/+] to] to advance through the numbers (1, 2, 3, etc.).
3. Press [MODE] to register your choice when you are done.

Note: PAN ID does not apply to BLE-equipped instruments.

20.7.18. Mesh Channel

Note: For mesh radio modems operating at 868MHz, only channel 0 is available. For other frequencies, channels 1 through 10 are allowed.

1. Press [Y/+] to increase the number and [N/-] to advance to the next digit.
2. After moving to the last digit and making changes, press [MODE].

- Press [Y/+] to save the change.
- Press [N/-] to undo the change.

Note: Mesh Channel does not apply to BLE-equipped instruments.

20.7.19. Mesh Interval

Set the time interval at which the instrument's mesh radio sends out a signal. This can range from once every 10 seconds to once every four minutes (240 seconds). The transmission frequency is user-adjustable, but a rate of at least once every 30 seconds is recommended.

Note: Shorter intervals reduce battery life.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make a selection.
3. When you are done, press [MODE].

Note: Mesh Interval does not apply to BLE-equipped instruments.

21. Hygiene Mode

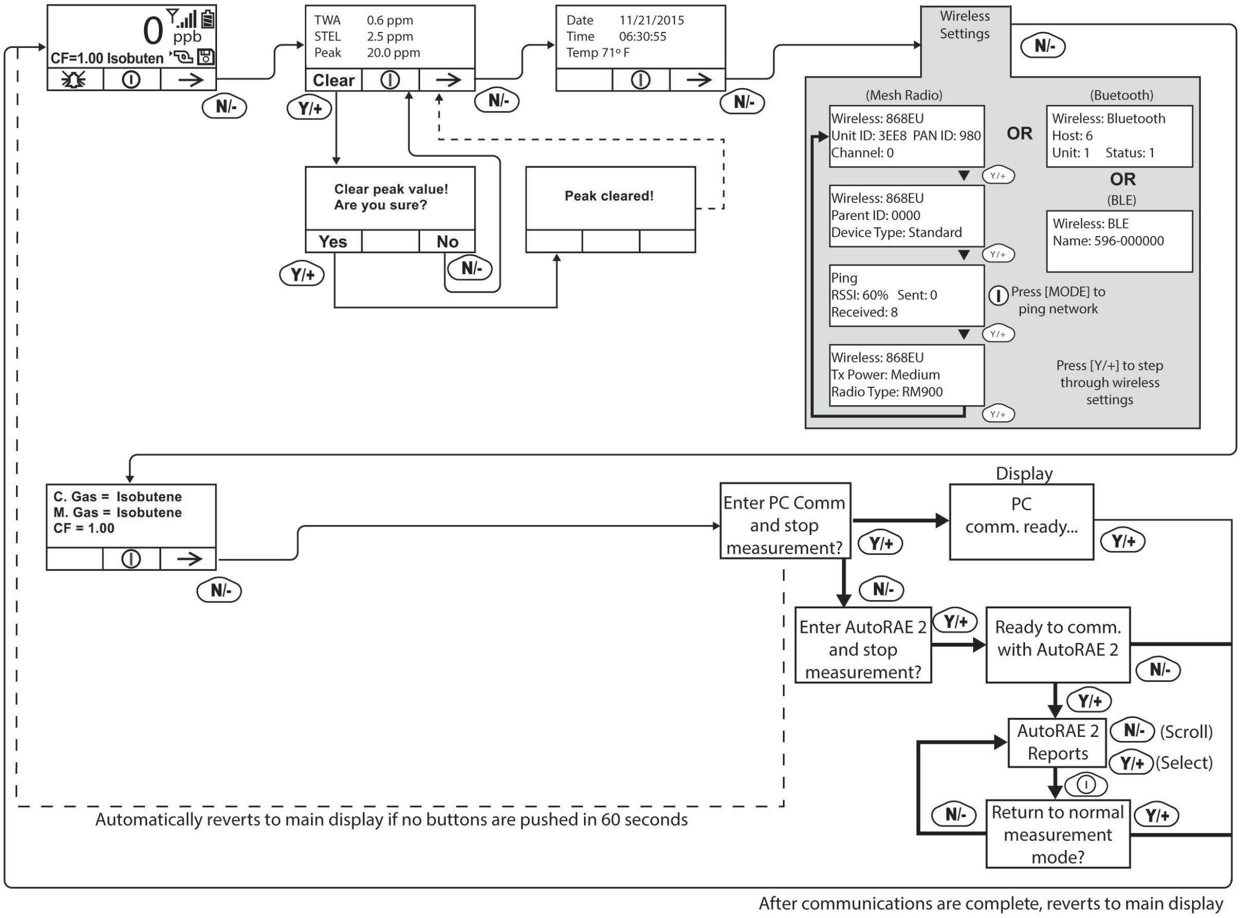
Note: This feature is not included on MiniRAE Lite+.

The instrument usually operates in Hygiene Mode, which provides basic functionality. However, it is possible to operate it in a second mode called Search Mode. Here are the primary differences:

Hygiene Mode:	Automatic measurements, continuously running and datalogging, and calculates additional exposure values.
Search Mode:	Manual start/stop of measurements and display of certain exposure values.

21.1. Basic User Level & Hygiene Mode

The default setting is navigated in the following way:



Note: Dashed line indicates automatic progression.

Pressing [N/-] steps you from screen to screen. Options include clearing the Peak value and turning on the instrument's PC Communications for data transfer to a PC.

21.2. Entering Search Mode From Hygiene Mode

In order to change the instrument's operational mode from Hygiene Mode to Search Mode, you must enter the password-protected Programming Mode:

1. Hold [MODE] and [N/-] until you see the password screen.
2. Use [Y/+] to increment to the number you want for the first digit. (If you pass by the desired number, press [Y/+] until it cycles through to 0 again. Then press [Y/+] until you reach the desired number.)
3. Press [N/-] to advance to the next digit.
4. Again press [Y/+] to increment the number.
5. Press [N/-] to advance to the next digit.

Continue the process until all four numbers of the password have been input. Then press [MODE] to proceed.

The screen changes to icons with the label "Calibration."

1. Press [N/-] to advance to "Monitor Setup."
2. Press [Y/+] to select Monitor Setup.

   Under Monitor Setup, you will see "Op Mode."

3. Press [Y/+] to select.

You will see:

Hygiene
Search

The current mode is indicated by a dark circle within the circle in front of either Hygiene or Search.

1. Select Hygiene or Search by pressing [N/-].
2. Press [Y/+] to place the instrument into the selected mode.
3. Press [MODE] when you want to register your selection to place the instrument in the selected mode.
4. Press [Y/+] to commit the change and exit to the Monitor Setup screen, or press [N/-] to Undo (exit to the Monitor Setup screen without changing the Mode).

