Site Characterization Work Plan

Former Commander Oil Terminal – Off-Site
Oyster Bay, New York
NYSDEC Site No. C130244A

Work Assignment # D009804-31

September 2024

Site Characterization Work Plan

Former Commander Oil Terminal – Off-Site
Oyster Bay, New York
NYSDEC Site No. C130244A

September 25, 2024

Prepared By:
Arcadis of New York, Inc.
855 Route 146, Suite 210
Clifton Park, NY 12065
United States
Phone: 518 250 7300
Fax: 518 371 2757

Prepared For:
NYSDEC
Division of Environmental Remediation
625 Broadway, 12th Floor
Albany, NY 12233

Our Ref:
30218263

Stefan Bagnato, P.G.
Principal Geologist

Andrew Gibson
Staff Geologist

Version Control

Revision No.	Date Issued	Description
0	September 3, 2024	Draft
1	September 25, 2024	Final

Contents

Tables

Figures

Appendix

Acronyms and Abbreviations

AOC	Area of Concern
AS	Air Sparge
BCP	Brownfield Cleanup Program
bgs	Below Ground Surface
CVOC	Chlorinated Volatile Organic Compound
DUSR	Data Usability Summary Report
ELAP	Environmental Laboratory Approval Program
ESA	Environmental Site Assessment
FAP	Field Activities Plan
GPR	Ground Penetrating Radar
HASP	Health and Safety Plan
IRM	Interim Remedial Measure
JSA	Job Safety Analyses
$\mu g/m^3$	Micrograms Per Cubic Meter
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAPL	Non Aqueous Phase Liquid
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
PCBs	Polychlorinated Biphenyls
PFAS	Per- and Polyfluoroalkyl Substances
PID	Photoionization detector
ppm	Parts per Million
PWGC	P.W. Grosser Consulting, Inc.
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act

REC	Recognized Environmental Condition
SC	Site Characterization
SCO	Soil Cleanup Objective
SIM	Selective Ion Monitoring
SVE	Soil Vapor Extraction
SVOCs	Semi-Volatile Organic Compounds
TCE	Trichloroethylene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds

1 Introduction

On behalf of the New York State Department of Environmental Conservation (NYSDEC), Arcadis of New York, Inc. (Arcadis) has prepared this Site Characterization Work Plan for investigation activities at the Former Commander Oil Terminal Off-Site area (C130244A) (Site) in Oyster Bay, Nassau County, New York (**Figure 1**). This site characterization (SC) aims to assess the potential off-site migration of contamination (primarily chlorinated volatile organic compounds [CVOCs] and petroleum) from the Former Commander Oil Terminal site (C130244). This document presents the Site history, summary of previous investigations, and a detailed outline of the proposed SC approach and field activities necessary to complete the investigation.

2 Site Background

The Site consists of the adjacent off-site areas (C130244A) associated with the Brownfield Cleanup Program (BCP) Former Commander Oil Terminal site No. C130244. The Site is located in a mixed area of industrial, commercial, and residential properties surrounding the Former Commander Oil Terminal at One Commander Square, Oyster Bay, New York. The Site properties consist of commercial properties to the North of the Former Commander Oil terminal, Whites Creek to the South, and Oyster Bay Harbor to the East. The nearest residential property is approximately 100 feet south of the Former Commander Oil Terminal (NYSDEC, 2024).

The Former Commander Oil Terminal has been in use since at least the late 1800s. Initially the property was a sawmill, coal yard, ice plant, and residence. After the 1930s the Oil Terminal property was used for major oil storage and associated activities through May 2022, after which MOSF operations ceased, the large capacity storage tanks and piping were emptied but still remain in place as decommissioning in ongoing in anticipation for site redevelopment. The Oil Terminal property has been shown to have volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals in the soil beneath it as well as soil vapor impacted with VOCs. The groundwater beneath the Oil Terminal has also been shown to have VOCs, SVOCs, metals, and Per- and Polyfluoroalkyl Substances (PFAS). The contamination at the Oil Terminal property appears to extend off-site and includes potential impacts from the operation of a vapor recovery unit (VRU) in the northern part of the property which utilized trichloroethylene (TCE) as a refrigerant (NYSDEC, 2024).

The commercial property to the north of the Oil Terminal operates as a commercial oyster harvesting and processing facility with areas sub-leased for storage. Whites Creek to the south is a stream which empties eastward into Oyster Bay (NYSDEC, 2024).

2.1 Geology/Hydrogeology

Based on previous investigations at the Oil Terminal, the local geology appears to consist of fill overlying silty sand and a discontinuous organic peat layer ranging in depth from six to ten feet (ft) below ground surface (bgs) (Kleinfelder, 2010). This peat layer ranges in thickness from two to five ft. Soils below the peat layer range from fine to coarse sands and gravel to approximately 30 feet bgs. Groundwater ranges from three to seven ft bgs and flows to the east-southeast above the peat layer and east-northeast below it (NYSDEC, 2024).

2.2 Previous Investigations

Numerous petroleum spills have occurred at the Oil Terminal property in the 1970s and 1980s, with spill cases having been closed. A 1985 spill of #2 fuel oil seeping through the seawall into Whites Creek and Oyster Bay (Spill No. 85-00426), and a 1995 spill of TCE (Spill No. 9925216) remained open with impacts to the site and potentially off-site areas. Multiple environmental investigations and remedial actions have been conducted at the Former Commander Oil Terminal site, associated with several spills (PWGC, 2024), including but not limited to the following:

- **2001 – Quarterly Monitoring** - Conestoga-Rovers & Associates (CRA) documented elevated photoionization detector PID readings from soils. CRA also noted a strong southeasterly component towards Whites Creek.
- **2005 – Investigation Plan** - In a 2005 investigation plan from Geologic Services Corporation, historical work to address the seep of #2 fuel oil into Oyster Bay and Whites Creek were documented. These activities began in 1987 and included:
    - injection of grout into the sea wall to prevent seepage;
    - excavation of the sump pit and bolstering of the seawall and lining with enviromat;
    - installation of pressure grout behind the seawall and repairs of cracks; and
    - installation of a product recovery and groundwater pump and treat system.
- **2007 – Sub-Surface Investigation** - In April 2007 Kleinfelder submitted a Sub-Surface Investigation Report in which 18 soil borings were completed along Whites Creek and Oyster Bay Harbor outside the seawall by hand auger. Kleinfelder noted petroleum like odors in multiple sampling locations.
- **2007 – Non-Ox Pilot Test** - In December 2007 Kleinfelder completed a pilot test for a Nano-Ox injection system for points along the seawall. Kleinfelder found a rebound of visual impacts and concluded that gravity fed injection worked poorly in the area due to low permeable soils and continued the injection into adjacent monitoring wells. There was no significant sustained reduction of VOCs in groundwater as a result of this pilot test.
- **2008 - Baseline Environmental Site Assessment** – Petroleum and CVOC impacts were noted by Environmental Compliance Services, Inc. (ECS) in soil and groundwater throughout the eastern and central portions of the Oil Terminal property, with CVOC impacts primarily in the north-central and central portions of the property. These impacts appeared to be associated with the 1995 surface spill of TCE from a former VRU; the spill case for which had been closed but was subsequently re-opened
- **2009 – Extended Pilot Test** - Kleinfelder conducted an in-situ chemical oxidation pilot program to target petroleum contamination behind the southeastern seawall of the Oil Terminal, with mixed results.
- **2010 – Groundwater Pump and Treat (GWPT) System** – A GWPT system targeting residual liquid-phase petroleum hydrocarbons was initiated consisting of two recovery wells, and oil-water separator, and treatment using granular activated carbon with subsequent discharge through the Oil Terminal property's Outfall #2.
- **2011 – Source Area Remediation and Groundwater Assessment** - Kleinfelder performed a removal of approximately 58 tons of CVOC-impacted soil from the Oil Terminal property to a depth of two feet bgs, though excavation was limited by shallow groundwater and elevated levels of vinyl chloride vapor in the work area air (Kleinfelder, 2011).

- **2012 – AS/SVE System** – Kleinfelder pilot tested an air sparge (AS) and soil vapor extraction (SVE) system as an IRM on the Oil Terminal property. AS wells were installed directly above the pear layer in the alleyway on the north side of the secondary containment wall for the northern bulk storage tanks while SVE wells were installed inside the secondary containment walls and screened down to the peat layer (Kleinfelder, 2012).
- **2013 – VRU and Impacted Soil Removal** - Kleinfelder performed the removal of the VRU on the Oil Terminal property and removed 52 tons of accessible soil beneath and around the VRU. TCE was detected at concentrations greater than the NYSDEC Soil Cleanup Objective for Restricted Use – Industrial in the excavated soil and endpoint samples (Kleinfelder, 2013). Prior to backfilling, a SVE system was proactively installed in this area for potential future use.
- **2019 – Off-Site Investigation Report -** The commercial oyster processing property at 2 Bayview Avenue, referred to as the “Flowers Property” was investigated by VHB on behalf of Commander Terminal Holdings, LLC at the request of NYSDEC. The request for investigation was intended to determine if spills on the Oil Terminal property had adversely affected the Flowers property. TCE and vinyl chloride were present at elevated concentrations near the property line. The VHB investigation found that observed VOC and SVOC impacts in soil and groundwater on the Flowers property were attributable to the adjacent releases at the Oil Terminal (VHB, 2019).
- **2019 – Phase I Environmental Site Assessment (ESA) -** P.W. Grosser Consulting, Inc. (PWGC) conducted a Phase I ESA , identifying multiple Recognized Environmental Conditions (RECs) associated with the Oil Terminal property, including historic industrial use, coal storage, major oil storage, and the two active spills noted above, among others.
- **2020 – Limited Subsurface Investigation** – PWGC noted a UST abandoned in place, and petroleum-related VOC and SVOC impacts in soil and groundwater surrounding and down-gradient of the UST containment dike (PWGC, 2024).
- **2021-2023 – BCP Remedial Investigation** – On behalf of the property owner that was accepted into the BCP, PWGC conducted an RI to delineate site impacts. Intermingled CVOC and petroleum impacts were noted with CVOC impacts extending beneath the peat layer as deep as 25-35 ft bgs. CVOCs in soil vapor were high enough to trigger VI mitigation if buildings were present. One area of concern (AOC), AOC 1 located near the northern Oil Terminal property boundary was investigated to identify potential CVOC impacts. Several VOCs were detected in soil at concentrations exceeding the applicable NYSDEC Standards, including TCE and vinyl chloride. In addition, several SVOCs and metals were detected at concentrations exceeding the applicable NYSDEC Standards. The emerging contaminants PFAS and 1,4-dioxane, as well as pesticides, herbicides, and PCBs were also analyzed in select samples and were not found at concentrations exceeding the applicable NYSDEC Standards (PWGC, 2024). PWGC continues to use oil absorbent materials and bentonite to prevent seepage of NAPL into Whites Creek and the Oyster Bay on a quarterly basis (PWGC, 2023).

3 Site Characterization

The scope of work for the SC is designed to evaluate the magnitude and extent of contaminants migrating off-site from the Former Commander Oil Terminal, assess whether contamination presents a significant threat (or reasonably foreseeable threat) to public health or the environment, and whether interim remedial measures (IRMs) may be warranted. The base scope of work includes a geophysical survey, overburden groundwater monitoring well installation, the sampling of the newly installed monitoring wells, sediment sampling, and soil vapor sampling at off-site locations selected by the NYSDEC. The sampling program described in this section is also summarized in **Tables 1-4**.

Advance notice will be given to the relevant property owners and/or occupants prior to any access to their properties. Any comments, questions, or complaints from the private property owner or general public will be forwarded and managed by NYSDEC staff.

Pace Analytical, an analytical laboratory approved by the New York State Department of Health (NYSDOH) under the Environmental Laboratory Approval Program (ELAP) and certified to perform NYSDEC Analytical Services Protocol (ASP) will analyze all samples collected during the SC under a NYSDEC Callout contract. Analytical results will be reported in ASP Category B data packages. A Data Usability Summary Report (DUSR) will be prepared upon the receipt of all analytical data to ensure that the quality of the data is sufficient to evaluate site conditions, site classification, and/or remedial alternatives. Sample collection, handling activities, and quality assurance (QA)/quality control (QC) sampling will be conducted in accordance with Arcadis' Generic Field Activities Plan (FAP) and Quality Assurance Project Plan (QAPP) (**Appendices A** and **B**, respectively), which have previously been submitted to the NYSDEC for work conducted under the NYSDEC State Superfund Standby Engineering Contract No. D009804.

3.1 Health and Safety Procedures and Community Air Monitoring Plan Implementation

To the extent possible, administrative and engineering controls will be implemented, prior to relying on the use of personal protective equipment, to safeguard against exposure to contaminated media. Hazardous Waste Operations and Emergency Response 40-hour trained staff will execute the field activities. A site-specific Health and Safety Plan (HASP) will be implemented to address Arcadis activities. The HASP will include Job Safety Analyses (JSAs) that outline the health and safety hazards and controls pertaining to the scope of work outlined in this Work Plan. Arcadis site personnel will be required to review the HASP and JSAs prior to the beginning of the work and will conduct the work in accordance with the HASP. Daily safety tailgate meetings will also be conducted prior to the commencement of the work. Subcontractors will prepare and provide a HASP for their site workers to follow pertaining to their specific tasks.

Arcadis will implement the site-specific Community Air Monitoring Plan (CAMP) (**Appendix C**) during ground-intrusive activities. The subcontractor will be responsible for taking action to reduce and mitigate dust generation and ambient air concentrations of total organic vapors if action levels in the CAMP are exceeded. The CAMP monitoring will be conducted to minimize the possibility that field personnel and the surrounding community will be exposed to Site contaminants during drilling activities and soil stockpiling/moving/and loading activities. The CAMP activities will include dust and PID VOC monitoring at one upwind and one downwind location.

All employees have Stop Work Authority if they have a reasonable belief that the task poses an imminent risk of death, physical harm, property damage, or other hazard.

3.2 Geophysical Survey/Utility Locating

Prior to ground-intrusive work, underground utilities in the vicinity of the proposed drilling locations will be located using electromagnetic resistivity and ground penetrating radar (GPR) methods to identify potential buried structures and/or disturbed soil, including the potential subterranean non-native structure.

3.3 Surface Soil Sampling

Surface soil samples will be collected at the locations shown on **Figure 1** from a depth of 0-2 inches bgs for metals and 0-6 inches bgs for all other analytes using hand collection methods. DPT-1, DPT-2, MW-1, and MW-2 will be analyzed for:

- Target Compound List (TCL) VOCs by United States Environmental Protection Agency (USEPA) Method 8260;
- TCL SVOCs by USEPA Method 8270;
- Target Analyte List (TAL) Metals by USEPA Method 6010 including mercury by USEPA Method 7470;
- Cyanide by USEPA Method 9010;
- Organochlorine Pesticides by USEPA Method 8081;
- Herbicides by USEPA Method 8151;
- Polychlorinated Biphenyls (PCBs) by USEPA Method 8082;
- 40 compound TAL PFAS by USEPA Method 1633; and
- 1,4-Dioxane by USEPA Method 8270 in selective ion monitoring (SIM) mode.

3.4 Soil Borings and Groundwater Well Installation

Eight soil borings will be advanced at the locations shown on **Figure 1** to the depths outlined below. Soil borings will be sampled continuously from ground surface to the final depth using macrocore liners collected via direct push. Soil samples will be submitted for laboratory analysis at intervals and for analytes as summarized below. Following completion of the soil borings, grab groundwater samples will be collected at four of the soil boring locations utilizing temporarily deployed well screens. These groundwater samples will be analyzed as summarized below. The remaining four soil borings will be converted into overburden multi-level monitoring wells at the locations shown on **Figure 1** to characterize groundwater conditions at three NYSDEC specified intervals. At each monitoring well location one interval will be screened across the water table (5-7 ft. bgs), one interval will be installed just below the previously observed ‘bog layer’ (15-17 ft. bgs), and the last interval will be set just above the previously observed clay layer (estimated at 22-25 ft. bgs). Due to anticipated tidal influence of approximately 1-2 feet, exact depths will be determined based on field conditions at the time of the work with the goal of allowing adequate water column for sampling regardless of the tidal cycle. The multi-level monitoring wells will be installed using hollow stem auger drilling methods.

Subsurface soil samples will be collected from DPT-1 at a depth of 5-10 ft. bgs and will be analyzed for:

- TCL VOCs by United States USEPA Method 8260;
- SVOCs by USEPA Method 8270;
- TAL Metals by USEPA Method 6010 including mercury by USEPA Method 7470;
- Cyanide by USEPA Method 9010;
- Organochlorine Pesticides by USEPA Method 8081;
- Herbicides by USEPA Method 8151; and
- PCBs by USEPA Method 8082.

Subsurface soil samples will be collected from DPT-2 at a depth of 5-10 ft. bgs and will be analyzed for:

- TCL VOCs by United States USEPA Method 8260;
- SVOCs by USEPA Method 8270;
- TAL Metals by USEPA Method 6010 including mercury by USEPA Method 7470;
- Cyanide by USEPA Method 9010;
- Organochlorine Pesticides by USEPA Method 8081;
- Herbicides by USEPA Method 8151;
- PCBs by USEPA Method 8082;
- 40 compound TAL PFAS by USEPA Method 1633; and
- 1,4-Dioxane by USEPA Method 8270 SIM.

Subsurface soil samples will be collected from DPT-3 and DPT-4 at a depth of 10-15 ft. bgs and will be analyzed for:

- TCL VOCs by United States USEPA Method 8260; and
- SVOCs by USEPA Method 8270.

Two subsurface soil samples will be collected from MW-1. One subsurface soil sample will be collected above the area’s bog layer (estimated depth of 11-13 ft. bgs) and one will be collected above the area’s clay layer (estimated depth of 22-25 ft. bgs). The samples will be analyzed for:

- TCL VOCs by United States USEPA Method 8260;
- SVOCs by USEPA Method 8270;
- TAL Metals by USEPA Method 6010 including mercury by USEPA Method 7470;
- Cyanide by USEPA Method 9010;
- Organochlorine Pesticides by USEPA Method 8081;
- Herbicides by USEPA Method 8151;
- PCBs by USEPA Method 8082;
- 40 compound TAL PFAS by USEPA Method 1633; and
- 1,4-Dioxane by USEPA Method 8270 SIM.

Up to two subsurface soil samples will be collected from MW-2, MW-3, and MW-4 at depths to be determined based on field observations (visual impacts, staining, odors, PID readings). The anticipated sample interval is just above the clay layer which is continuous over much of the area. The samples will be analyzed for:

- TCL VOCs by United States USEPA Method 8260; and
- additional analytes based on observed impacts, in consultation with NYSDEC.

Each multi-level well will be constructed of 1-inch inner diameter (I.D.) PVC casing and screen. Monitoring wells will be constructed with 3-foot-long sections of schedule 40 PVC 0.010-inch slot screen and PVC riser. A sand filter pack will be placed in the annular space around each well screen interval to approximately two feet above the top of the screen. A bentonite seal will be placed above the filter pack and extend to at least one foot below the bottom of the screen above it. The annular space above filter pack for the uppermost interval at the water table will be filled with a bentonite seal to two feet below grade. The remaining annular space will be filled with neat cement and will be completed with a flush-mount protective cover.

Upon completion, monitoring wells will be developed to minimize turbidity in groundwater samples collected from each well and to improve their hydraulic properties.

3.5 Decontamination

Equipment will be thoroughly decontaminated before being brought to the Site. Augers, drive casings, and other large equipment/drilling tooling will be steam cleaned between boreholes. Steam cleaning will be completed by the drillers within a temporary decontamination pad that is located outside the work zone. Smaller sized tools and equipment that come into contact with soil/groundwater will be decontaminated between locations using potable water and Alconox. Equipment being used to collect and analyze samples for PFAS will follow the current requirements for decontamination and include an additional rinse with laboratory-certified PFAS-free water/methanol or isopropyl alcohol. Decontamination water will be containerized in 55-gallon drums and staged at a location designated by NYSDEC for subsequent characterization and off-site disposal.

3.6 Groundwater Sampling

Upon completion of well installation and development, the four new wells will be sampled during one groundwater monitoring event. Prior to groundwater purging and sampling the depth to water and light non-aqueous phase liquid (LNAPL), if present, in each monitoring well will be measured using an oil/water interface probe and recorded. Groundwater sampling will be conducted in accordance with the USEPA Low-Flow/Low-Purge Sampling Protocol (USEPA, 2017). To the extent practicable, groundwater purging rates will be low enough to prevent significant drawdown of the groundwater level in the monitoring well. Water levels will be monitored during sampling to verify that excessive draw down is not occurring.

Groundwater collected from the first interval at MW-1 will be analyzed for:

- TCL VOCs by United States USEPA Method 8260;
- SVOCs by USEPA Method 8270;
- TAL Metals by USEPA Method 6010 including mercury by USEPA Method 7470;
- Cyanide by USEPA Method 9010;
- Organochlorine Pesticides by USEPA Method 8081;
- Herbicides by USEPA Method 8151;
- PCBs by USEPA Method 8082;
- 40 compound TAL PFAS by USEPA Method 1633; and
- 1,4-Dioxane by USEPA Method 8270 SIM

Groundwater collected from the second interval at MW-1 will be analyzed for:

- TCL VOCs by United States USEPA Method 8260;

Groundwater collected from the third interval at MW-1 will be analyzed for:

- TCL VOCs by United States USEPA Method 8260;
- SVOCs by USEPA Method 8270;
- TAL Metals by USEPA Method 6010 including mercury by USEPA Method 7470;
- Cyanide by USEPA Method 9010;
- Organochlorine Pesticides by USEPA Method 8081;
- Herbicides by USEPA Method 8151;
- PCBs by USEPA Method 8082;
- 40 compound TAL PFAS by USEPA Method 1633; and
- 1,4-Dioxane by USEPA Method 8270 SIM.

Groundwater collected from the first interval at MW-2 will be analyzed for:

- TCL VOCs by United States USEPA Method 8260;
- SVOCs by USEPA Method 8270;
- 40 compound TAL PFAS by USEPA Method 1633; and
- 1,4-Dioxane by USEPA Method 8270 SIM.

Groundwater collected from the second interval at MW-2 will be analyzed for:

- TCL VOCs by United States USEPA Method 8260.

Groundwater collected from the third interval at MW-2 will be analyzed for:

- TCL VOCs by United States USEPA Method 8260.

Groundwater collected from the first interval at MW-3 will be analyzed for:

- TCL VOCs by United States USEPA Method 8260;
- SVOCs by USEPA Method 8270;
- TAL Metals by USEPA Method 6010 including mercury by USEPA Method 7470;
- Cyanide by USEPA Method 9010;
- Organochlorine Pesticides by USEPA Method 8081;
- Herbicides by USEPA Method 8151;
- PCBs by USEPA Method 8082;
- 40 compound TAL PFAS by USEPA Method 1633; and
- 1,4-Dioxane by USEPA Method 8270 SIM.

Groundwater collected from the second interval at MW-3 will be analyzed for:

- TCL VOCs by USEPA Method 8260.

Groundwater collected from the third interval at MW-3 will be analyzed for:

- TCL VOCs by USEPA Method 8260.

Groundwater collected from the first interval at MW-4 will be analyzed for:

- TCL VOCs by USEPA Method 8260;
- SVOCs by USEPA Method 8270;
- 40 compound TAL PFAS by USEPA Method 1633; and
- 1,4-Dioxane by USEPA Method 8270 SIM.

Groundwater collected from the second interval at MW-4 will be analyzed for:

- TCL VOCs by USEPA Method 8260.

Groundwater collected from the third interval at MW-4 will be analyzed for:

- TCL VOCs by USEPA Method 8260.

Additionally, one of the samples listed above will also be analyzed for Hexavalent Chromium by USEPA Method 7196. The exact monitoring well and interval to be sampled will be determined in the field.

At the final depth of each DPT soil boring a temporary well screen will be deployed and will be purged until turbidity is as low as practically feasible, at which point a grab groundwater sample will be collected as specified by NYSDEC below:

Groundwater collected from DPT-1 and DPT-2 screened at an approximate depth of 5-7 ft bgs will be analyzed for:

- TCL VOCs by USEPA Method 8260;
- SVOCs by USEPA Method 8270.

Groundwater collected from DPT-1 and DPT-2 screened at an approximate depth of 15-17 ft bgs will be analyzed for:

- TCL VOCs by USEPA Method 8260;
- SVOCs by USEPA Method 8270;
- 40 compound TAL PFAS by USEPA Method 1633; and
- 1,4-Dioxane by USEPA Method 8270 SIM.

Groundwater collected from DPT-3 and DPT- 4 screened at an approximate depth of 10-12 ft will be analyzed for:

- TCL VOCs by USEPA Method 8260;
- SVOCs by USEPA Method 8270.

Groundwater collected from DPT-3 and DPT- 4 screened at an approximate depth of 20-22 ft will be analyzed for:

- TCL VOCs by USEPA Method 8260;
- SVOCs by USEPA Method 8270.

Quality assurance (QA)/quality control (QC) samples, including blind duplicates and matrix spike (MS)/MS duplicates (MSD) will be collected at a rate of 1 per 20, and trip blanks will also be analyzed for VOCs. Equipment blanks will be collected using lab provided analyte free water from all non-disposable equipment used during drilling and sampling activities. The equipment blanks will be analyzed for 40 compound TAL PFAS by USEPA Method 1633. Disposable sampling equipment will be used to purge groundwater and collect representative samples from each well.

3.7 Soil Vapor Assessment

Two soil vapor probes will be installed using direct push drilling methods to an approximate depth of five ft bgs. The approximate locations for these probes are shown on **Figure 1**.

One soil vapor sample will be collected from each of the two soil vapor probes concurrently using sampling procedures in accordance with Arcadis' Generic SAP for NYSDEC Standby Engineering Contract D009804 and the NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York, dated October 2006, and subsequent updates. A tracer gas test will be performed at each sub-slab soil vapor sampling location in accordance with NYSDOH, 2006 to confirm that the soil vapor probes were constructed in a manner that minimize the entrainment of ambient air into the soil vapor samples. Helium will be used as the tracer gas. If high concentrations (greater than 10 percent) of tracer gas are observed, the probe seal will be enhanced to reduce the infiltration of air. Air samples will be collected using batch-certified 2 or 6-liter summa canisters equipped with pre-calibrated flow controllers. Soil vapor samples will be collected over a 2-hour time period. Samples from each monitoring point will be analyzed for VOCs by USEPA Method TO-15. Analytical laboratory reporting limits will achieve 0.25 micrograms per cubic meter ($\mu g/m^3$) for trichloroethylene, carbon tetrachloride, and vinyl chloride and 1.0 $\mu g/m^3$ for all other analytes.

3.8 Sediment Sampling

Two sediment samples will be collected from each of the two locations shown on **Figure 1** along Whites Creek at low tide using a stainless-steel hand auger and/or other manual collection methods at 6-12 inches and 12-24 inches bgs. Each sample will be analyzed for:

- TCL VOCs by United States USEPA Method 8260;
- SVOCs by USEPA Method 8270;
- TAL Metals by USEPA Method 6010 including mercury by USEPA Method 7470;
- Cyanide by USEPA Method 9010;
- Organochlorine Pesticides by USEPA Method 8081;
- Herbicides by USEPA Method 8151;
- PCBs by USEPA Method 8082
- 40 compound TAL PFAS by USEPA Method 1633; and
- 1,4-Dioxane by USEPA Method 8270 SIM.

3.9 Investigation-Derived Waste

Based on historical sampling analytical data and as directed by NYSDEC, soil cuttings, decontamination water, well development water, and purge water generated during the SC will be contained in U.N.-approved 55 gallon drums pending full Resource Conservation and Recovery Act (RCRA) waste characterization analysis. Based on discussions with the NYSDEC, it is assumed that a central drum staging area will be made available on the off-site Flowers property. While it is assumed that SC wastes will be non-hazardous, the results of Toxicity Characteristic Leaching Procedure (TCLP) testing will be used to determine if the wastes are characteristically hazardous. If appropriate and based on consultation with NYSDEC, a contained-in determination will be prepared to allow for disposal of all waste as non-hazardous. Drums will be transported to a permitted facility for off-site disposal by an Arcadis-subcontracted waste hauler in accordance with federal, state, and local regulations.

3.10 Survey

The location and elevation of each new groundwater monitoring well installed during the SC field activities and existing groundwater monitoring wells will be surveyed to the nearest 0.01-foot vertically and 0.1-foot horizontally. Site features as applicable will also be surveyed. The surveyed data will be added to an AutoCAD or ArcGIS base map for the Site.

3.11 Data Validation

A DUSR will be prepared by a third-party validator upon the receipt of all SC analytical data to ensure that the quality of the data is sufficient to evaluate Site conditions, Site classification, and/or remedial alternatives.

4 Reporting

The results of the investigation activities will be provided to the NYSDEC in a SC report prepared based upon DER-10 and submitted to the NYSDEC for review and comment. The report will include the following:

- Discussion of field investigation activities and technologies.
- Discussion of the physical characteristics of the Site, including groundwater flow patterns.
- Presentation of analytical results for all media sampled.
- QA/QC evaluation of the analytical data including the results of the data quality review.
- Discussion of the nature and extent of contaminants.
- Comparison of analytical results to background concentrations and applicable regulatory standards and objectives.
- Supporting data, including analytical data packages and field log forms (boring logs, core logs, groundwater sampling logs, vapor intrusion logs, and monitoring well construction diagrams for new and previously installed monitoring wells).

Additionally, SC field and laboratory data will be submitted to the NYSDEC EQuIS™ database.

5 Schedule

The estimated project schedule for the initial field work and reporting is presented below.

Task	Start Date	Anticipated End Date
Investigation	September 2024	October 2024
• Utility Locating	September 2024	September 2024
• Soil Borings/Groundwater Well Installation	September 2024	October 2024
• Groundwater Sampling	October 2024	October 2024
• Vapor Intrusion Assessment	October 2024	October 2024
• Survey	October 2024	October 2024
• Laboratory Analysis	October 2024	November 2024
• Data Validation	October 2024	December 2024
Reporting	October 2024	January 2025

The actual schedule will be dependent on subcontractor availability, Site access, and the date of project initiation. The schedule does not account for delays due to unforeseen Site conditions (e.g., inclement weather, issues with access to Site or adjacent properties). Every attempt will be made to adhere to the schedule presented. Unexpected delays will be documented and reported to the NYSDEC in a timely fashion. In the event that the schedule needs to be modified, Arcadis will contact the NYSDEC for approval of the updated schedule.

6 References

Kleinfelder, 2010. Supplemental Subsurface Investigation Report, Commander Oil Terminal, NYSDEC Case No. 99-25216 (closed) Revision No. 1, April 15, 2010.

Kleinfelder, 2011. CVOC Source Area Remediation and Groundwater Assessment Report. Commander Oil Terminal, One Commander Square, Oyster Bay, New York, NYSDEC Case No. 99-25216, January 28, 2011.

Kleinfelder, 2012. Site Status Update Report, Commander Terminal, One Commander Square, Oyster Bay, New York, February 28, 2012.

Kleinfelder, 2013. Excavation Summary Vapor Recovery unit Area, Commander Oil Terminals, LLC, One Commander Square, Oyster Bay, New York, January 14, 2013.

NYSDEC, 2024. Site Briefing Report, Former Commander Oil Terminal – Off-Site, February 2, 2024.

NYSDEC, 2010. Program Policy DER-10 Technical Guidance for Site Investigation and Remediation, NYSDEC. May 3, 2010.

NYSDOH, 2006. Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York. New York State Department of Health, Center for Environmental Health, Bureau of Environmental Exposure Investigation. October 2006/May 2017.

PWGC. 2008. Baseline Environmental Site Assessment, Commander Oil Terminal, 1 Commander Square, Oyster Bay, NY, November 10, 2008.

PWGC, 2023. Quarterly Status Report, First Quarter 2023, Former Commander Oil Terminal, NYSDEC: Spill: 8500426 & 9925216, May 2023.

PWGC, 2024. Remedial Investigation Report, Former Commander Oil Terminal, 1 Commander Square, Oyster bay, NY, January 2024.

USEPA, 2017. Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, Quality Assurance Unit, USEPA Region 1, September 19, 2017.

VHB, 2019. Off-Site Site Investigation Report, Flowers Property, 2 Bayview Avenue, Oyster Bay, New York, 11771, May 24, 2019.

Tables

Sampling Plan Tables:

Table 1: Groundwater and Soil Gas Samples

Proposed Sample Name	Approximate Sample Interval (ft bgs)	Groundwater										VOCs Air
		VOC	**SVOC**	**Metals**	**Mercury**	**Pesticides**	**Herbicides**	**PCB**	**Cyanide**	**1,4-dioxane**	**PFAS**	**TO-15**
DPT-1	5-10	1	1									
	15-20	1	1							1	1	
DPT-2	5-10	1	1									
	15-20	1	1							1	1	
DPT-3	10-15	1	1									
	20-25	1	1									
DPT-4	10-15	1	1									
	20-25	1	1									
MW-1	above the bog layer	1	1	1	1	1	1	1	1	1	1	
	below the bog layer	1										
	above the clay layer	1	1	1	1	1	1	1	1	1	1	
MW-2	above the bog layer	1	1							1	1	
	below the bog layer	1										
	above the clay layer	1										
MW-3	above the bog layer	1	1	1	1	1	1	1	1	1	1	
	below the bog layer	1										
	above the clay layer	1										
MW-4	above the bog layer	1	1							1	1	
	below the bog layer	1										
	above the clay layer	1										
SV-2												1
SV-1												1

Table 2: Subsurface Soil Samples

Proposed Sample Name	Approximate Sample Interval (ft bgs)	Subsurface soil									
		VOC	**SVOC**	**Metals**	**Mercury**	**Pesticides**	**Herbicides**	**PCB**	**Cyanide**	**1,4-dioxane**	**PFAS**
DPT-1	5-10	1	1	1	1	1	1	1	1		
	15-20										
DPT-2	5-10	1	1	1	1	1	1	1	1	1	1
	15-20										
DPT-3	10-15	1	1								
	20-25										
DPT-4	10-15	1	1								
	20-25										
MW-1	above the bog layer	1	1	1	1	1	1	1	1	1	1
	below the bog layer										
	above the clay layer	1	1	1	1	1	1	1	1	1	1
MW-2	above the bog layer	1									
	below the bog layer										
	above the clay layer	1									
MW-3	above the bog layer										
	below the bog layer										
	above the clay layer	1									
MW-4	above the bog layer										
	below the bog layer										
	above the clay layer	1									

Table 3: Surface Soil Samples

Proposed Sample Name	Surface Soil									
	VOCs	**SVOC**	**Metals**	**Mercury**	**Pesticides**	**Herbicides**	**PCB**	**Cyanide**	**1,4-dioxane**	**PFAS**
DPT-1	1	1	1	1	1	1	1	1	1	1
DPT-2	1	1	1	1	1	1	1	1	1	1
DPT-3										
DPT-4										
MW-1	1	1	1	1	1	1	1	1	1	1
MW-2	1	1	1	1	1	1	1	1	1	1

DER-10, *Technical Guidance for Site Investigation and Remediation*, pg. 79:

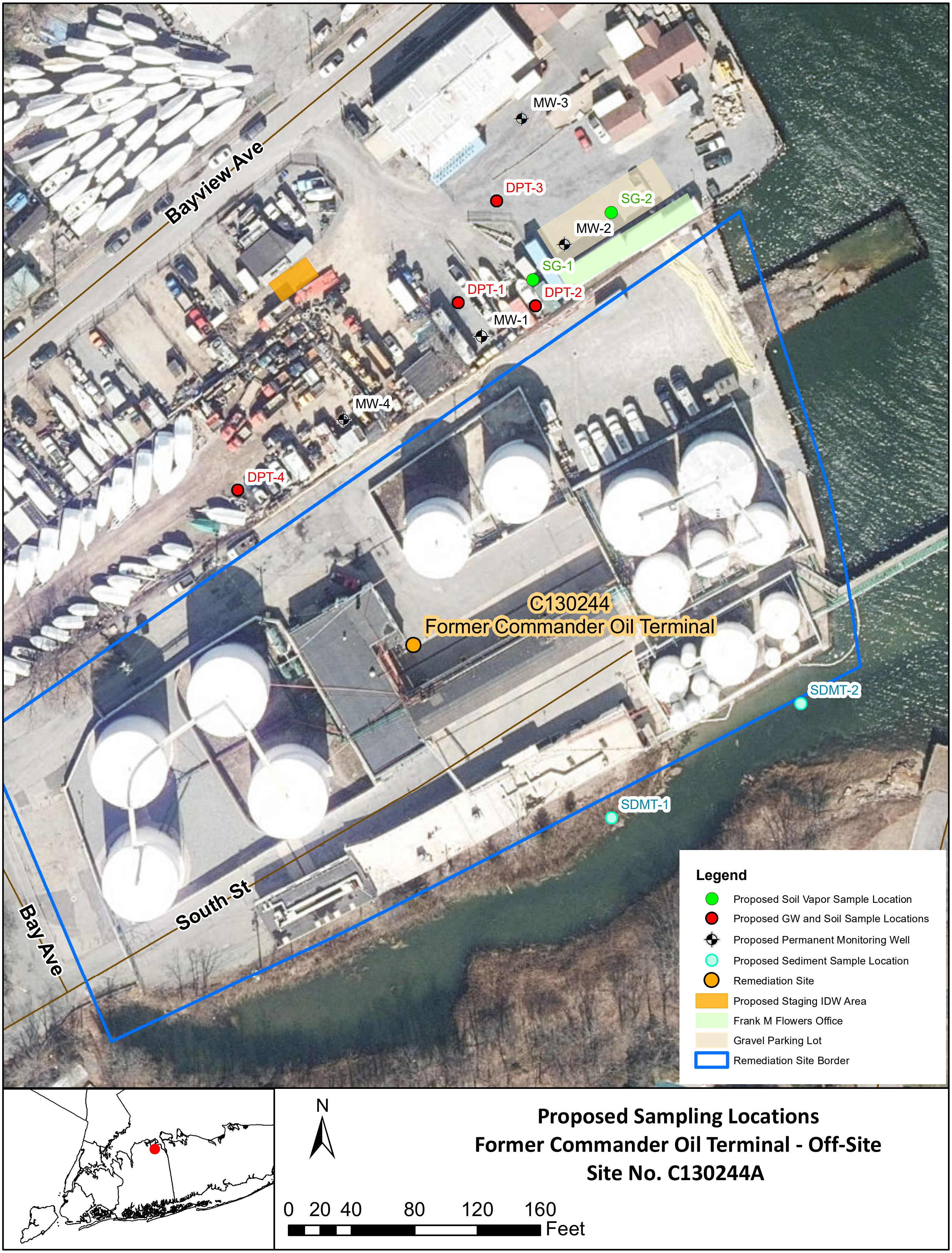
Surface soil sampling. Samples, except those being analyzed for VOCs as noted below, should be collected based upon the type of exposure or disposal to be assessed by the sample.