22. Advanced User Level (Hygiene Mode Or Search Mode)

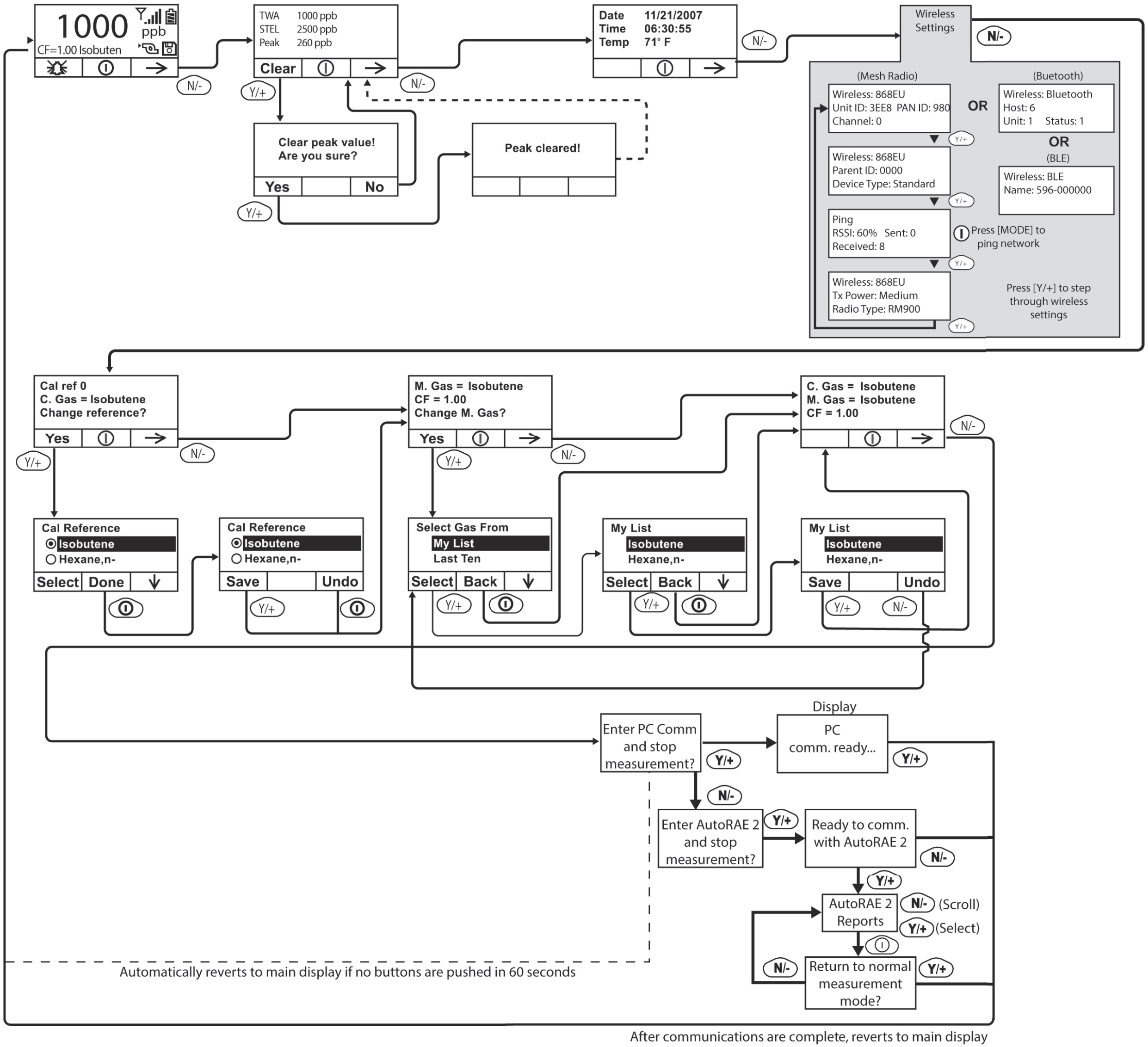
The User Mode called Advanced User Level allows a greater number of parameters to be changed than Basic User Level. It can be used with either of the Operation Modes, Hygiene Mode or Search Mode.

22.1. Advanced User Level & Hygiene Mode

With the instrument in Operation Mode: Hygiene Mode, enter User Mode: Advanced User Level (refer to the section called Monitor Mode for instructions).

Once you are in Advanced User Level and Hygiene Mode together, you can change the calibration reference and measurement gas, in addition to performing normal monitoring functions.

Pressing [N/-] progresses through the screens, while pressing [Y/+] selects options. Pressing [MODE] makes menu choices when it is shown for “Done” or “Back.” Pressing and holding [Mode] whenever the circle with a vertical line in the middle is shown activates the countdown to shutoff.

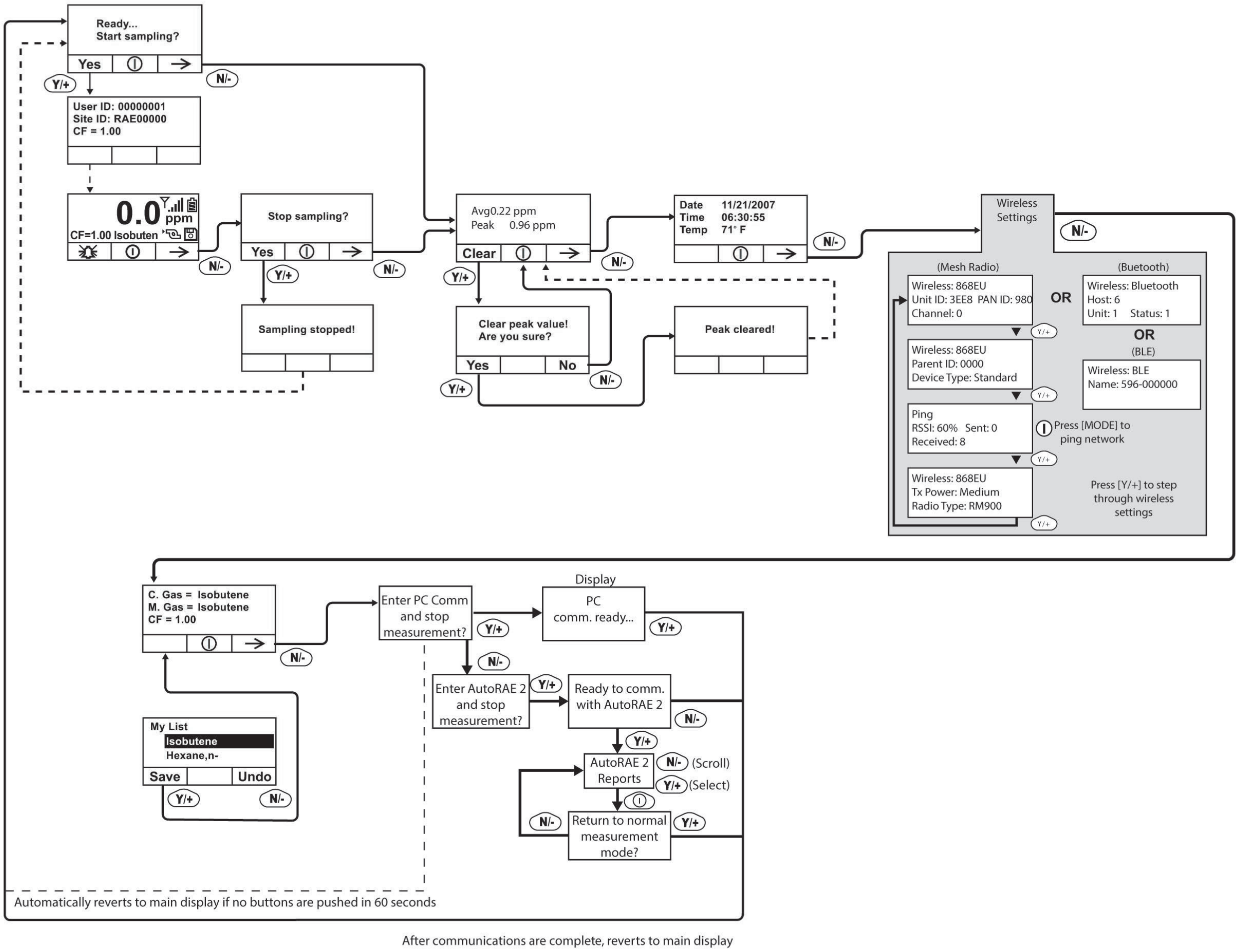


Note: Dashed line indicates automatic progression.

22.2. Basic User Level & Search Mode

With the instrument in Operation Mode: Search Mode, enter User Mode and select Basic User Level (refer to the section called User Mode for instructions).

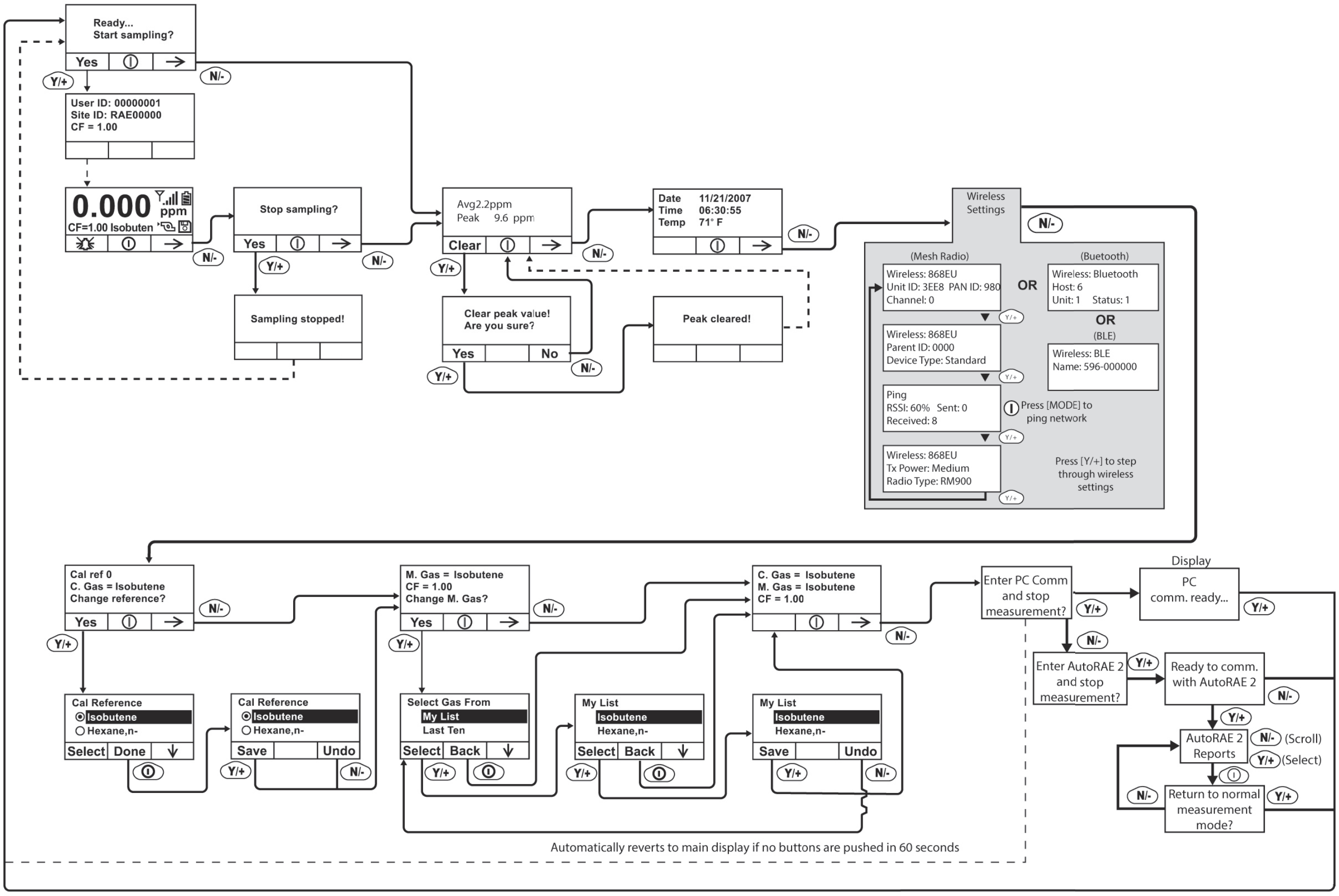
When the instrument is in Search Mode, it only samples when you activate sampling. When you see the display that says, “Ready…Start sampling?” press [Y/+] to start. The pump turns on and the instrument begins collecting data. To stop sampling, press [N/-] while the main display is showing. You will see a new screen that says, “Stop sampling?” Press [Y/+] to stop sampling. Press [N/-] if you want sampling to continue.



Note: Dashed line indicates automatic progression.

22.3. Advanced User Level & Search Mode

With the instrument in Operation Mode: Search Mode, enter User Mode and select Advanced User Level (refer to the section called Monitor Mode for instructions). Operation is similar to Basic User Level & Sampling Mode, but now allows you to change calibration and measurement reference gases. Refer to the section on measurement gases for more details.



Note: Dashed line indicates automatic progression.

23. Diagnostic Mode

IMPORTANT!

Diagnostic Mode is designed for servicing and manufacturing, and therefore is not intended for everyday use, even by advanced users. It provides raw data from sensors and about settings, but only allows adjustment of pump stall parameters, which should only be changed by qualified personnel.

Note: If the instrument is turned on in Diagnostic Mode and you switch to User Mode, datalog data remains in raw count form. To change to standard readings, you must restart the instrument.

23.1.1. Entering Diagnostic Mode

Note: To enter Diagnostic Mode, you must begin with the instrument turned off.

Press and hold [Y/+] and [MODE] until the instrument starts.

The instrument goes through a brief startup, and then displays raw data for the PID sensor. These numbers are raw sensor readings without calibration. The instrument is now in Diagnostic Mode.

Note: In Diagnostic Mode, the pump and lamp are normally on.

You can enter Programming Mode and calibrate the instrument as usual by pressing both [MODE] and [N/-] for three seconds.

You can enter Monitoring Mode by pressing [MODE] and [Y/+] together for three seconds.

Once the instrument is started up in Diagnostic Mode, you can switch between Diagnostic Mode and Monitoring Mode by pressing and holding [MODE] and [Y/+] simultaneously for two seconds.

In Diagnostic mode, you can step through parameter screens by pressing [MODE].

23.1.2. Adjusting The Pump Stall Threshold

If the gas inlet is blocked but the pump does not shut down, or the pump shuts down too easily with a slight blockage, the pump stall threshold value may be set too high or too low.

Use the following steps to adjust the pump stall threshold:

23.1.3. Pump High

In Diagnostic Mode, press the [MODE] key until “Pump High” is displayed. The display shows the maximum, minimum, and stall values for the pump at its high speed. Write down the “Max” reading.

Block the gas inlet and watch the pump current reading (labeled “I”) increase. Write down its blocked reading. **Note:** If the pump current reading does not increase significantly (less than 10 counts), then there may be a leak in the gas inlet or the pump is weak or defective.

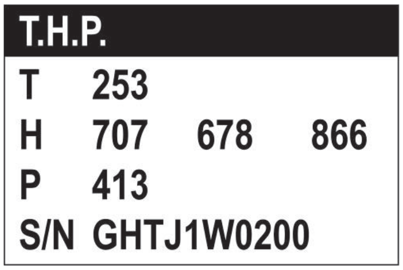
Add the two readings you wrote down. This is the average of the maximum block count and the maximum idle count. Divide that number by 2. Use the [Y/+] or [N/-] key to increase or decrease the stall value to equal that number.

Press the [MODE] key to exit this display.

23.1.4. Testing The Humidity Sensor

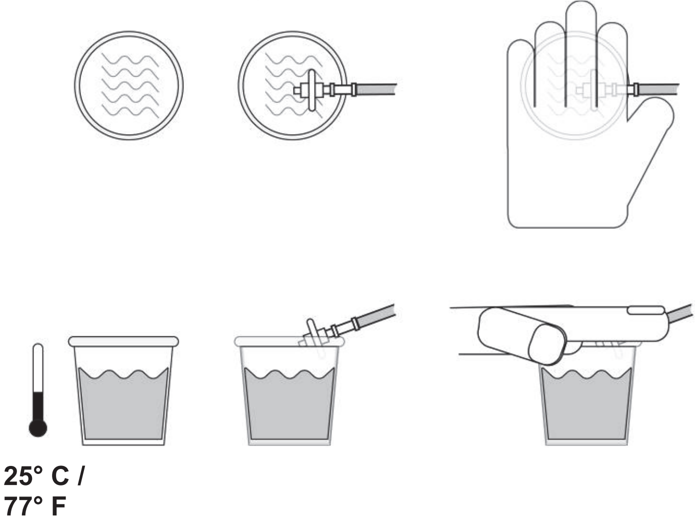
1. Press [MODE] to step through the diagnostic screens until you reach a screen that says “THP” (for “temperature, humidity, pressure,” although pressure is not supported) at the top.

   There are three numbers for the humidity reading (“H”). The first number is the current humidity reading from the sensor. The second is the reference number for 0% humidity, and the third number is the reference for 100% humidity.



```
T.H.P.
T    253
H    707   678   866
P    413
S/N  GHTJ1W0200
```

2. Fill a cup with warm water (>25° C/77° F).
3. Put a filter on the UltraRAE 3000+’s inlet probe.
4. Place the inlet probe over the warm water.
5. Cover the cup with your hand.



6. Wait a few seconds and check the high-humidity reading.
7. The humidity reading should be within ±10% of the 100% humidity reading. If it is not, then the THP Sensor (part number 023-3011-000-FRU) should be replaced.
8. Check the low-humidity reading by connecting the inlet probe to a tank of zero gas (air at 0% humidity).
9. Turn on the zero gas and wait a few seconds for the sensor reading to stabilize. It should read within 10% of the low-reference number. If it does not, replace the THP sensor.
10. Once you have finished testing the humidity sensor, exit Diagnostic Mode by shutting down the instrument (hold [MODE] through the countdown, and then release when it is off).

23.1.5. Pump Low

In Diagnostic Mode, press the [MODE] key until “Pump Low” is displayed. The display shows the maximum, minimum, and stall values for the pump at its low speed. Write down the “Max” reading.

Block the gas inlet and watch the pump current reading (labeled “I”) increase. Write down its blocked reading. **Note:** If the pump current reading does not increase significantly (less than 10 counts), then there may be a leak in the gas inlet or the pump is weak or defective.

Add the two readings you wrote down. This is the average of the maximum block count and the maximum idle count. Divide that number by 2. Use the [Y/+] or [N/-] key to increase or decrease the stall value to equal that number.

Press the [MODE] key to exit this display.