- Assessing human exposures to soil. When assessing the human exposure resulting from soil contamination related to:
  a. incidental soil ingestion, inhalation of soil or dermal contact with soil; soil samples should be collected from a depth of 0 to 2 inches below the vegetative cover, unless VOCs are the only contaminants of concern in which case the sampling should be from 0 to 6 inches; and/or
  b. vegetable/fruit gardens, soil samples should be collected from a depth of 0 to 6 inches below the vegetative cover.

Table 4: Sediment Samples

Proposed Sample Name	Approximate Sample Interval (in. bgs)	Sediment									
		VOCs	**SVOCs**	**Metals**	**Mercury**	**Pesticides**	**Herbicides**	**PCB**	**Cyanide**	**1,4-dioxane**	**PFAS**
SEDM-1	6"-12"	1	1	1	1	1	1	1	1	1	1
	12"-24"	1	1	1	1	1	1	1	1	1	1
SEDM-2	6"-12"	1	1	1	1	1	1	1	1	1	1
	12"-24"	1	1	1	1	1	1	1	1	1	1

Figures



Proposed Sampling Locations
Former Commander Oil Terminal - Off-Site
Site No. C130244A

Appendix A

Generic Field Activities Plan for Work Conducted under NYSDEC State Superfund Standby Engineering Contract No. D009804

Design & Consultancy for natural and built assets

New York State Department of Environmental Conservation

GENERIC FIELD ACTIVITIES PLAN FOR WORK ASSIGNMENTS

Standby Contract for Engineering Services

(No. D009804)

October 2021

GENERIC FIELD ACTIVITIES PLAN FOR WORK ASSIGNMENTS

Standby Contract for Engineering Services (No. D009804)

Prepared for:

New York State Department of Environmental Conservation

NYSDEC

625 Broadway

Albany, New York 12233

Prepared by:

Arcadis of New York, Inc.

855 Route 146

Suite 210

Clifton Park

New York 12065

Tel 518 250 7300

Fax 518 371 2757

Date:

October 2021

VERSION CONTROL

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By

CONTENTS

APPENDICES

ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
COC	Chain of Custody
CVOC	Chlorinated Volatile Organic Compounds
DER	Division of Environmental Remediation
DNAPL	Dense Non-aqueous Phase Liquid
DO	Dissolved Oxygen
ELAP	Environmental Laboratory Approval Program
eV	Electron-volts
FAP	Field Activities Plan
FID	Flame Ionization Detector
FSP	Field Sampling Plan
GIS	Geographic Information System
GPS	Global Positioning System
HDPE	High Density Polyethylene
HVAC	Heating, ventilation, and air conditioning
I.D.	Inner Diameter
IDW	Investigation Derived Waste
in. Hg	inches of mercury
LNAPL	Light Non-aqueous Phase Liquid
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MS	Matrix spikes
MSD	Matrix spike duplicate
NaI	sodium iodide
NAPL	Non-aqueous Phase Liquid
NBS	National Bureau of Standards
NTU	Nephelometric Turbidity Unit
NYCRR	New York Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O.D.	Outer Diameter
ORP	Oxidation Reduction Potential
PCB	Polychlorinated Biphenyls
PDB	Passive Diffusion Bag
PFAS	Broad group of perfluoroalkyl and polyfluoroalkyl substances
pH	power of hydrogen
PID	Photoionization Detector
PM-10	Particulate Matter 10 micrometers or less in diameter
ppb	Parts per billion
PPE	Personal protective equipment
ppm	Parts per million

PVC	Polyvinyl chloride
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
SDG	Sampled Delivery Group
SOPs	Standard Operating Procedures
SOW	Statement of Work
SSHASP	Site Specific Health and Safety Plan
SVOA	Semi-volatile organic analysis
SVOCs	Semi-volatile organic compounds
TAGM	Technical and Administrative Guidance Memorandum
TAL	Target Analyte List
TCL	Target Compound List
TGI	Technical Guidance Instructions
UN	United Nations
USACE	United States Army Corps of Engineers
USEPA or EPA	United States Environmental Protection Agency
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds
WA	Work Assignment

1 OBJECTIVES

1.1 Purpose

This Generic Field Activities Plan (FAP) has been prepared by Arcadis of New York Inc. (Arcadis) as an appendix to site-specific documents developed for Work Assignments (WAs) issued under the New York State Department of Environmental Conservation (NYSDEC) Standby Contract D009804. The purpose of this document is to provide field methods, procedures, and protocols for the collection of data during the work assignments.

This Generic FAP is provided as a supplement to the site-specific documents for Work Assignments under the NYSDEC Standby Contract. Deviations from, or additions to, the procedures and protocols provided in this Generic FAP will be detailed in Schedule 1 of the specific Work Assignment.

1.2 Generic FAP Objectives

The objective of this Generic FAP is to guide field data collection so that the data collected are of suitable quality and quantity to meet the Work Assignment objectives. The procedures summarized herein will be used to guide the collection of field data that is of sufficient quality and applicability for its anticipated use. Media-specific data quality objectives, which are discussed in the Generic Quality Assurance Project Plan (QAPP), have been developed based on the factors presented above. A summary of field activity methods, documentation, and Quality Assurance/ Quality Control (QA/QC) protocols is provided in Section 2. In addition to the procedures described in this document, field activities completed for work assignments issued under NYSDEC standby engineering services contract D009804 will be conducted in general accordance with the following:

- “DER-10 Technical Guidance for Site Investigation and Remediation” (NYSEC 2010)
- “Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York” (NYSDOH 2006), and subsequent updates
- “Sampling, Analysis, and Assessment of PFAS” (NYSDEC April 2023)
- “CP-43 Groundwater Monitoring Well Decommissioning Policy” (NYSDEC 2009)

2 FIELD INVESTIGATION PROCEDURES

A summary of objectives, equipment, and procedures for the following field activities is provided in this section:

- Field quality control samples
  - Trip blanks
  - Field blanks
  - Matrix spike/matrix spike duplicates
  - Field duplicates

- Field measurements
- Sample equipment decontamination
- Monitoring well installation and development
- Groundwater sampling
- Surface water sampling
- Sediment sampling
- Surface soil sampling
- Subsurface Soil sampling
- Exploratory test pits and trenches
- Air and soil vapor sampling
- Emerging contaminant assessment
- Community air monitoring program
- Storage and disposal of investigation derived waste
- Field documentation
- Sample handling

2.1 Field Quality Control Samples

Where required, quality control samples will be collected to evaluate potential bias to sample analytical quality. Quality control samples may include trip blanks, field blanks, duplicate samples, matrix spike samples and matrix spike duplicates will provide a quantitative basis for validating the analytical data. The anticipated QA/QC samples required for each work assignment will be presented in the Schedule 1 Scope of Work.

2.1.1 Trip Blanks

A trip blank is a clean sample matrix that is taken from the laboratory to the sampling site and transported back to the laboratory without having been exposed to sampling procedures. It is used to evaluate if there has been contamination from the shipping and field handling procedures. Trip blanks are typically collected with volatile organic compound (VOC) samples to determine the impact of ambient VOCs on samples arising from diffusion across the sample container membrane during shipping to and from, as well as on site. The VOC trip blanks will be prepared by the laboratory by filling 40 ml vials with a Teflon-lined septum with deionized, analyte-free water. The trip blank will always accompany the day's sample containers. One trip blank will be returned to the laboratory with the cooler containing aqueous samples for VOC analysis. The trip blank will be analyzed for VOCs to detect possible contamination during shipment. Trip blanks will remain in the shipping cooler from the time of packing in the laboratory, to arrival back at the laboratory.

2.1.2 Field Blanks

Field blanks are used to identify the effect of sampling equipment decontamination procedures on the sample results. A field blank consists of an empty set of laboratory-cleaned sample containers. At the field location, deionized, analyte-free water is passed through decontaminated sampling equipment and placed in the empty set of sample containers for analysis of the same parameters as the samples collected with the sampling equipment. Unless otherwise stated in the Schedule 1, one field blank will be collected per every 20 environmental samples sent to the analytical laboratory, per media.

2.1.3 Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) sample pairs are analyzed by the laboratory to provide a quantitative measure of the laboratory's precision and accuracy. When performing USEPA SW-846 volatile organic or organic extractable analysis with NYSDEC Category B deliverables, the laboratory must be supplied with triple sample volume for the Sample Delivery Group (SDG) in order to perform MS/MSD analyses. Blanks do not require separate matrix spike or duplicate analyses regardless of their matrix.

The limits on an SDG are:

- Cases for field samples, or
- 20 field samples within a case, or
- A fourteen-calendar day period during which field samples in a case are received (said period beginning with receipt of the first sample in the SDG), whichever comes first.

Field personnel will specify samples for MS/MSD analysis. Extra volume is not required for aqueous samples for inorganic analysis. Non-aqueous samples (soils) do not require that extra volume of sample be submitted to the laboratory for MS/MSD samples. Unless otherwise stated in the Schedule 1, one MS/MSD will be collected per every 20 environmental samples sent to the analytical laboratory, per media.

2.1.4 Field Duplicates

Duplicate samples are used to evaluate variability in sample results associated with sampling procedures. For the sample matrices, a field duplicate sample will be collected for the analytical laboratory at a rate of one sample per 20 environmental samples, per media. The duplicate sample is collected at the same location as the environmental sample. The field duplicate sample is identified using the sample designation system described in Section 2.15.1. The identity of the field duplicate is not revealed to the laboratory. The analytical results of the environmental sample will be compared to the field duplicate sample, to evaluate field sampling precision.

2.2 Field Measurements

Tasks requiring recording of field measurements include, but may not be limited to, field screening of samples, evaluating the progress of monitoring well development, monitoring well sample collection, collection of soil conductivity data, in-situ measurements, surveying sampling locations, and field analysis of samples using test kits. A summary of field measurements is provided below. Specific procedures for inspection and calibration of the related field equipment are provided in Section 3.

2.2.1 Water Level Measurements

2.2.1.1 Measurement Objectives

Water levels in monitoring wells will be measured and used in conjunction with horizontal and vertical ground survey data to assess the horizontal and vertical components of groundwater flow. Water level measurements will also be used to determine the volume of standing water in monitoring wells for development and purging activities. These measurements made during the initial site activities will be utilized to provide a baseline of groundwater elevations and flow at the site prior to subsequent activities.

2.2.1.2 Measurement Equipment

The following equipment will be used for the measurement of water levels:

- Electronic water level indicator and/or interface probe.
- Field logbook and pen, or electronic tablet.
- Photoionization Detector.
- Deionized Water.
- Low Phosphate Detergent.

2.2.1.3 Measurement Procedure

At sites where VOCs are the contaminant of concern, initial air quality readings in the breathing space around the well will be recorded with a photoionization detector (PID) before removing the well cap to initially check that no action levels specified in the site-specific health and safety plan have been exceeded. The first time water levels are measured at sites where VOCs are the contaminant of concern, the monitoring well expansion cap will be removed and the head space and breathing zone's air quality will be monitored. This step may be omitted in subsequent rounds of water level measurements in those monitoring wells that yielded no detectable amounts of vapors or gases from prior sampling rounds. If air quality readings in the breathing space around the well exceed action levels set in the site-specific health and safety plan (SSHASP), appropriate measures will be taken as listed in the SSHASP.

The battery of the electric water level indicator will be checked by pushing the battery check button and waiting for the audible signal to sound or the instrument light to come on. The water level indicator will be decontaminated before collecting a measurement in monitoring wells by using an Alconox™ wash and deionized water rinse. The instrument will then be turned on and the probe will be slowly lowered into the monitoring well, until the probe makes an audible signal, or the instrument light goes on, indicating that the sensor in the probe has contacted the water surface in the monitoring well.

In the presence of NAPL, an interface probe that can indicate and differentiate between the contact surfaces of NAPL and water will be used in the place of an electric water level indicator. The probe is checked, decontaminated, and used in the same manner as an electric water level indicator. When the sensor probe contacts the NAPL or water surfaces in a monitoring well, it makes an audible signal. In order to distinguish between NAPL and water surfaces, a different audible signal is used for the media (i.e., constant signal for NAPL, intermittent signal for water). The depth to water will be recorded to the nearest one-hundredth of a foot, from the top of the measuring mark on the monitoring well riser. The date, time, monitoring well number, and depth to water will be recorded in the field notebook or electronic tablet.

2.2.2 Water Quality Parameters

Water quality parameters, including pH, conductivity, dissolved oxygen, temperature, oxidation reduction potential, and turbidity are often measured during monitoring well development and groundwater and surface water sampling tasks. The parameters are typically measured using a multi-parameter water quality instrument equipped with a flow-through cell (e.g., U-52, YSI 556 MPS or YSI Pro DDS or equivalent). Technical Guidance Instructions (TGI) for measuring water quality parameters is provided in the Low-flow Groundwater Sampling TGI presented in Appendix A.

At a minimum, the multi-parameter water quality instrument will measure the following field parameters:

- Temperature
- Conductivity
- Dissolved oxygen (DO)
- pH
- Turbidity
- Oxidation Reduction Potential (ORP)
- Salinity

2.2.2.1 Water Quality Measurement Procedures

A calibrated water quality meter will be used (with or without a flow-through cell) to measure water quality parameters. Field personnel will follow the manufacturers procedures for calibration and operation of the instrument when collecting field parameter measurements. Specific procedures for operation and calibration of the multi-parameter water quality instrument are provided in Appendix B.

2.2.3 Field Screening of Soil Samples

Soil samples are screened using a PID to assess the presence of volatile organic vapors in soil samples from split-spoon samplers, direct-push core samples, and other soil sample types. The PID will be programmable and be equipped with the appropriate gas-discharge lamp (9.8, 10.6, or 11.7), measured in electron-volts (eV), based on the ionization potential of the target compounds.

When field screening soil samples, field personnel will follow procedures for calibration, operation, and preventive maintenance as specified in the operating manual provided by the manufacturer (Example in Appendix B).

2.2.3.1 Field Screening Equipment

The following equipment may be used for field screening of soil samples:

- PID

- Self-sealing quart-size polyethylene freezer bags, or 16-ounce glass jars. Jars must be decontaminated or certified as clean from a laboratory.

2.2.3.2 Field Screening Procedures

The polyethylene bag headspace method described below is one method to screen soil samples at the site. The collapse of the polyethylene bag during analysis allows uniform flow of contaminant vapors into the PID. However, a 16-ounce, decontaminated glass jar may be substituted or the soil in the split-spoon or macro-core may be screened directly.

1. Use a self-sealing quart-size polyethylene freezer bag. Half-fill the bag with sample (the volume ratio of soil to air is equal), then immediately seal it. Manually break up the soil clumps within the bag. Alternatively, soil in the split-spoon or direct-push macro-core may be screened directly immediately after opening the sampler.
2. When using glass jars:
   - Fill jars with a total capacity or 16 oz.
   - Seal the jars with one (1) or two (2) sheets of aluminum foil with the screw cap applied to secure the aluminum foil.

Note: Headspace development decreases with temperature. When temperatures are below the operating range of the instrument, perform headspace development and analysis in a heated vehicle or building. Record the ambient temperature during headspace screening. Complete headspace analysis within approximately 20 minutes of sample collection.

3. After headspace development, introduce the instrument sampling probe through a small opening in the bag to a point about one-half of the headspace depth. Keep the probe free of water droplets and soil particles.
4. Record the highest meter response on a sampling form. Maximum response usually occurs within about two seconds. Erratic meter response may occur if high organic vapor concentrations or moisture is present.

Note erratic headspace data in the sampling form. Do not collect analytical samples from the polyethylene bag.

2.2.4 Site and Data Point Surveys and Base Map Preparation

Sampling locations, temporary groundwater sampling points, and groundwater monitoring wells will be surveyed with accuracy and precision requirements discussed in work assignments. Measurement of sampling points will be recorded using either a portable Global Positioning System (GPS) unit suitable for field surveys, or appropriate land surveying equipment operated by a competent land surveyor under the supervision of a New York State Licensed Land Surveyor. Survey data will be used to develop a site base map. Base maps will be prepared using geographic information system (GIS) software.

2.2.5 Radiological Screening

If required, radiological surveys will be conducted to evaluate the presence of low-level radioactive materials. Specific sampling objectives will be outlined in applicable work assignments. If radiological characterization of subsurface soil and groundwater is necessary based on survey results, levels of radioactive materials in soil will be compared to "DER-38 Cleanup Guidelines for Soils Contaminated with Radioactive Materials" (NYSDEC, 2013).

Radiological screening activities will generally follow the guidelines presented in the "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)" (USEPA, 1997). Procedures and methods incorporated in the MARRISM are consistent with practices accepted by the NYSDEC, USEPA, and the United States Army Corps of Engineers (USACE).

Characterization of the extent of radiological contamination in the surface soils at a site will be conducted through a scoping survey. If radioactive contamination is discovered during the radiological screening, additional methods and protocols for subsurface sampling of soil and groundwater will be provided as an addendum to this FAP.

2.2.5.1 Radiological Screening Equipment

Radiological screening field equipment will consist of the following:

Ludlum Model 44-10 (or equivalent) sodium iodide (NaI) Gamma Scintillator coupled with a Ludlum Model 2221 (or equivalent) Scaler/Ratemeter.

- Global Positioning System (GPS) unit.
- Latex gloves (disposable).
- Neoprene gloves.
- Field logbook and pen, or electronic tablet.

2.2.5.2 Radiological Screening Procedures

A screening of the soils outside of site buildings will consist of a "walk-over" using a calibrated Ludlum Model 44-10 (or equivalent) 2-inch by 2-inch NaI Gamma Scintillator coupled with a Ludlum Model 2221 (or equivalent) Scaler/Ratemeter. This type of scan is used to detect radiological materials on the surface and in the top foot of the subsurface. Scanning will be carried out by walking over the outdoor area of the property at a speed of approximately 0.5 meters per second (about 1.5 feet per second), moving the detector in a serpentine fashion. Transects will be spaced to assure complete coverage of the area. A portable GPS unit will be used to map and record the results of the scan.

2.3 Sampling Equipment Decontamination

Cross contamination of samples is to be avoided. Sampling equipment must be clean and free from the residue of previous samples. Non-dedicated sampling equipment must be cleaned initially and prior to being re-used. The following is the procedure for decontamination and does not apply to heavy equipment or drilling equipment, apart from split spoons or equivalent samplers. Heavy equipment and drilling equipment will be steam cleaned in a predesignated location prior to use and between locations. Sampling procedures will be in accordance with "Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites" (ASTM, 1994).

2.3.1 Equipment and Supplies

The following equipment may be needed to decontaminate equipment and tools used to collect soil, sediment and water samples. The exact equipment will be dependent on the contaminants of concern.

1. Tap water for initial cleaning and rinsing of equipment.
2. Distilled water for final rinsing of equipment after tap water or solvent rinse.
3. Non-phosphate detergent (e.g., Alconox™) for cleaning equipment.
4. Dishwashing detergent to remove oily or organic residue.
5. Nitric acid as a 1% solution for removing metal contaminants from equipment
6. Isopropyl alcohol
7. Organic solvent for final cleaning of equipment (e.g., hexane or equivalent)
8. Personnel protective equipment (PPE) - including disposable gloves (Nitrile preferred), first aid kit, and waterproof outerwear (if necessary).
9. Re-sealable buckets approved for waste collection.
10. Squirt bottles for water, alcohol, and solvents.
11. Brushes for cleaning equipment.
12. Field notebooks, pens, pencils, and camera to document decontamination procedures.

2.3.2 Decontamination Guidelines

1. Non-dedicated soil and water sampling and processing equipment should be decontaminated between sampling intervals and between locations.

2. Solvents must be captured and disposed in appropriate, labeled, soil or aqueous waste containers. Instruments that come into contact with the sample water must be cleaned in the same manner as the sampling device.

3. Liquids collected into the chemical waste container must be discarded in an appropriate waste stream.

4. Staff performing decontamination procedures are required to wear appropriate PPE, gloves (e.g., Nitrile) and eye protection.

5. Care should be taken during cleaning to prevent cleaning solution contact with clothing. If circumstances dictate that contact will occur (e.g., high wind), waterproof outer clothing (e.g., foul weather gear or rain gear) and face shields must be worn.

6. The project work plan may designate collection of equipment rinse samples to document the effectiveness of cleaning.

7. This FAP does not address radioactive waste decontamination, PPE for radioactive waste, or disposal of radioactive contaminated waste material. If needed, these will be presented in a FAP addendum.

2.3.3 Decontamination Procedures

The following general procedures will be followed for decontamination at Nonradioactive Waste Sites. Site-specific decontamination procedures may vary depending on analytes sampled, contaminated media, and/or physical features of the work areas.

1. Disassemble item(s) (if necessary).

2. Rinse item(s) with tap water.

3. Thoroughly scrub the item with a brush and soapy water, using non-phosphate detergent such as Alconox™ for non-oily residue, or a detergent for items with oily or other sticky organic residue.

4. During the scrubbing process, be sure to bleed Alconox™ solution or equivalent through small passageways/nozzles/vents, etc.

5. Rinse the item with tap water to remove residual soap. Be sure to bleed tap water through small passageways/nozzles/vents, etc.

6. If required, rinse the item with 10% nitric acid to remove residual metals (if deemed necessary). Be sure to bleed 10% nitric acid through small passageways/nozzles/vents, etc.

7. If required, rinse the item with de-ionized water. Be sure to bleed de-ionized water through small passageways/nozzles/vents, etc.

8. If required, rinse the item with isopropyl alcohol. Be sure to bleed isopropyl alcohol through small passageways/nozzles/vents, etc.

9. If required, rinse the item with de-ionized water. Be sure to bleed de-ionized water through small passageways/nozzles/vents, etc.

10. If required, rinse the item with organic solvent (e.g., hexane or equivalent) if deemed necessary. Be sure to bleed organic solvent through small passageways/nozzles/vents, etc.

11. If required, rinse the item three (3) times with de-ionized or analyte-free water and allow to air dry. Be sure to bleed de-ionized or analyte-free water through small passageways, nozzles, vents, etc.

12. Re-assemble item(s) (if necessary).

13. Wrap the item(s) in aluminum foil or plastic bag if necessary to protect it until it is used.

Equipment used for sampling water from monitoring wells such as pneumatic bladder pumps will be decontaminated by thoroughly washing internal and external surfaces with soapy water and rinsing with deionized water prior to use. Tubing must be dedicated to individual monitoring wells (i.e., tubing cannot be reused). Field instrumentation will be cleaned per manufacturer's instructions (Appendix B). Probes, such as those used in pH and conductivity meters, and thermometers will be rinsed prior to and after use with deionized water.

2.4 Monitoring Well Installation and Development

2.4.1 Installation Objectives

Permanent monitoring wells will be installed to collect groundwater samples for chemical quality analysis. Groundwater levels in the wells will be measured to evaluate the horizontal component of groundwater flow.

2.4.2 Installation Equipment

Monitoring wells may be installed using a truck-mounted rotary drilling rig, truck-mounted sonic drill rig, or truck or track-mounted direct-push drill rig, These rigs may be equipped with hollow-stem augers,, sonic casing, and/or direct-push casing. Well materials will generally include polyvinyl chloride (PVC) screen and riser pipe, PVC or steel surface casing. Borehole annular space will generally be filled with clean filter pack sand, bentonite chips or pellets, and/or Portland Type I cement with bentonite powder. Large pieces of equipment that come into contact with the soil will be steam cleaned before use and between locations. If visibly contaminated with free phase products or other contaminants, probes and other equipment will be decontaminated by the following the procedures in Section 2.3. Surface completions will generally include either a flush-mount cover or stickup steel protective casing set in a concrete pad. See TGIs for monitoring well installation and development in Appendix A.

Prior to well drilling, site personnel will determine if there are problems accessing the well location:

- Obtain underground utility clearance.
- Confirm that there are no overhead obstructions.
- Describe approximate location relative to landmarks and provide a sketch on test pit log.
- Create a contingency plan to enact if drums or other potentially hazardous materials are encountered during excavation.

2.4.3 Installation Procedures (Overburden Monitoring Wells)

A minimum of six inches of clean filter pack sand will be emplaced into the bottom of the casing. The monitoring well assembly, consisting of two-inch inner diameter (I.D.) schedule-40 PVC casing with approximately five to 10 feet of continuous 0.01-inch slot schedule-40 PVC screen, will be inserted through the augers. For overburden water table wells, monitoring well screens will be placed so that a minimum of two feet of well screen is above the water table.

Clean filter pack sand will then be poured into the annular space between the augers and the monitoring well assembly as the augers are slowly removed. The filter pack sand will extend approximately two feet above the screened interval. A minimum one-foot thick layer of bentonite pellets will be placed above the filter pack by slowly dropping the pellets along the side of the monitoring well casing. If the bentonite pellets are emplaced above the water table, they will be hydrated with potable water. The augers will then be removed as the remainder of the annulus is tremie grouted to within two feet of the ground surface with a cement-bentonite grout. The cement-bentonite grout will consist of a mixture of Portland cement and water in the proportion of five to six gallons of water per 94-pound bag of cement, with approximately three to five percent bentonite powder.

2.4.4 Installation Procedures (Bedrock Monitoring Wells – 4 Inch Diameter)

Six and one-quarter inch I.D. hollow-stem augers will be advanced to the top of competent bedrock. A 5-7/8-inch O.D. roller bit will then be inserted into the hollow-stem augers and used to drill at least five feet into competent bedrock, creating a “rock socket” in which to set a surface casing. The “rock socket” will be flushed with potable water to remove rock cuttings. Four-inch I.D. steel or Schedule 40 PVC casing with an end cap and centralizers will then be placed in the augers and pushed to the bottom of the “rock socket”. Cement-bentonite grout will then be tremie pumped from the bottom of the “rock socket” to three feet below the ground surface. The augers will be incrementally withdrawn as the grout is emplaced. Pressure grouting is also acceptable. After the grout has cured for 24 hours, the wells will then be completed to the final depth using HQ wire-line rock coring techniques or NQ coring followed by 3- 7/8-inch O.D. roller bit to ream out the hole. Bedrock section will be left open (no screen or filter pack). For bedrock wells of other diameters, this general procedure is to be followed, but the specific dimensions will require modification.

2.4.5 Monitoring Well Completion

Wells will be completed with a stick-up or flush-mount cover set into a one square foot concrete pad as described in the monitoring well installation TGI document provided in Appendix A.

2.4.6 Monitoring Well Development

2.4.6.1 Development Objectives

Monitoring wells installed at the site will be developed to improve their hydraulic properties by removing sediment from the monitoring well and clearing the monitoring well screen of fine particles. See the monitoring well development TGI in Appendix A.

2.4.6.2 Development Equipment

The following equipment will be needed to develop the monitoring wells:

- Electric water level indicator;

- Polyethylene, HDPE or Nalgene tubing and foot-valve;
- Bottom-filling PVC bailer;
- Bailer cord;
- Temperature, pH, dissolved oxygen, oxidation-reduction potential (ORP), specific conductivity and turbidity meters;
- Photoionization detector (PID);
- Field logbook, field data sheets, or electronic tablet;
- Roll of polyethylene sheeting; and
- Decontamination equipment.

2.4.6.3 Development Procedures

Monitoring well development will be conducted using one or more of the following techniques:

- Bailing.
- Inertial Pumping.
- Surge Block.

Monitoring well development will be performed no sooner than 24 hours after well installation. Prior to developing monitoring wells, the initial water level and total depth will be measured. Following well development, the total depth will again be measured to evaluate the quantity of sediment removed (if any).

All equipment placed into the monitoring well will be either decontaminated prior to its introduction into the monitoring well, in accordance with Section 2.3, or it will be dedicated. Monitoring well development will proceed with repeated alternating sequences of surging and removal of water from the monitoring well, until the discharge water is relatively sediment free.

The effectiveness of the development procedure will be monitored after the well volume has been removed by measurements of field parameters, such as turbidity, pH, ORP, temperature, and conductivity, as described in Section 2.2.2. These field measurements and other observations will be recorded on a Well Development/Purging Log, an example of which is presented in Appendix C.

In general, monitoring well development will be discontinued after a minimum of 10 well volumes or the volume of fluid lost during drilling, whichever is greater, have been removed and stabilization of field parameter measurements has occurred, or when the turbidity of the discharge water reaches 50 nephelometric turbidity units (NTUs) or less. Specific procedures for monitoring well development are provided in the well development TGI document provided in Appendix A.

2.5 Emerging Contaminants

Future work plans should include PFAS and 1,4-dioxane sampling and analysis procedures that conform to the guidelines provided by the NYSDEC. As part of a site investigation or remedial action compliance program, whenever samples of potentially affected media are collected and analyzed for the standard Target Analyte List/Target Compound List (TAL/TCL), PFAS and 1,4-dioxane analysis should also be performed. When sampling for these contaminants refer to respective sample media listed above. Also refer to the TGI in Appendix A for approved equipment, and sampling procedures. Potentially affected media can include soil, groundwater, surface water, and sediment. Based upon the potential for biota to be affected, biota sampling and analysis for PFAS may also be warranted as determined pursuant to a Fish and Wildlife Impact Analysis. Soil vapor sampling for PFAS is not required.

2.5.1 Per- and Polyfluoroalkyl Substances (PFAS)

2.5.1.1 Field Sampling Procedures

Field sampling guidance is provided in “Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substance (PFAS)” (NYSDEC, 2021) and in the TGI for PFAS sampling in Appendix A. However, procedures for PFAS are subject to rapid change, due to the evolving nature of these contaminants. Care should be taken to review and apply the most recent NYSDEC and Arcadis documentation when field sampling.

Due to the prevalence of PFAS, the potential for cross-contamination exists from many sources. These sources include field personnel clothing, PPE, personal care products, food packaging, and sampling equipment. Items that will come in direct contact with PFAS samples, such as sample containers, should not be used unless they are PFAS-free. Field personnel should avoid wearing water-resistant synthetic clothing or Gore-Tex™, and should not apply personal care products (sunscreen, insect repellent, etc.) or eat in the sampling area.

The NYSDEC’s Division of Environmental Remediation (DER) specifies technical guidance applicable to DER’s remedial programs. Given the prevalence and use of PFAS, DER has developed “Sampling, Analysis, and Assessment of PFAS” (NYSDEC, 2021) which summarized currently accepted procedures and updates pertaining to PFAS. As specified in Chapter 2 of “DER-10 Technical Guidance for Site Investigation and Remediation” (NYSDEC, 2010), quality assurance procedures are to be submitted with investigation work plans. Typically, these procedures are incorporated into a work plan, or submitted as a stand-alone document. Field sampling for PFAS performed under DER remedial programs should follow the appropriate procedures for the specific sampling media outlined in Appendices A-F of “Sampling, Analysis, and Assessment of PFAS” (NYSDEC, 2021).

QA/QC samples (e.g., duplicates, MS/MSD) should be collected as specified in “DER-10 Technical Guidance for Site Investigation and Remediation” (NYSDEC, 2010), Section 2.3(c). For sampling equipment coming in contact with aqueous samples only, rinsate or equipment blanks should be collected. Equipment blanks should be collected at a minimum frequency of one per day or one per twenty samples, whichever is more frequent.

2.6 Groundwater Sampling

2.6.1 Sampling Objectives

Groundwater samples will be collected to evaluate the nature and extent of contaminants in groundwater. Specific sampling objectives will be outlined in the work assignments.

2.6.2 Sampling Equipment

The following equipment may be required for groundwater sampling:

- Electric water level indicator and/or interface probe.
- Peristaltic pump.
- Polyethylene or Teflon®-lined polyethylene tubing.
- Silicone tubing.
- Direct-push retractable screen sampler or equivalent for soil boring groundwater grab samples.
- No purge sampler (passive diffusion bags [PDBs], HydraSleeves, Snap Samplers, etc.)
- Temperature, pH, dissolved oxygen, ORP, specific conductivity, and turbidity meters.
- Photoionization detector.
- Field logbook and field data sheets, or electronic tablet.
- Laboratory prepared sample containers.
- Roll of polyethylene tubing.
- Decontamination equipment.
- Disposable latex or nitrile gloves.

2.6.3 Sampling Procedures (Permanent Monitoring Wells)

Groundwater sampling will typically be conducted in accordance with "Region I Low Stress (Low-Flow) Purging and Sampling Procedure for Collecting Ground Water Samples from Monitoring Wells, Final." (USEPA, 2017). Alternative methods, such as the collection of groundwater samples with passive diffusion bags or following purging of three well volumes, may be used at some sites based on project requirements and site conditions. Refer to Section 2.5 for information regarding groundwater sampling of emerging contaminants. Specific TGIs are provided for traditional purging and groundwater sampling, low-flow groundwater sampling, Hydrasleeves, and passive diffusion bag in in Appendix A. General low-flow sampling procedures using a peristaltic pump are summarized below.

The PID will be calibrated before the start of sampling events. In sites where VOCs are the contaminant of concern, initial air quality readings in the breathing space around the well will be taken with a photoionization detector (PID) <u>before</u> removing the well cap to initially check that no action levels specified in the site-specific health and safety plan have been exceeded. The first time water levels are measured at sites where VOCs are the contaminant of concern, the monitoring well expansion cap will be removed and the head space and breathing zone's air quality will be monitored. This step may be omitted in those monitoring wells which have already demonstrated in the previous rounds of water level measurement that they contain no or insignificant amounts of volatile organic vapors. If air quality readings in the breathing space around the well exceed action levels set in the site-specific health and safety plan (SSHASP), appropriate measures will be taken as listed in the SSHASP.

Clean, new polyethylene or Teflon®-lined polyethylene tubing will be lowered into the water column to a maximum depth of two feet above the bottom of the monitoring well when sampling for VOCs, SVOCs, pesticides, PCBs, and organics. PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses and High Density Polyethylene (HDPE) tubing is to be used when sampling for PFAS and 1,4-dioxane. The polyethylene/PVC/polypropylene tubing will be connected to a piece of silicone tubing that is inserted into the mechanical rollers of a peristaltic pump. By using the process of mechanical peristalsis, the peristaltic pump draws groundwater through the tubing to the surface, so that a sample can be collected. The well will be purged at a rate suitable to minimize drawdown. Field parameters, consisting of pH, specific conductance, temperature, dissolved oxygen, ORP, and turbidity will be measured in samples collected from a monitoring point using individual meters. Both the pH and the specific conductivity meters will be calibrated for water temperature before sampling events.

The volume of water removed from monitoring wells will be dependent upon the amount of time required for stabilization of the field parameters. In general, the well will be considered stabilized for sample collection when field parameters have stabilized for three consecutive readings as follows:

- pH: +/- 0.1 standard units
- Specific Conductance: +/- 3%
- Oxidation-Reduction Potential: +/- 10 millivolts
- Dissolved Oxygen +/- 10%
- Turbidity +/- 10%

When the field parameters have stabilized, the volume of water purged will be recorded, and the monitoring point will be sampled in the same manner as was used to purge the well. Once a groundwater sample is collected from the well, the polyethylene tubing will be disposed of as ordinary solid waste.

After recording field measurements, the analytical parameters and order of sample collection for groundwater samples will be:

1. TCL VOCs
2. TCL SVOCs
3. Other Parameters (TAL Metals, Pesticides, PCBs, etc.)

The sample bottles will be pre-preserved by the laboratory. The sample bottles will be immediately placed in a cooler held at 4°C. Disposable latex or nitrile gloves will be worn by the sampling personnel and changed between sampling points. Data to be recorded in the field logbook or electronic tablet will include purging and sampling methods, depth to water, volume of water removed during purging, pH, temperature, ORP, dissolved oxygen, turbidity, and specific conductivity values, and PID readings.

Groundwater that is purged from monitoring wells before sampling must be collected, handled and discharged/disposed of pursuant to “DER-10 Technical Guidance for Site Investigation and Remediation” (NYSDEC, 2010), section 3.3 (e) 5. Groundwater derived from monitoring well development or purging may be discharged to the ground surface within 50 feet of the monitoring well location only if the following criteria are met:

1. There is a defined site which is the source of the groundwater contamination;
2. There is no free product observed such as DNAPLs or LNAPLs;

3. The infiltrating groundwater is being returned to the same water bearing zone from which it is being purged;
4. There is no visual evidence of contamination (discoloration, sheen);
5. There is no olfactory evidence of contamination;
6. The groundwater does not contain concentrations of contaminants above groundwater standards at levels of concern based on previous sampling;
7. The groundwater can be recharged in a manner that does not result in surface runoff;
8. Prior approval has been granted by the NYSDEC Department of Environmental Remediation.

If there is no recharge surface (i.e., grass, uncovered soil, etc.) located within 50 feet of a well, or if the groundwater does not meet the above criteria, then the purge water will be containerized and disposed of off-site. Purge water requiring off-site disposal will be handled in accordance with Section 2.14.

2.6.4 Sampling Procedures (Temporary Sampling Points)

A direct-push retractable screen sampler or equivalent will be utilized to collect discrete groundwater samples at various depths at the sample locations. A 1 ¾-inch hollow push rod with a steel drop off tip will be advanced to a designated depth and then retracted. When the push rod is retracted a filter screen is exposed, allowing groundwater to hydrostatically enter the inlet screen from the formation. Clean, new Teflon®-lined polyethylene tubing will be lowered into the water column to a maximum depth of two feet above the bottom of the monitoring well when sampling for VOCs, SVOCs, pesticides, PCBs, and organics. PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses. High Density Polyethylene (HDPE) tubing is to be used when sampling for per- and polyfluoroalkyl substances (PFAS) and 1,4-dioxane. The polyethylene tubing will be connected to a piece of silicone tubing that is inserted into the mechanical rollers of a peristaltic pump. By using the process of mechanical peristalsis, the peristaltic pump draws groundwater through the tubing to the surface, so that a sample can be collected. Field parameters, consisting of pH, specific conductance, temperature, dissolved oxygen, ORP, and turbidity will be measured in samples collected from a monitoring point through the use of individual meters. Both the pH and the specific conductivity meters will be calibrated for water temperature before sampling events.

The volume of water removed from sampling points will be dependent upon the amount of time required for stabilization of the field parameters. In general, the point will be considered stabilized for sample collection when field parameters have stabilized for three consecutive readings as follows:

- pH: +/- 0.1 standard units
- Specific Conductance: +/- 3%
- Oxidation-Reduction Potential: +/- 10 millivolts
- Dissolved Oxygen +/- 10%
- Turbidity +/- 10%

When the field parameters have stabilized, the volume of water purged will be recorded, and the sampling point will be sampled in the same manner as was used to purge the well. The purge water will be handled in accordance with Section 2.6.3.

After taking field measurements, the analytical parameters and order of sample collection for groundwater samples will be:

1. TCL VOCs
2. TCL SVOCs
3. Other Parameters (TAL Metals, Pesticides, PCBs, etc.)

The sample bottles will be pre-preserved by the laboratory. The sample bottles will be immediately placed in an insulated cooler maintained at 4°C. Disposable latex or nitrile gloves will be worn by the sampling personnel and changed between sampling points.

2.6.5 Sampling Procedures (No Purge Sampling)

In instances where wells have reduced production and/or recharge, or required analytes are amenable to no purge sampling methods, passive diffusion bags (PDBs), Hydrasleeves, Snap Samplers, etc., may be used with the permission of the NYSDEC. It is noted that efficacy testing of these methods versus traditional low-flow sampling may be required by the NYSDEC prior to routine usage for a WA.

PDBs

Due to the nature of their semipermeable membrane, PDBs are currently only appropriate for collection of samples for analysis of VOCs. Further, their use in low permeability formations (less than approximately 1×10^{-6} cm/sec) should be considered carefully due to limited self-purging of wells and contaminant diffusion. General PDB deployment and sampling procedures are summarized below. A TGI for passive diffusion bags can be found in Appendix A, and PDB sampler instructions are provided in Appendix B.

Deploy PDBs as soon as possible following receipt from lab/supplier. Care should be taken to avoid long term storage or storage near VOC-containing materials to prevent cross-contamination. PDBs prefilled with laboratory grade deionized water are suspended in the water column with appropriate weight, string/rope, and attachment equipment. While PDBs are typically suspended at the middle of the well screen interval, deployment depth may vary based on project-specific objectives. After securing the line to the well head, PDBs should be deployed in monitoring wells for at least 14 days prior to retrieval to allow sufficient time for equilibration/diffusion of COCs.

Following retrieval of the PDB, the contents of the PDB should be poured into laboratory-suppled vials. The sample bottles will be immediately placed in an insulated cooler maintained at 4°C. Disposable latex or nitrile gloves will be worn by the sampling personnel and changed between sampling points. .

Hydrasleeves

For collection of field parameters or laboratory parameters not conducive to PDB sampling, Hydrasleeve samplers may be used to obtain required volume without purging the well. General Hydrasleeve sampling procedures are summarized below and in the TGI for Hydrasleeves in Appendix A. Additional information is provided in Appendix B.

The Hydrasleeve will be deployed to the midpoint of the screen interval in the monitoring well and pulled upward approximately 1 to 2 feet and dropped back to the starting point. The cycle will be repeated 3 to 5 times then the sample will be collected.

Field parameters may be measured using a field water quality meter and sample volume for laboratory analysis may be transferred to the appropriate laboratory-suppled bottles. The sample bottles will be immediately placed in an insulated cooler maintained at 4°C. Disposable latex or nitrile gloves will be worn by the sampling personnel and changed between sampling points.

Snap Samplers

The Snap Sampler is a passive groundwater sampling technology that employs a double-ended opening bottle with sealing end caps. It can be deployed at the desired screen interval within a well. The general Snap Sampler procedure is summarized below. Additional information is provided in Appendix B.

The Snap Sampler will be deployed to the desired monitoring depth with an attachment line and left to equilibrate for a specified time. To collect the samples, pull a mechanical trigger line which releases a cap and seals the double ended bottle. The end caps are designed to seal the water sample with no headspace vapor. Once the vials are retrieved from the well, the bottles are prepared with standard septa screw caps and labelled for laboratory submittal. The sample bottles will be immediately placed in an insulated cooler maintained at 4°C. Disposable latex or nitrile gloves will be worn by the sampling personnel and changed between sampling points.

2.7 Surface Water Sampling

2.7.1 Sampling Objectives

Surface water samples are collected from lakes, streams, rivers, stormwater catch basins, etc. to evaluate the nature and extent of contaminants of concern at concentrations greater than NYSDEC surface water standards. Refer to Section 2.5 for information regarding surface water sampling of emerging contaminants.

2.7.2 Sampling Equipment

The following equipment will be needed to collect groundwater samples for analysis:

- Glass beaker.
- Laboratory prepared sample containers.
- Temperature, pH, dissolved oxygen, ORP, specific conductivity and turbidity meters.
- Field logbook and field data sheets, or electronic tablet.
- Disposable latex or nitrile gloves.

2.7.3 Sampling Procedures

Surface water sampling will be conducted in order from the furthest downstream location to the furthest upstream location to prevent cross contamination. The surface water sample will be collected directly from the surface water body by partially submerging a pre-cleaned glass beaker or unpreserved sample container into the surface water. The glass beaker will be allowed to fill slowly and continuously. Once the glass beaker is completely filled, the surface water will be transferred directly into the laboratory-provided sample containers by slightly tilting the mouth of the sample bottle below the beaker edge. Surface water in the beaker will be emptied slowly into the sample bottle to minimize the disturbance created during transfer. If the surface water is not at the surface, a stainless-steel dipper will be utilized to collect a sample. The dipper will be lowered into the water and brought to the surface with minimal disturbance. The transfer of surface water from the dipper to the sample bottles will be the same as the procedure described using a beaker described above.

Field parameters, consisting of pH, specific conductance, temperature, dissolved oxygen, ORP, and turbidity will be measured prior to the collection of the sample. Both the pH and the specific conductivity meters will be calibrated for water temperature before the sampling event.

After taking field measurements, the analytical parameters and order of sample collection for groundwater samples will be:

1. TCL VOCs
2. TCL SVOCs
3. Other Parameters (TAL Metals, Pesticides, PCBs, etc.)

The sample bottles will be pre-preserved by the laboratory. The sample bottles will be immediately placed in an insulated cooler maintained at 4°C. Disposable latex or nitrile gloves will be worn by the sampling personnel and changed between sampling points.

2.8 Sediment Sampling

2.8.1 Sampling Objectives

Sediment samples will be collected to evaluate the nature and extent of contaminants at concentrations greater than 6 NYCRR Subpart 375-6: Remedial Program Cleanup Objectives, "Screening and Assessment of Contaminated Sediment" (NYSDEC, 2014) criteria, or site-specific standards. Refer to Section 2.5 for information regarding sediment sampling of emerging contaminants. The objectives of a sediment sampling program are to assess the nature and extent of sediment contamination and evaluate the need for remediation. The location of surface soil samples will be measured relative to permanent site features or recorded using a GPS device and marked on a site diagram in the field logbook or electronic notebook. Additionally, sediment sampling locations in shallow water will be marked in the field with a survey stake and labeled with the sample identification. to facilitate subsequent surveying of the sampling location.

2.8.2 Sampling Equipment

The following equipment will be needed to collect sediment samples for analysis:

- Stainless steel trowel, shovel, or scoop
- Stainless steel bowl

- Appropriate sampling device and/or transfer device

2.8.3 Sampling Procedures

In general, the following considerations should be considered during sediment sampling activities:

- Collect the sediment sample after the surface water sample if both media are to be sampled at the same location.
- Collect downstream sediment samples before upstream samples.
- Do not stand in the sediment deposits being sampled.
- Twigs, leaves roots, grass, and rocks are not considered part of the sediment matrix and will be removed from the sample.
- If collected as a composite, collect at least three small, equal-sized sediment sample aliquots. Carefully composite the sample in a stainless-steel mixing bowl prior to homogenization and filling of the sample containers.

The preferred order of sample collection is as follows:

- In-situ measurements (i.e., temperature, pH and specific conductance)
- Volatile Organics (VOA) – Do not use homogenization or composite sampling techniques when sampling volatile compounds – collect a grab sample.
- Semi-volatile Organics (SVOA)
- TAL Metals
- Radionuclides and other parameters

Collect the VOA fraction using the stainless-steel trowel/scoop or other sampling device, avoiding the collection of rocks, twigs, leaves and other debris. Fill the VOA sample containers to zero headspace, directly from the sampling device.

For non-VOA sample fractions, remove the sample from the sampling device or stainless-steel trowel/scoop, avoiding the collection of rocks, twigs, leaves and other debris, and place the sample into a stainless-steel bowl, then follow the procedure for homogenization:

1. Thoroughly mix the sample, using the same stainless-steel trowel or scoop, as used during the sample collection. The sediment in the bowl should be scraped from the sides, corner and bottom, rolled to the middle of the bowl and initially mixed.
2. The sample should be quartered and separated.
3. The quarters should be mixed individually and then rolled to the center of the bowl.
4. Mix the entire sample again.
5. Fill sample containers in the order specified above or as described in the work assignment.
6. Transfer the homogenized non-VOA fraction into the appropriate sample containers using the same stainless-steel trowel or scoop used throughout this entire procedure.

Decontaminate sampling equipment between sampling locations following the procedures discussed in Section 2.3.

2.9 Surface Soil Sampling

2.9.1 Sampling Objectives

Surface soil samples will be collected to evaluate the nature and extent of contaminants at concentrations greater than 6 NYCRR Subpart 375-6: Remedial Program Cleanup Objectives. Refer to Section 2.5 for information regarding surface soil sampling of emerging contaminants. The objectives of a surface soil sampling program are to assess the nature and extent of soil contamination and evaluate the need for remediation. The location of surface soil samples will be measured relative to permanent site features or recorded using a GPS device and marked on a site diagram in the field logbook or electronic tablet. Additionally, sampling locations will be marked in the field with a survey stake and labeled with the sample identification to facilitate subsequent surveying of the sampling location.

2.9.2 Sampling Equipment

The following equipment may be required for surface soil sampling:

- Stainless steel trowel, shovel, or scoop
- Hand Augers (multiple size stainless steel buckets)
- Labels
- Cooler
- Stainless steel trowels
- Field logbook or electronic tablet
- Shovels (to remove gravel and debris)
- Soils Data form, Daily QC form, etc.
- Plastic sheeting and/or aluminum foil
- Decontamination equipment as required
- Appropriate sample bottles
- Hand tools (for equipment or other needs)
- Plastic bags (sealable)
- Camera
- Compass
- 200-ft tape

2.9.3 Sampling Procedures

Surface soil samples may be collected at the same location as a soil boring, but is not required. In the event that the surface soil sample is in the same location as a soil boring, a surface soil sample will be collected prior to initiation of boring and sampling.

Vegetation at the sample location is removed by cutting or scraping away with a stainless-steel trowel. Twigs, leaves roots, grass, and rocks are not considered part of the soil matrix and will be removed from the sample. Remove gravel or other debris from the surface before advancing the auger or trowel to a depth of approximately six inches. Using pre-cleaned stainless-steel equipment, extrude the soil directly into the sampling containers. If dedicated sampling equipment is not used, sampling equipment must be decontaminated before collecting another sample.

Samples for VOC analysis must be collected first. Fill VOC sample containers as full as possible to minimize headspace losses. Fill separate containers with a sufficient quantity of soil for analyses of other required parameters. Samples will be immediately placed in an insulated cooler and maintained at a temperature of 4°C. Enter data into a permanent field logbook or electronic tablet. VOC samples will be collected as grab samples.

Other samples may be collected as grab samples or composite samples. For composite samples, a volume of soil 6 inches by 6 inches by 2 inches deep (72 cubic inches) will be collected using a stainless-steel trowel and transferred to a stainless-steel mixing bowl. Upon collection, the sample will be homogenized in a stainless-steel bowl and classified. Twigs, leaves roots, grass, and rocks are not considered part of the soil matrix and will be removed from the sample. After the soil is homogenized, a sample will be placed in laboratory-provided sample containers.

Field personnel will describe the soil samples, screen the soil samples for VOCs with a PID, and record observations in the field log or electronic tablet. The location(s) for collection of field duplicates, field blanks, and matrix spike/matrix spike duplicate samples will be determined in the field.

Sampling equipment will be decontaminated as discussed in Section 2.3. Disposable gloves will be worn by the sampling personnel and changed between sampling points.

2.10 Subsurface Soil Sampling

2.10.1 Soil Sampling Objectives

Soil samples will be collected at discrete depth intervals to evaluate the nature and extent of contaminants at concentrations greater than 6 NYCRR Subpart 375-6: Remedial Program Cleanup Objectives in subsurface soil and to document the underlying stratigraphy. Analytical data will be used to evaluate the need for remediation.

2.10.2 Soil Sampling Equipment

The following equipment may be used to collect soil samples:

- Photoionization Detector.
- Roll of polyethylene sheeting.
- Stainless steel spatula or spoon.
- Stainless steel trowel.
- Stainless steel bowl.

- Disposable nitrile or latex gloves.
- Certified, pre-cleaned sample containers.
- Aluminum foil.
- Field logbook and pen, or electronic tablet.
- Decontamination equipment.

2.10.3 Soil Sampling Procedures

Prior to soil boring, site personnel will determine if there are problems with the bore location:

- Obtain underground utility clearance.
- Confirm that there are no overhead obstructions.
- Describe approximate location relative to landmarks and provide a sketch on test pit log.
- Create a contingency plan to enact if drums or other potentially hazardous materials are encountered during excavation.

2.10.3.1 Direct-push Soil Sampling

A direct-push drill rig (e.g., Geoprobe® or equivalent) will drive a dual-tube sampler, blind probe, or similar direct push system into the subsurface to create a borehole approximately 1.5 to two inches in diameter. Subsurface soil samples will be removed from the borehole in four- or five-foot intervals in acrylic tubes. The total number of four- or five-foot tubes collected from soil borings will be dependent on the final depth of the boring.

Before the soil is characterized and the boring is logged, the plastic tube will be cut along its length and the soil core will be screened for VOCs using a PID. Field Personnel will characterize the soil samples and record observations in the field log. A standard boring log is provided in Appendix C.

Soil samples designated for VOC analysis will be collected directly from the sampling device. Grab sample will be placed in laboratory-provided sample containers. Samples will be immediately placed in a cooler and held at 4ºC until the samples are sent to a NYSDOH ELAP certified laboratory and analyzed for the applicable analyses. The location(s) for collection of field duplicates, field blanks, and matrix spike/matrix spike duplicate samples will be determined in the field based on subsurface soil conditions.

Other samples may be collected as grab samples or composite samples, directly from the sampling device. For composite samples, soil will be directly from the sampling tube and transferred to a stainless-steel mixing bowl, where it will be homogenized. After the soil is homogenized, a sample will be placed in laboratory-provided sample containers.

Sampling equipment will be decontaminated as discussed in Section 2.3. Disposable gloves will be worn by the sampling personnel and changed between sampling points.

2.10.3.2 Split-barrel (Split-spoon) Sampling

When direct-push sampling is not practical, a 24-inch long stainless-steel split-barrel sampler can be driven a total of 24 inches into the undisturbed materials by typically dropping a 140-lb weight 30 inches. A 3- inch diameter split spoon may be used to increase the chances of sufficient volume recovery for sampling purposes. Split spoon samples will be collected in accordance with the American Society for Testing and Materials (ASTM) “Standard Test Method for Penetration Test and Split-barrel Samplings of Soils, Method D 1586-99” (ASTM, 1999).

2.11 Exploratory Test Pits and Trenches

Test pits and trenches will be excavated to determine stratigraphy to a maximum depth of approximately 15 feet. A contractor will be required to provide the backhoe or other equipment and an operator. Soil samples will be collected at various depths within the test pit as detailed below. A test pit excavation program will include recording of visual observations and information on the nature of the soil, including whether or not it is native soil or fill.

2.11.1 Test Pit Sampling Equipment

Materials useful for test pit excavations include the following:

- Test Pit Log
- Site Map
- Camera
- Measuring Tape
- Photoionization Detector (PID)
- Excavation Equipment
- Sheet polyethylene, hay bales, etc. for staging of excavated soil in compliance with appropriate erosion control/soil placement requirements.

2.11.2 Test Pit Sampling Procedures

A test pit log (Appendix C) should be provided for to record observations. The form will include information on the location of the test pit in relation to permanent site features, the excavated soil, and other relevant observations, as listed below:

- Date test pit excavation was started/finished
- Test pit number
- Site/project/client name
- Project number
- Your name
- Surface conditions, such as asphalt, concrete, grass, mud, etc.
- Weather and temperature

- Excavation equipment make and model
- Contractor company name and personnel
- Site location

Prior to test pit excavation, site personnel will determine if there are problems accessing the test pit location:

- Obtain underground utility clearance.
- Confirm that there are no overhead obstructions.
- Describe approximate location relative to landmarks and provide a sketch on test pit log.
- Create a contingency plan to enact if drums or other potentially hazardous materials are encountered during excavation.

Soil sampling procedures during test pit operations will be the same as those described for surface soil sampling (Section 2.9). In addition to documentation requirements for soil sampling, the following will also be noted during test pit sampling, and recorded on the test pit log (Appendix C):

- Describe the soil excavated, including color, texture, consistency, and moisture at a specific depth interval (e.g., every one or two feet)
- Record if there are odors and, if so, describe.
- If appropriate, take and record a PID measurement the depth intervals.
- Collect soil samples at predetermined depths or as appropriate based on-site conditions. Record sample number on test pit log.
- Sketch a cross section of the test pit showing relevant observations.

2.12 Air and Soil Vapor Sampling

2.12.1 Air and Soil Vapor Sampling Objectives

Air and soil vapor sampling is intended to evaluate the potential for migration of VOCs from the subsurface into indoor air and the potential for current and future human exposures related to soil vapor intrusion. Indoor air, ambient air, soil vapor, and sub-slab vapor samples will be collected to evaluate the nature and extent of VOCs in these media. Ambient air samples will be collected from outside of the building to provide information on background VOC concentrations. Sub-slab soil vapor samples will be collected from just below the concrete slab of a building to evaluate the potential for soil vapor intrusion.

2.12.2 Air Sampling Equipment

Air and sub-slab soil vapor samples will be collected using a Summa canister sampling train. The typical Summa canister sampling train consists of the following:

- Summa canister.
- Flow controller.
- Particulate filter.

- Pressure gage.
- Fittings and a sampling line.

The laboratory will evacuate the canister to a minimum vacuum of negative 28 inches (± 2 inches) of mercury (in. Hg) prior to sampling. After sampling, the final vacuum will be recorded on a chain of custody form to confirm sample integrity. A pressure gage will be used to monitor the vacuum before, during, and after sampling. A seven-micron particulate filter will be used upstream of the flow controller to prevent blockage of the flow controller. The sampling line will consist of new, unused, ¼-inch diameter flexible Teflon® tubing. Parts of the sampling train coming into direct contact with the sample will be made of stainless steel or Teflon®. The following general set-up procedure will be followed for sampling locations:

1. Place Summa canister at sampling location.
2. Note the environmental conditions in the sample area on the air sampling sheet.
3. Assemble the Summa canister sampling train. Follow the laboratory instructions for pressure measurement, particulate filter placement, and flow controller attachment.
4. Begin sampling following the procedures described below.

2.12.3 Indoor and Ambient Air Sampling Procedures

Indoor and ambient air samples will be collected in accordance with the “Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York” (NYSDOH, 2006), including subsequent updates, and the Technical Guidance Instructions for Air Sampling with Summa Canisters (Appendix A). The procedures implemented for the collection of indoor and ambient air samples are summarized as follows:

1. Remove the brass plug fitting covering the 6-liter stainless steel Summa canister sampling port using a wrench.
2. Connect the pressure gage or flow controller with integral pressure gage to the Summa canister sampling port. Open the valve on the canister and quickly measure the vacuum within the canister. If the vacuum is greater than negative 25 inches of mercury, then the canister is acceptable for sampling. Canisters with a vacuum less than negative 25 inches of mercury should not be used for sampling. Close the valve and record the measurement on the sampling sheet.
3. Assemble the sampling train. Fittings should be hand tightened and then tightened with a wrench approximately ¼ turn.
4. Confirm that the sampling train is airtight by conducting a vacuum test. Place the brass cap at the end of the sampling train (particulate filter), quickly open and close the sampling valve and monitor the vacuum on the pressure gage. If the vacuum decreases, there is a leak in the system. Fittings should be rechecked and the vacuum test redone.
5. Initiate sampling by opening the Summa canister valve. Record starting time on the sampling sheet.
6. During sampling, the pressure will be monitored periodically to verify that the flow controller is operating properly.
7. When the time corresponding to the calibrated flow controller (for indoor air – 24 hours) has elapsed, close the canister valve. Disassemble the sampling train. Check the vacuum within the canister using the pressure gage and record the measurement on the sampling sheet.

8. Since the flow rate into the canister can fluctuate due to variations in atmospheric conditions, the measured final vacuum may range from 4 to 12 in. Hg. If the measured vacuum is greater than 12 in. Hg or less than 3 in. Hg, the sample may be flagged, and re-sampling may be needed.
9. Place the brass cap on the sampling port of the canister and tighten. The air sampling is complete.
10. Place the air sample in the travel box and complete the chain of custody forms and identification tag on the canister.
11. Send the canister to the laboratory via next day airmail service for analysis of VOCs by Method TO-15.

2.12.4 Sub-Slab and Soil Vapor Sampling Procedures

Sub-slab vapor and soil vapor sampling points will be constructed in the same manner at the sampling locations to minimize possible discrepancies. Sub-slab vapor and soil vapor sampling points will be constructed in compliance with the procedures outlined in the "Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York" (NYSDOH, 2006) and subsequent updates.

The building's heating system will be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time. Prior to installation of the sub-slab vapor probe, the building floor will be inspected and penetrations (cracks, floor drains, utility perforations, sumps, etc.) will be noted and recorded. Probes will be installed at locations where the potential for ambient air infiltration via floor penetrations is minimal.

Temporary sub-slab vapor sampling points will be constructed in accordance with the "Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York" (NYSDOH, 2006) and will include the following:

- Drill a 1-inch diameter hole approximately 1-inch into the concrete floor slab using an electric hammer drill.
- Drill a 1/4-inch diameter hole through the 1-inch hole completely through the concrete floor slab but extending no further than 2 inches below the bottom of the floor slab.
- Insert inert tubing, such as Teflon or Teflon-lined polyethylene tubing (¼-inch outer diameter [O.D.]), approximately 3 feet long; into the hole drilled in the floor, extending to the bottom of the floor slab.
- Seal the tubing at the floor penetration with bentonite, melted bees wax, or modeling clay ensuring that an effective seal has been established.
- Conduct tracer gas test in accordance with "Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York" (NYSDOH, 2006).
- Attach a syringe to the sampling tube and purge approximately 100 mL of air/vapor at a consistent flow rate that is less than or equal to 0.2 liters per minute. The syringe will be capped, and the air released outside the building or into a Tedlar® bag using a three-way valve so as not to influence the indoor air quality.

Permanent sub-slab vapor sampling points will be constructed in accordance with the USEPA Method TO-15 to Support Vapor Intrusion Investigations and will include the following:

- 1.5-inch and ¼-inch holes will be drilled using the same methods described above for temporary sub-slab vapor sampling points.

- Recessed probes will be constructed with brass or stainless-steel fittings and inert tubing (e.g., polyethylene, stainless steel, nylon, Teflon®, etc.) of the appropriate size (approximately 1/8-inch to ¼-inch diameter), and of laboratory or food grade quality;
- Tubing will not extend beyond the base of the concrete slab;
- Implants will be sealed to the slab with non-VOC-containing and non-shrinking cement grout.

Soil vapor probes will be semi-permanent and will be installed in accordance with the "Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York" (NYSDOH, 2006). The actual locations of the points will be dependent on the locations of subsurface utilities. In general, the target depth for the soil vapor points will be the basement floor level of the adjacent residential structures or just above the groundwater table, whichever is shallower. The soil vapor points will be installed using a direct-push drilling rig to advance a borehole and collect soil samples continuously to the target depth. Upon reaching the target depth, a six-inch small-diameter stainless steel screen attached to Teflon or Teflon-lined tubing will be lowered to the bottom of the borehole. The bottom one foot of the borehole will then be backfilled with clean silica sand. The remaining borehole annulus will be backfilled to the surface with hydrated bentonite. The point will be completed with a stick-up or flush mount casing.

To obtain representative samples that meet the data quality objectives, sub-slab and soil vapor samples will be collected in accordance with the "Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York" (NYSDOH, 2006) and summarized as follows:

- To verify samples collected are representative, one to three volumes (i.e., the volume of the sample probe and tube) will be purged using disposable syringes after installation of the probes and prior to collecting the samples;
- A vacuum will not be used to clear the sample hole after boring through the sub slab;
- Sample flow rates for both purging and collecting must will not exceed 0.2 liters per minute to minimize ambient air infiltration during sampling;
- Conduct tracer gas test in accordance with "Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York" (NYSDOH, 2006).
- Samples will be collected, using conventional sampling methods as described in Section 2.12.3, in a laboratory-certified Summa canister that is consistent with the sampling and analytical methods;
- Summa canisters will be either batch or individually certified as analyte free by the laboratory; and
- Samples will be collected over the same period of time as concurrent indoor and outdoor air samples.

2.13 Community Air Monitoring Program

As required, Arcadis will conduct monitoring for volatile organic compounds (VOCs) and/or particulate matter (dust) during ground intrusive activities. Monitoring will be conducted at the downwind perimeter of work areas. Continuous monitoring will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. Additional guidance can be found in Appendix 1A of “DER-10 Technical Guidance for Site Investigation and Remediation” (NYSDEC, 2010).

2.13.1 VOC Monitoring, Response Levels, and Actions

Volatile organic compounds (VOCs) will be monitored on a continuous basis during ground-intrusive activities and periodically during non-intrusive activities. Upwind concentrations will be measured at the start of the workday and periodically thereafter to establish background conditions. VOC monitoring will be conducted using PID. The PID will be calibrated at least daily using the span calibration gas recommended by the manufacturer. The PID measurements will be compared to the action levels specified below.

Action Levels

- If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities will be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities will resume with continued monitoring.
- If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities will be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities will resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.
- If the organic vapor level is above 25 ppm at the perimeter of the work area, work activities will be stopped.
- Measurement will be recorded and made available upon request, for State (NYSDEC and NYSDOH) personnel to review.

2.13.2 Particulate Monitoring, Response Levels, and Actions

Particulate concentrations will be monitored continuously at the upwind and downwind perimeter of work areas during ground-intrusive activities. Real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) will be used for the particulate monitoring. The equipment will be equipped with an audible alarm to indicate exceedance of the action levels summarized below. Fugitive dust migration will also be visually assessed during work activities.

Action Levels

- If the downwind PM-10 particulate level is 0.1 milligrams per cubic meter (mg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques will be employed. Work will continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 0.15 mg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

- If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 0.15 mg/m^3 above the upwind level, work will be stopped and a re-evaluation of activities initiated. Work will resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 0.15 mg/m^3 of the upwind level and in preventing visible dust migration.

Particulate monitoring measurements readings will be recorded and made available upon request for NYSDEC,NYSDOH, and County Health personnel to review.

2.14 Storage and Disposal of Investigation Derived Waste

Investigation derived wastes (IDW) will be handled in accordance with the NYSDEC and federal regulations. Purged water not requiring off-site disposal will be handled in accordance with the procedures described in Section 2.6.3. Soil cuttings and purged water requiring off-site disposal will be containerized in UN-approved, 55-gallon steel drums. Some disposable personal protective equipment (PPE) and decontamination fluids will be generated. Attempts will be made to wash surface contamination off so that PPE (i.e., gloves and other disposable items) may be disposed of as ordinary solid waste. If contamination is suspected, these materials will be collected and containerized in UN-approved, 55-gallon steel drums (separately from contaminated soil and groundwater) and disposed of off-site.

Containerized materials will be labeled and staged at a location designated by the NYSDEC. Logs will be maintained of the containers and their contents. The contents will be evaluated upon receipt of analytical results from the field investigations. Containerized IDW will be transported by a licensed waste hauler and disposed of at an approved facility in accordance with applicable regulations.

2.15 Field Documentation

The following information must be provided on the inside front cover of the field logbook:

- Project Name (Site Name).
- Site Location.
- Site Manager.
- Date of Issue.

Control and maintenance of field logbooks is the responsibility of the Field Team Leader. Field documentation quality procedures can be found in Appendix B.

2.15.1 Sample Designation

A sample numbering system will be used to identify samples. This system will provide a tracking procedure to allow retrieval of information about a particular sample and will verify that samples are uniquely numbered. The sample identification will consist of at least three components as described below. Identification numbers for soil boring samples will also have a fourth component.

Sample labels will include the following information:

- Project site
- Sample type (media)
- Sample location
- Date

2.15.2 Documentation and Field Activities

Field Activities may be documented in logbook entries, on preformatted data reporting forms, or on a tablet with electronic forms developed for the specific WA. Field logbook entries must be legibly written and provide a concise, detailed picture of field activities.

Guidance for documenting field activities in a logbook is provided below. :

- Identify the date, time, site name, location, Arcadis personnel and their responsibilities, other non-personnel and observed weather conditions. Additionally, during the course of site activities, deviations from the work plan must also be documented.
- Photos taken must be traceable to field logbook entries. It is recommended to reference photo locations on the site sketch or map.
- Make entries in ink. Waterproof ink is recommended.
- Accompany entries with the appropriate time.
- Errors must be lined through and initialed. No erroneous notes are to be made illegible.
- Sign and date pages as they are completed.
- Additions, clarifications, or corrections made after completion of field activities must be dated and signed.

2.15.3 General Site Information

Record general site characteristics. Information may include:

- Type of access into facility (locked gates, etc.).
- Information obtained from interview with access or responsible party personnel (if applicable), or other interested party contact on-site.
- Names of community contacts on-site.
- A site map or sketch may be provided. It can be sketched into the logbook or attached to the book.

2.15.4 Sample Activities

A chronological record of sampling activity may include:

- Explanation of sampling at the location identified in the sampling plan (e.g., discolored soil, stressed vegetation).
- Exact sample location, using permanent recognizable landmarks and reproducible measurements.

- Sample matrix.
- Sample descriptions, i.e., color, texture, odor (e.g., soil type) and other important distinguishing features.
- Locations of duplicates or other QA samples.
- Decontamination procedures, if used.

As part of chain of custody procedures, recorded on-site sampling information must include sample number, date, time, sampling personnel, sample type, designation of sample as a grab or composite, and preservative used (if applicable). Sample locations should be referenced by sample number on the site sketch or map. The offer and/or act of providing sample splits to a third party (e.g., the responsible party representative; state, county, or municipal, environmental and/or health agency, etc.) must be documented.

2.15.4.1 Soil Vapor and Ambient Air Sampling Information

In addition to the above information, the following will be documented during sub-slab soil vapor sample collection:

- Historic and current storage and uses of volatile chemicals;
- Type and operation of heating or air conditioning systems during sampling;
- Floor plan sketches that document the floor layout with sampling locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system air supply and return registers, footings that create separate foundation sections;
- Weather conditions (e.g., precipitation and indoor and outdoor temperature) and ventilation conditions (e.g., heating system active and windows closed); and,
- Additional pertinent observations, such as spills, floor stains, smoke tube results, odors and readings from field instrumentation.

The field sampling team will maintain a sample log sheet for soil vapor sample locations that include the following:

- Sample identification;
- Date and time of sample collection;
- Sampling depth;
- Identity of samplers;
- Sampling methods and devices;
- Soil vapor purge volumes;
- Volume of soil vapor extracted;
- Vacuum of canisters before and after samples collected;
- Apparent moisture content (dry, moist, saturated, etc.) of the sampling zone; and,
- Chain of custody protocols and records used to track samples from sampling point to analysis.

2.15.5 Sample Dispatch Information

When sampling is complete, sample documentation such as chain of custody forms will be copied and copies placed in the project files. A notation of numbers of coolers shipped, carrier and time delivered to pick-up point should be made in a field notebook.

2.16 Sample Handling

The analytical laboratory will provide the sample containers necessary for soil, groundwater, surface water, air, and soil vapor samples. Container closures for samples, except air and soil vapor, will be screw-on type and made of inert materials. Sample containers will be cleaned and prepared by the laboratory prior to being sent to the site. Trip blanks will be used to check for false positives due to laboratory cleaning procedures or cross contamination during sample shipment.

Samples collected will be identified with a sample label. A label will be attached to bottles and samples will be identified with a unique sample number.

Immediately following sample collection, sample containers will be marked with the following information:

- Sample Code.
- Project Number.
- Date/Time.
- Sample Type.
- Requested Analysis.
- Preservative, if used.
- Sampler's Initials.

The sample code will indicate the site location, media sampled, and the sample station.

After sample identification information has been recorded, sample labels will be covered with waterproof clear plastic tape to preserve its integrity. Samples will be recorded and tracked under strict chain of custody protocols. In the field, samples will be checked for proper labeling. The samples will then be packed into coolers with ice following guidance provided by the laboratory and shipped to the laboratory, if applicable. A chain of custody form will be completed for the coolers. The form will be signed and dated by the person who collected the samples, the person the samples were relinquished to for transport to the laboratory, and the laboratory sample controller/custodian who receives the samples.

2.16.1 Chain of Custody Record

A chain of custody (COC) record is a printed form that accompanies a sample or group of samples as custody is transferred from person to person. A sample chain of custody form is included in Appendix C. It documents custody transfer from person to person and sample information recorded on bottle labels. A chain of custody record is a controlled document.

As soon as practical after sample collection, preferably after decontamination, the following information must be entered on the chain of custody form. Information is to be recorded in ink:

- Arcadis project number. Enter the eight-digit alphanumeric designation assigned by Arcadis that uniquely identifies the project site.
- Project name. Enter site name.
- Samplers. Sign the name(s) of the sampler(s).
- Station number. Enter the sample number for samples in the shipment. This number appears on the Arcadis sample identification label.
- Date (year, month, day).
- Time. Enter a four-digit number indicating the military time of collection; for example, 1354.
- Composite or grab. Indicate the type of sample.
- Station location. Describe the location where the sample was collected.
- Number of containers. For sample numbers, enter the number of sample bottles that are contained in the shipment.
- Remarks. Enter appropriate remarks.

2.16.2 Transferring to Common Carrier

Instructions for Arcadis shipper transferring custody of samples to a common carrier are as follows:

1. Sign, date, and enter time under "Relinquished by" entry.
2. Enter name of carrier (e.g., UPS, Federal Express) under "Received by."
3. Enter bill-of-lading of Federal Express airbill number under "Remarks."
4. Place the original of the chain of custody form in the appropriate sample shipping package. Retain a copy with field records.
5. Sign and date the custody seal. The custody seal is part of the chain of custody process and is used to prevent tampering with samples after they have been collected in the field.
6. Wrap the seal across filament tape that has been wrapped around the package at least twice.
7. Fold the custody seal over on itself so that it sticks together.
8. Complete the Shipping Determination Form and follow instructions on how to properly package and document samples for shipping based on contents of samples.

Common carriers will usually not accept responsibility for handling chain of custody forms; this necessitates packing the record in the sample package.

2.16.3 Transferring Custody Directly to a Courier

To transfer custody of samples from the Arcadis sampler directly to a carrier, proceed as above, except eliminate the Arcadis shipper's signature.

3 FIELD INVESTIGATION PROCEDURES

Instruments must be properly calibrated to produce technically valid data. Documented calibration and calibration check results verify that the instruments used for measurement are in proper working order and the data produced is reliable. The calibration requirements described or referenced in this section are necessary to support the data quality objectives for this project. When calibration requirements are met, the data will support the focused investigation decisions dealing with the nature and extent of contamination and safety concerns.

3.1 Calibration Procedures for Field Equipment

The manufacturer specifications for operation and maintenance procedures for the field equipment to be used during these tasks are provided in Appendix B. General calibration procedures and requirements include the following:

- Instruments will be calibrated at least once a month.
- Instruments will have the calibrations checked at a minimum at the start of the day before measurements are made.
- The calibration and calibration checks will indicate that the sensitivity of the instrument (practical detection limit) is adequate to meet project needs and that the instrument is accurate over the working range.
- Calibration information will be recorded in the field logbook. This includes date and time, technician signature, calibration procedure, calibration results, calibration problems, recalibration and maintenance, and instrument serial numbers.