23.1.6. Exiting Diagnostic Mode

You can exit Diagnostic Mode and go directly to Programming Mode or Monitor Mode as outlined above, or you can exit Diagnostic Mode completely.

To exit Diagnostic Mode so that it cannot be re-entered without a restart:

Shut down the instrument. When it is off, restart it by holding the [MODE] key. Diagnostic Mode cannot be entered until the instrument is restarted as outlined in “Entering Diagnostic Mode.”

24. Transferring Data To & From A Computer

Once you have connected your instrument cradle to the PC, you can can transfer data, including a download of the datalog to the computer and updates of firmware to the instrument (should this ever be necessary).

24.1. Downloading The Datalog To A PC

1. Connect the data cable to the PC and the cradle.
2. Place the instrument into its cradle. The charging LED should be illuminated.
3. Start ProRAE Studio II or Honeywell Safety Suite Device Configurator on your PC.
4. Select "Operation" and select Setup Connection.
5. Select the COM port to establish a communication link between the PC and the instrument.
6. To receive the datalog in the PC, select "Downlog Datalog."
7. When you see "Unit Information," click OK.

During the data transfer, the display shows a progress bar.

When the transfer is done, you will see a screen with the datalog information. You can now export this datalog for other use or printing.

24.2. Uploading Firmware To The instrument From A PC

Uploading new firmware to your instrument requires connecting the instrument and PC. Follow these steps to make the connection:

1. Connect the data cable to the PC and the cradle.
2. Place the instrument into its cradle. The charging LED should be illuminated.
3. Start ProRAE Studio II or Honeywell Safety Suite Device Configurator on your PC.
4. With ProRAE Studio II, click the "Firmware" icon on the left,side. Then click "Run programmer" to open
   RAEProgrammer 4000.
5. From RAEProgrammer 4000, select "Open" and select the firmware to upgrade
6. Select the COM port to establish a communication link between the PC and the instrument.
7. Click "Start" button

Once communication is established, follow the instructions that accompany RAEProgrammer 4000 and the firmware to upload the new firmware to your instrument.

Note: Check for the latest updates to ProRAE Studio II or Honeywell Safety Suite Device Configurator at www.raesystems.com.

25. Maintenance

The major maintenance items of the instrument are:

- Battery pack
- Sensor module
- PID lamp
- Sampling pump
- Inlet connectors and filters

Note: Maintenance should be performed by qualified personnel only.

Note: The printed circuit board of the instrument is connected to the battery pack even if the power is turned off. Therefore, it is very important to disconnect the battery pack before servicing or replacing any components inside the instrument. Severe damage to the printed circuit board or battery may occur if the battery pack is not disconnected before servicing the unit.

25.1. Battery Charging & Replacement

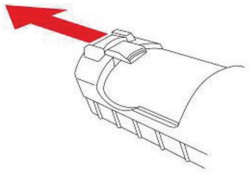
When the display shows a flashing empty battery icon, the battery requires recharging. It is recommended to recharge the instrument upon returning from fieldwork. A fully charged battery runs a instrument for 16 hours continuously. The charging time is less than 8 hours for a fully discharged battery. The battery may be replaced in the field (in areas known to be non-hazardous), if required.

WARNING!

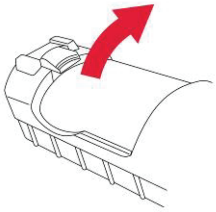
To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in areas known to be non-hazardous.

25.1.1. Replacing The Li-ion Battery

1. Turn off the instrument.
2. Located on the rear of the instrument is a battery tab. Slide it down to unlock the battery.



3. Remove the battery pack from the battery compartment by tilting it out.



4. Replace a fully charged spare battery pack inside the battery compartment. Make sure the battery pack is oriented properly inside the compartment.

Slide the capture tab back up to its locked position.

25.1.2. Replacing The Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500) and provides approximately 12 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the Li-ion battery pack.

To insert batteries into the adapter:

1. Remove the three Philips-head screws to open the compartment.
2. Insert four fresh AA batteries as indicated by the polarity (+/-) markings.
3. Replace the cover. Replace the three screws.

To install the adapter in the instrument:

1. Remove the Li-ion battery pack from the battery compartment by sliding the tab and tilting out the battery.
2. Replace it with the alkaline battery adapter
3. Slide the tab back into place to secure the battery adapter.

IMPORTANT!

Alkaline batteries cannot be recharged. The instrument's internal circuit detects alkaline batteries and will not allow recharging. If you place the instrument in its cradle, the alkaline battery will not be recharged. The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the instrument.

Note: When replacing alkaline batteries, dispose of old ones properly.

WARNING!

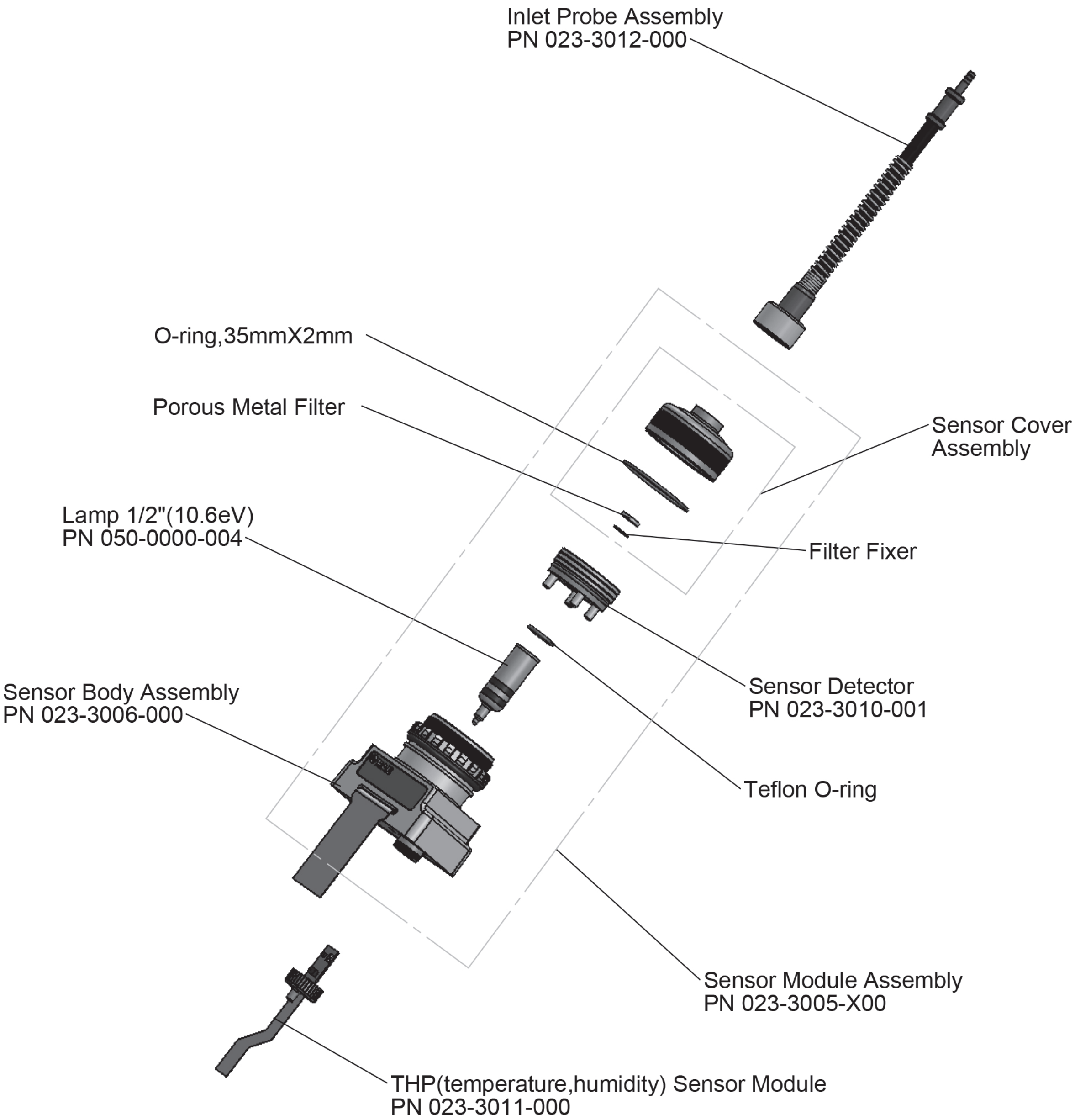
To reduce the risk of ignition of hazardous atmospheres, recharge the battery only in areas known to be non-hazardous. Remove and replace the battery only in areas known to be non-hazardous.