Calibration standards will be of National Bureau of Standards (NBS) quality and their sources listed and documented so that standards are traceable. In addition, only technicians trained in the use of the field instruments will operate them. If the instrument readings are incorrect at the time of the initial calibration, the instrument will either be calibrated by the technician or returned to the manufacturer for calibration. If the instrument readings are incorrect after a continuing calibration check, the preceding sample results will be reviewed for validity, and reanalyzed if necessary.

3.2 Laboratory Calibration Procedures

Samples analyzed according to the USEPA SW-846 analytical methodologies will follow the procedures described in the applicable WA. The calibration procedures and frequency are specifically described for analyses contained in the WA. Calibration results will be recorded and kept on file, and will be reviewed and evaluated by the data validator as part of analytical data validation procedures.

Instrument calibration will be checked with a reference standard prior to the sample analysis. The standards used for calibrations will be traceable to the NBS, and calibrations will be recorded in the laboratory notebook for the particular analysis. Printouts, chromatograms, etc., generated for the calibration will be kept on file.

4 REFERENCES

ASTM, 1994. “Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites. Designation: D 5088 – 90.”

ASTM, 19996. “Standard Test Method for Penetration Test and Split-barrel Sampling of Soils. Method D 1586-99.”

NYSDEC, 2010. "DER-10 Technical Guidance for Site Investigation and Remediation." New York State Department of Environmental Conservation, Division of Environmental Remediation.

NYSDEC, 2013. “DER-38 Cleanup Guidelines for Soils Contaminated with Radioactive Materials”. New York State Department of Environmental Conservation, Division of Environmental Remediation.

NYSDEC, 2021. “Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS)”. New York State Department of Environmental Conservation, Division of Environmental Remediation.

NYSDEC, 2009. “CP-43: Groundwater Monitoring Well Decommissioning Policy”. New York State Department of Environmental Conservation

NYSDEC, 2014. “CP-60 Screening and Assessment of Contaminated Sediment”. New York State Department of Environmental Conservation, Division of Fish, Wildlife and Marine Resources. NYSDOH, 2006. “Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York”. New York State Department of Health Center for Environmental Health, Bureau of Environmental Exposure Investigation.

6 NYCRR Subpart 375-6: Remedial Program Soil Cleanup Objectives

USEPA . “Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846”

USEPA, 1997 “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), EPA 402-R-97-016, Revision 1.”

USEPA, 2017. “Region I Low Stress (Low-Flow) Purging and Sampling Procedure for Collecting Ground Water Samples from Monitoring Wells, Final.”

.”

USEPA, 1999. "Air Method, Toxic Organics-15 (TO-15): Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition: Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)."

APPENDIX A

Field Activity Technical Guidance Instructions (TGI)

TGI FOR CONDUCTING MIP INVESTIGATIONS

Rev: 0

Rev Date: 02/09/2018

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	February 9, 2018			Nick Welty

APPROVAL SIGNATURES

Prepared by:	Ankit Gupta	02/09/2018
	Ankit Gupta	Date:
Technical Expert Reviewed by:	Niklaus Welty	02/09/2018
	Nick Welty	Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) is intended to provide general guidance on the design and oversight of Membrane Interface Probe (MIP) investigations. MIP is a system manufactured by Geoprobe Systems® for the detection and measurement of Volatile Organic Compounds (VOCs) in the subsurface (Geoprobe® 2015).

The MIP system comprises of a heated probe carrying a permeable membrane that is advanced to depth into the soil using Direct Push Technology (DPT). VOCs in the subsurface cross the membrane, enter into a carrier gas stream and are swept to gas phase detectors at ground surface for measurement (Geoprobe® 2015). More details regarding the science and technology behind MIP system can be found in the Geoprobe® MIP SOP (Geoprobe® 2015).

This TGI is applicable to all Arcadis CPMs and employees designing and overseeing a MIP investigation undertaken by a qualified MIP subcontractor. While procuring the services of subcontractors for a MIP investigation, it is generally a good idea to check the names of the bidders against the list of subcontractors formally trained by Geoprobe Systems® on the proper operation of their Direct Image®

(DI) equipment. This list can be accessed at the Geoprobe® website link - http://geoprobe.com/di-field-contractors.

The applicability of the MIP system in achieving project objectives should be carefully evaluated. The MIP is recommended as a tool to identify relative levels of contamination across a site, but it should not be used to determine the concentration of the compounds (Geoprobe® 2015). Thus, MIP is a qualitative screening tool and does not replace actual collection of soil and groundwater samples and analyses of samples by a qualified laboratory. Generally, MIP investigations are designed in a phased manner, with the MIP tool used to initially screen an area vertically and horizontally to determine potential depths and locations for sample collection, followed by a confirmatory sampling program involving collection of soil and groundwater samples and chemical analyses by a qualified mobile onsite or a fixed offsite laboratory.

Since the MIP system is easily available by most subcontractors as a combined MiHPT system with the Geoprobe®'s hydraulic profiling tool (HPT), it is highly advised to consider a MiHPT investigation instead of the MIP investigation only. The combined MiHPT allows the project teams to not just evaluate site contaminants, but also aquifer hydraulics and permeability, and arrive at relative flux evaluations. For more information on the HPT, refer to Arcadis SOP for Use of the Geoprobe® HPT. For assistance with design of relative flux investigation or evaluation of MiHPT data, consult with appropriate technical resources within Arcadis who are familiar and well-versed with the applications and limitations of both MIP and HPT technologies.

3 PERSONNEL QUALIFICATIONS

It is very important that project teams designing MIP investigations for achieving certain project objectives consult with appropriate technical resources within Arcadis who are familiar and well-versed with the applications and limitations of the MIP technology. At a minimum, the project teams should consult with the identified technical resources during:

- Screening of data quality objectives against MIP to determine if it is the proper tool,
- MIP investigation design (work plan stage),
- procurement of subcontractors for performing MIP work,
- fieldwork implementation,
- as well as during data analysis and reporting.

The field resource overseeing the subcontractor fieldwork should consult with the identified technical resource on any field decisions, quality assurance(QA)/quality control (QC) issues as well as real-time interpretation of MIP logs.

4 EQUIPMENT LIST

Typically, all required equipment is provided by the Subcontractor. Arcadis field staff should wear all required health and safety equipment defined in the project Health and Safety Plan (HASP).

It is also recommended that the Arcadis field resource keep a field log book to note entry and exit times of subcontractor staff, as well as any time lost due to subcontractor equipment quality issues and any other events that may occur during fieldwork that need to be recorded or referenced later.

5 CAUTIONS

MIP is advanced into the subsurface via DPT, thus all cautions associated with DPT drilling and subcontractor management and oversight also apply to MIP investigation. In addition, the specialized nature of MIP investigation warrants caution regarding the field interpretation of data and resulting field decisions and ensuring quality of data. Below are some of the cautions that the project teams should consider when designing or implementing a MIP investigation:

- MIP investigations typically only provide screening level data pointing towards the potential location (lateral and vertical) of soil or groundwater VOC impacts. Project teams should exercise caution when analyzing MIP data to not make any quantitative correlations between MIP detector readings and compound soil or groundwater concentrations and consider following the MIP investigation with a confirmatory sampling event to determine actual soil and groundwater concentrations present at the site.
- Caution should be taken to use the appropriate detector response to screen for the specific family of compounds, as following:
  - **Photo-Ionization Detector (PID)** – The PID responds to compounds which have an ionization potential less than or equal to the electron voltage of the PID bulb (typically 10.6 electron volts [eV]). These compounds include both chlorinated and non-chlorinated hydrocarbons. Aromatic hydrocarbons like benzene, toluene, ethylbenzene and xylenes (BTEX) will respond on the PID but not so well on other detectors.
  - **Flame-Ionization Detector (FID)** – The FID responds to organic compounds (anything containing carbon) present at high-enough concentrations to burn up the flame which increases the flame ionization voltage.
  - **Electron Capture Detector (ECD)** – The ECD is a legacy detector found on older MIP systems, and has been replaced with the XSD detector described below. It is generally advised that the XSD be employed for MIP investigations. The ECD is sensitive toward electronegative functional groups such as halogens, peroxides, quinines, and nitro groups. The MIP system primarily uses the ECD for the detection of chlorinated VOCs. The ECD is increasingly sensitive to the number of halogens on a molecule.
  - **Halogen Specific Detector (XSD)** – The XSD responds only to halogenated compounds which are made up of chlorinated (most typical halogen environmental contaminant), brominated and fluorinated compounds. The XSD provides a more consistent response to analyte mass regardless of the number of halogens bonded on the molecule as compared to the electron capture detector (ECD). The XSD also provides a larger linear range of detection for these compounds than the ECD detector.
- Caution should be taken when interpreting electrical conductivity (EC) logs for soil lithology. It is advised that soil core samples be taken to confirm lithologic changes as suggested by EC log since each EC log is unique to the site. As a generalization, a high EC reading indicates a smaller grain size, and a low EC reading indicates a larger grain size (Geoprobe® 2015). Thus, clays typically exhibit a relatively high EC (100 to 300+ mill-Siemens per meter [mS/m]), and in fresh water settings, clay content often controls the bulk formation EC of unconsolidated formations. However, some clay minerals do not exhibit high electrical conductance, and this can complicate lithologic interpretation based solely on EC when these types of clays are present in the area

being investigated. The presence of even modest levels of ionic contaminants in groundwater or across salt water interfaces can overwhelm and mask natural formation EC responses making it difficult if not impossible to interpret formation type based solely on EC (McCall et al 2016).

- MIP detector saturation may require a short period of time for the detector to return to baseline after a log has been performed in higher concentrations. During a log and the removal of the tool string, contaminants can absorb onto the surface of the membrane and trunk-line material causing elevated detector baseline signals. It is very important that the probe and trunk-line system is clean enough to see the low concentrations typically used in the chemical response test. Not adequately decontaminating the probe prior to performing a response test can elevate the concentration of the standard causing an inaccurate high response to the specific concentration of standard that was prepared for the test.
- Caution should be taken to check if the MIP detectors will respond to site contaminant concentrations, especially if contaminants are compounds other than BTEX, TCE or PCE or present at very low concentrations. Up to 0.2 milligrams per liter (mg/L) or parts per million (ppm) concentrations can be detected for BTEX, PCE and TCE using standard MIP configuration. If the site contaminant of concern is an obscure chemical not normally tested for, the MIP Subcontractor should run some of that chemical for response tests to confirm it can be detected and to determine reasonable detection limits. The CPM, project team or technical lead should request MIP detector chemical response data from the Subcontractor prior to MIP system mobilization for site contaminants of concern at anticipated concentrations to ensure the sensitivity of the MIP system.
- An approximate 10x improvement in sensitivity for low concentrations of site contaminants can be achieved by running the MIP in a low-level (LL) mode. This requires additional equipment and additional cost charges and availability should be checked with the subcontractor prior to specifying its use. For detectors that are well maintained by subcontractors, the LL MIP can *theoretically* provide sub-100 micrograms per liter (ug/L) or parts per billion (ppb) concentration detection capabilities. The LL mode will improve specific detector system signal by approximately an order of magnitude over whatever that system is capable of detecting by standard MIP.

6 HEALTH AND SAFETY CONSIDERATIONS

The primary H&S considerations involved with MIP fieldwork are the same as encountered during DPT drilling activities.

7 PROCEDURE

The following procedure is recommended to be followed by Arcadis field resource providing field oversight to the MIP subcontractor:

1. At the start of the field work day, check the DPT rig using the Drill Rig Inspection Checklist to ensure that the rig is fully functional and capable of advancing the MIP to desired depth.
2. Oversee all H&S orientations including daily tailgate safety meetings and familiarization of all personnel involved in fieldwork with the site hazards and project HASP.

3. Check the length of the trunk-line and the rods carried by the Subcontractor to ensure that the MIP can be advanced to target depth at all site borings.
4. Check the condition of the threads on the rods. If the threads seem too worn out, ensure that the Subcontractor changes the rods, since rods with worn out threads may result in breakage of the rod assembly or downhole loss of the MIP while advancement.
5. Obtain a copy of the subcontract from the CPM of the project. Check the fine print on the subcontract to understand if the subcontractor will charge for any equipment loss (e.g. downhole loss of MIP) as well as time lost due to equipment quality issues. Also check if the subcontract is based on a daily/hourly rental rate or on a per foot basis.
    a. If the subcontract is on a per foot basis, note the start and end footage of MIP advancement at the start and end of each day respectively.
    b. If the subcontract is on a per day or per hour rental rate, note the entry and exit times of subcontractor staff each day, as well as any down times associated with subcontractor staff breaks or equipment malfunction issues or equipment quality issues.
6. Check the dates of preparation of the standard stock solutions and if they are preserved on ice. If preserved on ice, the standard stock solutions should have been prepared within the last one month. If not preserved on ice, they should have been prepared within the last 3 – 7 days. Also ensure that the correct stock standards are used by MIP operator for the specific site contaminants of concern during pre-log QA testing.
7. Check that the MIP operator performs the appropriate pre-log QA tests before each MIP log as specified in the Section 10 of this SOP. Prior to the start of each MIP log, the MIP operator should make a fresh working standard using the stock standards for use in pre-log chemical response tests. Following the completion of the pre-log chemical response test, record the height of the peak response and the chemical trip time into a field notebook, and check that the MIP operator enters the chemical trip time into the MIP software.
8. Following the completion of appropriate pre-log QA tests, record the system parameters in the field notebook (i.e. flow, pressure, trip time, detector baseline voltages).
9. At this point, provide permission to the Subcontractor crew to install the MIP probe to the DPT rig. Check that the probe is aligned exactly vertically straight and allow the probe to be advanced to the starting depth where the MIP membrane is even with ground surface.
10. Check with the MIP operator that the MIP software logging has been started before the probe is advanced further into the ground. The probe advancement should occur at the standard rate of one ft/min broken down as one foot advanced in 15 seconds followed by hold-time of 45 seconds.
11. The MIP probe can be advanced using a continuous push method with no stopping intervals, however this will result in higher detection limits and the data may not be directly comparable to data collected by the standard advancement method discussed above. Check with the CPM or the technical resource prior to allowing continuous push advancement of the MIP probe.
12. Refusal is attained when it takes longer than 1 minutes of continuous hammering to advance the probe one foot. This is the maximum time to reach one foot of probe travel.
13. Once the MIP log is complete to target depth, the Subcontractor will pull the probe rod string out. Check that the MIP operator cleans the probe and membrane with a detergent/water mix prior to running a post-log response test.

14. Check with the MIP operator that the probe heat is turned back on to clean off the probe membrane and trunk-line of any residual contaminant vapors and the detector baselines are stable prior to running a post-log response test.
15. Record the post-log response test results in the field notebook and compare against the pre-log response test results. This system check ensures the data collected in the log is valid.

8 WASTE MANAGEMENT

Any investigation derived wastes (IDW) should be handled in accordance with Arcadis TGI for IDW handling and storage.

9 DATA RECORDING AND MANAGEMENT

The subcontractor typically provides field logs (electronic and printed) demonstrating the depth vs. detector response graphs (EC, PID, FID, XSD) and other MIP parameters like temperature, pressure etc. Project teams are advised to check with Subcontractors in advance to ensure that the MIP trailer has internet capabilities so that the logs can be emailed to identified technical resources from the field to aid in field data interpretation and field decisions. The Arcadis field resource should ensure that for each log, the subcontractor MIP operator also emails the raw data (typically a zip file containing various text files with pre- and post-response test data as specified in the next section as well as raw detector response values with depth). This raw data is extremely valuable if the project teams decide to analyze the logs in different combinations than those provided by the Subcontractor or in three-dimensional (3D) models.

It is highly advised that the CPM, project team or technical lead consult with identified technical resources regarding the best way to analyze and manage the raw data and field logs. The raw data is typically imported into Geoprobe®'s Direct Image (DI) Viewer software freely available on Geoprobe website. The software can be used to generate logs of MIP detectors and parameters in different combinations. The use of 3D models is also highly advised to manage the large amount of data generated by MIP and utilize it to the best efficiency for project objectives. Typically, subcontractors often include 3D modeling services in their bids; CPMs, project teams and technical leads are **emphatically advised to decline these services** since Arcadis can self-perform this work and do it at a much higher quality. For assistance with 3D modeling, visualization and management of MIP data, CPMs, project teams and technical leads are advised to consult with the identified technical resources.

10 QUALITY ASSURANCE

QA testing should be conducted on each of the detectors and sensors on the probe prior to and after each drilling log to validate that the equipment is capable of generating good data. The following tests should be conducted.

Chemical Response Test – During this test, the operator introduces a working standard of the known site contaminant of concern to the membrane for a set time of 45 seconds which should match the residence or holding time at each sampling interval and notes the detector response. The following steps are undertaken during the test:

- An initial stock standard of the contaminant of concern is made using 25 milliliters (mL) of methanol at 50 milligrams per milliliter (mg/mL) concentration.
- Stock standards should be kept cold in a refrigerator or freezer to ensure they can last up to one month, otherwise they should be made up more frequently as often as every three days, especially in the summer months without any cooling. The more volatile the compound is, the quicker it will lose its concentration.
- A working standard is made using a known volume of the stock standard (10 microliters [uL], 100 uL, 1000 uL etc.) mixed in with a half-liter of fresh potable water. The working standard is prepared in a 40-mL vial. The working standard should be representative of anticipated concentrations of site contaminants of concern. For e.g. if the objective is to delineate a TCE plume, the working standard should be a detection limit standard (1 milligram per liter [mg/L]) of TCE, vs. if the objective is to delineate a source zone of TCE, the working standard should be at a higher concentration standard (10 – 50 mg/L) of TCE.
- A new log is started in the DI-Acquisition software, and the screen is set at the Response Test. The detector signals are monitored and should be stable before proceeding with the test. The operator should “clear the response” test prior to initiating the test.
- At initiation, the operator will start the response test by clicking on the “Run Response Test” button and immediately take the freshly prepared working standard in the 40-mL vial and invert it over the membrane and hold it for 45 seconds. This time is to be equal to the resonance time at each depth interval during probe advancement.
- After a certain duration equal to the trip time of the standard through the trunk-line, the membrane response should start climbing up and show a clear signal above baseline noise. The operator should make a note of the chemical trip time and enter it into the MIP software to accurately plot the contaminants depth position.

Since detector systems can vary in the level of response for a given chemical concentration depending on detector age, model, and maintenance performed, Geoprobe® specifies that the detector system be able to provide at least a 5:1 signal to noise ratio for 1 parts per million (ppm) of Benzene or TCE using PID and XSD detectors respectively. Other compounds or concentration may be performed at the client requests however they may have different response magnitudes and signal to noise ratios at 1ppm.

EC Dipole Test – After the completion of the chemical response test, the EC dipole test screen will come up on the DI Acquisition software. The following steps are undertaken during the test:

- Place the low (brass) side of the EC Dipole test jig between the EC dipole and body of the probe and start the low-level test, hold for 5 seconds until the system captures the data.
- Repeat for the high (stainless steel) EC test.
- These tests should result in readings of 55mS/m and 290mS/m ± 10%.

11 REFERENCES

Geoprobe®, 2015. Membrane Interface Probe (MIP) Standard Operating Procedure. Technical Bulletin No. MK3010. Prepared: May 2003. Revised: January 2015.

McCall, W., Christy, T.M., Evald, M.K., 2016. Applying the HPT-GWS for Hydrostratigraphy, Water Quality and Aquifer Recharge Investigations. *Groundwater Monitoring and Remediation*.

TGI - GROUNDWATER SAMPLING WITH HYDRASLEEVES™

Rev: 0

Rev Date: October 12, 2018

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	October 12, 2018	All	Updated and re-written as TGI	Marc Killingstad

APPROVAL SIGNATURES

Prepared by:		10/12/2018
	Christian Seidel	Date:
Technical Expert Reviewed by:		10/12/2018
	Marc Killingstad (Technical Expert)	Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

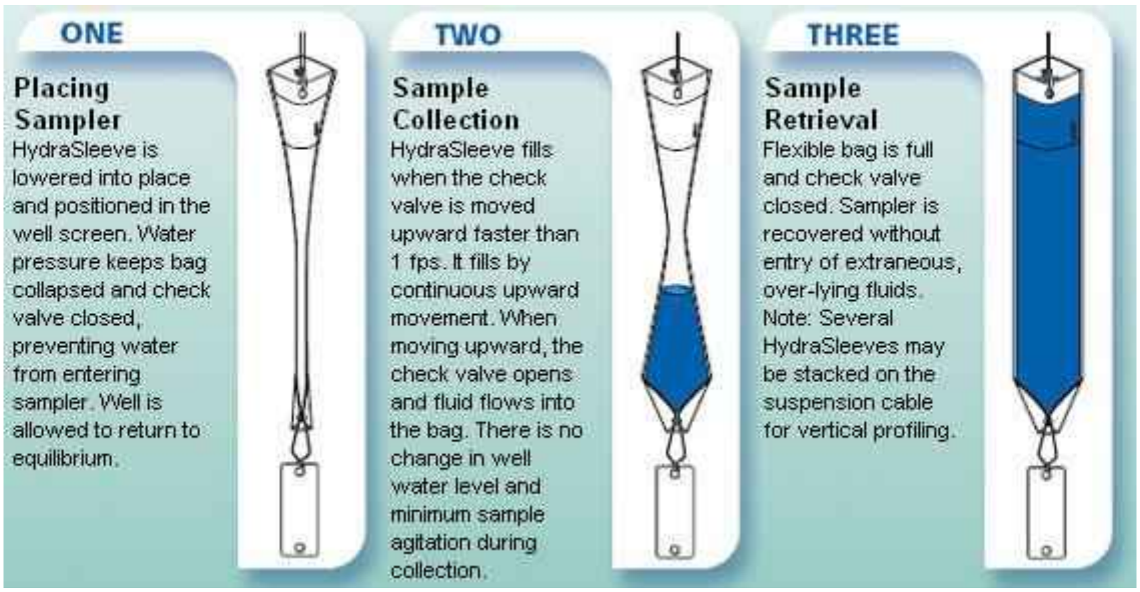
2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) establishes guidelines for use by field personnel in the deployment and subsequent retrieval of HydraSleeves™ for collection and documentation of groundwater samples for chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of collected groundwater samples.

Details within this TGI are to be used in conjunction with/to assist in the development of site-specific work plans (e.g., Field Implementation Plans [FIP]).

HydraSleeve™ groundwater samplers can be used to collect a representative sample for most physical and chemical parameters without purging of a well. It collects a groundwater sample from a user-defined interval while limiting mixing fluid from other intervals. The HydraSleeve™ is deployed to a depth within the screened interval of the monitoring well and time is allowed for the well to re-equilibrate following deployment. The sealed HydraSleeve™ can be activated and removed for sample collection within several hours to several months. When activated, the HydraSleeve™ collects a sample with minimal drawdown and agitation of the water column. Once the sampler is full, a one-way reed valve at the top of the sleeve collapses, preventing mixing of extraneous, non-representative fluid during HydraSleeve™ recovery from the well.

HydraSleeve™ samplers can provide groundwater samples for site characterization, evaluation of remediation alternatives, long-term monitoring, Level III and Level IV analytical data for use in risk assessments, and a number of other applications.



3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as specified in the Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The HASP and other documents will identify other training requirements or access control requirements.

The designated Field Manager is responsible for periodic observation of field activities and review of field generated documentation associated with this TGI. The Field Manager is also responsible for implementation of corrective action if problems occur (e.g., retraining personnel, additional review of work plans and TGIs, variances to QC sampling requirements, issuing non-conformances, etc.).

Field personnel assigned to collect groundwater samples are responsible for completing their tasks in accordance with the specifications outlined in this TGI and other appropriate and relevant guidelines. Field staff will have prior experience in groundwater sampling.

The determination of placement depth of the HydraSleeve™ in the monitoring well will be made by a qualified geoscientist/engineer prior to field mobilization and will be outlined in the work plan/field implementation plan (FIP). Any changes in field conditions (typically due to fluctuations in water table elevation) will require discussion between field personnel and the technical lead for the project. All staff are responsible for reporting deviations from procedures in the Field Activity Daily Log, and to the designated Field Manager and/or Project Manager.

4 EQUIPMENT LIST

There are three (3) main steps for collecting groundwater samples with the HydraSleeve™: 1) assembly and deployment, 2) retrieval of the sleeve after the equilibration period, and 3) transferring collected groundwater sample into the appropriate sampling containers while minimizing disturbance to the sample. The equipment needed for HydraSleeve™ sampling is listed below.

Equipment needed throughout the scope for both deployment and retrieval of HydraSleeve™:

- Approved site-specific Health and Safety Plan (HASP)
- Approved site-specific work plan/FIP and/or Field Sampling Plan (FSP) which will include:
    - Well location map
    - Planned Sample Table (PST) identifying
        - Type of HydraSleeve™ samplers (size and material)
        - Deployment locations/depths
        - Well construction details (including well screen intervals)
        - Sample analyses, sample volume required, and sample holding time
- Field notebook and/or smart device (phone or tablet)
- HydraSleeve™ specific field forms (**Attachment A**)
- Appropriate personal protective equipment (PPE) (e.g., latex or nitrile gloves, safety glasses, etc.) as specified in the HASP
- Well keys and other tools to remove manhole covers (manual torque wrench with 9/16” socket and flat head screwdriver typical)
- Photoionization detector (PID) or Flame ionization detector (FID) (as appropriate, depending on site-specific constituents of concern)
- Electronic water-level indicator or oil/water interface probe with 0.01-foot accuracy (oil/water as appropriate, note that sampling will not be performed when sheen or light non-aqueous phase liquid [LNAPL] is present)
- Down-hole multiparameter sonde (e.g., YSI)
- Plastic sheeting (e.g., Weatherall Visqueen) to protect all down-hole sampling equipment from contact with potential sources of contamination.
- Decontamination equipment

    - Non-phosphate laboratory soap (Alconox or equivalent), brushes, clean buckets or clean wash tubs—new buckets or tubs will be purchased if it cannot be determined if the present items are clean
    - Distilled or de-ionized water for equipment decontamination
- Indelible ink pen
- 150-foot measuring tape (or sufficient length for the maximum site depth requirement)

Equipment needed for assembly and deployment of the HydraSleeve™:

- Appropriate HydraSleeve™ (size and material) for the wells being sampled (NOTE: Sampling protocols and materials for sites with Per- and Polyfluoroalkyl Substances [PFAS] concerns are not discussed in detail in this TGI, but if there is a concern that PFAS may be present at the site and/or if PFAS is being analyzed, there are specific HydraSleeve™ samplers that will be used.
- Some examples of sleeves are provided below—check with the manufacturer for additional options
    - 2-L 2" HydraSleeve™ SuperSleeve (SS) (1.9" OD, 60" long; volume of 2 liters; requires special 2-piece top weight) for 2" diameter Schedule 40 wells
    - 1-L 2" HydraSleeve™ (1.75" OD, 36" long; volume of 1 liter) for 2" diameter wells
    - 1.5" HydraSleeve™ (1.5" OD, 30" long; volume of 625 milliliters [mL]) for 2" diameter wells
    - 1" HydraSleeve™ (1" OD, 48" long; volume of 325 mL) for wells less than 1.5" diameter
- J-plug style cap to hold sleeve tether either supplied by HydraSleeve™ manufacturer or modified by Arcadis
- 1/8-inch diameter braided polypropylene rope (for tethers)
- Weights (stainless steel or other inert material) to anchor the HydraSleeve™ in the well (NOTE: special weights are required for the SuperSleeve-style HydraSleeve™)
- Cable ties to anchor HydraSleeve™ to tether
- 150-foot measuring tape (or sufficient length for the maximum site depth requirement)
- Safety cutting tool (e.g., self-retracting safety knife)

Equipment needed for retrieval of HydraSleeve™ and collection of groundwater samples:

- Sample labels and Chain-of-Custody forms (COC).
- Appropriate sampling containers (sample bottles, coolers, and ice).
- 5-gallon bucket or other container to hold extra groundwater.
- If field filtering of samples is required: Hand pump for transfer vessel (Pine part ID 71631), individually wrapped transfer vessels (Pine part 71628), and appropriately sized filters. Only one

hand pump is needed to apply pressure, but each sample will require its own transfer vessel and filter.

- Additional HydraSleeve™ samplers and zip ties to deploy for the next sampling event, as required.

Unless otherwise specified in the site-specific work plan/FIP, it is advisable to establish a sampling order starting with the least contaminated well and progressing to the most contaminated well last.

5 CAUTIONS

Selection of the appropriate size HydraSleeve™ depends on sample volume requirements, well diameter, and the length of the saturated screened interval, which dictates the maximum distance allowed over which to pull and fill the HydraSleeve. The largest HydraSleeve™ available (60-inch) holds 2 liters (L) of groundwater while the smallest holds 325 mL of groundwater. Sample volume requirements must be outlined in the FIP and verified with the laboratory before ordering and deploying the HydraSleeve™ samplers.

The HydraSleeve™ sampler is designed for single use (deployment and sample collection) only; tethers and weights can only be reused after proper decontamination.

According to the manufacturer, HydraSleeve™ has been used successfully with no equilibration period at some sites for some analytical parameters. HydraSleeve™ does not require dissolved compounds to diffuse across a membrane as in the case of polyethylene diffusion bag (PDB) samplers (ITRC, 2004). Because the HydraSleeve™ mechanically obtains a “core” of the water column, rather than relying on diffusion through a membrane, the sampler can be retrieved shortly after deployment in many cases.

One way to conservatively estimate the maximum required equilibration period is to estimate the time to ‘flush’ the well based on the Darcy velocity within the formation (hydraulic conductivity times gradient) (see **Attachment B**). Some project teams have adopted a minimum 24-hour undisturbed deployment time or other rules of thumb to use prior to sleeve retrieval.

Note that representative groundwater sampling may occur with a shorter flushing period, or no flushing period at all, if the well contains minimal accumulated silt and care is taken to minimize disturbance in the well during HydraSleeve™ deployment.

If sampling for turbidity-sensitive analytes (e.g., metals), waiting some time prior to retrieval is recommended.

Site-specific testing versus another accepted groundwater sampling method (i.e., side-by-side testing) can be performed at a subset of wells—preferably spanning a range of hydraulic conductivity, geologic materials, and chemical concentrations—to verify that the HydraSleeve™ device produces samples similar to those obtained from the other accepted method.

A study conducted by (McHugh et al, 2016) indicated that analytical results for samples collected with HydraSleeve™ were biased low when sampling volatile organic compounds (VOCs) relative to samples collected from the same wells using purge sampling methods and when monitoring wells had more than 10 feet of water above the well screen. The difference was attributed to filling errors that resulted in samples collected from a contaminant depleted water column above the well screen. This type of error could occur if the HydraSleeve™ was pulled too slowly through the screened interval and did not close properly or when other factors interfered with the opening or closing of the check valve of the sampler.

6 HEALTH AND SAFETY CONSIDERATIONS

The HASP will be followed, as appropriate, to ensure the safety of field personnel.

Appropriate personal protective equipment (PPE) will be worn at all times in line with the task and the site-specific HASP.

Access to wells may expose field personnel to hazardous materials such as contaminated groundwater or non-aqueous phase liquid (NAPL) (e.g., oil). Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g. ticks in long grass/weeds around well head), and potentially the use of sharp cutting tools (scissors, knife)—open well caps slowly and keep face and body away to allow to vent any built-up pressure; only use non-toxic peppermint oil spray for stinging insect nests; review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives, and use appropriate hand protection.

Deploying and retrieving HydraSleeve™ samplers requires staff to lower and raise materials into and out of the monitoring well. Be sure to use proper bending and lifting techniques to avoid muscle strain and other potential injuries.

7 PROCEDURE

Field personnel will set up, deploy, and retrieve HydraSleeve™ samplers in accordance with the following procedures.

Preliminary Tasks

1. Visually inspect the well to ensure that it is undamaged, properly labeled and secured
    a. Damage or other conditions that may affect the integrity of the well will be recorded in the Field Activity Daily Log and brought to the attention of the designated Field Manager and/or Project Manager
    b. Note well construction and conditions on the HydraSleeve™ Field Form (**Attachment A**)
2. All equipment will either be new or decontaminated in accordance with appropriate guidance document (*TGI – Groundwater and Soil Sampling Equipment Decontamination)* prior to use
3. Calibrate all field equipment (e.g., water-level meter and down-hole sonde [pH, temperature, conductivity, ORP, turbidity, and DO]) according to the instrument manufacturer's specifications
    a. Daily calibration results will be recorded on the appropriate form(s) as specified by the FIP/PST
    b. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.
4. Don appropriate PPE

5. Lay out plastic sheeting to create a clean work area and set up monitoring and sampling equipment
6. Observe if any air is flowing into or out of the casing (e.g., bubbles, hissing sounds); if so, note accordingly on the HydraSleeve™ Field Form (**Attachment A**).
7. Safely (slowly) remove the well cap
8. If specified in the site-specific workplan/FIP, measure VOCs at the rim of the well with a PID and FID instrument record the reading in the field logbook
    a. Also measure the breathing space adjacent to the well and check any measurements against the HASP guidelines to be sure conditions are safe to work
9. If the well casing does not have a reference point to measure from, usually a V-cut or indelible mark in the well casing, create one and perform/record all measurements from this mark
10. If specified in the site-specific workplan/FIP, determine if non-aqueous phase liquid (NAPL) is present in the well using an oil/water interface probe in accordance with appropriate TGI
    a. If NAPL is present, record the depth to NAPL and static water level on the HydraSleeve™ Field Form
    b. Sleeves will not be deployed, and samples will not be collected from wells where NAPL is present
11. Measure and record the depth to water and the total depth of the groundwater monitoring well (to 0.01 ft) on the HydraSleeve™ Field Form—care will be taken to minimize disturbance of the water column and to any particulates attached to the sides or at the bottom of the well
12. Compare the measurement of the total depth of the well with the previous measurement and check against the well screen details provided in the FIP and/or PST to determine the percent of screen occluded by sediment (if any)
    a. If more than 20 percent of a well screen is occluded by sediment, the well will not be sampled until it is re-developed
13. Collect and record field parameters using a multiparameter down-hole sonde (e.g., YSI)

Assembly and Deployment of Standard HydraSleeve™

Assemble the HydraSleeve™ sampler

1. Remove the HydraSleeve™ from the package and grasp top to “pop” open (Figure 1)
2. Squeeze side fins together at top to bend reinforcing strips outward (Figure 2)
3. Attach either a tethered spring clip to both holes (preferred) or attached rope to the hole on one side at the top of the HydraSleeve™ (using cable ties) (Figure 3)
4. Fold to align the two holes at bottom of HydraSleeve™ together and attach the weight using a zip tie or weight clip (Figure 4)
5. The sampler is ready to insert into the well at the pre-determined depth specified in the FIP/PST (Figure 5)

Figure 1

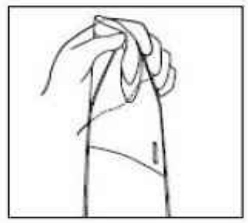


Figure 2

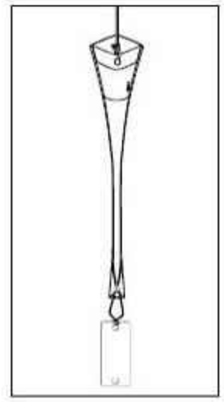


Figure 5

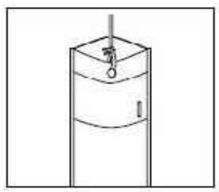


Figure 3

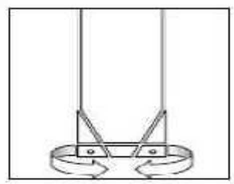
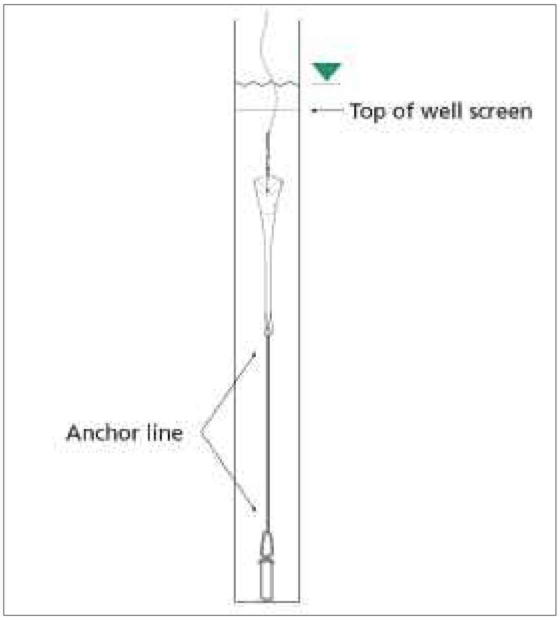


Figure 4

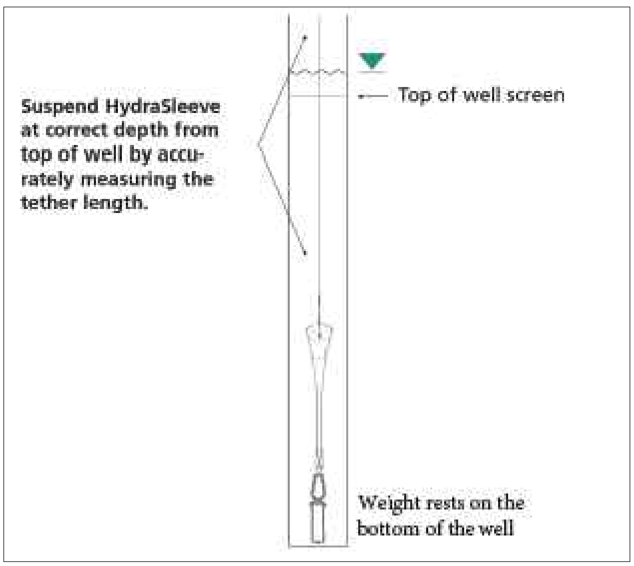
Deploy HydraSleeve™ sampler

- Once assembled, two (2) methods of deployment can be used—note that both options require the top of the HydraSleeve™ to be positioned below the midpoint of the saturated screened interval by a distance approximately equal to 0.75 times the full length of the sleeve (e.g., a 36-inch HydraSleeve™ will be lowered so that the top of the sleeve is approximately 27 inches below the midpoint of the saturated screened interval which is the appropriate position to collect the groundwater sample from approximately the middle of the saturated screened interval when the sleeve is pulled upward)

  1. *Bottom Anchor Deployment* (preferred). Bottom down deployment is preferred because there is less of a potential margin for error in measuring and correcting for the distance between the bottom of the well and the bottom of the HydraSleeve™, versus measuring and correcting for the distance between the top of well casing and the top of the HydraSleeve™. Using the determined well depth, calculate the distance from the bottom of the well to the desired sampling depth (specified in the FIP/PST and HydraSleeve™ Field Form). Attach an appropriate length anchor line between the weight and the bottom of the sampler and *slowly* lower the assembly until the weight rests on the bottom of the well, allowing the top of the sampler to float at the correct sampling depth. Attach the suspension line to the well cap to suspend the HydraSleeve™ at the correct depth until activated for sampling.



2. *Top-Down Deployment*. Measure and assemble the correct amount of suspension line needed to "hang" the top of the HydraSleeve™ at the desired sampling depth (specified in the FIP and on the HydraSleeve™ Field Form). Once constructed, *slowly* lower the assembly in the well and attach the suspension line to the well cap to suspend the HydraSleeve™ at the correct depth until activated for sampling.



- For wells in which more than one sampling device will be used, please refer to the configurations shown on pages 5 and 6 of **Attachment C** (Eon Products Inc. *Interim Field Manual*)

- If more samplers are needed due to sample volume requirements, it is recommended to increase HydraSleeve™ size rather than to use multiple samplers.
- Top weights on samplers may be required to ensure the targeted sample interval will be sampled by the HydraSleeve™
- For wells with screen lengths less than 10 feet (as indicated in the FIP and on the HydraSleeve™ Field Form) or where the saturated screen length is less than 10 feet (determined during initial water-level gauging), top-down deployment will be used as described above with the exception of the placement of a top weight:
  1. The weight for these wells will be placed on the top of the HydraSleeve™ as shown in the figure below (**Photo 1**)
  2. The hanging clip is inserted locking the top of the HydraSleeve™ and the weight together, and the tether will be attached to the apex of the clip, as shown below (**Photo 2**)
  3. Addition of a top weight is necessary to compress the sampler so it will fill at a lower depth than it would if it were merely suspended in the well


Photo 1

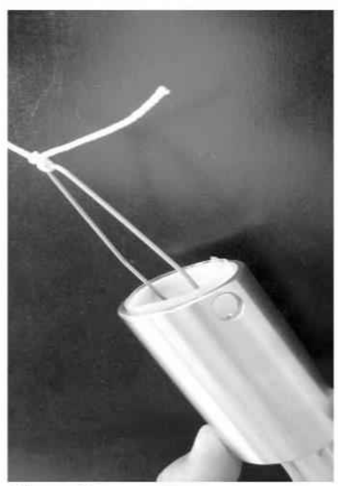


Photo 2

- At this point deployment is complete; allow time for stabilization following any disturbance caused by the sampler deployment prior to collecting groundwater samples
  - The manufacturer's recommended deployment time is hours to months
  - The time prior to sampler retrieval will be considered in the context of both groundwater flow velocity at the site and the potential for turbidity to affect sample quality
  - The time will be specified in the FIP/PST
  - The maximum deployment time at the site will be one year.

- After the stabilization/equilibration period, groundwater samples can be collected for analysis

Assembly and Deployment of SuperSleeve-style HydraSleeve™ SS

Assemble the HydraSleeve™ SS

1. Remove sampler from the package and attach the bottom weight (Photos 3 and 4).
2. Fold the two holes at bottom of HydraSleeve™ SS together
3. Open prongs of bottom weight clip by squeezing
4. Insert reusable weight clip through holes and attach the bottom weight

Photo 3

Photo 4

5. Attach the top weight as follows: Insert the open (check valve) end of the HydraSleeve™ SS through the bottom of the stainless-steel portion of top weight until about 1/2 inch of the open sleeve protrudes above the female threads
6. Thread stainless steel weight (female thread) onto PVC top piece (male thread) locking the top of the HydraSleeve™ SS between the threads (Photo 5)

Photo 5

7. Attach rope to top weight (using cable ties).
8. The sampler is ready to insert into the well at the pre-determined depth specified in the FIP/PST

Deploy the HydraSleeve™ SS

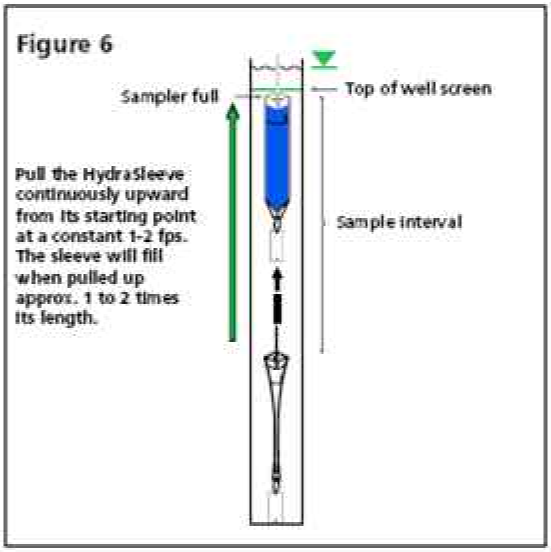
1. Lower the HydraSleeve™ SS into the well slowly until the bottom weight touches the bottom
2. Provide enough slack in the tether to allow the top weight to fully compress the sampler into the bottom of the well
    a. For example: a 2-liter HydraSleeve™ SS [5-feet long] will compress to within 2 feet of bottom of a 2-inch well screen in about 4 hours; a 2-liter HydraSleeve™ SS requires about 5 feet of water on top of the sampler to completely fill, so it cannot be used in wells with shorter than a 10-ft saturated screen length

Collecting Groundwater Samples from HydraSleeves™

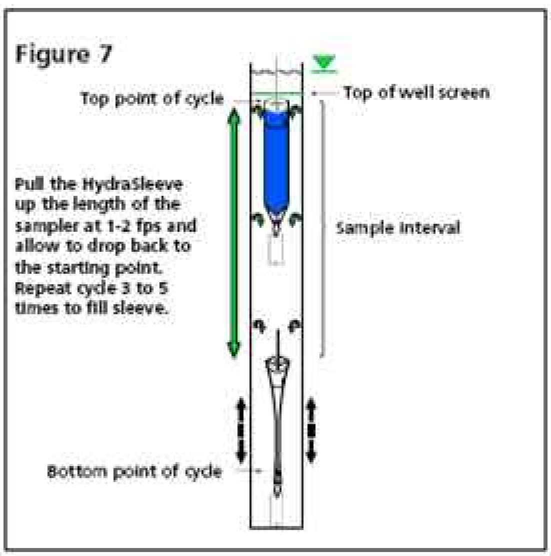
1. Perform *Preliminary Tasks* detailed above; *however, measure depth to groundwater prior to retrieval of the HydraSleeve™ while total well depth will be collected after the HydraSleeve™ has been retrieved from the well*
2. All groundwater samples, including QA/QC samples for a given well will be collected with one HydraSleeve™
    a. If the volume requirement for sample analysis exceeds the capacity of the sleeve, it is not acceptable to redeploy the same or a second HydraSleeve™ to fill additional bottles.
    b. Instead, the sampling process will be repeated using a larger size HydraSleeve™ or another approved sampling method (e.g., low-flow) will be performed
3. Fill out sample documentation on the HydraSleeve™ Field Form (**Attachment A**).
4. Inspect the sample bottles (obtained from the analytical laboratory prior to the sampling event) to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added
    a. The types of sample containers to be used and sample preservation requirements will be provided in the FIP/PST.
5. The HydraSleeve™ Field Form will specify the sample collection method for each well—the *Continuous Pull Method* is preferred and will be used for the majority of the wells; however, if the well to be sampled has saturated screen length less than 10 feet in length, or if the HydraSleeve™ diameter is undersized when compared to the well diameter, the *Short Strokes Method* may be used
    a. *Continuous Pull Method* – Move the sampler upward at an approximate rate of 1 to 2 feet per second (ft/sec) (about the speed a bailer is usually pulled upward) for water to pass through the check valve into the sample sleeve until full
        i. The total upward distance the check valve must travel to fill the sample sleeve is about 1 to 2 times the length of the sampler

ii. For example, a 36-inch HydraSleeve™ needs a total upward movement of 36 inches to no more than 72 inches to fill

iii. This method usually provides the least turbid samples and is analogous to coring the water column from the bottom up (Figure 6).



b. *Short Strokes Method* – Pull the sampler upward at about 1 to 2 ft/sec for the length of the sampler (e.g., 36 inches), let it drop back to the starting point, and repeat the cycle 3 to 5 times (Figure 7)



6. Once retrieved, if the sleeve is not completely full, a sample will not be collected and a new HydraSleeve™ will be deployed and the process repeated

7. To remove a sample from the HydraSleeve™ with the least amount of aeration and agitation use the short plastic discharge tube included with the sampler

a. First, squeeze the full sampler just below the top to expel water resting above the flexible check valve (Photo 8)

Photo 8

b. Then push the pointed discharge tube through the outer polyethylene sleeve about 3-4 inches below the white reinforcing strips (Photo 9)

Photo 9

c. Discharge the sample into the desired container (Photo 10) in the order described below

d. Raising and lowering the bottom of the sampler or pinching the sample sleeve just below the discharge tube will control the flow of the sample

e. The sample sleeve can also be squeezed, forcing fluid up through the discharge tube, similar to squeezing a tube of toothpaste

Photo 10

8. Collect sample parameters in the following order: VOCs (care will be taken to avoid agitation and volatilization of sample during the decanting process), explosives, metals, and other parameters
    a. Samples will be collected and labeled in accordance with relevant TGIs
    b. Types of sample bottles and volume requirements for each analysis are provided in the Quality Assurance Project Plan (QAPP) and FIP
    c. Metals samples will not be field filtered unless specified
    d. If field filtering is required for any analyte, groundwater to be filtered will be placed into a dedicated transfer vessel and filtered using a small hand pump as shown below in Photo 7 (these items are available through environmental equipment vendors)

Photo 7

9. To obtain a duplicate/blind duplicate sample, collect a duplicate from the same bag as an original sample and send for analysis with the appropriate labeling
10. To obtain an equipment blank, pour deionized water into a **new, unused** HydraSleeve™ and collect the blank using the same method as the samples; send for analysis with the appropriate labeling
11. If turbidity of the collected sample is to be measured, use the collected sample water to fill the LaMotte turbidimeter vial, and measure and record turbidity on the HydraSleeve™ Field Form (**Attachment A**)
12. Place collected samples immediately in a sample cooler that is already full of ice or ice packs such that the samples are immediately chilled and stored at a temperature of 4° Celsius, in accordance with relevant TGIs
13. Field parameter measurements (temperature, specific conductance, pH, DO, and ORP) can now be taken using a down-hole multi-meter (e.g., a YSI 600XL). Gently lower the probe of the meter down the well until it reaches the middle of the well screen noted on the PST and HydraSleeve™ Field Form. Follow the manufacturer's guidelines on how to determine stability of parameter readings. Once the meter readings have stabilized, record them on the HydraSleeve™ Field Form.
14. Measured and record total well depth on the HydraSleeve™ Field Form.
15. NOTE: After the groundwater samples and field measurements have been collected, it may be necessary to deploy another HydraSleeve™ in the well for future sampling events (e.g., quarterly, semi-annually, etc.)
    a. This reduces the effort required to perform future events
    b. The FIP and/or PST will state if another HydraSleeve™ is to be deployed
    c. The same suspension line or well-specific tether will be reused for additional deployment to ensure consistency in the deployment depth
    d. Follow the steps outlined previously in this TGI for assembly and deployment instructions
16. Secure the well.
17. Properly dispose of PPE and disposable equipment.
18. Decontaminate any cutting devices, reusable weights, suspension lines, or sampler attachment mechanisms after each usage as described in the *TGI – Groundwater and Soil Sampling Equipment Decontamination*

8 WASTE MANAGEMENT

Materials generated during groundwater sampling activities, including disposable equipment and excess water in the Hydrasleeves™, will be stored on site in appropriate labeled containers and disposed of properly. Waste will be managed in accordance with the *TGI – Investigation-Derived Waste Handling and*

Storage, the procedures identified in the FIP or QAPP as well as state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field log book.

9 DATA RECORDING AND MANAGEMENT

Field forms (e.g., HydraSleeve™ Field Forms), logs/notes (including daily field and calibration logs), digital records, and chain-of-custody records will be maintained by the field team lead.

Field logs and chain-of-custody records will be transmitted to the Arcadis Project Manager and/or Task Manager, as appropriate, at the end of each day unless otherwise directed. Electronic data files will be sent to the project team and uploaded to the electronic project folder daily.

The groundwater sampling field lead retains copies of the HydraSleeve™ Field Forms and chain-of-custody records.

Management of the original documents from the field will be completed in accordance with the site-specific QAPP.

In instances where samplers are deployed for the next event in advance and sampling events are months or years following deployment, the groundwater sampling field lead will file the deployment HydraSleeve™ Field Forms and communicate the physical location of them to the Arcadis Project Manager and/or Task Manager so they can be completed during the future sampling event.

Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

10 QUALITY ASSURANCE

Quality assurance and quality control (QA/QC) samples collected during the retrieval and sampling of Hydrasleeve™ samplers, as described in this TGI, include equipment blanks and field duplicates. QA/QC procedures will be conducted in accordance with the Arcadis Quality Management System and the site-specific QAPP.

11 REFERENCES

Cordry, K.E., 2006. HydraSleeve™ Field Manual. Las Cruces, N.M.: GeoInsight, Inc. http://www.hydrasleeve.com/images/stories/support/HydraSleeve_No-Purge_manual_updated.pdf

Eon Products, Inc. 2018. Interim Field Manual. Received September 14.

GeoInsight, Inc. 2010a. Standard Operating Procedure: Sampling Groundwater with a HydraSleeve™. Las Cruces, N.M.: GeoInsight, Inc. http://www.hydrasleeve.com/images/stories/support/HydraSleeve_SOP.pdf

GeoInsight, Inc. 2010b. SuperSleeve Assembly Instructions. Las Cruces, N.M. http://www.hydrasleeve.com/images/stories/support/SSfield_manual.pdf

Interstate Technology and Regulatory Council. 2004. Technical and Regulatory Guidance for Using Polyethylene Diffusion Bag Samplers to Monitor Volatile Organic Compounds in Groundwater. February.

McHugh, T, et al. 2016. Negative Bias and Increased Variability in VOC Concentrations Using the HydraSleeve™ in Monitoring Wells. Groundwater Monitoring & Remediation

12 ATTACHMENTS

Attachment A - HydraSleeve™ Field Form

Attachment B - Calculation of Maximum Required HydraSleeve™ Equilibration Period (Flush-Out Time) Based on Well Geometry and Darcy Velocity

Attachment C - Interim HydraSleeve™ Field Manual by Eon Products, Inc.

ATTACHMENT A

HydraSleeve™ Field Form

ARCADIS Design & Consultancy for natural and built assets

HydraSleeve™ Field Form

Site: ______________________________
Location: ______________________________
Well ID: ______________________________

Well Type: ☐Monitoring ☐Other: ______________________________
Well Finish: ☐Stick Up ☐Flush Mount
Measuring Pt: ☐Top of Casing ☐Other (specify):____________________
Total Depth As Constructed (ft bgs): ____________ **Screened Interval (ft bgs):**________________
Well Casing: Diameter: ____________ Material: ______________________
Well Screen: Diameter: ____________

Deployment

Date and Time of Deployment: Date: ____________________ Time: ____________
Weather Conditions: ______________________________
Depth to groundwater at time of deployment: ______________________________
Total well depth at time of deployment: ______________________________
Dimensions of HydraSleeve™: Length (in.) __________ Diameter (in.) __________
Deployment Method/Position of Weight:
☐Bottom Anchor: Weight attached to bottom of HydraSleeve™. Weight rests on well bottom.
☐Top-Down: Weight attached to bottom of HydraSleeve™. Weight suspended in well.
☐Top-Down: Weight attached to top of HydraSleeve™. Weight suspended in well.
Deployment Depth (Top of HydraSleeve™) (ft bgs): ______________________________

Retrieval

Date and Time of Retrieval: Date: ____________________ Time: ____________
Total # of days deployed: ______________________________
Weather Conditions: ______________________________
Retrieval Method:
☐ Continuous Pull (preferred)
☐ Short Strokes
Depth to groundwater at time of retrieval (measured before retrieval): ____________________
Total well depth at time of retrieval (measured after retrieval): ____________________
Downhole Field Parameters Upon Retrieval:
Temp:__________ **(^{o}C)** **ORP:**____________ **(mV)** **Water quality meter:**_________________
pH:_____________ **DO:**____________ **(mg/L)** **Serial #:**_____________________________
Turbidity of Groundwater Sample (dispensed from HydraSleeve^{TM}):
Turbidity:_______ **(NTU)** **Turbidity meter:**____________ **Serial #:**_____________________________

Notes/Observations:

Field Sampling Technician: Name(s) and Company

Name Company

____

____

ATTACHMENT B

Calculation of Maximum Required HydraSleeve™ Equilibration Period (Flush-Out Time)
Based on Well Geometry and Darcy Velocity

ATTACHMENT B

CALCULATION OF MAXIMUM REQUIRED EQUILIBRATION PERIOD (FLUSH-OUT TIME) BASED ON WELL GEOMETRY AND DARCY VELOCITY

Example Calculations

Well Diam (inches)	Darcy v (ft/day)	Flush %	Flush Time (hours)
2	0.001	90	458
2	0.01	90	46
2	0.1	90	4.6
2	1	90	0.46
2	10	90	0.05
2	0.001	95	600
2	0.01	95	60
2	0.1	95	6.0
2	1	95	0.60
2	10	95	0.06
4	0.001	90	917
4	0.01	90	92
4	0.1	90	9.2
4	1	90	0.92
4	10	90	0.10
4	0.001	95	1200
4	0.01	95	120
4	0.1	95	12.0
4	1	95	1.20
4	10	95	0.12

General Equation for Flushing Time

t = [0.25 wd / (vd cf)] [-ln (1-f)]

where:

t = maximum required flushing time (hours)

wd = well diameter (inches)

vd = Darcy velocity, Ki (feet per day)

K = hydraulic conductivity (feet per day)

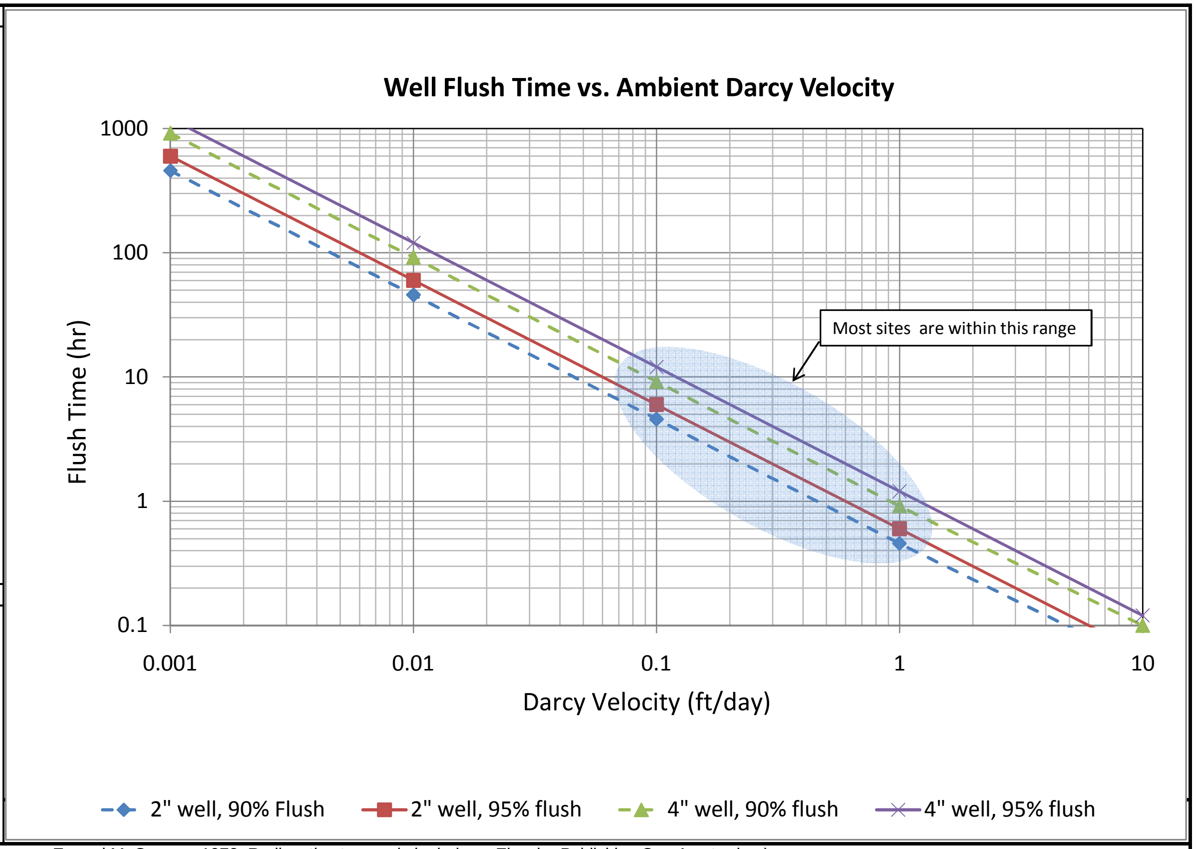
i = hydraulic gradient (dimensionless)

cf = flow convergence factor (typically between 2 and 3)

example calcs. assume cf = 2.5

f = % flush expressed as fraction

(e.g., 95% = 0.95, 90% = 0.90, etc.)



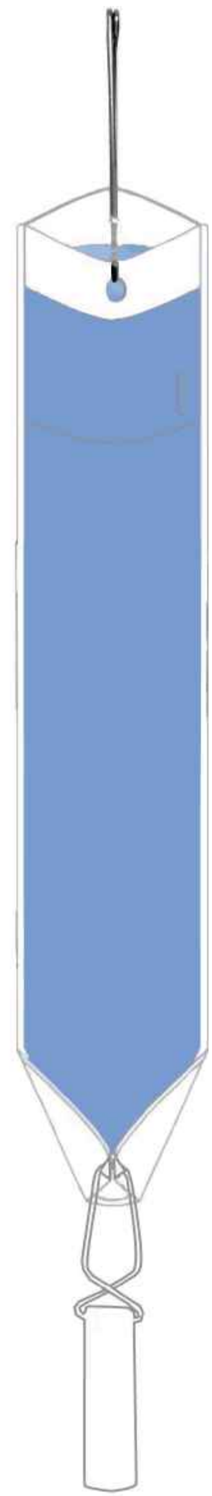
(*Based on:* Gaspar, E., and M. Onescu. 1972. Radioactive tracers in hydrology. Elsevier Publishing Co., Amsterdam)

ATTACHMENT C

Interim HydraSleeve™ Field Manual by Eon Products, Inc.

EON PRODUCTS INC.
800-474-2490
eonpro.com
· SAMPLING · MEASURING · MONITORING ·

Interim Field Manual



Please call if you have any questions. 800-474-2490

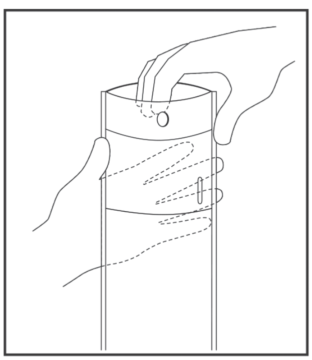
Introduction

Please read the manual in its entirety before sampling with HydraSleeve.

The HydraSleeve groundwater sampler can be used to collect a representative sample for most physical and chemical parameters without purging the well. It collects a whole water sample from a user-defined interval (typically within the well screen), without mixing fluid from other intervals. One or more HydraSleeves are placed within the screened interval of the monitoring well, and a period of time is allocated for the well to re-equilibrate. Hours to months later, the sealed HydraSleeve can be activated for sample collection. (Note: the new SpeedBags can be immediately deployed and recovered.) When activated by rapid upward motion, the check value opens and the HydraSleeve collects a sample with no drawdown and minimal agitation or displacement of the water column. Once the sampler is full, the one-way reed valve collapses, preventing mixing of extraneous, non-representative fluid during recovery. HydraSleeves go in flat and closed and come out full and closed.

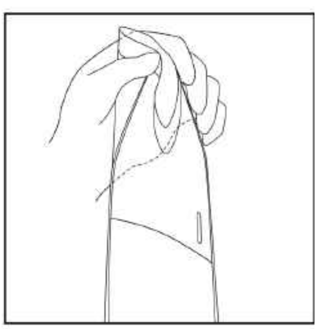
Assembly

Assembling the HydraSleeve is simple, and can be done by one person in the field, taking only a minute or two.



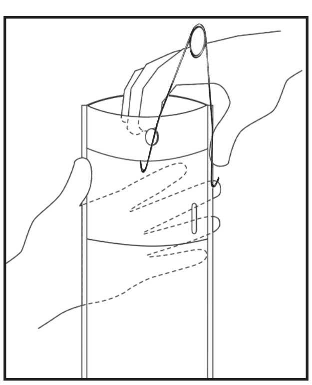
1

Remove HydraSleeve from package and grasp top to “pop” open.
Remember to save the discharge tube for later.



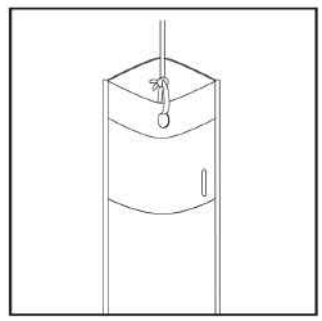
2

Squeeze side fins together at top to bend reinforcing strips outward. Crimp the corners to remain open



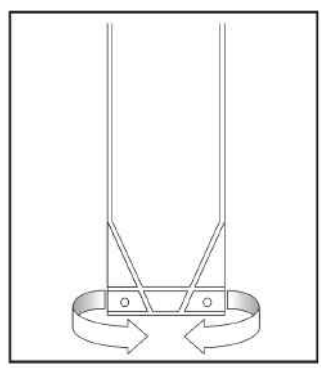
3 Preferred

Attach the tethered spring clip (see separate spring clip instructions); or



4 Option B

Alternatively attach the line to one side of the HydraSleeve if spring clips are not being used. Be sure the top is sharply crimped open.



5

Align the two holes at bottom of HydraSleeve together and attach weight with the weight clip.

6

Sampler is ready to be placed in the well.

Placing the HydraSleeve(s)

To collect a representative groundwater sample without purging, the well usually needs to be allowed time to equilibrate after placement of the sampler. When any device is lowered into a well, some mixing of the water column occurs. The diameter of the device, how tightly it fits in the well, and its shape greatly affect the degree of mixing. The flat cross-section of the empty HydraSleeve minimizes the disturbance to the water column as the sampler is lowered into position, reducing the time needed for the well to return to equilibrium. Using a SpeedBag HydraSleeve eliminates equilibration time for most wells.

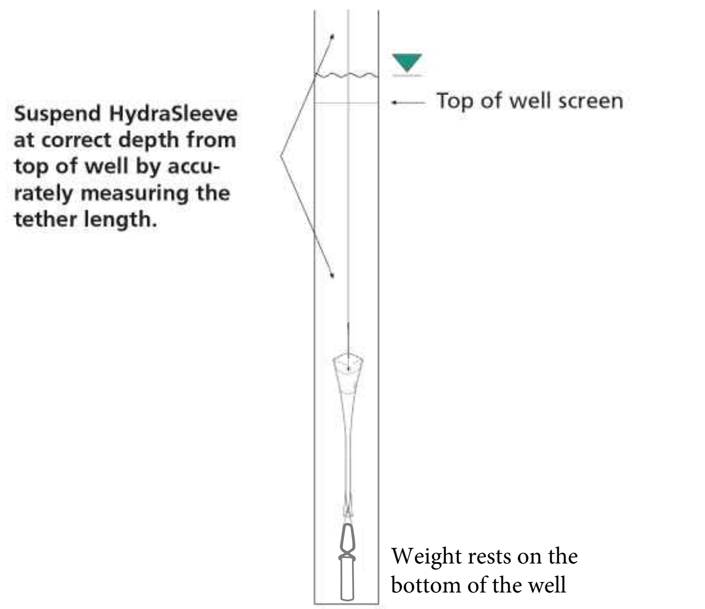
There are several methods for holding a HydraSleeve in position as the well equilibrates.

Most HydraSleeves and SuperSleeves are 3-5 feet long. The weight will go to the bottom of well but sample will come from upper half of well; because the sleeve will be suspended ~3-5 feet from the bottom up.

Most Common
TOP DOWN DEPLOYMENT (Figure 1)
Measure the correct amount of suspension line needed to "hang" the top of the HydraSleeve(s) at the desired sampling depth (in most cases, this will be at the bottom of the sampling zone). The upper end of the tether can be connected to the well cap to suspend the HydraSleeve at the correct depth until activated for sampling.

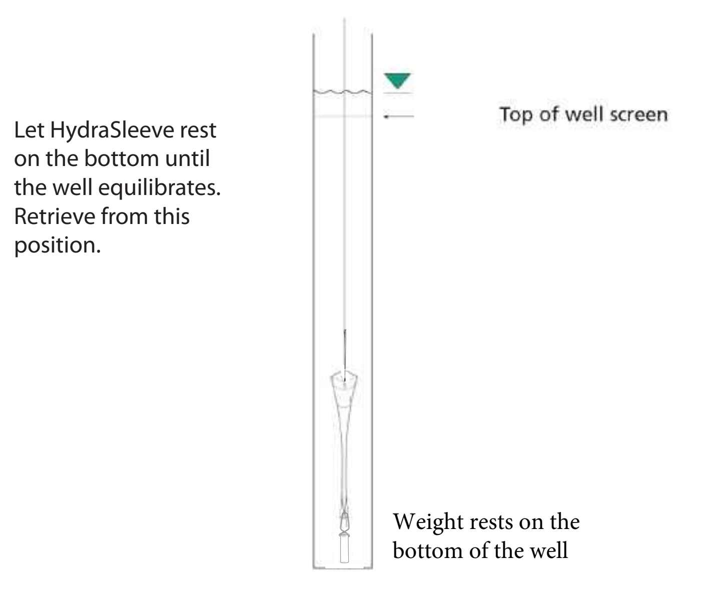
Note: For deep settings, it may be difficult to accurately measure long segments of suspension line in the field. Using our optional calibrated tether (marked sequentially in feet) will help solve this problem.

Figure 1



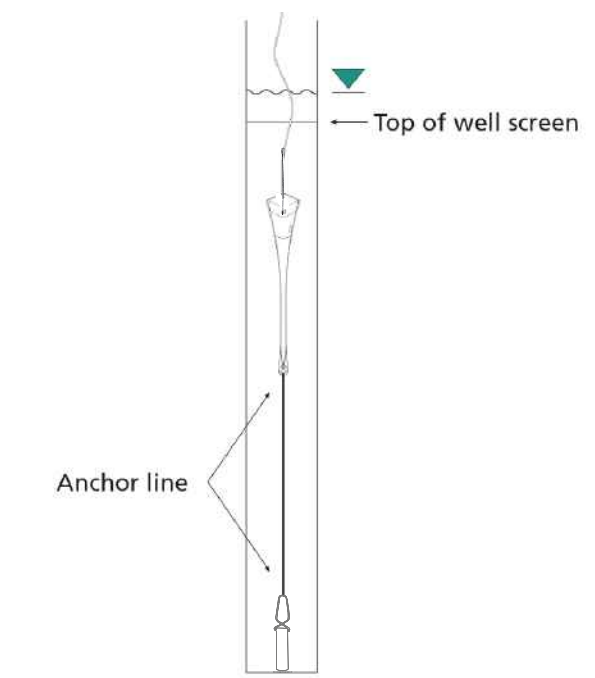
BOTTOM DEPLOYMENT (Figure 2)
Sound the well to determine the exact depth. Lower the weighted HydraSleeve into the well and let it rest on the bottom. The HydraSleeve sits suspended off the bottom & typically sample will be collected from the area directly above the top of the sleeve at this point without adjustment. Attach the suspension line to the top of the well to suspend it at this depth. (It is often easier to measure a few feet from the bottom of the well up to the sample point, than it is to measure many feet from the top of the well down.)

Figure 2



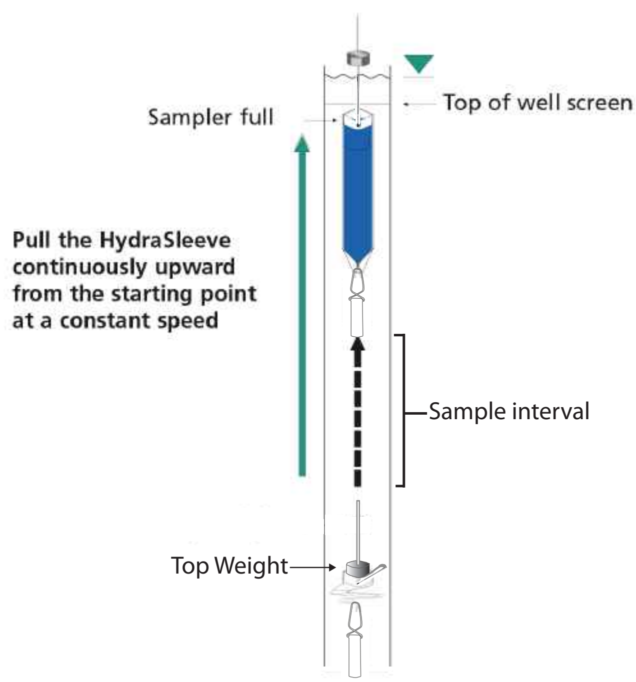
BOTTOM ANCHOR (Figure 3)
Determine the exact depth of the well. Calculate the distance from the bottom of the well to the desired sampling depth. Attach an appropriate length anchor line between the weight and the bottom of the sampler and lower the assembly until the weight rests on the bottom of the well, allowing the top of the sampler to float at the correct sampling depth.

Figure 3



TOP WEIGHTED ASSEMBLIES (Figure 4)
Using a top weight for short water collumns will compress the HydraSleeve into the bottom of the well. This allows for sample collection to begin at the lowest point possible. It provides for more saturated screen above the check valve from which to collect the sample. Insert the top wighted assembly into the well. Allow it to reach the bottom. Be sure to leave enough slack (at least the length of the sampler) so that there is enough tether to allow the HydraSleeve to compress over a period of time. The length of time and compression area are determined by the type and size of HydraSleeve being used.

Figure 4



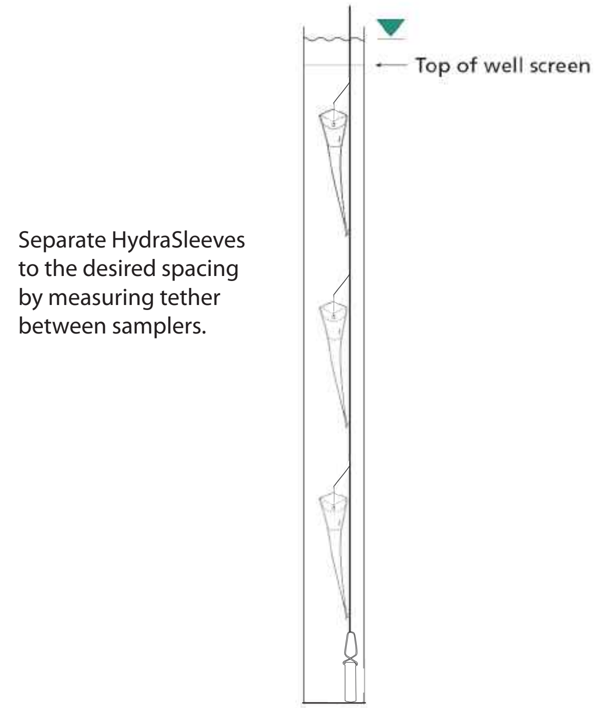
Multiple Interval Deployment

There are 3 basic methods for placing multiple HydraSleeves in a well to collect samples from different levels simultaneously.

ATTACHED TO A SINGLE TETHER (Figure 5)
To use 3 or more samplers simultaneously, we recommend attaching them all to a tether for support to prevent the sampling string from pulling apart. The weight is attached to a single length of suspension line and allowed to rest on the bottom of the well. The top and bottom of each HydraSleeve are attached to the tether at the desired sample intervals. Cable tie or stainless steel clips (optional) work well for attaching the HydraSleeves to the line. Simply push one end of the clip between strands of the rope and tie a knot at the desired point before attaching the clip to the HydraSleeve.

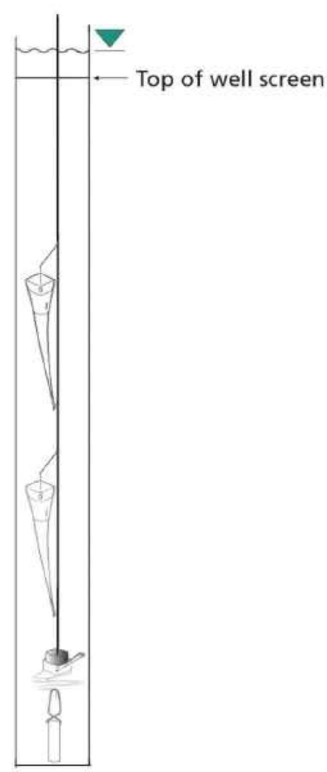
Note: if many HydraSleeves are attached to a tether, more bottom weight will be required than with a single sampler.