Note: The internal charging circuit is designed to prevent charging to alkaline batteries.

25.2. PID Sensor & Lamp Cleaning/Replacement

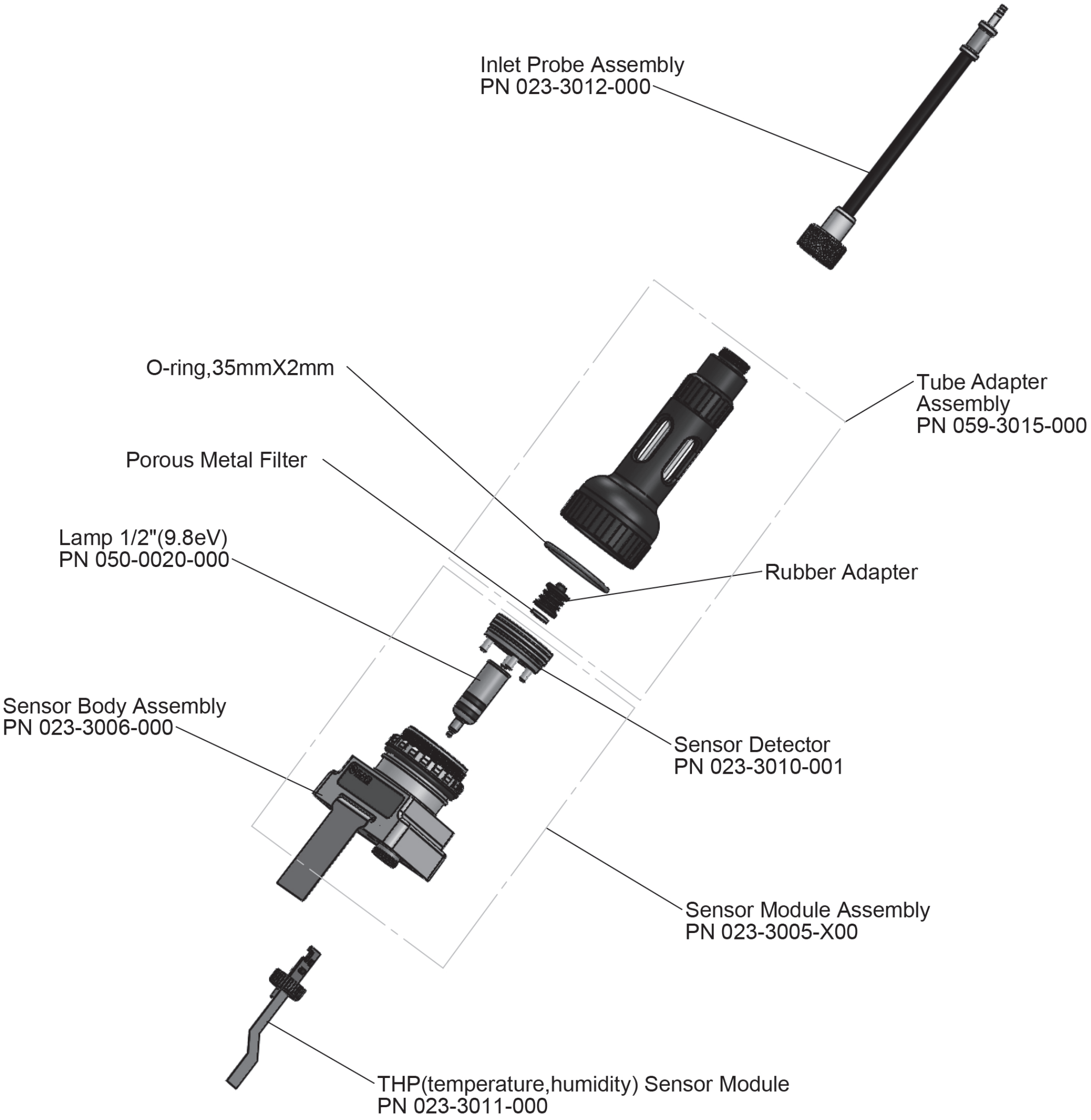
Sensor Components – MiniRAE 3000+, ppbRAE 3000+, MiniRAE Lite+

The sensor module is made of several components and is attached to the lamp-housing unit as shown below.



Sensor Components – UltraRAE 3000+

The sensor module is made of several components and is attached to the lamp-housing unit as shown below.



Note: The cleaning procedure is not normally needed. Clean the PID sensor module, the lamp and the lamp housing only when one of the following has happened:

1. The reading is inaccurate even after calibration.
2. The reading is very sensitive to air moisture.
3. A chemical liquid has been sucked into the unit and damaged the unit.

Use of the external filter helps to prevent contamination of the sensor.
To access the sensor components and lamp, gently unscrew the lamp-housing cap, remove the sensor adapter with the gas inlet probe and the metal filter all together. Then hold the PID sensor and pull it straight out. A slight, gentle rocking motion helps release the sensor.

25.2.1. Cleaning The PID Sensor

Place the entire PID sensor module into GC grade methanol. It is highly recommended that an ultrasound bath to be used to clean the sensor for at least 15 minutes. Then dry the sensor thoroughly. Never touch the electrodes of the sensor by hand.

Also use a methanol-soaked cotton swab to wipe off the lamp housing where it contacts the sensor when the sensor is installed.

Turn over the sensor so that the pins point up and the sensor cavity is visible. Examine the sensor electrodes for any corrosion, damage, or bending out of alignment. The metal sensor electrode "fingers" should be flat and straight. If necessary, carefully bend the sensor fingers to ensure that they do not touch the Teflon portions and that they are parallel to each other. Make sure that the nuts on the sensor pins are snug but not overtight. If the sensor is corroded or otherwise damaged, it should be replaced.

25.2.2. Cleaning The Lamp Housing Or Changing The Lamp

If the lamp does not turn on, the instrument will display an error message to indicate replacement of the lamp may be required.

1. If the lamp is operational, clean the lamp window surface and the lamp housing by wiping it with GC grade methanol using a cotton swab using moderate pressure. After cleaning, hold the lamp up to the light at an angle to detect any remaining film. Repeat the process until the lamp window is clean. Never use water solutions to clean the lamp. Dry the lamp and the lamp housing thoroughly after cleaning.

   CAUTION: Never touch the window surface with the fingers or anything else that may leave a film. Never use acetone or aqueous solutions.

2. If the lamp does not turn on, remove the lamp from the lamp housing. Place the lamp O-ring onto the new lamp. Insert the new lamp, avoiding contact with the flat window surface.
3. Reinstall the PID sensor module.
4. Tighten the Lamp Housing Cap.

25.2.3. Determining The Lamp Type

Note: This feature is not included on the MiniRAE Lite+.

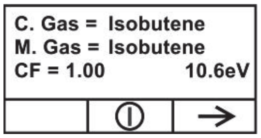
The monitor can accommodate two lamp values: 10.6eV (standard) and 9.8eV.

There are two ways to determine the lamp type.

1. Turn off the instrument and remove the lamp. Now look at the serial number. The following identify the lamp type:

10.6eV	SN:106 XXXXXXX
9.8eV	SN:098 XXXXXXX
11.7eV	SN:117 XXXXXXX

2. When the monitor is running, the lamp type is shown along with the calibration and measurement gas and Correction Factor:



C. Gas = Isobutene
M. Gas = Isobutene
CF = 1.00 10.6eV

3. **Note:** This screen can be accessed from the reading screen by pressing [N/-] four times.

Programming The Lamp ID

The correct measurement gas library is used by the instrument when you ensure that the right lamp value is programmed.

To manually select the Lamp ID:

1. Enter the Programming menu.
2. Select Monitor Setup.
3. Scroll down and select the Lamp ID sub-menu.
4. Press [N/-] to scroll down to the desired Lamp ID.
5. Press [Y/+] to select.
6. Press [MODE] to select Done.
7. Select “Save.”
8. Return to the main menu.

Recalibrate the instrument before returning it to service.

25.2.4. Sampling Pump

When approaching the end of the specified lifetime of the pump, it will consume higher amount of energy and reduce its sample draw capability significantly. When this occurs, it is necessary to replace or rebuild the pump. When checking the pump flow, make sure that the inlet connector is tight and the inlet tubing is in good condition. Connect a flow meter to the gas inlet probe. The flow rate should be above 450 cc/min when there is no air leakage.

If the pump is not working properly, refer the instrument to qualified service personnel for further testing and, if necessary, pump repair or replacement.

25.2.5. Cleaning The Instrument

Occasional cleaning with a soft cloth is recommended. Do not use detergents or chemicals.

Visually inspect the contacts at the base of the instrument, on the battery, and on the Charger Stand to make sure they are clean. If they are not, wipe them with a soft, dry cloth. Never use solvents or cleaners.

25.3. Special Servicing Note

If the instrument needs to be serviced, contact either:

1. The Honeywell distributor from whom the instrument was purchased; they will return the instrument on your behalf.

   or

2. The Honeywell Technical Service Department. Before returning the instrument for service or repair, obtain a Returned Material Authorization (RMA) number for proper tracking of your equipment. This number needs to be on all documentation and posted on the outside of the box in which the instrument is returned for service or upgrade. Packages without RMA Numbers will be refused at the factory.

25.4. Crash Recovery

3G Firmware Crash Recovery Procedure:

1. Press [Y/+] and [MODE] and [N/-] keys simultaneously. **Note:** The display will be blank and no LED will glow.
2. Use a USB cable to onnect the instrument to a PC using a Travel Charger or Charger Stand.
3. Connect the 12-volt DC power supply to the Travel Charger or Charger Stand.
4. Open RAEProgrammer 4000 in ProRAE Studio II.

Option 1 (only applicable only to a 64-bit Operating System):

- Verify correct COM Port prior to downloading
- Local disk(C) >> Program Files(x86) >> RAE Systems by Honeywell >> ProRAE Studio II >> Programmer >> RAEProgrammer 4000 >> RAEProgrammer4000.exe.

Option 2: Connect a known good instrument to the PC, open ProRAE Studio II, click on "Auto Detect," select "Firmware," and click on "Run Programmer" under "Application Firmware." Disconnect the instrument and then connect the instrument that requires recovery.

5. Load the Application Firmware.

Notes:

- On the instrument, no LEDs will turn on and the display will be blank during downloading.
- Firmware download is in process when Duration time in Processing Information section of RAE Programmer4000 is counting up.

When the instrument is turned on, RAEProgrammer 4000 will show a message that shows it has loaded the application firmware.

26. Troubleshooting

Problem	Possible Reasons & Solutions	
Cannot turn on power after charging the battery	**Reasons:**	Discharged battery. Defective battery.
	Solutions:	Charge or replace battery.
Lost password	**Solutions:**	Call Technical Support
Reading abnormally High	**Reasons:**	Dirty filter. Dirty sensor module. Excessive moisture and water condensation. Incorrect calibration.
	Solutions:	Replace filter. Blow-dry the sensor module. Calibrate the unit.
Reading abnormally Low	**Reasons:**	Dirty filter. Dirty sensor module. Weak or dirty lamp. Incorrect calibration.
	Solutions:	Replace filter. Remove Calibration Adapter. Calibrate the unit. Check for air leakage.
Buzzer Inoperative	**Reasons:**	Bad buzzer.
	Solutions:	Check that buzzer is not turned off. Call authorized service center.
Inlet flow too low	**Reasons:**	Pump diaphragm damaged or has debris. Flow path leaks.
	Solutions:	Check flow path for leaks; sensor module O-ring, tube connectors, Teflon tube compression fitting. Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
"Lamp" message during operation	**Reasons:**	Lamp drive circuit. Weak or defective PID lamp, defective.
	Solutions:	Turn the unit off and back on. Replace UV lamp

27. Technical Support

To contact Honeywell Technical Support Team:

Brazil: +55 11 3309 1030

Canada: +1 800 663 4164

China: +86 21 5855 7305

Europe: +41 44 943 4380

India: +91 124 4752700

Japan: **+81 3 6730 7320**

Korea: +82 2 69090300

Latin America (Spanish): +57 1 64 0401 3

Middle East: +971 4 4505800

Russia/CIS: +7 495 796 9800

Singapore: +65 65803572

Taiwan: +886 3 5169284

USA: +1 888 749 8878

28. Controlled Part Of Manual

Intrinsic Safety:
US and Canada: Class I, Division 1, Groups A,B,C,D T4

Europe: ATEX (2460 Ex II 2G Ex ia IIC/IIB T4 Gb)
Sira 17ATEX2082X
Complies with EN60079-0:2013, EN60079-11:2012
IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb
Complies with IEC 60079-0:2011, IEC 60079-11:2011

Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)

29. Basic Operation

29.1. Turning The Instrument On

1. With the instrument turned off, press and hold [MODE].
2. When the display turns on, release the [MODE] key.

The instrument is now operating and performs self tests. Once the self tests are complete, the display shows a graph or numerical gas reading. This indicates that the instrument is fully functional and ready to use.

29.2. Turning The Instrument Off

1. Press and hold the Mode key for 3 seconds. A 5-second countdown to shutoff begins.
2. When you see “Unit off...” release your finger from the [MODE] key. The instrument is now off.

Note: You must hold your finger on the key for the entire shutoff process. If you remove your finger from the key during the countdown, the shutoff operation is canceled and the instrument continues normal operation.

30. Alarm Signals

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn you of the alarm condition. In addition, the instrument alarms if one of the following conditions occurs: battery voltage falls below a preset voltage level, failure of the UV lamp, pump stall, or when the datalog memory is full.

30.1. Alarm Signal Summary

Message	**Condition**	**Alarm Signal**
HIGH	Gas exceeds "High Alarm" limit	3 beeps/flashes per second*
OVR	Gas exceeds measurement range	3 beeps/flashes per second*
MAX	Gas exceeds electronics' maximum range	3 beeps/flashes per second*
LOW	Gas exceeds "Low Alarm" limit	2 beeps/flashes per second*
TWA	Gas exceeds "TWA" limit	1 Beep/flash per second*
STEL	Gas exceeds "STEL" limit	1 Beep/flash per second*
Pump icon flashes	Pump failure	3 beeps/flashes per second
Lamp	PID lamp failure	3 beeps/flashes per second plus "Lamp" message on display
Battery icon flashes	Low battery	1 flash, 1 beep per minute plus battery icon flashes on display
CAL	Calibration failed, or needs calibration	1 beep/flash per second
NEG	Gas reading measures less than number stored in calibration	1 beep/flash per second

Preset Alarm Limits & Calibration

The instrument is factory calibrated with standard calibration gas, and is programmed with default alarm limits.

Cal Gas (Isobutylene)	**Cal Span**	unit	**Low**	**High**	**TWA**	**STEL**
MiniRAE Lite+	100	ppm	50	100	10	25
MiniRAE 3000+	100	ppm	50	100	10	25
ppbRAE 3000+	10	ppm	10	25	10	25
UltraRAE 3000+ (Isobutylene)	100	ppm	50	100	10	25
UltraRAE 3000+ (Benzene)	5	ppm	2	5	0.5	2.5
UltraRAE 3000+ (Butadiene)	10	ppm	5	10	2	5

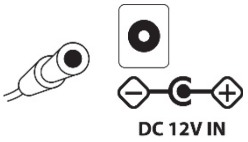
31. Charging The Battery

Always fully charge the battery before using the instrument. The instrument’s Li-ion/NiMH battery is charged by placing the instrument in its cradle. Contacts on the bottom of the instrument meet the cradle’s contacts, transferring power without other connections.

Note: Before setting the instrument into its Charger Stand or Travel Charger, visually inspect the contacts to make sure they are clean. If they are not, wipe them with a soft cloth. Do not use solvents or cleaners.

Follow this procedure to charge the instrument:

1. Plug the AC/DC adapter’s barrel connector into the instrument’s Charger Stand or Travel Charger.



2. Plug the AC/DC adapter into the wall outlet.
3. Place the instrument into the cradle, press down, and lean it back. It locks in place and the LED in the cradle glows.

Note: To release the instrument, press down and tilt the top out of the cradle and lift up.

The instrument begins charging automatically. The LED on the front of the cradle marked “Primary” blinks during charging. During charging, the diagonal lines in the battery icon on the instrument’s display are animated and you see the message “Charging...”

When the instrument’s battery is fully charged, the battery icon is no longer animated and shows a full battery. The message “Fully charged!” is shown and the Primary LED on the cradle glows continuously green.

Note: A spare Li-ion battery (059-3051-000) or NiMH(059-3054-000) can be charged by placing it directly in the charging port on the back of the cradle. It can be charged at the same time as the instrument. Press the battery in place, sliding it slightly toward the front of the cradle. This locks it in the cradle. To release the battery, slide it forward again and tilt it up.

Note: An Alkaline Battery Adapter (part number 059-3052-000), which uses four AA alkaline batteries (Duracell MN1500), may be substituted for the Li-Ion battery.

WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge and replace batteries only in areas known to be non-hazardous. Remove and replace batteries only in areas known to be non-hazardous.