Figure 5



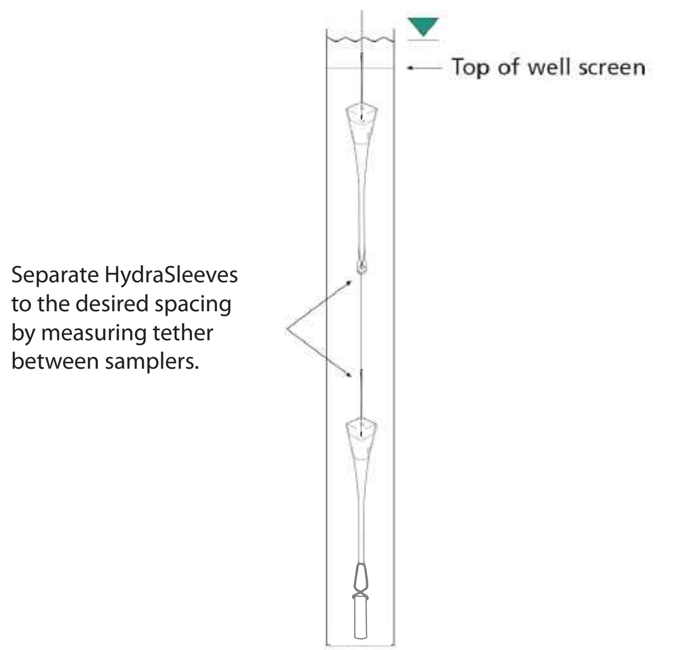
ATTACHED TO A SINGLE TETHER WITH A TOP WEIGHT ON THE BOTTOM (Figure 6)
Attach the HydraSleeves in the same manner as figure 5 but put a top weight on the bottom HydraSleeve. Remember to leave enough slack in the tether (at least the length of the bottom sleeve) so the assembly can be compressed into the bottom of the well.

Figure 6



ATTACHED END TO END (Figure 7)
To place 2 stacked HydraSleeves for vertical profiling, use one of the methods described above to locate where you want to place the bottom sampler. Attach the bottom of the top sampler to the top of the following HydraSleeve with a carefully measured length of suspension cable. Connect the weight to the bottom sampler. Heavier bottom weight will be required for this application.

Figure 7



NOTE: If multiple sleeves are being used soley to provide additional sample volume, consider a single longer (often top-weighted) custom sleeve instead of multiple shorter sleeves. It's simpler and more reliable.

Sample Collection

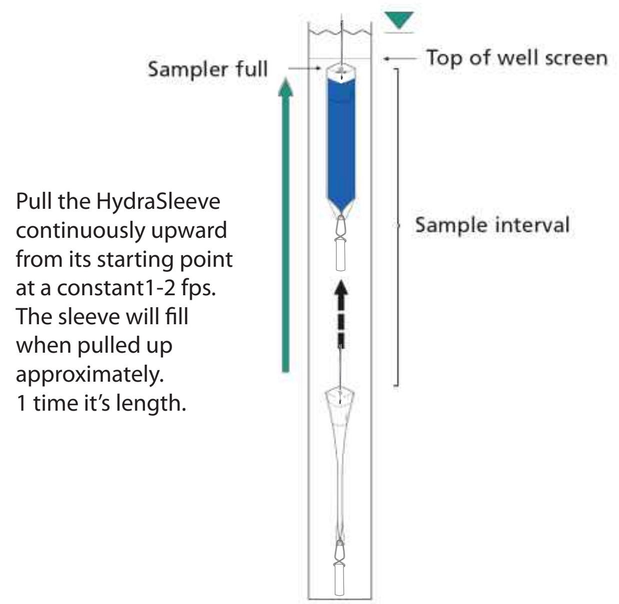
The HydraSleeve must move upward at a rate of one foot per second or faster (about the speed a bailer is usually pulled upward) for water to pass through the check valve into the sample sleeve. For most applications the HydraSleeve will fill within the length of the sampler. For example, a 30-inch HydraSleeve needs a total upward movement of 30 inches to fill.
There are times when the total upward distance the check valve must travel to fill the sample sleeve is longer. When using a smaller sleeve diameter in a larger diameter well the pull-to-fill distance will be longer. The upward motion can be accomplished using one of several variations of cycling or long continuous pull or any combination that moves the check valve the required distance within the saturated screen zone in the open position.

To ensure the Hydrasleeve is full and check valve closed we recommend one of the cycling methods is followed see below.

CONTINUOUS PULL (Figure 8)
Pull the HydraSleeve continuously upward from its starting point at a constant 1 to 2 feet per second until full. This method is analogous to coring the water column from the bottom up.

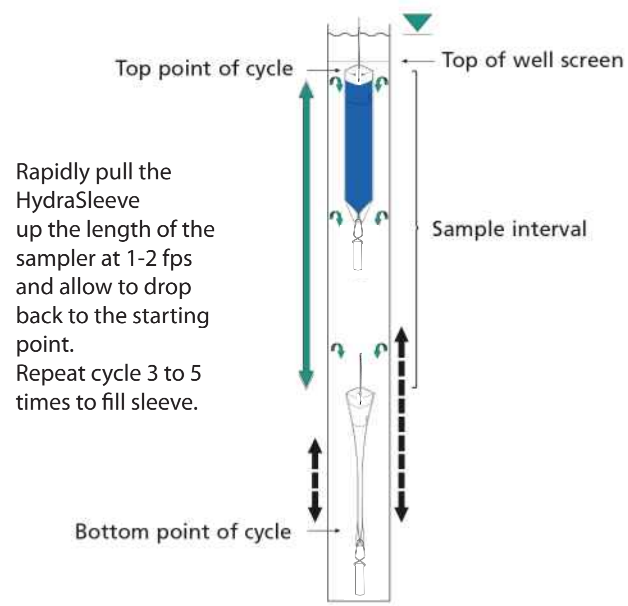
Note: When using this method, the screen interval must be long enough so the sampler fills before exiting the top of the screen. Fill rate is dependent on the sleeve being sized for the well diameter. 2-inch sleeves for 2-inch wells. 4-inch sleeves for 4-inch wells. If using undersized sleeves please use a cycling method to assure the sleeve fills in the screened interval.

Figure 8



CYCLING THE SLEEVE (Figure 9)
Pull the sampler upward at about 1 to 2 feet or the length of the sampler and let it drop back to the starting point. Repeat the cycle 3 to 5 times.
This method provides a shorter sampling interval than the continuous pull method (above), and usually reduces the turbidity levels of the sample below that of numerous rapid, short cycles (below). The sample comes from between the top of the cycle and the bottom of the sampler at its lowest point.

Figure 9



Sample Discharge

The best way to remove a sample from the HydraSleeve with the least amount of aeration and agitation is with the short plastic discharge tube (included).

First, squeeze the full sampler just below the top to expel water resting above the flexible check valve. **(Fig. 10, top right)** Fold the stiffeners over to make sure all of the water is off the top of the check valve.

Then, push the pointed discharge tube through the outer polyethylene sleeve as desired but at least 3-4 inches below the white reinforcing strips. **(Fig. 11, middle right)**

Note: For some contaminants (VOC's/sinkers) the best location for discharge is the middle to bottom of the sampler. This would be representative of the deeper portion of the well screen.

Discharge the sample into the desired container.**(Fig. 12, bottom right)**

Raising and lowering the bottom of the sampler or pinching the sample sleeve just below the discharge tube will control the flow of the sample. The sample sleeve can also be squeezed, forcing fluid up through the discharge tube, similar to squeezing a tube of toothpaste. With a little practice, and using a flat surface to set the sample containers on, HydraSleeve sampling becomes a one-person operation.

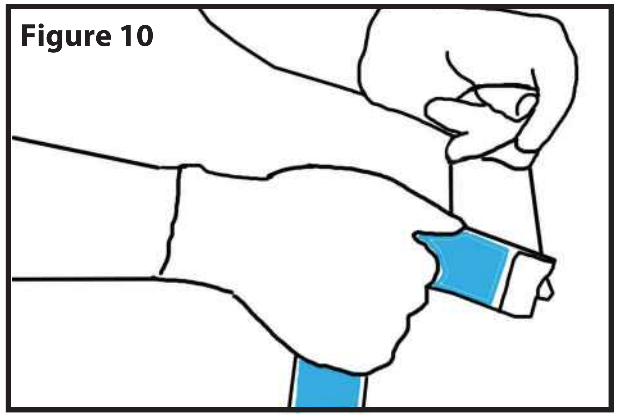


Figure 10

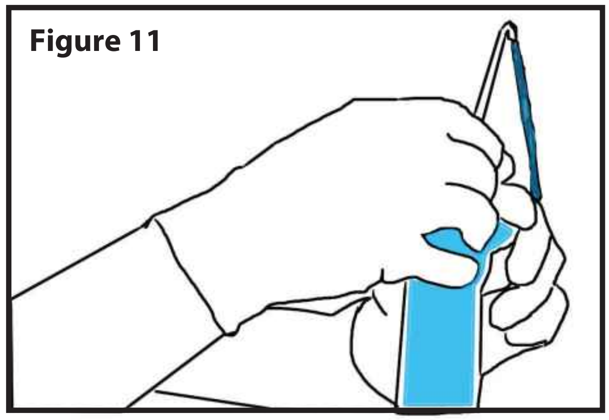


Figure 11

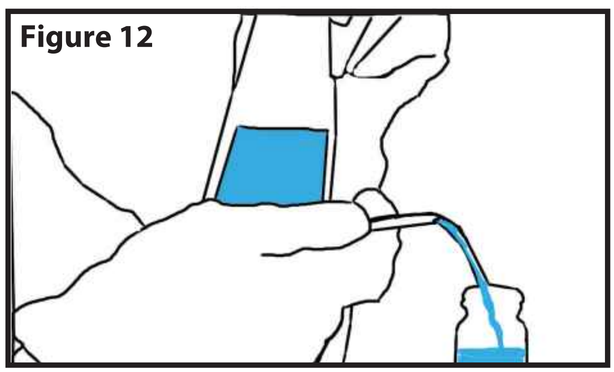


Figure 12

EON PRODUCTS INC.
800-474-2490
eonpro.com
·SAMPLING·MEASURING·MONITORING·

TGI - LOW-FLOW GROUNDWATER PURGING AND SAMPLING PROCEDURES FOR MONITORING WELLS

Rev: #1

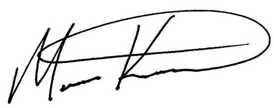
Rev Date: May 8, 2020

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	October 12, 2018	All	Updated and re-written as TGI with new branding and content	Marc Killingstad
1	May 8, 2020	Pages 5, 10-11	Added clarification/details for equipment requirements and procedure steps based on USEPA guidance	Marc Killingstad

APPROVAL SIGNATURES

Prepared by:		10/12/2018
	Ryan McKinney	Date:



Technical Expert Reviewed by:		May 8, 2020
	Marc Killingstad (Technical Expert)	Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

Groundwater samples are collected from monitoring wells to evaluate groundwater quality. The protocol presented in this Technical Guidance Instruction (TGI) describes the procedures to purge monitoring wells and collect groundwater samples using the low flow purging/sampling methodology. This protocol has been developed in accordance with the United States Environmental Protection Agency (USEPA) Region I *Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells* (EQASOP-GW4; September 19, 2017).

Both filtered and unfiltered groundwater samples may be collected using this low-flow sampling method. Filtered samples will be obtained using a 0.45-micron disposable filter. Project teams will evaluate the last time the monitoring wells were developed and determine if additional development might be necessary. Water samples will not be taken immediately following well development. Sufficient time will be allowed for the groundwater flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, the groundwater sampling team will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP)/field sampling plan, Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Additionally, the groundwater sampling team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

4 EQUIPMENT LIST

Specific to this activity, the following materials (or equivalent) will be used:

- Site-specific HASP and health and safety documents identified in the HASP
- Field Implementation Plan (FIP) that includes site map, well construction records, sampling plan (sample analyses, sample volume required, and sample holding time), and prior groundwater sampling records (if available)
- Field notebook and/or smart device (phone or tablet)
- Low-flow sampling field forms (**Attachment A**)
- Appropriate personal protective equipment (PPE) (e.g., latex or nitrile gloves, safety glasses, etc.) as specified in the HASP
- Well keys and other tools to remove manhole covers (manual torque wrench with 9/16” socket and flat head screwdriver typical)
- Photoionization detector (PID) or Flame ionization detector (FID) (as appropriate, depending on site-specific constituents of concern)
- Electronic water-level indicator (e.g., Solinist Model 101) or oil/water interface probe with 0.01-foot accuracy (oil/water as appropriate, note that sampling will not be performed when sheen or light non-aqueous phase liquid [LNAPL] is present)
- Down-hole multi-parameter water-quality sonde (temperature/pH/specific conductivity/oxidation reduction [ORP]/turbidity/dissolved oxygen) meter coupled with flow-through-cell for measurements, for example:

  - YSI 6-Series Multi-Parameter Instrument
  - Horiba U-22 Multi-Parameter Instrument.
  - Hydrolab Series 3 or Series 4a Multiprobe and Display.

  NOTE: *Transparent, small volume flow-through-cells (e.g., 250 milliliters or less) are preferred as they allow for easy detection of air bubbles and sediment buildup in the cell, which can interfere with the monitoring instrument probes. A small volume cell also allows for quick turnover of water in the cell between measurements of the indicator field parameters. It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.*

- Plastic sheeting (e.g., Weatherall Visqueen) to protect all down-hole sampling equipment from contact with potential sources of contamination.
- Decontamination equipment
  - Non-phosphate laboratory soap (Alconox or equivalent), brushes, clean buckets or clean wash tubs—new buckets or tubs will be purchased if it cannot be determined if the present items are clean
  - Distilled or de-ionized water for equipment decontamination
- Indelible ink pen
- 150-foot measuring tape (or sufficient length for the maximum site depth requirement)
- Sampling pump, which may consist of one or more of the following:
  - Submersible pump (e.g., Grundfos Redi-Flo 2)
  - Peristaltic pump (e.g., ISCO Model 150)
  - Bladder pump (e.g., Marschalk System 1, QED Micropurge, Geotech)
- Appropriate controller and power source for pump:
  - Submersible and peristaltic pumps require electric power from either a generator or a deep cell battery
  - Submersible pumps such as Grundfos require a pump controller to run the pump
  - Bladder pumps require a pump controller and a gas source (e.g., air compressor or compressed N2 or CO2 gas cylinders)
- Teflon® tubing or Teflon®-lined polyethylene tubing of an appropriate size for the pump being used
  - For peristaltic pumps, dedicated Tygon® tubing (or other type as specified by the manufacturer) will be used through the pump apparatus
  - Teflon® will not be used when sampling for per- and polyfluoroalkyl substances (PFAS)
- Graduated cylinder and stop watch or other device to measure time to determine pumping rate

- Appropriate water sample containers (supplied by the laboratory)
- Appropriate blanks (trip blank supplied by the laboratory)
- Sample labels and Chain-of-Custody forms (COC)
- 0.45-micron disposable filters (if field filtering is required)
- A supplemental turbidity meter (e.g., Horiba U-10, Hach 2100P, LaMotte 2020) may be required for specific projects and will be specified in the project FIP/ work plan and the kick-off notes.
    - If used, in-line 'T' and valve allows for collection of water for turbidity measurements before the pump discharge enters the flow-through cell

NOTE: *The maintenance requirements for the above equipment generally involve decontamination or periodic cleaning, battery charging, and proper storage, as specified by the manufacturer. For operational difficulties, the equipment will be serviced by a qualified technician.*

5 CAUTIONS

Different USEPA regions and/or state regulatory agencies may stipulate deviations from this document. It is the responsibility of the Project Team (Project Manager and Technical Lead) to be fully aware of the requirements from the applicable regulatory framework.

Weather

- If heavy precipitation occurs, and no cover over the sampling area and monitoring well can be erected, sampling may be discontinued until adequate cover is provided. Rain water could compromise groundwater samples.
- Avoid extreme weather situations. Be aware that thermal currents and vertical mixing of cold and warm water inside the well casing could create a convection cell within the well and compromise data collection (e.g., biological mechanisms).
    - Direct sunlight and hot ambient temperatures may cause the groundwater in the tubing or flow-through-cell to heat up and de-gas. This may result in the loss of volatile organic compounds (VOCs) and dissolved gases. Shade the equipment from direct sunlight, keep the tubing as short as possible, and avoid the hottest times of the day.
    - Sampling during freezing conditions may adversely impact the data quality objectives. USEPA recommends low-flow sampling be conducted at air temperatures above 32°F (0°C) or taking special precautions to prevent groundwater from freezing in the equipment.

Cross-Contamination

- To mitigate potential cross-contamination, groundwater samples are to be collected in a pre-determined order from least impacted to impacted based on previous analytical data. If no analytical data are available, collect samples in order of up-gradient, then furthest down-gradient to source area locations.

- Note that permanent markers could introduce volatile constituents into the samples; *therefore, indelible ink is recommended* to be used for labels on sample containers or sample coolers.
- When using a gasoline generator, this power source will be set-up at least 30 feet downwind from the well to avoid exhaust fumes to contaminate samples.

Pumps

- Preferred methods of extracting groundwater are adjustable rate, submersible pumps - such as centrifugal pumps or bladder pumps – constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e. Teflon®). However, *PTFE will not be used when sampling for per- and polyfluoroalkyl substances (PFAS). PTFE could contain PFAS*.
- When using a bladder pump for collecting VOCs and dissolved gases, “best practice” is to set-up the pump to deliver sufficient water to fill a 40 mL VOC vial.
- The use of peristaltic pumps will be based on the type of data to be collected. *Because the use a peristaltic pump can result in de-gassing of VOC and / or dissolved gases from groundwater, a different type of pump will be considered if these compounds are of concern.*
- *Manual or motor driven inertial pumping devices are not recommended because they cause greater disturbance during purging and pumping than regular pumps and are less easily controlled. This could cause a higher degree of data variability.*

Tubing

- When sampling for VOCs, SVOCs, pesticides, PCBs and inorganics, use of PTFE (Teflon®) or PTFE-lined tubing is preferred. However, PTFE tubing will not be used when sampling for PFAS.
- PVC, polypropylene or polyethelene tubing may be used when sampling for metals or other inorganics.
- Tubing with inside diameters of 1/4 or 3/8 inch is recommended because this will help ensure tubing remains water filled when operating at very low pumping rates.

General Precautions

- Store and/or stage empty and full sample containers and coolers out of direct sunlight.
- It may be necessary to field filter the groundwater for some parameters (e.g., metals) during collection, depending on preservation, analytical method, and project quality objectives. The task-kick-off notes and the FIP/work plan will list the samples that require field filtering.
- Be careful not to overtighten lids with Teflon® liners or septa (e.g., 40 mL vials). Over-tightening can cause the glass to shatter or impair the integrity of the Teflon® seal.

6 HEALTH AND SAFETY CONSIDERATIONS

The HASP will be followed, as appropriate, to ensure the safety of field personnel.

Appropriate personal protective equipment (PPE) will be worn at all times in line with the task and the site-specific HASP.

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work.

Access to wells may expose field personnel to hazardous materials such as contaminated groundwater or non-aqueous phase liquid (NAPL) (e.g., oil). Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g. ticks in long grass/weeds around well head), and potentially the use of sharp cutting tools (scissors, knife)—open well caps slowly and keep face and body away to allow to vent any built-up pressure; only use non-toxic peppermint oil spray for stinging insect nests; review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives, and use appropriate hand protection.

Generators and cord and plug equipment will employ an overcurrent protection device such as an integrated ground fault circuit interrupter (GFCI) cord. Grundfos pump controllers will not run properly with a GFCI, so the power source will be equipped with other overcurrent protection means.

Overtightening of lids with Teflon® liners can cause the glass to shatter and create a risk for hand injuries.

7 PROCEDURE

Field personnel will set up and perform low-flow sampling in accordance with the following procedures.

1. Review FIP and groundwater sampling records from previous sampling events (if available) prior to mobilization to estimate the optimum pumping rate and anticipated drawdown for each well to perform sampling as efficiently as possible (i.e., reach a stabilized pumping condition).
2. Calibrate field instruments according to manufacturer procedures for calibration and record calibration procedure and results in field log.
3. All equipment will either be new or decontaminated in accordance with appropriate guidance document (*TGI – Groundwater and Soil Sampling Equipment Decontamination)* prior to use.
4. Visually inspect the well to ensure that it is undamaged, properly labeled and secured
   a) Damage or other conditions that may affect the integrity of the well will be recorded in the Field Activity Daily Log and brought to the attention of the designated Field Manager and/or Project Manager
   b) Record well construction and conditions on the Low-Flow Sampling Field Form (**Attachment A**)
5. Place clean plastic sheeting on the ground near the well to keep monitoring and sampling equipment off the surface unless the equipment is elevated above the ground (e.g. on a table).
6. Open the well cover while standing upwind of the well. Remove the well cap and place it on the plastic sheeting. If appropriate or required for site-specific conditions, insert the photoionization detector (PID) probe approximately 4 to 6 inches into the casing or the well headspace and cover it with a gloved hand. Record the PID reading in the field log. Perform air monitoring in the breathing zone according to the HASP and/or JSA.
7. Measure and record the initial depth to groundwater prior to placing the pumps.

8. Prepare and install the pump in the well.

   NOTE: *Groundwater will be purged from the wells using an appropriate pump. If the depth to water is below the sampling range of a peristaltic pump (approximately 25 feet below ground surface), a submersible or bladder pump will be used, provided that the well is constructed with a casing diameter of at least two (2) inches (the minimum well diameter capable of accommodating such pumps). For smaller diameter wells, where the depth to water is below the sampling range of a peristaltic pump, alternative sampling methods (i.e., bailing or small diameter bladder pumps) will be used to purge and sample the groundwater. Bladder pumps are preferred over peristaltic and submersible pumps to prevent volatilization if sampling of VOCs and/or dissolved gasses is required. Purge water will be collected and containerized according to the direction of the project team.*

   a) For submersible and non-dedicated bladder pumps, decontaminate the pump according to site decontamination procedures. Non-dedicated bladder pumps will require a new bladder and attachment of an air-line, sample discharge line, and safety cable prior to placement in the well. Attach the air-line tubing to the air-port on the top of the bladder pump. Attach the sample discharge tubing to the water port on the top of the bladder pump. Take care not to reverse the air and discharge tubing lines during bladder pump setup, as this could result in bladder failure or rupture. Attach and secure a safety cable to the eyebolt on the top of pump (if present, depending on pump model used). Slowly lower the pump, safety cable, tubing, and electrical lines into the well to a depth corresponding to the approximate center of the saturated screen section of the well. Avoid twisting and tangling of safety cable, tubing, and electrical lines while lowering the pump into the well; twisted and tangled lines could result in the pump becoming stuck in the well casing. Also, make sure to keep tubing and lines from touching the ground or other surfaces while introducing them into the well, as this could lead to unintended contamination.

   b) If using a bladder pump, connect the air-line to the pump controller output port. The pump controller will be connected to a supply line from an air compressor or compressed gas cylinder using an appropriate regulator and air hose. Tighten the regulator connector onto the gas cylinder (if used) to prevent leaks. Teflon® tape may be used on the threads of the cylinder to provide a tighter seal. Once the air compressor or gas cylinder is connected to the pump controller, turn on the compressor or open the valve on the cylinder to begin the gas flow. Turn on the pump controller power (if an on/off switch is present) and verify that all batteries are charged and fully functioning before starting the pump.

   c) If a peristaltic pump is being used, slowly lower the sampling tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well. The pump intake or sampling tube must be kept at least two (2) feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well.

   d) If using an in-line 'T' and valve, install between pump discharge water line and the bottom inlet port of the flow-through cell. Attach a short piece of tubing to the outlet. This set-up will be used to collect samples for turbidity readings.

9. Connect the pump discharge water line to the bottom inlet port on the flow-through cell connected to the multi-parameter water-quality sonde and make sure to record equipment/instrument identification (manufacturer and model number).
10. Before starting the pump, ensure that the water level inside the well has stabilized (i.e., measure the water level multiple times after deploying the pump in the well).
11. Start pumping the well at 200 to 500 milliliters (mL) per minute (or at lower site-specific rate if specified) and adjust the pumping rate to cause little or no water level drawdown in the well (less than 0.3 feet below the initial static depth to water measurement): the water level should stabilize, however, this is not always possible.
12. If the well diameter is of sufficient size, measure the water level every 3 to 5 minutes (or as appropriate, lower flow rates may require longer time between readings) during pumping.
13. Maintain a steady flow rate to the extent practicable and do not break pump suction or cause entrainment of air in the sample.
14. Record pumping rate adjustments and depths to water.

    If necessary, reduce pumping rates to the minimum capabilities of the pump to avoid pumping the well dry and/or to stabilize indicator parameters; if the recharge rate of the well is very low, use alternative purging techniques, which will vary based on the well construction and screen position.

    For wells screened across the water table, the well may be pumped dry and sampling can commence as soon as the volume in the well has recovered sufficiently to permit collection of samples.

    For wells screened entirely below the water table, the well can be pumped until a stabilized level (which may be greater than the maximum displacement goal of 0.3 feet) is maintained and monitoring for stabilization of field indicator parameters can commence; if a lower stabilization level cannot be maintained, the well may be pumped until the drawdown is at a level slightly higher than top of the well screen.
15. After water levels have stabilized and a sufficient volume has been purged (*see note below*), continue pumping and begin monitoring field indicator parameters using a multi-parameter water-quality sonde coupled with a flow-through-cell.

    NOTE: *The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.*
16. Use the flow to measure all indicator field parameters, except for turbidity, every 3 to 5 minutes (or after each volume of the flow-through cell has been purged or other appropriate interval); turbidity samples will be collected before the flow-through-cell using the T-valve and a clean container such as a glass beaker.
17. Record field indicator parameters on the groundwater sampling log.

18. The well is considered stabilized and ready for sample collection when three consecutive readings are within the following limits:

    - **Turbidity** within ± 10% for values greater than 5 nephelometric turbidity units [NTUs] or if three turbidity values are less than 5 NTUs, consider the values stabilized
    - **Dissolved Oxygen (DO)** within ± 10% for values greater than 0.5 mg/L or if three DO values are less than 0.5 mg/L, consider the values stabilized
    - **Specific Conductance** within ± 3%
    - **Temperature** within ± 3%
    - **pH** within ± 0.1 unit
    - **Oxidation/Reduction Potential (ORP)** within ±10 millivolts (mV)

    NOTE: *Alternate stabilization goals may exist in different geographic regions, consult the site-specific FIP/work plan for stabilization criteria).*

    NOTE: *While achieving turbidity levels less than 5 NTU and a stable drawdown of less than 0.3 feet is desirable, sample collection may still take place provided the indicator field parameter criteria in this procedure are met.*

19. If the parameters have stabilized but turbidity remains relatively high (e.g., greater than 50 NTUs), the pump flow rate may be decreased to a minimum rate of 100 mL/min to reduce turbidity levels as low as possible. If groundwater turbidity has been minimized (i.e., consecutive readings within ± 10%) and the values for all other parameters have stabilized, the well may be sampled; however, consult specifications in the FIP/work plan and/or the project technical lead prior to sampling.

20. If after one (1) hour of purging indicator field parameters have not stabilized, consult specifications in the FIP/work plan and/or the project technical lead prior to sampling.

    In general, three potential options are available if stabilization criteria are not met:

    a) Continue purging until stabilization is achieved.

    b) Discontinue purging, do not collect any samples, and record in field logbook/on the sampling form that stabilization could not be achieved (documentation must describe attempts to achieve stabilization).

    c) Discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization. *There is a risk that the analytical data obtained under these conditions, particularly metals and hydrophobic organic analytes, may reflect a sampling bias and, as a result, the data may not meet the data quality objectives of the sampling event.*

    NOTE: *DO is extremely susceptible to various external influences (including temperature or the presence of bubbles on the DO meter); therefore, great care will be taken to minimize the agitation or other disturbance of water within the flow-through cell while collecting these measurements. If air bubbles are present on the DO probe or in the discharge tubing, remove them before taking a measurement. If DO values are not within acceptable range for the temperature of groundwater, again check for and remove air bubbles on the probe before re-measuring. The table below may be* *used as a general guide for DO values under various temperatures; however, understand that the table corresponds to freshwater solubility and groundwater contaminants may affect oxygen solubility. If DO value is 0.00 or less, then the meter will be serviced and re-calibrated. If DO values are above possible results, then the meter will be serviced and re-calibrated.*

NOTE: *During extreme weather conditions, stabilization of field indicator parameters may be difficult to attain. Modifications to the sampling procedures to alleviate these conditions (e.g., measuring the water temperature in the well adjacent to the pump intake) will be documented in the field logbook/on the sampling form.*

NOTE: *If other field conditions are suspected of preventing stabilization of certain parameters, detailed observations will be documented in the field logbook/on the sampling form.*

Oxygen Solubility in Fresh Water

Temperature (degrees C)	Dissolved Oxygen (mg/L)
0	14.6
1	14.19
2	13.81
3	13.44
4	13.09
5	12.75
6	12.43
7	12.12
8	11.83
9	11.55
10	11.27
11	11.01
12	10.76
13	10.52
14	10.29
15	10.07
16	9.85
17	9.65
18	9.45
19	9.26
20	9.07
21	8.9
22	8.72
23	8.56
24	8.4
25	8.24
26	8.09
27	7.95
28	7.81
29	7.67
30	7.54
31	7.41
32	7.28
33	7.16
34	7.05
35	6.93

Reference: Vesilind, P.A., *Introduction to Environmental Engineering*, PWS Publishing Company, Boston, 468 pages (1996).

21. Complete the sample label(s) and cover the label(s) with clear packing tape to secure the label onto the container.

22. After the indicator parameters have stabilized, collect groundwater samples by diverting flow out of the unfiltered discharge tubing into the appropriate labeled sample container.

    a) If a flow-through analytical cell is being used to measure field parameters, the flow-through cell will be disconnected after stabilization of the field indicator parameters and prior to groundwater sample collection.

    b) Under no circumstances will analytical samples be collected from the discharge of the flow-through cell.

    c) If an in-line 'T' and valve are used, the valve needs to be removed as well.

    d) Samples will be collected in the following order: VOCs, total organic carbon (TOC), semi-volatile organic compounds (SVOCs), metals and cyanide, and others (or other order as defined in the site-specific FIP/work plan).

    e) When the container is full, tightly screw on the cap.

23. If sampling for total and filtered metals and/or polychlorinated biphenyls (PCBs), a filtered and unfiltered sample will be collected.

    a) Install an in-line, disposable 0.45-micron particle filter on the discharge tubing after the appropriate unfiltered groundwater sample has been collected.

    b) Continue to run the pump until an initial volume of "flush" water has been run through the filter in accordance with the manufacturer's directions (generally 100 to 300 mL).

    c) Collect the filtered groundwater sample by diverting flow out of the filter into the appropriately labeled sample container.

    d) When the container is full, tightly screw on the cap.

24. Secure with packing material and store the samples on ice in an insulated transport container provided by the laboratory and include a temperature blank in each container to be shipped.

25. Record on the Low-Flow Sampling Field Form (and bound field logbook) the time at which sampling procedures were completed, any pertinent observations of the sample (e.g., physical appearance and the presence or lack of odors or sheens), and the values of the stabilized field indicator parameters as measured during the final reading during purging (see **Attachment A**).

26. Turn off the pump and air compressor or close the gas cylinder valve if using a bladder pump setup.

27. Slowly remove the pump, tubing, lines, and safety cable from the well.

    a) If using dedicated tubing, do not allow the tubing or lines to touch the ground or any other surfaces which could contaminate them.

    b) If using dedicated tubing, it will be folded - without pinching it - to a length that will allow the well to be capped and also facilitate retrieval of the tubing during later sampling events.

    c) Use a length of rope or string to tie the tubing to the well cap.

d) Alternatively, if tubing and safety line are to be saved and reused for sampling the well at a later date, coil the tubing neatly and placed in a clean plastic bag that is clearly labeled with the well ID ensuring the bag is tightly sealed before placing it in storage.

28. Secure the well and properly dispose of personal protective equipment (PPE) and disposable equipment.
29. Complete the procedures for packaging, shipping, and handling with the associated Chain-of-Custody.
30. Complete decontamination for flow-through analytical cell and submersible or bladder pump, as appropriate (*TGI – Groundwater and Soil Sampling Equipment Decontamination*).
31. At the end of each day of the sampling event, perform calibration check of field instruments and record procedure and results in field log.

8 WASTE MANAGEMENT

Materials generated during groundwater sampling activities, including disposable equipment and excess purge water, will be stored on site in appropriately labeled containers and disposed of properly. Waste will be managed in accordance with the *TGI – Investigation-Derived Waste Handling and Storage,* the procedures identified in the FIP or QAPP as well as state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field logbook.

9 DATA RECORDING AND MANAGEMENT

Management of the original documents from the field will be completed in accordance with the site-specific QAPP.

In general, forms (e.g., Low-Flow Sampling Field Forms), logs/notes (including daily field and calibration logs), digital records, and Chain-of-Custody records will be maintained by the field team lead.

Field logs and Chain-of-Custody records will be transmitted to the Arcadis Project Manager and/or Task Manager, as appropriate, at the end of each day unless otherwise directed. Electronic data files will be sent to the project team and uploaded to the electronic project folder daily.

Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

10 QUALITY ASSURANCE

Quality assurance procedures shall be conducted in accordance with the Arcadis Quality Management System or the site-specific QAPP.

Unless described otherwise in the project-specific FIP/work plan, QAPP, or Sampling and Analysis Plan, quality assurance/quality control samples will be collected as follows:

- One duplicate for every 10 samples

- One laboratory matrix/matrix spike sample for every 20 samples

In addition to the quality control samples to be collected in accordance with this TGI, the following quality control procedures will be observed in the field:

- Collect samples from monitoring wells, in order of increasing concentration, to the extent known based on review of historical site information if available
- Equipment blanks will include the pump and tubing (if using disposable tubing) or the pump only (if using tubing dedicated to each well)
- Collect equipment blanks after wells with higher concentrations (if known) have been sampled
- Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures—calibrate instruments at the beginning of each day, verify the calibration at the end of each day, and record all calibration activities in the field notebook
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well following the procedure for equipment decontamination

11 REFERENCES

USEPA. 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document* (September 1986).

USEPA. 1991. *Handbook Groundwater, Volume II Methodology*, Office of Research and Development, Washington, DC. USEPN62S, /6-90/016b (July 1991).

USEPA Region I. 2017. *Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells* (EQASOP-GW4; September 19, 2017).

U.S. Geological Survey (USGS). 1977. *National Handbook of Recommended Methods for Water-Data Acquisition: USGS Office of Water Data Coordination*. Reston, Virginia.

12 ATTACHMENTS

A. Low-Flow Sampling Field Form

GROUNDWATER SAMPLING FORM

ARCADIS

Project No. ______________ Well ID ______________ Date ______________

Project Name/Location ______________ Weather ______________

Measuring Pt. Description ______________ Screen Setting (ft-bmp) ______________ Casing Diameter (in.) ______________ Well Material ____ PVC ____ SS

Static Water Level (ft-bmp) ______________ Total Depth (ft-bmp) ______________ Water Column (ft) ______________ Gallons in Well ______________

MP Elevation ______________ Pump Intake (ft-bmp) ______________ Purge Method: ______________ Sample Method ______________

Pump On/Off ______________ Centrifugal ______________ Submersible ______________ Other ______________

Sample Time: ______________ Volumes Purged ______________

Purge Start ______________ Gallons Purged ______________ Sample ID ______________ Sampled by ______________

Purge End ______________ Replicate/Code No. ______________

Time	Minutes Elapsed	Rate (gpm)/(mL/min) 200mL/min +	Depth to Water (ft) -0.3	Gallons Purged	pH ± 0.1	Cond. (μMhos)/(mS/cm) ± 3%	Turbidity (NTU) ± 10%	DO (mg/L) ± 10%	Temp. (°C)/(°F) ± 3%	Redox (mV) ± 10mV	Appearance Color	Appearance Odor
Stabilization Calculations (±)												
Stabilization Criteria					**± 0.1 s.u.**	**±3%**	**± 10% or within 1 NTU (1)**	**± 10%**	**±3%**	**±10 mV**		

(1) **Turbidity** < 50 NTU and ±10% or within 1 NTU of a previous reading when <10 NTU

Constituents Sampled	**Container**	**Number**	**Preservative**

Comments ______________

Well Casing Volumes

Gallons/Foot	***1" = 0.04***	***1.5" = 0.09***	***2.5" = 0.26***	***3.5" = 0.50***	***6" = 1.47***
	1.25" = 0.06	***2" = 0.16***	***3" = 0.37***	***4" = 0.65***	

Well Information

Well Location:		Well Locked at Arrival:	Yes / No
Condition of Well:		Well Locked at Departure:	Yes / No
Well Completion:	Flush Mount / Stick Up	Key Number To Well:	

TECHNICAL GUIDANCE INSTRUCTION - MONITORING WELL DEVELOPMENT

Rev: #0

Rev Date: April 24, 2017

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	4/24/2017	All	Re-written as TGI	Marc Killingstad

APPROVAL SIGNATURES

Prepared by:	Jay Erickson	4/24/2017 Date:
Technical Expert Reviewed by:	Marc Killingstad	4/24/2017 Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) covers the development of screened wells used for obtaining representative groundwater information and samples from granular aquifers (i.e., monitoring wells). Note that this TGI only applies to monitoring well development and not remediation (injection/extraction) well development.

The purposes of Monitoring Well Development are:

1. Repair damage to the borehole wall from drilling that can include clogging, smearing or compaction of aquifer materials;
2. Remove fine grained sediment from the formation and filter pack that may result in high turbidity levels in groundwater samples;
3. To re-sort formation and filter pack material adjacent to the well screen;

4. To recover any drilling fluids (if used) that may affect the permeability of the formation and filter pack or alter the water quality around the well; and
5. To optimize the well efficiency and hydraulic communication between the well screen and the formation.