31.1. Low Voltage Warning

When the battery’s charge falls below a preset voltage, the instrument warns you by beeping once and flashing once every minute, and the battery icon blinks once per second. You should turn off the instrument within 10 minutes and either recharge the battery by placing the instrument in its cradle, or replace the battery with a fresh one with a full charge.

31.2. Clock Battery

An internal clock battery is mounted on one of the instrument's printed circuit boards. This long-life battery keeps settings in memory from being lost whenever the Li-ion, NiMH, or alkaline batteries are removed. This backup battery should last approximately five years, and must be replaced by an authorized RAE Systems service technician. It is not user-replaceable.

WARNING

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in an area known to be non-hazardous.

31.3. Replacing Rechargeable Li-Ion or NiMH Battery

Caution: Turn off the instrument before removing or replacing the battery.

31.4. Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500).

Do not mix old and new batteries or different type batteries.

31.5. Troubleshooting

Problem	Possible Reasons & Solutions	
Cannot turn on power after charging the battery	**Reasons:**	Discharged battery. Defective battery.
	Solutions:	Charge or replace battery.
Lost password	**Solutions:**	Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
Reading abnormally High	**Reasons:**	Dirty filter. Dirty sensor module. Excessive moisture and water condensation. Incorrect calibration.
	Solutions:	Replace filter. Blow-dry the sensor module. Calibrate the unit.
Reading abnormally Low	**Reasons:**	Dirty filter. Dirty sensor module. Weak or dirty lamp. Incorrect calibration.
	Solutions:	Replace filter. Remove Calibration Adapter. Calibrate the unit. Check for air leakage.
Buzzer Inoperative	**Reasons:**	Bad buzzer.
	Solutions:	Check that buzzer is not turned off. Call authorized service center.
Inlet flow too low	**Reasons:**	Pump diaphragm damaged or has debris. Flow path leaks.
	Solutions:	Check flow path for leaks; sensor module O-ring, tube connectors, Teflon tube compression fitting. Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
“Lamp” message during operation	**Reasons:**	Lamp drive circuit. Weak or defective PID lamp, defective.
	Solutions:	Turn the unit off and back on. Replace UV lamp

32. Specifications

32.1. MiniRAE Lite+ Specifications

Size:	9.25" L x 3.6" W x 2.9" H
Weight:	28 oz with battery pack
Detector:	Photoionization sensor with 10.6 eV UV lamp
Battery:	Rechargeable Lithium-Ion battery pack (snap in, field replaceable) Alkaline battery holder (for 4 AA batteries)
Battery Charging:	Less than 8 hours to full charge
Operating Hours:	Non-wireless Up to 16 hours continuous operation with rechargeable battery Up to 12 hours with alkaline battery Wireless Up to 13 hours continuous operation with rechargeable battery
Display:	Large dot matrix screen with backlight

Measurement range & resolution

Lamp	Range	Resolution
10.6 eV	0.1 ppm to 5,000 ppm	0.1 ppm

Response time (T_{90}):	2 seconds
Accuracy (Isobutylene):	10 to 2000 ppm: ±5% at calibration point.
PID Detector:	Easy access to lamp and sensor for cleaning and replacement
Calibration:	Two-point field calibration of zero and standard reference gases Patented Reflex PID™ technology
Inlet Probe:	Flexible 5" tubing
Keypad:	1 operation key and 2 programming keys; 1 flashlight switch
Direct Readout:	Instantaneous, peak value, and battery voltage
Datalogging:	260,000 points with time stamp, serial number, user ID, site ID, etc
Intrinsic Safety:	US and Canada: Class I, Division 1, Groups A, B, C, D Europe: ATEX (2460 Ex II 2G Ex ia IIC/IIB T4 Gb) Sira 17ATEX2082X Complies with EN60079-0: 2013, EN60079-11:2012 IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb Complies with IEC 60079-0: 2011, IEC 60079-11:2011 (IIC: 059-3051-000 Li-ion battery pack or 059-3054-000 NiMH battery pack; IIB: 059-3052-000 alkaline battery pack)
EM Interference:	Highly resistant to EMI/RFI.
Alarm Setting:	Separate alarm limit settings for Low Alarm and High Alarm
Alarm:	Buzzer 95dB at 30cm and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure
Alarm Type:	Latching or automatic reset
Real-time Clock:	Automatic date and time
Communication:	Download instrument setup from PC via RS-232 with Travel Charger, or via USB with optional Charger Stand

Upload data to PC and download instrument setup from PC via USB on charging station.
Enhanced datalogging capability through BLE module and mobile app
Sampling Pump: Internally integrated. Flow rate: 450 to 550 cc/min.
Temperature: -20º C to 50º C (-4º to 122º F)
Humidity: 0% to 95% relative humidity (non-condensing)
Housing (including rubber boot): Polycarbonate, splashproof and dustproof
Battery can be changed without removing rubber boot.

32.2. MiniRAE 3000+ Specifications

Size: 25.5 cm x 7.6 cm x 6.4 cm (9.25" L x 3.6" W x 2.9" H)
Weight: 738 g / 28 oz with battery pack
Detector: Photoionization sensor with 9.8, 10.6, or 11.7 eV UV lamp
Battery: A 3.7V rechargeable Lithium-Ion battery pack (snap in, field replaceable, at non-hazardous location only)
Alkaline battery holder (for 4 AA batteries)
Battery Charging: Less than 8 hours to full charge
Operating Hours: Non-wireless Up to 16 hours continuous operation with rechargeable battery
Up to 12 hours with alkaline battery
Wireless Up to 13 hours continuous operation with rechargeable battery
Display: Large dot matrix screen with backlight

Measurement range & resolution

Lamp	Range	Resolution
10.6 eV	0 to 999.9 ppm 1,000 to 15,000 ppm	0.1 ppm 1ppm
9.8 eV	0.1 ppm to 5,000 ppm	0.1 ppm
11.7 eV	0.1 ppm to 2,000 ppm	0.1 ppm

Response time (T_{90}): 2 seconds
Accuracy (Isobutylene): 10 to 2,000 ppm: ±3% at calibration point.
PID Detector: Easy access to lamp and sensor for cleaning and replacement
Correction Factors: Over 200 VOC gases built in (based on RAE Systems Technical Note TN-106)
Calibration: Two-point field calibration of zero and standard reference gases
Patented Reflex PID™ technology
Calibration Reference: Store up to 8 sets of calibration data, alarm limits and span values
Inlet Probe: Flexible 5" tubing

Radio module: BLE (2.4GHz),Bluetooth (2.4GHz) or RF module (, 868MHz or 915MHz)

Keypad: 1 operation key and 2 programming keys; 1 flashlight switch
Direct Readout: Instantaneous, average, STEL, TWA and peak value, and battery voltage
Intrinsic Safety: US and Canada: Class I, Division 1, Groups A,B, C, D
Europe: ATEX (2460 Ex II 2G Ex ia
IIC/IIB T4 Gb)
Sira 17ATEX2082X
Complies with EN60079-0: 2013,
EN60079-11:2012
IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb
Complies with IEC 60079-0: 2011,
IEC 60079-11:2011
(IIC: 059-3051-000 Li-ion battery pack

	or 059-3054-000 NiMH battery pack; IIB: 059-3052-000 alkaline battery pack)
EM Interference:	Highly resistant to EMI/RFI. Compliant with EMC RE-D (RF Modules)
Alarm Setting:	Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode:	Hygiene or Search mode
Alarm:	Buzzer 95dB at 30cm and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure
Alarm Type:	Latching or Automatic Reset
Real-time Clock:	Automatic date and time stamps on datalogged information
Datalogging:	260,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC via USB on charging station. Enhanced datalogging capability through BLE module and mobile app
Sampling Pump:	Internally integrated. Flow rate: 450 to 550 cc/min.
Wireless Network:	Mesh RAE Systems Dedicated Wireless Network (or Wi-Fi network for Wi-Fi-equipped instruments) Bluetooth Low energy
Wireless Frequency:	ISM license-free band, 902 to 907.5 MHz and 915 to 928 MHz, FCC Part 15, CE RE-D, IEEE 802.11 b/g bands (2.4 GHz)
Modulation:	802.15.4 DSSS BPSK
RF Power (Tx):	10dBm
Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)
Housing (including rubber boot):	Polycarbonate, splashproof and dustproof Battery can be changed without removing rubber boot.

32.3. ppbRAE 3000+ Specifications

Size: 25.5 cm x 7.6 cm x 6.4 cm / 9.25" L x 3.6" W x 2.9" H
Weight: 738g /28 oz with battery pack
Detector: Photoionization sensor with 9.8eV or 10.6eV UV lamp
Battery: A 3.7V rechargeable Lithium-Ion battery pack (snap in, field replaceable, at non-hazardous location only)
Alkaline battery holder (for 4 AA batteries)
Battery Charging: Less than 8 hours to full charge
Operating Hours: Non-wireless Up to 16 hours continuous operation with rechargeable battery
Up to 12 hours with alkaline battery
Wireless Up to 13 hours continuous operation with rechargeable battery
Display: Large dot matrix screen with backlight

Measurement range & resolution

Lamp	Range	Resolution
10.6 eV	0 to 9999 ppb	1 ppb
	10 to 99 ppm	0.01 ppm
	100 to 99 ppm	0.1 ppm
	1000 to 9999 ppm	1 ppm
9.8 eV	0.01 ppm to 5,000 ppm	10 ppb

Response time (T_{90}): 2 seconds
Accuracy (Isobutylene): 10 to 2,000 ppm: ±3% at calibration point.
PID Detector: Easy access to lamp and sensor for cleaning and replacement
Correction Factors: Over 200 VOC gases built in (based on RAE Systems Technical Note TN-106)
Calibration: Two-point field calibration of zero and standard reference gases
Patented Reflex PID™ technology
Calibration Reference: Store up to 8 sets of calibration data, alarm limits and span values
Inlet Probe: Flexible 5" tubing
Radio module: BLE (2.4GHz) Bluetooth (2.4GHz) or RF module (868MHz, 915MHz)
Keypad: 1 operation key and 2 programming keys; 1 flashlight switch
Direct Readout: Instantaneous, average, STEL, TWA and peak value, and battery voltage
Intrinsic Safety: US and Canada: Class I, Division 1, Groups
A, B, C, D
Europe: ATEX (2460 Ex II 2G Ex ia
IIC/IIB T4 Gb)
Sira 17ATEX2082X
Complies with EN60079-0: 2013,
EN60079-11:2012
IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb
Complies with IEC 60079-0: 2011,
IEC 60079-11:2011
(IIC: 059-3051-000 Li-ion battery pack
or 059-3054-000 NiMH battery pack;
IIB: 059-3052-000 alkaline battery pack)

EM Interference: Highly resistant to EMI/RFI. Compliant with EMC RE-D (RF Modules)
Alarm Setting: Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode: Hygiene or Search mode
Alarm: Buzzer (95dB at 30cm) and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure
Alarm Type: Latching or automatic reset

Real-time Clock:	Automatic date and time stamps on datalogged information
Datalogging:	260,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC via USB on charging station. Enhanced datalogging capability through BLE module and mobile app
Wireless Network:	Mesh RAE Systems Dedicated Wireless Network Bluetooth Low Energy (BLE) module
Sampling Pump:	Internally integrated. Flow rate: 450 to 550 cc/min.
Wireless Frequency:	ISM license-free band, 902 to 907.5 MHz and 915 to 928 MHz, FCC Part 15, CE RE-D
Modulation:	802.15.4 DSSS BPSK
RF Power (Tx):	10dBm
Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)
Housing (including rubber boot):	Polycarbonate, splashproof and dustproof Battery can be changed without removing rubber boot.

32.4. UltraRAE 3000+ Specifications

Size:	10" L x 3" W x 2.5" H (25.5 cm x 7.6 cm x 6.4 cm)
Weight:	26 oz (738 g) with battery pack
Detector:	Photoionization sensor with 9.8, 10.6, or 11.7 eV UV lamp
Battery:	A 4.2V rechargeable Lithium-Ion battery pack (snap in, field replaceable, at non-hazardous location only) Alkaline battery holder (for 4 AA batteries)
Battery Charging:	Less than 8 hours to full charge
Operating Hours:	Non-wireless Up to 16 hours continuous operation with rechargeable battery Up to 12 hours with alkaline battery Wireless Up to 13 hours continuous operation with rechargeable battery
Display:	Large dot matrix screen with backlight

Measurement range & resolution

Lamp	Range	Resolution
10.6 eV (TVOC)	0 to 99.99 ppm 100 to 999.9 ppm 1000 to 9999 ppm	10 ppb 0.1ppm 1ppm
9.8 eV (TVOC)	0 to 5000 ppm	10 ppb
9.8eV (Benzene butadiene;**)**	10 ppb to 200 ppm	10 ppb (0.001 ppm)

Response time (T_{90}):	2 seconds
Accuracy (Isobutylene):	3% at calibration point
PID Detector:	Easy access to lamp and sensor for cleaning and replacement
Correction Factors:	Over 200 VOC gases built in (based on RAE Systems Technical Note TN-106)
Calibration:	Two-point field calibration of zero and standard reference gases Patented Reflex PID™ technology
Calibration Reference:	Store up to 8 sets of calibration data, alarm limits and span values
Inlet Probe:	Flexible 5" tubing (a short tube is also available) Separation tube housing with permanent VOC tube
Radio module:	BLE (2.4GHz), Bluetooth (2.4GHz) or RF module (868MHz , 915MHz,)

Wireless Network:	Mesh RAE Systems Dedicated Wireless Network Bluetooth Low Energy (BLE) module
Wireless Frequency:	ISM license-free band, 902 to 907.5 MHz and 915 to 928 MHz, FCC Part 15, CE RE-D
Modulation:	802.15.4 DSSS BPSK
RF Power (Tx):	10dBm
Keypad:	1 operation key and 2 programming keys; 1 flashlight switch
Direct Readout:	Instantaneous, average, STEL, TWA and peak value, and battery voltage
Intrinsic Safety:	US and Canada: Class I, Division 1, Groups A, B, C, D Europe: ATEX (2460 Ex II 2G Ex ia IIC/IIB T4 Gb) Sira 17ATEX2082X Complies with EN60079-0: 2013, EN60079-11:2012 IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb Complies with IEC 60079-0: 2011, IEC 60079-11:2011 (IIC: 059-3051-000 Li-ion battery pack or 059-3054-000 NiMH battery pack; IIB: 059-3052-000 alkaline battery pack)
EM Interference:	Highly resistant to EMI/RFI. Compliant with EMC RE-D (RF Modules)
Alarm Setting:	Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode:	Hygiene or Search mode
Alarm:	Buzzer 95dB at 12″ (30cm) and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure
Alarm Type:	Latching or automatic reset
Real-time Clock:	Automatic date and time stamps on datalogged information
Datalogging:	260,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC via USB on charging station. Enhanced datalogging capability through BLE module and mobile APP
Sampling Pump:	Internally integrated. Flow rate: 450 to 550 cc/min.
Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)
Housing (including rubber boot):	Polycarbonate, splashproof and dustproof Battery can be changed without removing rubber boot.

FCC Information

Contains FCC ID: SU3RMBLEB or SU3RM900

The enclosed 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 interference that may cause undesired operation.

Wireless Approval For UAE In Middle East

TRA REGISTERED No: ER36153/14 or ER36153/15
DEALER No.: HONEYWELL INTERNATIONAL MIDDLE EAST – LTD – DUBAI BR

Wireless Approval For QATAR In Middle East

ictQATAR
Type Approval Reg. No.: R-4466 or R-4635

contém o módulo wireless: RM900

ANATEL

2781-14-6496

(01)07898911288364

Este equipamento opera em caráter secundário, isto é, não tem direito a proteção contra interferência prejudicial, mesmo de estações do mesmo tipo, e não pode causar interferência a sistemas operando em caráter primário.

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For more information
www.honeywellanalytics.com
www.raesystems.com

Europe, Middle East, Africa

Life Safety Distribution GmbH
Tel: 00800 333 222 44 (Freephone number)
Tel: +41 44 943 4380 (Alternative number)
Fax: 00800 333 222 55
Middle East Tel: +971 4 450 5800
(Fixed Gas Detection)
Middle East Tel: +971 4 450 5852
(Portable Gas Detection)
gasdetection@honeywell.com

Americas

Honeywell Analytics
Distribution Inc.
Tel: +1 847 955 8200
Toll free: +1 800 538 0363
Fax: +1 847 955 8210
detectgas@honeywell.com

RAE Systems by Honeywell
Phone: 408.952.8200
Toll Free: 1.888.723.4800
Fax: 408.952.8480

Asia Pacific

Honeywell Analytics Asia Pacific
Tel: +82 (0) 2 6909 0300
Fax: +82 (0) 2 2025 0328
India Tel: +91 124 4752700
analytics.ap@honeywell.com

Technical Services

EMEA: HAexpert@honeywell.com
US: ha.us.service@honeywell.com
AP: ha.ap.service@honeywell.com

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