Successful monitoring well development is dependent on the following:

1. Hydrostratigraphy – Permeable formations containing primarily sand and gravel are more easily developed due to lower percentages of silt and clay material. Water in permeable formations can be moved in and out of the screen and/or through the formation easier than in less permeable deposits
2. Well Diameter – Development tooling including brushes, surge blocks, pumps and jetting tools are more readily available for wells 4 inches in diameter and greater.
3. Well Design – Wells with filter packs and screens designed to match the formation through the analysis of formation sieve samples are easier to develop. An important aspect to well design is to minimize the size of the annular space between the formation and well screen. Adequate room must be allowed for the proper installation of well materials, but not too large as to prevent/reduce communication with the surrounding formation.
4. Drilling Methods – Different drilling methods result in varying amount of borehole damage and, therefore, impact the degree to which development will be successful.

Well development methods for monitoring wells include the following:

1. Bailing – use of a bailer to remove water and sediment from the well casing. This technique does little to remove fines from the filter pack and may lead to bridging of sediment since the flow in only in one direction, toward the well screen.
2. Pumping/overpumping – use of a pump to remove water and sediment from the well casing, overpumping involves pumping the well at a rate that exceeds the design capacity of the well. Similar to bailing, this technique does little to remove fines from the filter pack and may lead to bridging of sediment since the flow in only in one direction, toward the well screen. Small diameter monitoring wells have the additional constraint on pump size and flow rates.
3. Backwashing (rawhiding) – consists of starting and stopping a pump intermittently to produce rapid pressure changes in a well. This method can produce better results than pumping alone since the procedure involves movement of the water in and out of the screen and formation. However, in many cases the surging action is not rigorous enough to fully develop the well.
4. Surging/swabbing – use of a mechanical surge block or swabbing tool to operate like a piston with an up and down motion. The downstroke causes a backwash action that breaks up bridged sediment and the upstroke pulls the dislodged sediment into the well. This method works well for small and large diameter wells. Care should be taken on the downstroke so as not to force fines back into the formation, frequent pumping/purging during surging help to keep fines out of the well. Double surge blocks are recommended.
5. Jetting – use of a tool fitted with nozzles that direct streams of water horizontally into well screens at high velocity. Due to the size of the tooling, this method is better suited for wells 4 inch in diameter and larger. The method is also more effective with wire-wrapped/continuous slot screens due to the

increased open area. Jetting requires specialized equipment and concurrent pumping to prevent reintroducing fines into the filter pack. Additionally, jetting requires subsequent surging to remove fines dislodged in the filter pack and formation.

For most situations, gentle surging coupled with bailing or pumping to remove dislodged materials is recommended.

Well development for properly designed and constructed monitoring wells may begin after the annular seal materials have been installed and allowed to cure, since these wells are designed to retain 90-99% of the filter pack material. This cure time is typically at least 24 to 48 hours after the sealing materials have been installed.

This TGI is meant to provide a general guide for proper monitoring well development. A site-specific field implementation plan for well installation and development detailing the specific methods and tools should be developed to provide site-specific instruction and guidance.

3 PERSONNEL QUALIFICATIONS

Monitoring well development activities will be performed by persons who have been trained in proper well development procedures under the guidance of an experienced field geologist, engineer, or technician.

4 EQUIPMENT LIST

Required equipment depends on the selected method and should be detailed in the site-specific field implementation plan. However, the following are typically required.

- Health and safety equipment, as required by the site Health and Safety Plan (HASP):
- Cleaning equipment
- Field notebook and/or personal digital assistant (PDA)
- Monitoring well keys
- Water level indicator
- Field parameter meter (YSI)
- Well Development Logs
- Well construction logs/diagrams
- Weighted tape (measure depth)
- Turbidity meter
- Camera
- Watch/timing device.

5 CAUTIONS

Where surging is performed to assist in removing fine-grained material from the sand pack, surging must be performed in a gentle manner. Excessive suction could promote fine-grained sediment entry into the outside of the sand pack from the formation.

Avoid using development fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions.

In some cases, it may be necessary to add potable water to a well to allow surging and development, especially for new monitoring wells installed in low permeability formations. Before adding potable water to a well, the Certified Project Manager (CPM) and/or Project Hydrogeologist must be notified and the CPM shall make the decision regarding the appropriateness and applicability of adding potable water to a well during well development procedures. If potable water is to be added to a well as part of development, the potable water source should be sampled and analyzed for constituents of concern, and the results evaluated by the CPM prior to adding the potable water to the well. If potable water is added to a well for development purposes, at the end of development the well will be purged dry to remove the potable water, or if the well no longer goes dry then the well will be purged to remove at least three times the volume of potable water that was added.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with monitoring well development will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities.

7 PROCEDURE

As indicated above, for most monitoring wells, gentle surging coupled with bailing or pumping to remove dislodged sediment is recommended.

1 Ensure sufficient time has passed to allow for proper curing of the well seal.

2 Don appropriate PPE (as required by the site-specific HASP).

3 Place plastic sheeting around the well.

4 Clean all equipment entering each monitoring well, except for new, disposable materials that have not been previously used.

5 Open the well cover while standing upwind of the well, remove well cap. Insert PID probe approximately 4 to 6 inches into the casing or the well headspace and cover with gloved hand. Record the PID reading in the field notebook. If the well headspace reading is less than 5 PID units, proceed; if the headspace reading is greater than 5 PID units, screen the air within the breathing zone. If the PID reading in the breathing zone is below 5 PID units, proceed. If the PID reading is above 5 PID units, move upwind from well for 5 minutes to allow the volatiles to dissipate. Repeat the breathing zone test. If the reading is still above 5 PID units, don the appropriate respiratory protection in accordance with the requirements of the HASP. Record all PID readings.

6 Obtain an initial measurement of the depth to water and the total well depth from the reference point at the top of the well casing. Record these measurements in the field log book. It is recommended to use a weighted tape for the total well depth measurement.

7 The depth to the bottom of the well should be sounded and then compared to the completion form or construction diagram for the well. Any discrepancies should be reported immediately to the CPM and/or Project Hydrogeologist. If sand or sediment is present inside the well, it should first be removed by bailing. Do not insert bailers, pumps, or surge blocks into the well if obstructions, parting of the casing, or other damage to the well is suspected. Instead report the conditions to the CPM and/or Project Hydrogeologist and obtain approval to continue or cease well development activities.

8 Lower a double surge block into the screened portion of the well. Starting from the bottom of the screen using 2 foot throws, gently raise and lower the surge block to force water in and out of the screen slots and sand pack. Continue surging for 15 to 30 minutes.

9 Lower a bottom-loading bailer, submersible pump, or inertia pump tubing with check valve to the bottom of the well and gently bounce on the bottom of the well to collect/remove accumulated sediment, if any. Remove and empty the bailer, if used. Repeat until the bailed/pumped water is free of excessive sediment and contact at the bottom of the well feels solid. Alternatively, measurement of the well depth with a weighted tape can be used to verify that sediment and/or silt has been removed to the extent practicable, based on a comparison with the well installation log or previous measurement of total well depth.

10 After surging the well for a minimum of two cycles and removing excess accumulated sediment from the bottom of the well, re-measure the depth-to-water and the total well depth from the reference point at the top of the well casing. Record these measurements in the field log book.

11 Remove formation water by pumping/bailing. Where pumping is used, measure and record the pre-pumping water level. Operate the pump at a relatively constant rate. Measure the pumping rate using a calibrated container and stop watch, and record the pumping rate in the field log book. Measure and record the water level in the well at least once every 5 minutes during pumping. Note any relevant observations in terms of water color, visual level of turbidity, sheen, odors, etc. Pump or bail until termination criteria specified in the Site-Specific Field Implementation plan are reached. Note: the project-specific field implementation plan may also specify a maximum turbidity requirement for completion of development. Unless otherwise specified the maximum turbidity should be 50 NTUs or less. Record the total volume of water purged from the well.

12 While developing, take periodic water level measurements (at least one every five minutes) to determine if drawdown is occurring and record the measurements on the Well Development Log.

13 While developing, calculate the rate at which water is being removed from the well. Record the volume on the Well Development Log.

14 While developing, water is also periodically collected directly from the well or bailer discharge and readings taken of the indicator parameters: pH, specific conductance, and temperature. Development is considered complete when the indicator parameters have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans or within 10% if not otherwise specified), the extracted water is clear and free

of fine sediment and most importantly, when acceptable volume of water has been removed and/or a sufficient amount of surging has been performed.

15 In certain instances, for slow recharging wells, the parameters may not stabilize. In this case, well development is considered complete when minimal amounts of fine-grained sediments are recovered and acceptable volume of water has been removed.

16 If the well goes dry, stop pumping or bailing. Note the time that the well went dry. After allowing the well to recover, note the time and depth to water. Resume pumping or bailing when sufficient water has recharged the well.

17 Contain all development water in appropriate containers.

18 When complete, secure the lid back on the well.

19 Place disposable materials in plastic bags for appropriate disposal and decontaminate reusable, downhole pump components and/or bailer

8 WASTE MANAGEMENT

Materials generated during monitoring well installation and development will be placed in appropriate labeled containers and disposed of as described in the Work Plan/Field Implementation Plan or Field Sampling Plan.

9 DATA RECORDING AND MANAGEMENT

All well development activities should be documented on appropriate log forms as well as in a proper field notebook and/or PDA. Additionally, all documents (and photographs) should be scanned and electronically filed in the appropriate project directory for easy access. Pertinent information will include personnel present on site; times of arrival and departure; significant weather conditions; timing of well development activities; development method(s); observations of purge water color, turbidity, odor, sheen, etc.; purge rate; and water levels before, during, and after pumping.

10 QUALITY ASSURANCE

All reused, non-disposable, downhole well development equipment should be cleaned in accordance with the procedures outlined in the project documents.

11 REFERENCES

American Society for Testing Materials (ASTM), Designation D5521-05. *Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers*. American Society for Testing Materials. West Conshohocken, Pennsylvania.

TGI - MONITORING WELL INSTALLATION

Rev #: 0

Rev Date: April 24, 2017

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	4/24/2017	All	Re-written as a TGI	Marc Killingstad Peter C. Frederick

APPROVAL SIGNATURES

Prepared by:	Jay Erickson	4/20/17 Date:
Technical Expert Reviewed by:	Marc Killingstad	4/24/17 Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) describes methods used to install groundwater monitoring wells in granular aquifers. It is assumed that the monitoring well has been properly designed, including sizing of the filter pack and screen, the length of the screen, total depth of the well, material strength and compatibility and surface completion. Typical monitoring wells are constructed of manufactured screen and engineered filter pack and are generally suitable for formations with granular materials having a grain size distribution with up to 50% passing a #200 sieve and up to 20% clay-sized material. Monitoring wells installed in formations finer than this may not be able to produce turbidity free water.

The monitoring well installation procedures set forth herein are consistent with the approach and methods presented in the American Society of Testing and Materials (ASTM) D5092 – *Standard Practice for Design and Installation of Groundwater Monitoring Wells* (ASTM D5092). As such, following this TGI in combination with proper well design (see appropriate TGI), well development (see appropriate TGI), groundwater sampling procedures (see appropriate TGI), and well maintenance and rehabilitation (see appropriate TGI), will result in a monitoring well suitable for: (1) collection of groundwater samples representative of the surrounding formation and free of artificial turbidity; (2) measurement of accurate groundwater levels; and (3) hydraulic conductivity testing of formation sediments immediately adjacent to the open interval of the well (e.g., slug testing).

Monitoring well boreholes in unconsolidated (overburden) materials are typically drilled using the hollow-stem auger drilling method. Other drilling methods that are also suitable for installing overburden monitoring wells, and are sometimes necessary due to site-specific geologic conditions or project objectives, include: drive-and-wash, spun casing, Rotasonic, dual-rotary (Barber Rig), and fluid/mud rotary with core barrel or roller bit. Direct-push techniques (e.g., Geoprobe or cone penetrometer) and driven well points may also be used in some cases within the overburden. Monitoring wells to be installed within consolidated materials such as fractured bedrock are commonly drilled using water-rotary (coring or tri-cone roller bit), air rotary or Rotasonic methods. For guidance when installing monitoring wells in consolidated materials, please refer to the appropriate document. The drilling method to be used at a given site will be selected based on site-specific consideration of anticipated drilling/well depths, site or regional geologic knowledge, type of monitoring to be conducted using the installed well, project objectives, and cost.

No oils or grease will be used on equipment introduced into the boring (e.g., drill rod, casing, or sampling tools). No polyvinyl chloride (PVC) glue/cement will be used in constructing or retrofitting monitoring wells that will be used for water-quality monitoring. No coated bentonite pellets will be used in the well drilling or construction process. Specifications of materials to be installed in the borehole will be obtained prior to mobilizing onsite; these materials generally include:

- Well casing (length, material, and diameter);
- Well screen (length, material, diameter, and slot size);
- Bentonite (type, as applicable, chips, non-coated and granular bentonite are acceptable);
- Filter pack (filter pack type and fine sand seal type, as applicable); and
- Grout (type, as applicable).

Well materials will be inspected and, if needed, cleaned or replaced prior to installation.

3 PERSONNEL QUALIFICATIONS

Monitoring well installation activities will be performed by persons who have been trained in proper well installation procedures under the guidance of an experienced field geologist, engineer, or technician. Where field sampling is performed for soil or bedrock characterization, field personnel will have undergone in-field training in soil or bedrock description methods, as described in the appropriate Standard Operating Procedures (SOPs) and/or TGIs for those activities.

4 EQUIPMENT LIST

The following materials will be available during soil boring and monitoring well installation activities, as required:

- Site Plan with proposed soil boring/well locations;

- Work Plan (or equivalent), Field Sampling Plan (FSP), and site-specific Health and Safety Plan (HASP);
- Personal protective equipment (PPE), as required by the HASP;
- Traffic cones, delineators, caution tape, and/or fencing as appropriate for securing the work area, if such are not provided by drillers;
- Appropriate soil sampling equipment (e.g., stainless steel spatulas, knife);
- Soil and/or bedrock logging equipment as specified in the appropriate project documents;
- Appropriate sample containers and labels;
- Drum labels as required for investigation derived waste handling;
- Chain-of-custody forms;
- Insulated coolers with ice, when collecting samples requiring preservation by chilling;
- Photoionization detector (PID) or flame ionization detector (FID);
- Ziplock style bags;
- Water level or oil/water interface meter;
- Locks and keys for securing the well after installation;
- Decontamination equipment (bucket, distilled or deionized water, cleansers appropriate for removing expected chemicals of concern, paper towels);
- Engineer's tape/measuring wheel;
- Weighted tape;
- Disposable bailers;
- Digital camera (or phone with camera)
- Field notebook or Personal Digital Assistant (PDA); and
- Appropriate field forms, consider including a photo of the well head and a Google Earth map showing the well location.

Prior to mobilizing to the site, Arcadis personnel will contact the drilling subcontractor or in-house driller (as appropriate) to confirm that appropriate sampling and well installation equipment will be provided. Specifications of the sampling and well installation equipment are expected to vary by project, and so communication with the driller is necessary to ensure that the materials provided will meet the project objectives. Equipment/materials typically provided by the driller could include:

- Drilling equipment required by the ASTM standard guidance document D1586, when performing split-spoon sampling;
- Disposable plastic liners (when drilling with direct-push equipment);
- Drums for investigation derived waste;

- Drilling and sampling equipment decontamination materials;
- Decontamination pad materials, if required; and
- Well construction materials.

5 CAUTIONS

Prior to beginning field work, underground utilities in the vicinity of the drilling areas will be delineated by the drilling contractor or an independent underground utility locator service. See appropriate guidance for proper utility clearance protocol.

Prior to beginning field work, contact the project technical team to ensure that all field logistics (e.g., access issues, health and safety issues, communication network, schedules, etc.) and task objectives are clearly understood by all team members.

Some regulatory agencies require a minimum annular space between the well or permanent casing and the borehole wall. When specified, the minimum clearance is typically 2 inches on all sides (e.g., a 2-inch diameter well requires a 6-inch diameter borehole). In addition, some regulatory agencies have specific requirements regarding grout mixtures. Determine whether the oversight agency has any such requirements prior to finalizing the drilling and well installation plan.

If dense non-aqueous phase liquids (DNAPL) are known or expected to exist at the site, refer to the project specific documents for additional details regarding drilling and well installation to reduce the potential for inadvertent DNAPL remobilization.

Similarly, if light non-aqueous phase liquids (LNAPLs) are known or expected to be present as “perched” layers above the water table, refer to the DNAPL Contingency Plan. Follow the general provisions and concepts in the DNAPL contingency plan during drilling above the water table at known or expected LNAPL sites.

Avoid using drilling fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions.

Similarly, consider the compatibility between the well materials and the surrounding environment. For example, PVC well materials are not preferred when DNAPL is present. In addition, some groundwater conditions leach metals from stainless steel or are corrosive to metal well materials. If questions arise, contact the CPM and/or project technical lead to discuss.

Water used for drilling and sampling of soil or bedrock, decontamination of drilling/sampling equipment, or grouting boreholes upon completion will be of a quality acceptable for project objectives. Testing of water supply should be considered.

Specifications of materials used for backfilling the borehole will be obtained, reviewed and approved to meet project quality objectives. Bentonite is not recommended where DNAPLs are likely to be present or in groundwater with high salinity. In these situations, neat cement grout is preferred.

As noted above, coated bentonite pellets will not be used in monitoring well construction, as the coating could impact the water quality in the completed well.

Heat of hydration during neat cement grout curing must be considered to avoid damage to PVC well materials. The annular space for a typical monitoring well is small enough that heat of hydration should not create excessive temperature increases which may damage PVC well material. However, washouts in the borehole can lead to thick accumulations of grout which can produce enough heat during curing to weaken and potentially damage PVC casing. If heat of hydration is a concern, contact the project technical lead to address the issue.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with monitoring well installation will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities.

7 PROCEDURE

The procedures for installing groundwater monitoring wells are presented below:

Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods

1. Prior to monitoring well installation, determine the expected volumes of filter pack and seal materials including bentonite (if applicable) and grout (neat cement or cement-bentonite).
2. Locate boring/well location, establish work zone, and set up sampling equipment decontamination area.
3. Advance boring to desired depth. Collect soil and/or bedrock samples at appropriate interval as specified in the Work Plan (or equivalent) and/or FSP. Collect, document, and store samples for laboratory analysis as specified in the Work Plan and/or FSP. Decontaminate equipment between samples in accordance with the Work Plan (or equivalent) and/or FSP. A common sampling method that produces high-quality soil samples with relatively little soil disturbance is described in ASTM D1586 – *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils* (ASTM D1586). Split-spoon samples are obtained during drilling using hollow-stem auger, drive-and-wash, spun casing, and fluid/mud rotary. Rotasonic drilling produces soil cores that, for the most part, are relatively undisturbed, but note that when drilling in consolidated or finer-grained sediment the vibratory action during core barrel advancement may create secondary fractures or breaks. Dual-rotary removes cuttings by compressed air or water/mud and allow only a general assessment of geology.
4. Describe each soil sample as outlined in the appropriate project records. Record descriptions in the field notebook and/or personal digital assistant (PDA). It is also beneficial to photo document the samples. It should be noted that PDA logs must be electronically backed up and transferred to a location accessible to other project team members as soon as feasible to retain and protect the field data. During soil boring advancement, document all drilling events in field notebook, including blow counts (number of blows required to advance split-spoon sampler in 6-inch increments) and work stoppages. Blow counts will not be available if Rotasonic, dual-rotary, or direct-push methods are used.

5. If it is necessary to install a monitor well into a permeable zone below a confining layer, particularly if the deeper zone is believed to have water quality that differs significantly from the zone above the confining layer, then a telescopic well construction should be considered. In this case, the borehole is advanced approximately 3 to 5 feet into the top of the confining layer, and a permanent casing (typically PVC, black steel or stainless steel) is installed into the socket drilled into the top of the confining layer. The casing is then grouted in place. The preferred methods of grouting telescoping casings include: pressure-injection grouting using an inflatable packer installed temporarily into the base of the casing, such that grout is injected out the bottom of the casing until it is observed at ground surface outside the casing; displacement-method grouting (also known as the Halliburton method), which entails filling the casing with grout and displacing the grout out the bottom of the casing by pushing a drillable plug, typically made of wood to the bottom of the casing, following by tremie grouting the remainder of the annulus outside the casing; or tremie grouting the annulus surrounding the casing using a tremie pipe installed to the base of the borehole. In all three cases, the casing is grouted to the ground surface, and the grout is allowed to set prior to drilling deeper through the casing. Site-specific criteria and work plans should be created for the completion of non-standard monitoring wells, including telescopic wells.

6. Before installing a screened, it is important to confirm that the borehole has been advanced into the targeted saturated zone. This is particularly important for wells installed to monitor the water table and/or the shallow saturated zone, as the capillary fringe may cause soils above the water table to appear saturated. If one or more previously installed monitoring wells exist nearby, use the depth to water at such well(s) to estimate the water-table depth at the new borehole location.

   To verify that the borehole has been advanced into the saturated zone, it is necessary to measure the water level in the borehole. For boreholes drilled without using water (e.g., hollow-stem auger, cable-tool, air rotary, air hammer), verify the presence of groundwater (and /or LNAPL, if applicable) in the borehole using an electronic water level probe, oil-water interface probe, or a new or decontaminated bailer. For boreholes drilled using water (e.g., drive and wash, spun-casing with roller-bit wash, Rotasonic, or water rotary with core or roller bit), monitor the water level in the borehole as it re-equilibrates to the static level. In low-permeability units like clay, fine-grained glacial tills, shale and other bedrock formations, it may be necessary to wait overnight to allow the water level to equilibrate. Document depth to water in the borehole on the appropriate field forms and field notebook. If there are questions concerning the depth of the well/screen interval, consult with the project technical lead prior to finalizing well depth/screen interval. To the extent practicable, ensure that the depth of the well below the apparent water table is deep enough so that the installed well can monitor groundwater year-round, accounting for seasonal water-table fluctuations. When in doubt, err on the side of slightly deeper well installation.

7. Upon completing the borehole to the desired depth, if a screened well construction is desired, install the monitoring well by lowering the screen and casing assembly with sump through the augers or casing. Monitoring wells typically will be constructed of 2-inch-diameter (although sometimes 4-inch), flush-threaded PVC or stainless steel slotted or wire wrapped well screen and blank riser casing. Smaller diameters may be used if wells are installed using direct-push methodology or if multiple wells are to be installed in a single borehole. The screen length will be specified in the Work Plan (or equivalent) or FSP based on regulatory requirements and specific monitoring objectives. Monitoring well screens are usually 5 to 10 feet long, but may be up to 25 feet long in very low permeability, thick

geologic formations. The screen length will depend on the purpose for the well and the objectives of the groundwater investigation and will (in most cases) be determined prior to the field mobilization.

The slot size and filter pack gradation should be predetermined in the Work Plan (or equivalent) or FSP and based on site-specific grain-size analysis (sieve analysis) or other geologic considerations or monitoring objectives. Typically, slot sizes for monitoring wells will range from 0.010 inches to 0.020 inches while the filter pack will be 20-40, Morie No. 0, or equivalent. In very fine-grained formations where sample turbidity needs to be minimized, it may be preferred to use a 0.006-inch slot size and 30-65, Morie No. 00, or equivalent filter pack. Alternatively, where monitoring wells are installed in coarse-grained deposits and higher well yield is required, a 0.020-inch slot size and 10-20, Morie No. 1, or equivalent filter pack may be preferred. If the screen slot size and filter pack have not been based on site-specific grain-size analysis, consider collecting soil samples during well installation so future wells can be properly designed.

A blank sump may be attached below the well screen if the well is being installed for DNAPL recovery/monitoring purposes. If so, the annular space around the sump may be backfilled with neat cement grout using a tremie to the bottom of the well screen prior to placing the filter pack around the screen. A blank riser will extend from the top of the screen to approximately 2.5 feet above grade or, if necessary, just below grade where conditions warrant a flush-mounted monitoring well. For wells greater than 50 feet deep, centralizers may be desired to assist in centering the monitoring well in the borehole during construction.

8. When the monitoring well assembly has been set in place and the grout has been placed around the sump (if any), place a washed silica filter pack in the annular space from the bottom of the boring to a height of 1 to 2 feet above the top of the well screen (following specifications in the Work Plan) using a tremie. The filter pack is placed and drilling equipment extracted in increments until the top of the sand pack is at the appropriate depth. Verify that the expected volume of filter pack matches with the actual amount installed. There can be differences due to irregularities in the borehole. Washout of the borehole will result in the need for greater than calculated well materials. If a difference of more than 10% is noted, consult with the project technical team. The filter pack will be consistent with the screen slot size and the soil particle size in the screened interval, as specified in the Work Plan (or equivalent) or FSP. The well should be gently surged to prevent filter pack material bridging and to settled the filter pack prior to well seal installation.

9. A hydrated bentonite seal (a minimum of 2 feet thick) will then be placed in the annular space above the sand pack (alternatively, in some cases a fine sand seal may be installed instead of bentonite—follow the specifications in the Work Plan). If non-hydrated bentonite is used, the bentonite should be permitted to hydrate in place for a minimum of 30 minutes before proceeding. *No coated bentonite pellets will be used in monitoring well drilling or construction*. Potable water may be added to hydrate the bentonite if the seal is above the water table. Monitor the placement of the sand pack and bentonite with a weighted tape measure.

10. During the extraction of the augers or casing, a cement/bentonite or neat cement grout will be placed in the annular space from the bentonite seal to a depth approximately 2 ft. below groundwater surface (bgs) or as specified in the Work Plan (or equivalent). As with the filter pack, it is recommended that seal material be placed with a tremie pipe. Ensure that seal materials are mixed at the proper ratios with water following manufacturer's recommendations.

11. Install the monitoring well completion as specified Work Plan (or equivalent). Typical completions are a locking, steel protective casing (extended at least 1.5 feet below grade and 2 feet above grade) over the riser casing and secure with a neat cement seal. Alternatively, for flush-mount completions, place a steel curb box with a bolt-down lid over the riser casing and secure with a neat cement seal. In either case, the cement seal will extend approximately 1.5 to 2.0 feet below grade and laterally at least 1 foot in all directions from the protective casing, and should slope gently away to promote drainage away from the well.
12. Monitoring wells should be labeled using indelible ink or paint with the appropriate designation on both the inner and outer well casings or inside of the curb box lid.
13. When an above-grade completion is used, the riser will be sealed using an expandable locking plug and the top of the well will be vented by drilling a small-diameter (1/8 inch) hole near the top of the well casing or through the locking plug, or by cutting a vertical slot in the top of the well casing. When a flush-mount installation is used, the riser will be sealed using an unvented, expandable locking plug.
14. During well installation, record construction details and actual measurements relayed by the drilling contractor and tabulate materials used (e.g., screen and riser footages; bags of bentonite, cement, and sand) in the field notebook as well as appropriate field forms.
15. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section 7 below.

Direct-Push Method

The direct-push drilling method may also be used to complete soil borings and install monitoring wells. Examples of this technique include the Diedrich ESP vibratory probe system, GeoProbe®, or AMS Power Probe® dual-tube system. Environmental probe systems typically use a hydraulically operated percussion hammer. Depending on the equipment used, the hammer delivers 140- to 350-foot pounds of energy with each blow. The hammer provides the force needed to penetrate very stiff to medium dense soil formations. The hammer simultaneously advances an outer steel casing that contains a dual-tube liner for sampling soil. The outside diameter (OD) of the outer casing ranges from 1.75 to 2.4 inches and the OD of the inner sampling tube ranges from 1.1 to 1.8 inches. The outer casing isolates shallow layers and permits the unit to continue to probe at depth. The double-rod system provides a borehole that may be tremie-grouted from the bottom up. Alternatively, the inside diameter (ID) of the steel casing provides clearance for the installation of small-diameter (e.g., 0.75- to 1-inch ID) micro-wells. The procedures for installing monitoring wells in soil using the direct-push method are described below.

1. Locate boring/well location, establish work zone, and set up sample equipment decontamination area.
2. Advance soil boring to designated depth, collecting samples at intervals specified in the Work Plan (or equivalent). Samples will be collected using dedicated, disposable, plastic liners. Describe samples in accordance with the procedures outlined in Step 3 above. Collect samples for laboratory analysis as specified in the Work Plan (or equivalent) and/or FSP.
3. Upon advancing the borehole to the desired depth, install the micro-well through the inner drill casing. The micro-well will consist of approximately 1-inch ID PVC or stainless steel slotted screen and blank riser. The sand pack, bentonite seal, and cement/bentonite grout will be installed as described, where applicable, in Steps 9 through 11 above.

4. Install protective steel casing or flush-mount, as appropriate, as described in Step 12 above. During well installation, record construction details and tabulate materials used in field notebook as well as appropriate field forms.
5. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section 8 below.

Driven Well Point Installation

Well points will be installed by pushing or driving using a drilling rig or direct-push rig, or hand-driven where possible. The well point construction materials will consist of a 1- to 2-inch-diameter threaded steel casing with either 0.010- or 0.020-inch slotted stainless steel screen. The screen length will vary depending on the hydrogeologic conditions of the site. The casings will be joined together with threaded couplings and the terminal end will consist of a steel well point. Because they are driven or pushed to the desired depth, well points do not have annular backfill materials such as sand pack or grout.

8 WASTE MANAGEMENT

Investigation-derived wastes (IDW), including soil cuttings and excess drilling fluids (if used), decontamination liquids, and disposable materials (well material packages, PPE, etc.), will be placed in clearly labeled, appropriate containers, or managed as otherwise specified in the Work Plan (or equivalent), FSP, and/or IDW management guidance document.

9 DATA RECORDING AND MANAGEMENT

Drilling activities should be documented on appropriate field/log forms as well as in a proper field notebook and/or PDA. Additionally, all documents (and photographs) should be scanned and electronically filed in the appropriate project directory for easy access. Pertinent information will include personnel present on site, times of arrival and departure, significant weather conditions, timing of well installation activities, soil descriptions, well construction specifications (screen and riser material and diameter, sump length, screen length and slot size, riser length, sand pack type), and quantities of materials used. In addition, the locations of newly-installed wells will be documented photographically or in a site sketch. If appropriate, a measuring wheel or engineer’s tape will be used to determine approximate distances between important site features.

The well location, ground surface elevation, and inner and outer casing elevations will be surveyed using the method specified in the site Work Plan (or equivalent). Generally, a local baseline control will be set up. This local baseline control can then be tied into the appropriate vertical and horizontal datum, such as the National Geodetic Vertical Datum of 1929 or 1988 and the State Plane Coordinate System. At a minimum, the elevation of the top of the inner casing used for water-level measurements should be measured to the nearest 0.01 foot. Elevations will be established in relation to the National Geodetic Vertical Datum of 1929. A permanent mark will be placed on top of the inner casing to mark the point for water-level measurements.

10 QUALITY ASSURANCE

All drilling equipment and associated tools (including augers, drill rods, sampling equipment, wrenches, and any other equipment or tools) that may have come in contact with soil will be cleaned in accordance with the procedures outlined in the appropriate SOP. Well materials will also be cleaned prior to well installation.

11 REFERENCES

American Society for Testing Materials (ASTM) D5092 - *Standard Practice for Design and Installation of Ground Water Monitoring Wells*. American Society for Testing Materials. West Conshohocken, Pennsylvania.

American Society of Testing and Materials (ASTM) D1586 - *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*. American Society for Testing Materials. West Conshohocken, Pennsylvania.

TGI - PASSIVE DIFFUSION BAG (PDB) SAMPLING

Rev: 0

Rev Date: October 12, 2018

SOP VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	October 12, 2018	All	Updated and re-written as TGI	Marc Killingstad

APPROVAL SIGNATURES

Prepared by:		10/12/2018
	Christian Seidel	Date:
Technical Expert Reviewed by:		10/12/2018
	Marc Killingstad (Technical Expert)	Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

The purpose of this Technical Guidance Instruction (TGI) is to establish protocols for the collection of groundwater samples from monitoring wells using passive diffusion bag (PDB) sampling techniques. A PDB is a semi-permeable low-density polyethylene (LDPE) bag filled with deionized water. When deployed within the screened interval of a monitoring well, volatile organic compounds (VOCs) in groundwater diffuse through the LDPE membrane into the deionized water in the bag. The PDB remains in the well for a time sufficient to reach equilibrium between VOC concentrations inside the PDB and surrounding groundwater (typically at least two weeks but will be based on site-specific hydrogeologic conditions). At that time, the PDB is retrieved from the well and the water from inside the bag is poured into sample bottles for laboratory analysis.

This TGI is based on the technical requirements provided in the USGS *User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells* (USGS 2001). Additional technical information on this topic can be found at the Interstate Technology and

Regulatory Council's (ITRC) *Passive/Diffusion Samplers Resources and Links* webpage (https://www.itrcweb.org/Team/Resources?teamID=29&teamID=29).

Figure 1. Typical water-filled passive diffusion bag samplers used in wells, including (A) diffusion bag with polyethylene mesh, (B) diffusion bag without mesh, and (C) bag and mesh attached to bailer bottom.

The PDB sampling method has several technical and logistical benefits compared to standard well-purging methods; however, PDBs are not applicable for all contaminants or sites. See **Attachment 1** for ITRC's *Screening Worksheet for PDB Implementation*.

Because the PDB technology relies on diffusion of contaminants through the LDPE membrane, this approach is only applicable for volatile organics (including ethene, ethane, and methane). PDBs are not applicable for field parameters, ionic parameters (alkalinity, nitrate, sulfate, etc), or non-VOC contaminants (i.e. semi-volatiles).

The primary benefits of using PDBs as opposed to standard well purging methods include decreased sampling time, lack of investigation derived waste, and the ability to collect samples from multiple depths within a well screen while avoiding dilution concerns associated with well purging. If VOC contamination is stratified, multiple PDBs can be deployed within the screened interval or open bore hole. There is less equipment, and the devices are relatively inexpensive and disposable. Vendors can also modify the length and width of the sampler to meet specific sampling requirements.

Figure 2. Example of multiple PDB samplers prepared for deployment.

Additionally, the effervescence associated with hydrochloric acid (HCl) preservation of VOC samples is avoided as dissolved ions that contribute to alkalinity in the well do not diffuse across the PDB membrane into the bag, thus reducing losses due to volatilization.

PDBs are typically best suited to sites where regular monitoring of VOCs is performed within a well characterized plume. This technique is typically not well suited to characterization activities, where vertical stratification of VOC contamination is not well understood, or for monitoring programs that include additional analytes besides VOCs.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as specified in the Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed.

Arcadis personnel performing groundwater PDB sample collection and associated activities should have a minimum of 6 months of related experience or an advanced degree in environmental sciences, engineering, hydrogeology, or geology. The supervisor of the groundwater sampling team should have at least 1 year of previous supervised groundwater sampling experience.

In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The HASP and other documents will identify other training requirements or access control requirements.

Prior to mobilizing to the field, the groundwater sampling team will review and be thoroughly familiar with relevant site-specific documents including but not limited to site work plans (e.g., Field Implementation Plan [FIP]), Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), HASP, historical information, and relevant site/task-related documents. Additionally, the groundwater sampling team will review and be thoroughly familiar with documentation provided by equipment manufacturers for all equipment that will be used in the field prior to mobilization.

4 EQUIPMENT LIST

Specific to this activity, the following materials (or equivalent) is required:

- Health and safety documents and equipment (as identified in the site-specific HASP)
- Field Implementation Plan that includes site map, well construction records, and prior groundwater sampling records (if available)
- Personal protective equipment (e.g., latex or nitrile gloves, safety glasses, etc.) as specified in the site-specific HASP
- PDB Sampler made of 4-mil. low-density polyethylene (LDPE) flat tubing (NOTE: these samplers typically come pre-filled by the vendor and samplers may have a protective polyethylene mesh sleeve to protect the bags during deployment and recovery)
- Teflon-coated stainless-steel wire or low-stretch braided, polyester rope to be used to suspend the passive diffusion bag samplers in the well screen interval (NOTE: if rope is used it must be dedicated to a specific well)
- Stainless-steel weights to counterbalance the buoyancy of the PDB samplers
- Electronic water-level indicator, 0.01-foot accuracy
- Down-hole multiparameter sonde (e.g., YSI)
- 150-foot measuring tape (or sufficient length for the maximum site depth requirement)
- Safety cutting tools
- Nylon cable ties or stainless-steel clips to attach the PDB bag to the line
- Decontamination supplies

  - Non-phosphate laboratory soap (Alconox or equivalent), brushes, clean buckets or clean wash tubs
  - New buckets or tubs will be purchased if it cannot be determined if the present items are clean
  - Distilled or de-ionized water for equipment decontamination
- Sample bottles, labels, and preservation supplies
- Field logbook, smart device (phone or tablet), appropriate field forms (see **Attachment 2**), and chain-of-custody forms
- Indelible ink pen
- Plastic sheeting (e.g., Weatherall Visqueen) to protect all down-hole sampling equipment from contact with potential sources of contamination

5 CAUTIONS

The PDB technology is only applicable to VOC contaminants. If there is a question regarding a specific analyte, please contact Technical Lead for resolution.

Determine well construction prior to ordering PDBs. In some older wells, the well screen could have a smaller diameter than the well casing. PDBs may not fit in the screen. Vendors can modify the length and width of the sampler to meet specific well requirements.

Analytical results for samples collected from PDBs could be higher or lower than those collected with conventional sampling methods. The conceptual site model (CSM) will provide the basis for understanding of the distribution of VOC contaminants and support predictions related to the potential differences between PDB vs. datasets from other sampling methods.

All parties involved in the deployment of PDBs for long term monitoring at regulated sites need to agree on data quality objectives, data evaluation techniques, and data end use before deployment at a site. Some sites may require the collection of “side-by-side” data to validate the applicability of PDBs to adequately monitor VOC concentrations compared to established well purging techniques.

Before placing PDBs in a well, vertical stratification needs to be considered. A single, 18-inch long PDB is sufficient for saturated well screens 5 feet or less. In general, when investigating vertical stratification of VOCs, a single 18-inch long PDB should not represent more than 5 feet of saturated screen.

6 HEALTH AND SAFETY CONSIDERATIONS

The HASP will be followed, as appropriate, to ensure the safety of field personnel.

Appropriate personal protective equipment (PPE) will be worn during these activities.

Access to wells may expose field personnel to hazardous materials such as contaminated groundwater or oil. Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g. ticks in long grass/weeds around well head), and potentially the use of sharp cutting tools (scissors, knife). Only use non-toxic peppermint oil spray for stinging insect nests. Open well caps slowly and keep face and body away to allow to vent any built-up pressure.

Field personnel will thoroughly review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives.

Deploying and retrieving PDB samplers requires staff to lower and raise materials into and out of the monitoring well. Be sure to use proper bending and lifting techniques to avoid muscle strain and other potential injuries.

7 PROCEDURE

7.1 Initial Site Activities

- Check well for damage or evidence of tampering, record pertinent observations in the field logbook and, if possible, take digital photograph to document damage
- Lay out plastic sheeting and set up monitoring and sampling equipment
- Don appropriate personal protective equipment (PPE)
- Safely remove well cap
- If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), create one and record all measurements from this mark
- Measure and record the depth to water and the total depth of the groundwater monitoring well (to 0.01 ft) in all wells to be sampled being careful to minimize disturbance to the water column and to any particulates attached to the sides or at the bottom of the well
- Collect and record field parameters using a multiparameter down-hole sonde (e.g., YSI) prior to deploying PDBs

7.2 Deployment of Passive Diffusion Bag Samplers

- The PDB sampler assembly will be pre-determined and communicated to the vendor (NOTE: the assembly will be shipped to Arcadis to the size and depth specifications requested and outlined in the site-specific Work Plan/Field Implementation Plan and SAP)
- Compare the measured depth of the well to the as-built well construction details (well construction table) to determine if sediment has accumulated at the bottom of the well (NOTE: identify if wells have been constructed with sediment traps or sumps)
- Provide attachment points for deployment using loops in the weighted line at appropriate points or movable clamps with rings
    - Attach the PDB sampler using cable ties, stainless clamps, or simply tie in a way that prevents slipping
    - Take care to eliminate sharp points or ends of camps and cable ties to decrease the potential for punctures or tears to the PDB

- Lower the assembly line of PDB samplers and weights down the well until the pre-measured cable is taught—the samplers will now be positioned at the expected depth.
- Secure the assembly in this position.
  - A suggested method is to attach the weighted line to a hook on the inside of the well cap and reattach the well cap
  - The well will be sealed in such a way as to prevent surface-water invasion—this is particularly important in flush-mounted well vaults that are prone to flooding
- After the samplers have been deployed, collect the trip blank and equipment blank sample from an unused extra pre-filled PDB sampler—the samplers used for the trip blanks will be transported and stored at all times with the other samplers
- Allow the system to remain undisturbed as the samplers equilibrate. The recommended equilibration period is two weeks.

Courtesy of EON Products, Inc.

7.3 Sample Retrieval

- Measure and record the depth to groundwater within the monitoring well via the non-metallic water level indicator (weighted tape-measure)
- Collect and record field parameters using a multiparameter down-hole sonde (e.g., YSI) prior to retrieving PDBs
- Remove the sampler upward and out of the well using the deployment line
  - When removing multiple samplers from a single well, only one sampler will be removed and processed at a time withthe remaining samplers suspended in the well until they can be processed
- Do not expose the samplers to heat or agitate
- Examine samplers and note observations on field sampling form and field book
  - Examine the surface of the sampler for evidence of algae, iron or other coatings, and for tears in the membrane
  - If there are tears in the membrane, the sample will be rejected
- Record sample information for each sampler on the field sampling form
  - If multiple samplers are being retrieved from a single well, care must be taken to ensure the vertical placement of the sample within the well is accurately recorded on each sample vial and on the corresponding field sampling form
- If a protective outer coating is used during deployment, remove the sampler bag and dry excess water from the bag using a lab wipe
- Transfer water from the sampler bag to VOC sample vials using one of the following options—in all cases, use care to transfer the sample as the bags are not rigid and can bend or collapse during handling:
  1. Carefully cut the sampler bag at the top corner using a decontaminated safety cutting tools and carefully decant the sample into the VOC vials
  2. Some samplers are equipped with a removable end cap that can be removed to allow the sample to be gently poured into VOC sample vials
  3. Some samplers are equipped with a small lab-cleaned straw that has a sharpened end—the straw is used to pierce the bag at the bottom and the sample is decanted through the straw into sample vials
- To obtain a duplicate/blind duplicate sample, collect a duplicate from the same bag as an original sample and send for analysis with the appropriate labeling
- Place collected samples immediately in a sample cooler that is already full of ice or ice packs such that the samples are immediately chilled and stored at a temperature of 4° Celsius

- Measure and record the depth to groundwater within the monitoring well via the non-metallic water level indicator (weighted tape-measure)
- Secure the well
- Decontaminate any cutting devices, reusable weights, teflon-coated lines, or bag attachment mechanisms after each usage as described in the *TGI – Groundwater and Soil Sampling Equipment Decontamination*

8 WASTE MANAGEMENT

Materials generated during groundwater sampling activities, including disposable equipment and excess water in the PDBs, will be properly stored on site in labeled containers and disposed of properly. Be certain that waste containers are properly labeled and documented in the field log book. Waste will be managed in accordance with the *TGI – Investigation-Derived Waste Handling and Storage* as well as state- or client-specific requirements. Note that the PDB samplers and protective mesh covers will be shipped back to the vendor at the completion of the sampling event to be refilled and deployed again during the next groundwater sampling event.

9 DATA RECORDING AND MANAGEMENT

Field forms, logs/notes, digital records, and chain-of-custody records will be maintained by the field team lead and uploaded to the project directory on the Arcadis server at the completion of the groundwater monitoring event. Electronic data files will be sent to the project team and uploaded to the electronic project folder daily. Management of the original documents from the field will be completed in accordance with the site-specific QAPP.

10 QUALITY ASSURANCE

Quality assurance and quality control (QA/QC) samples collected during the retrieval and sampling of PDB samplers include: equipment blanks, field duplicates, and matrix spike/matrix spike duplicate (MS/MSD).

An equipment blank sample will be collected from a pre-filled PDB during the day of deployment.

Field duplicates and MS/MSDs will be collected during the sampling event.

QA/QC samples will be collected in accordance with the site-specific QAPP .

11 REFERENCES

USGS 2001. User’s Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells, 2001.

ITRC 2004. Technical and regulatory Guidance for Using Polyethylene Diffusion Bag samplers to Monitor Volatile Organic Compounds in Groundwater. February 2004.

12 ATTACHMENTS

Attachment 1 – PBD Screening Worksheet

Attachment 2 – PBD Field Form

ATTACHMENT 1

PBD Screening Worksheet

Screening Worksheet for PDB Implementation

A negative answer to any of the following questions will require further action or investigation before PDB samplers can be deployed. If all answers are affirmative PDB, sampling is likely to be a viable option for the site.

Question	YES	NO
1. Is sampling being done for long-term groundwater monitoring?		
2. Have the groundwater contaminants at the site been fully characterized?		
3. Is groundwater sampling at the site focused on VOCs?		
4. Can all target analytes at the site be expected to be taken up by PDB samplers? (Section 1.1, Table 1-1 and Section 4.2.2, Table 4-1)		
5. Is groundwater temperature anticipated to be above 10ºC (50ºF) during all sampling events?		
6. Have you discussed the potential use of PDB samplers with regulators?		
7. Are site regulators familiar with PDB sampling technology, and will they allow the data to be used for the same purposes as those obtained by conventional sampling?		
8. Are the monitoring wells to be sampled in an area where there is sufficient groundwater velocity? Low groundwater velocity can result from either a low hydraulic conductivity or a low hydraulic gradient.		
9. Are the monitoring wells currently free of dedicated pumps or other sampling equipment?		
10. Has a cost analysis shown PDB samplers to offer a cost savings compared to current sampling techniques?		

ATTACHMENT 2

PBD Field Form

ARCADIS Design & Consultancy for natural and built assets

Passive Diffusion Bag (PDB) Sampling Form

Site: ______________________________
Location: ______________________________
Well ID: ______________________________

Well Type: ☐Monitoring ☐Other: ______________________________
Well Finish: ☐Stick Up ☐Flush Mount
Measuring Pt: ☐Top of Casing ☐Other (specify):____________________
Total Depth (ft bgs)**:** ____________________ **Screened Interval** (ft bgs)**:**________________
Well Casing: Diameter: __________ Material: ____________________
Well Screen: Diameter: __________

Deployment

Date and Time of Deployment: Date: ____________________ Time: ____________________
Weather Conditions: ______________________________
Depth to groundwater at time of deployment: ______________________________
Depth to Top of PDB: ______________________________

Downhole Field Parameters Prior to Deployment (*Collected via downhole sonde [e.g., YSI]*):
Temp:__________ (mV) **ORP:**____________ **(mV)** **Water quality meter:**________________
pH:____________ **DO:**____________ **(mg/L)** **Serial #:**______________________

Type of PDB used: ☐Lab Filled (Modified Trip Blank must be taken at time of deployment)
☐Field Filled (Modified Equipment Blank of fill water must be taken at time of deployment)

Dimensions of PDB: Length (in.) __________ Diameter (in.) __________

Position of PDB weight: ☐Attached to bottom of PDB and suspended in well
☐Attached to bottom of deployment line and suspended in well
☐Attached to bottom of deployment line and resting on bottom of well

Retrieval (note: minimum deployment period is 2 weeks)

Date and Time of Retrieval: Date: ____________________ Time: ____________________
Total # of days deployed: ______________________________
Weather Conditions: ______________________________
Depth to groundwater at time of retrieval: ______________________________
Downhole Field Parameters Prior to Retrieval (*Collected via downhole sonde [e.g., YSI]*):
Temp:__________ (mV) **ORP:**____________ **(mV)** **Water quality meter:**________________
pH:____________ **DO:**____________ **(mg/L)** **Serial #:**______________________

Notes/Observations:

Field Sampling Technician: Name(s) and Company

Name	Company

POLY- AND PERFLUORINATED ALKYL SUBSTANCES (PFAS) FIELD SAMPLING GUIDANCE

Rev: 4

Rev Date: March 26, 2019

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	April 27, 2017	All	Initial Release	Erica Kalve Erika Houtz Sue Tauro
1	June 19, 2018	1 through 4 and 17	Updated Information on Sampling Materials	Erica Kalve Erika Houtz
2	October 15, 2018	6 to 16	Minor updates on laboratory elements, updates to decontamination procedures, and clarification on equipment and reagent blank collection	Erika Houtz Erica Kalve
3	December 17, 2018	4, 6, 17	Removed Sharpies from acceptable field writing implements; Changed language in Section 3.2 and Section 10.5 to provide stricter guidance for DoD projects.	Erika Houtz, Erica Kalve
4	March 26, 2019	4,5	Removed Citranox from acceptable Decon solutions in Table 1a, added all fluoropolymer containing materials to prohibited items in Table 1b. Made a correction that Liquinox contains trace levels of 1,4 Dioxane, not Alconox.	Erika Houtz

APPROVAL SIGNATURES

Prepared by:		3/26/2019
	Erika F. Houtz, PhD, PE Environmental Engineer and PFAS Analytical Lead	Date:
Reviewed by:		12/17/2018
	Erica Kalve, PG-CA Emerging Contaminants Focus Group Leader	Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

The purpose of this Technical Guidance Instructions (TGI) is to provide guidance on field sampling to be used for poly-and perfluorinated alkyl substances (PFASs). This protocol was adapted from various sources including Arcadis Australia, Transport Canada, and the U.S Army Corp of Engineers (USACE) Omaha. In general, sampling techniques used for PFAS site characterization are consistent with conventional sampling techniques used in the environmental industry, but special consideration is made regarding PFAS-containing materials and cross-contamination potential. **Table 1a** provides a summary of materials that have been approved for site investigation; this list is expected to grow longer as industry experience increases. **Table 1b** provides a summary of field equipment and materials that have available testing information and/or industry knowledge regarding PFAS cross-contamination potential and it is recommended that these materials be prohibited for sample collection; for materials that are suspected of containing PFASs and/or to retain PFASs, these recommendations are considered preliminary and subject to change.

Table 1a: Summary of Acceptable Sampling Equipment and Materials for PFAS Site Investigations

Sampling Materials	Additional Considerations	References
Water Sampling Materials		
High density polyethylene (HDPE) or silicone tubing materials	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
HDPE HydraSleeves™	Low density polyethylene (LDPE) HydraSleeves™ are not recommended	USACE 2016; MassDEP 2017
Drilling and Soil Sampling Materials		
PFAS-free drilling fluids	--	DER 2016
PFAS-free makeup water	Confirm PFAS-free water source via laboratory analysis prior to investigation	--
Acetate liners	For use in soil sampling	USACE 2016
Sample Containers and Storage		
HDPE sample containers with HDPE lined lids for soil and water samples	Laboratory should provide; whole bottle analysis of aqueous samples combined with a solvent rinse of bottle is recommended	DER 2016, MassDEP 2017
Ice contained in plastic (polyethylene) bags (double bagged)	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation		
Ball point pens	--	MassDEP 2017
Standard paper and paper labels	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Decontamination		
Water-only decontamination	Confirm PFAS-free water source via laboratory analysis prior to investigation	DER 2016
Alconox® or Liquinox® followed by deionized water or PFAS-free water rinse	Liquinox® known to contain trace levels of 1,4-dioxane	NHDES 2016; USACE 2016; MassDEP 2017
Methanol, isopropanol, or acetone	Special health and safety precautions are necessary	UNEP 2015; USACE 2016

Note: This list is considered preliminary and additional materials may be added as additional information becomes available. Project teams are expected to follow a methodical evaluation process of materials to be used and confirm acceptance prior to implementation of field activities.

Table 1b: Summary of Sampling Equipment and Materials Not Recommended for PFAS Site Investigations.

Sampling Materials	Known PFAS-Containing Materials	Suspected PFAS-Containing Materials	Materials with Potential to Retain PFASs	References
Water Sampling Materials				
Teflon®, PTFE-containing or other fluoropolymer coated or containing field equipment (e.g., tubing, bailers, liners, tape, plumbing paste, pump parts)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Passive diffusion bags			x	MassDEP 2017
LDPE HydraSleeves ™			x	USACE 2016; MassDEP 2017
Water particle filters			x	MassDEP 2017
Drilling and Soil Sampling Materials				
Aluminum foil			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Drilling fluid containing PFASs	x	x		DER 2016
Sample Containers and Storage				
Glass sample containers with lined lids			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
LDPE containers and lined lids			x	USACE 2016
Teflon® or PTFE- lined lids on containers (e.g., sample containers, rinsate water storage containers)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Reusable chemical or gel ice packs (e.g., BlueIce®)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation				
Self-sticking notes and similar office products (e.g., 3M Post-it-notes)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Waterproof paper, notebooks, and labels	x			DER 2016, MassDEP 2017
Non-Sharpie® markers		x		NHDES 2016
Decontamination				
[Some] detergents and decontamination solutions (e.g., Decon 90® Decontamination Solution)	x	x		DER 2016; NHDES 2016; MassDEP 2017

Note: For materials that are suspected of containing PFASs, or have the potential to retain PFASs, project specific considerations may provide adequate justification for use during the field event. For example, further evaluation may be conducted in the form of pre-field equipment blank sample analysis.

Given the extremely low detection limits associated with PFAS analysis and the many potential sources of trace levels of PFASs, field personnel are advised to err on the side of caution by strictly following these protocols, frequently replacing nitrile gloves, and rinsing field equipment to help mitigate the potential for false detections of PFASs. A summary of other specific items related to field sampling for PFASs are discussed in the sections below.

This TGI applies to all Arcadis and subcontractor personnel involved in field sampling for PFAS.

3 PERSONNEL QUALIFICATIONS

3.1 Sampling Personnel

Field personnel must have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, and site-specific training, as needed. In addition, field personnel will be versed in the other relevant SOPs (e.g., low flow sampling) and will possess the skills and experience necessary to successfully complete the desired field work. The site Health and Safety Plan (HASP) and other documents will identify any other training requirements such as site-specific safety training or access control requirements.

3.2 Laboratories

These laboratories are example laboratories that could be used to analyze environmental media for PFASs, pending project approval:

- United States: TestAmerica, SGS, Vista, ALS, and Eurofins
- Canada: Axys-SGS and Maxxam Laboratories

Other laboratories may be used if they are appropriately accredited for PFAS analysis according to any project requirements. It is recommended that a laboratory is Environmental Laboratory Accreditation Program (ELAP)-accredited for PFAS analysis in accordance with the Department of Defense (DoD) Quality Systems Manual (QSM) 5.1 Table B-15 or any subsequent updates. **For all data collection efforts at DoD sites, PFAS data must be obtained using a method that is DoD ELAP-accredited under QSM 5.1 or later.**

4 EQUIPMENT LIST

The following equipment and materials must be available for sampling:

- Site plan of sampling locations, relevant work plan (or equivalent), and this TGI;
- Appropriate health and safety equipment, as specified in the site HASP;
- Dedicated plastic sheeting (preferably high-density polyethylene [HDPE]) or other clean surface to prevent sample contact with the ground;
- Conductivity/temperature/pH meter;
- Dissolved oxygen meter, oxidation reduction potential meter, and turbidity meter;
- Depth to water meter;

- If using low-flow groundwater sampling techniques, peristaltic pump (groundwater sampling)/bladder pump (with PFAS free bladder/ HDPE bladder), flow through cell, and accompanying HDPE and silicone tubing;
- Hydrasleeves, if using Hydrasleeves for groundwater sampling;
- Metal trowel for soil samples; specialized soil/sediment sampling equipment as required;
- Brushes for scrubbing sampling equipment;
- Pens, pencils, and/or Sharpies for writing;
- Clipboards, field binders, and field note pages that are not waterproof;
- Labeled sample bottles:
    - Water: HDPE bottles fitted with polypropylene screw cap only; some types of PFAS samples (primarily drinking water) may require preservative, which will be indicated by the laboratory conducting the analysis. The laboratory will specify the sample bottle volume.
    - Soil and sediment: HDPE bottles fitted with polypropylene screw cap only; no preservatives. The laboratory will specify the sample bottle volume.
- If high concentrations of PFASs related to class B firefighting foams are expected, bring additional small vials to conduct field-based shaker tests for foaming;
- Ziploc® bags to hold ice and samples;
- Bottles containing “PFAS-free” water used for reagent blanks;
- Labeled coolers for samples with ice; Blue ice is not permitted;
- Deionized or distilled water for initial decontamination rinsing;
- “PFAS-free” water provided by the laboratory for final decontamination rinsing;
- Methanol, isopropanol, or acetone if able to be brought safely to field site; especially important for decontamination during soil sampling;
- Alconox or Liquinox®;
- Packing and shipping materials;
- Groundwater Sampling Log; and
- Chain-of-Custody (COC) Forms.

5 CAUTIONS

5.1 Food Packaging

Some food packaging may be treated with PFAS-containing chemicals to prevent permeation of oil and water in the food outside of the packaging. To avoid potential food packaging-related PFAS contact:

- Do not bring any food outside of the field vehicles onsite and eat snacks and meals offsite.
- Wash hands after eating.
- Remove any field garments or outer layers prior to eating. Do not put them back on until done eating and hands are washed.

5.2 Field Gear

5.2.1 Clothing

Many types of clothing are treated with PFASs for stain and water resistance, in particular outdoor performance wear under brand names such as Gore-Tex®. To avoid potential clothing-related PFAS contact:

- Do not wear any outdoor performance wear that is water or stain resistant, or appears to be. Err on the side of caution.
- Wear pre-laundered (multiple washings, i.e. 6+) clothing that is not stain resistant or water proof.
- Natural fabrics such as cotton are preferred. Synthetic fabrics may also be acceptable if there is no indication on the label that the fabric is water and stain resistant.
- Most importantly, avoid contacting your clothing with sampling equipment, bottles, and samples.

5.2.2 Personal Protective Equipment

Safety Footwear

Some safety footwear has been treated to provide a degree of waterproofing and increased durability and may represent a source of trace PFASs. For the health and safety of field personnel, footwear must be protected at all times to avoid potential PFAS contamination. To do this:

- Do not contact your footwear with equipment, bottles, or samples in any way.
- Do not allow gloves used for sampling to come in contact with safety footwear.

Nitrile Gloves

Wear disposable nitrile gloves at all times. Don a new pair of nitrile gloves **before** the following activities at each sample location:

- Decontamination of re-usable sampling equipment;
- Contact with sample bottles or "PFAS-free" water bottles;
- Insertion of anything into the sample ports (e.g., HDPE tubing); and
- Handling of any quality assurance/quality control (QA/QC) samples including field blanks and equipment blanks.

Don a new pair of nitrile gloves **after** the following activities:

- Handling of any non-dedicated sampling equipment;
- Contact with contaminated surfaces; or
- When judged necessary by field personnel.

5.3 Personal Hygiene

- Shower at night.
- Do not use personal care products after showering such as lotions, makeup, and perfumes, UNLESS medically necessary.
- Use sunscreen and insect repellent ONLY if necessary for health and safety. If they are necessary, apply sunscreen and repellant prior to initiating field sampling. If sunscreen and/or repellant need to

be reapplied, ensure a safe distance away from the sampling locations and equipment (i.e., more than 10 meters (m) away). Wash hands after application.

5.4 Visitors

Visitors to the site are asked to remain at least 10 m from sampling areas.

5.5 Rain Events

Special care should be taken when rain is falling at the project site:

- Do not perform field sampling when rain fall is persistent at a consistent rate that saturates the ground (i.e., formation of puddles) because rain gear is not permitted while sampling. Intermittent showers or fog are acceptable conditions to proceed. If rain showers occur; field gear must be removed from the monitoring well location until the rain subsides.
- If project timelines are tight, consider the use of a gazebo tent that can be erected over the top of the monitoring well to provide shelter from the rain. The canopy material is possibly a PFAS-treated surface and should be managed as such; therefore, wear gloves when moving the tent, change them immediately after moving the tent, and avoid further contact with the tent until all sampling activities have been finished and the team is ready to move on to the next site.

6 HEALTH AND SAFETY CONSIDERATIONS

- The ability to safely access the surface water sampling locations must be verified before sampling.
- Field activities must be performed in accordance with the site HASP, a copy of which will be present onsite during such activities.
- Safety hazards associated with sampling surface water include fast-moving water, deep water, and steep slopes close to sampling sites. Use extreme caution when approaching sampling sites.
- If thunder or lighting is present, discontinue sampling and take cover until 30 minutes have passed after the last occurrence of thunder or lighting.
- Use caution when removing well caps as well may be under pressure, cap can dislodge forcefully and cause injury.

7 PROCEDURE

7.1 Field Equipment Cleaning

Reusable field sampling equipment will require cleaning between uses. For groundwater sampling, between uses, decontaminate the flow-through cell and any non-dedicated equipment (i.e., interface probe of depth to water meter) that comes into contact with well water. Trowels and other materials used to sample soil samples will also require decontamination, although dedicated, single use equipment such as liners should be used where possible.

After donning a new pair of nitrile gloves:

- Rinse sampling equipment with Alconox or Liquinox® cleaning solution; Scrub equipment with a plastic brush if needed;
- Rinse two times with distilled water or deionized water;

- Rinse one time with “PFAS-free” water or once with methanol/isopropanol/acetone, if it is available, and once with “PFAS-free” water; organic solvents are especially useful for decontaminating soil sampling equipment. If organic cleaning solvents cannot be brought to site, scrub equipment a second time after a single distilled or deionized water rinse, then rinse two times with distilled or deionized water and once with “PFAS-free” water (i.e., two scrubbings and four water rinsings total).
- Collect all rinsate in a sealed pail for disposal. Do not reuse decontamination solutions between sampling locations.

7.2 Borehole/Monitoring Well Development

If a drill rig is being used to drill for soil cores or to install monitoring wells, wear clean nitrile gloves before collecting <u>each</u> continuous soil sample. Additional requirements include the following:

- Verify in writing with the manufacturer that single-use liners used to collect each sample are made of a material that does not contain PFASs;
- Collect soil samples in laboratory-supplied HDPE bottles.
- Store the sample bottles in coolers and keep at a temperature of 0 to 6ºC until transported to the laboratory.

7.2.1 Well Condition Survey/ Water Level Monitoring

Using equipment that has been thoroughly decontaminated according to the procedures in Section 7.1, conduct the well condition surveys and water level monitoring:

- Conduct monitoring well inspections and record water levels.
- Use an interface probe to evaluate presence/absence of non-aqueous phase liquid (NAPL).
- Measure the depth to water from the top of the polyvinyl chloride (PVC) riser and the total depth of the well.
- Record information in the field notes.

7.2.2 Monitoring Well Development and Purging

Follow these requirements for monitoring well development and purging:

- Do not use Teflon™ tubing for purging or sample collection. HDPE tubing is acceptable.
- Do not re-use materials between wells. Upon completion of use, remove all disposable materials (such as HDPE and/or silicone tubing) and place in heavy duty garbage bags for disposal.
- During development of the well, create sufficient energy to agitate the water column and create flow reversals in the well screen, filter pack and formation to loosen fine-grained materials and draw them into the well. The pumping or bailing action should then draw all drilling fluids and fine-grained material out of the borehole and adjacent formation and then out of the well. Review the Arcadis Monitoring Well Development guidance (Arcadis 2010) for more detailed information.
- Follow the low-flow purge and sampling techniques per the U.S. Protection Agency’s (EPA’s) guidance document titled *Low Stress (Low Flow) purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells* (2010) and ASTM’s standard titled *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations* (2002). Also available for review is the Arcadis Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells (Arcadis 2011).

- To purge the well, if using HDPE tubing and a peristaltic pump, insert the end of the tubing to the approximate depth of the midpoint of the screened section of the monitoring wells. Measure the length of HDPE tubing to be inserted into each monitoring well and pre-cut it to approximate lengths (such as the previously measured arm span of a field technician) to avoid contact with any materials other than the monitoring well and peristaltic pump. Flow rates should be as low as can be reasonably achieved. Collect and appropriately dispose of purge water.
- Silicone tubing should direct the purge water through a flow-through cell for field parameter measurements of pH, conductivity, temperature, dissolved oxygen, and turbidity. Calibrate the instrument in the field prior to use. Decontaminate the instrument and flow-through cell at each monitoring well location before purging.
- Record field parameters in intervals (generally of 3-minute duration) to ensure purge water has cycled through the flow-through cell. Sample the wells after field parameter measurements indicate stabilization, which allows collection of representative formation water (generally acceptable standards are three consecutive pH readings to within ±0.1 units, and three consecutive conductivity, temperature and dissolved oxygen measurements to within 3%). Turbidity must be monitored, but does not need to be used as a stabilization indicator of purge completion. Record field parameter measurements at each well. Drawdown should be monitored throughout the purge.
- If wells are suspected to be dewatering throughout the purge (i.e., reduced flow rate/difficulty pumping water or bubbles begin to come through the flow through cell), turn off the pump and allow the water level to recover for ½ hour, followed by sample collection. Document these activities in the field notes.

7.3 Sample Collection

Different laboratories may supply sample collection bottles of varying sizes depending on the type of media to be sampled.

7.3.1 Sample Containers

- Collect samples in HDPE bottles fitted with an unlined (no Teflon™), polypropylene screw cap.
- Complete bottle labels after the caps have been placed back on each bottle.
- Do not use glass bottles due to potential loss of analyte through adsorption. This is particularly important for aqueous samples.
- Review with analytical lab the sample size, sample container, etc. depending upon the type of PFAS analysis that is being requested.

7.3.2 Soil Sampling

Before Sample Collection

- Place plastic sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Trowels or drilling equipment that will come into contact with a sample should be decontaminated prior to sample collection, preferably with methanol/isopropanol/acetone;
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.

During Sample Collection

- Collect soil samples using a clean stainless steel trowel or with single-use PFAS-free liners;
- Place soil samples in labeled HDPE bottles supplied by the laboratory.
- Note the time on the sample label.
- Collect any necessary duplicates/co-located samples and matrix spikes – verify with laboratory whether they need to be collected in separate sample bottles.
- Collect any necessary equipment blanks. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.
- Collect any necessary field reagent blanks. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.

After Sample Collection

- Place soil sample bottles in a sealed Ziploc© bag (optional).
- Record the label information and time of sampling in the field notes.
- Place soil sample bottles in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. Do not use blue ice.

7.3.3 Groundwater Sampling

Before Sample Collection

- Place plastic sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the labeled HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.
- Measure depth to water and field parameters. Turbidity and the physical appearance of the purged water should be noted on the Groundwater Sampling Log.

During Sample Collection

- Start groundwater sample collection upon stabilization of field parameters.
- If low-flow groundwater sampling techniques are being used, disconnect the silicone tubing from the flow-through cell, enabling collection of groundwater samples prior to passing through the cell.
- Hydrasleeves are also considered acceptable for sampling of PFAS in groundwater – consult the project manager to determine which technique should be used. In general, low flow sampling is preferable.
- Collect groundwater samples (to the neck of the bottle, some headspace is acceptable) from the dedicated sampling ports at the center of the well screen. While collecting the sample, make sure the bottle cap remains in the other hand of the sampler, until replaced on the bottle.
- To mitigate cross contamination, collect groundwater samples in a pre-determined order from least impacted to greater impacted based on previous analytical data or knowledge about past activities at the site. If no analytical data are available, samples are to be collected in the following order:
    1. First sample the upgradient well(s).

2. Next, sample the well located furthest downgradient of the interpreted or known source.
3. The remaining wells should be progressively sampled in order from downgradient to upgradient, such that the wells closest to the interpreted or known source are sampled last.

- NOTE: If high concentrations of PFASs related to class B firefighting foams are expected in a groundwater sample, conduct a Shaker test by collecting and shaking a small portion of the sample (~10 to 25 mL) on site in a small disposable vial. If foaming is noted within the sample, document the foaming when samples are submitted for analysis; the 'shaker test' vial can then be disposed. This shaker test provides information about how each of the samples should be handled analytically.
- After collecting the sample, tightly screw on the polypropylene cap (snug, but not too tight). This will minimize leaking or cross contamination of the sample. Most PFASs, including all analytes measured by USEPA Method 537, are not volatile at environmental pH.
- Note the time on the sample label.
- Collect any necessary duplicates and matrix spikes. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
- Collect any necessary equipment blanks. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.
- Collect any necessary field reagent blanks. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.
- Do not rinse PFAS sample bottles during sampling. Do not filter samples.

After Sample Collection

- Place groundwater sample bottles in a sealed Ziploc© bag (optional).
- Record the label information and time of sampling in the field notes and COC. Note ‘shake test’ results if appropriate.
- Place groundwater samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**
- Treat all disposable sampling materials as single use and dispose of them appropriately after sampling at each monitoring well.

7.3.4 Sediment Sampling

Before Sample Collection

- Place plastic sheeting (preferably HDPE) adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.

During Sample Collection

- Where surface water samples and sediment samples are collected at the same location, collect surface water samples first to minimize siltation.

- Collect sediment samples either manually using a stainless steel trowel or using a petite ponar grab sampler, depending on field conditions at each sampling location during sampling program.
- Collect sediment samples from the upper 10 cm of sediment.
- For a sample to be acceptable overlying, low turbidity water must be present.
- Decant the overlying water and use a stainless steel trowel to collect only the upper 5 centimeters (cm) of sediment.
- Collect sediment samples directly into laboratory-supplied bottles that are suitable in both material and size.
- Do not overfill the sample bottle.
- Make sure that the sample does not contain vegetation, that the sediment is undisturbed, and that the sampler shows no signs of winnowing or leaking.
- Make sure bottle caps remain in the gloved hand of the sampler until sampling is complete and caps are replaced on the bottle.
- Note the time on the sample label.
- Collect any necessary duplicates and matrix spikes.
- Collect any necessary equipment blanks. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.
- Collect any necessary field reagent blanks. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.

After Sample Collection

- Place sample bottles in a sealed Ziploc© bag (optional).
- Record the label information and time of sampling in the field notes.
- Place samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**
- Measure surface water pH, conductivity, temperature, and total dissolved solids (TDS) at each location **after** both surface water and sediment sampling is completed.

7.3.5 Surface Water Sampling

Before Sample Collection

- Place plastic sheeting (preferably HDPE) adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.

During Sample Collection

- Avoid sampling the surface.
- Where surface water samples and sediment samples are collected at the same location, collect surface water samples first to minimize siltation.

- Collect surface water samples directly into laboratory-supplied bottles; wide-mouth bottles may be preferable to narrow mouth bottles for ease of surface water collection.
- Make sure bottle caps remain in the gloved hand of the sampler until sampling is complete and caps are replaced on the bottle.
- Note the time on the sample bottle.
- Collect any necessary duplicates and matrix spikes. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
- Collect any necessary equipment blanks. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.
- Collect any necessary field reagent blanks. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.

After Sample Collection

- Place sample bottles in a sealed Ziploc© bag (optional).
- Record the label information and time of sampling in the field notes.
- Place samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**
- Measure surface water pH, conductivity, temperature, and TDS at each location **<u>after</u>** both surface water and sediment sampling.

7.4 Shipping

- If samples cannot be shipped the same day as collected, arrange an appropriate means of keeping the samples cool overnight and maintain the temperature between 0 and 10°C for the first 48 hours after collection, and then between 0 and 6°C thereafter.
- Store samples in appropriate transport bottles (coolers) with ice (Ziploc© bags for use as ice containers) with appropriate labeling. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**
- Complete the appropriate procedures for COC, handling, packing, and shipping.
- Fill out and check COC Forms against the labels on the sample bottles progressively after each sample is collected.
- Place all disposable sampling materials (such as plastic sheeting, and health and safety equipment) in appropriate containers.
- Ship samples via courier service with priority overnight delivery. Tracking numbers for all shipments should be provided and recorded after they have been sent out to ensure their timely delivery.
- Do not ship samples via Fed Ex for Saturday delivery.

8 WASTE MANAGEMENT

All rinsate should be collected in a sealed pail for disposal. Drill cuttings and purge water will be managed as specified in the Field Sampling Plan (FSP) or Work Plan, and according to state and/or federal requirements. PPE and decontaminated fluids will be contained separately and staged at the sampling location. Containers must be labeled at the time of collection. Labels will include date, location(s), site name, city, state, and description of matrix contained (e.g., soil, groundwater, PPE). General guidelines for investigation derived waste (IDW) handling and storage are set forth in a separate IDW guidance document (Arcadis 2009).

Typical waste characterization procedures include collection of a composite sample of the drill cutting material and a composite sample of the purge water for laboratory analysis. Samples are typically analyzed for disposal toxicity characteristic leaching procedure (TCLP) analysis for metals and VOCs. For PFASs, a simple leach test with neutral pH water may be more indicative of actual risk. Additionally, generators of waste are required to include analysis of other constituents that are reasonably believed to be present including (in this case) PFASs.

Emerging contaminants pose a unique challenge for disposal because acceptance of such waste will be based on the local facility and their permit restrictions. Project teams will be required to identify appropriate facilities based on the facility's legal ability to accept the waste and the team should confirm that the facility is meeting the regulatory requirements for accepting waste containing PFASs. In general, facilities that provide solidification and/or incineration will be likely to meet the necessary requirements to accept PFAS-containing waste. The facility will then provide the definitive laboratory analysis requirements needed to meet their permit requirements for waste classification.

9 DATA RECORDING AND MANAGEMENT

9.1 Field Notes

Waterproof field books must not be used for field notes. Instead, field notes should be on loose paper on Masonite, plastic, or aluminum clip boards. Other requirements for field notes include:

- Pens, pencils, and Sharpies may be used.
- Keep field notes and writing implements away from samples and sampling materials.
- One person should conduct sampling while another records field notes.
- Do not write on sampling bottles unless they are closed.

9.2 Other Project Documentation

- Complete Groundwater Sampling Logs.
- Make sure COC Forms are properly completed. Verify which PFAS analytes (e.g., just PFOS and PFOA, some or all of the 537 list, etc.) are required for analysis and note on the COC.

10 QUALITY CONTROL

Refer to quality control requirements for the project to ensure that appropriate quality assurance and quality control (QA/QC) samples are collected. When collecting QA/QC samples, the same guidelines apply as when collecting regular samples – specifically that:

- Samples should be collected in laboratory-supplied HDPE bottles;
- Bottle caps must remain in the hand of the sampler until replaced on the bottle;
- Labels must be completed after the caps have been placed back on each bottle; and

- Samples must be stored in appropriate transport bottles (coolers) with ice (Ziploc© bags for use as ice containers) with appropriate labeling. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**

10.1 Equipment Blanks (if relevant)

QA/QC sampling typically includes daily collection of equipment blanks using the laboratory-supplied “PFAS-free” water. For peristaltic pump tubing, laboratory supplied “PFAS-free” water should be poured into a clean HDPE sample bottle and then pumped through new HDPE tubing using the peristaltic pump (with new silicone tubing). The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

10.2 Field Duplicates

QA/QC sampling typically includes the collection of one field duplicate for every 10 or 20 samples collected. Each duplicate sample will be collected immediately after the initial sample of which it is a duplicate into a separate laboratory-provided sample bottle. Do not indicate to the laboratory which sample the duplicate replicates, i.e. it should be given a blind reference on the COC and sample name such as “duplicate”.

10.3 Field Reagent Blanks

QA/QC sampling for PFASs typically includes the submission of one laboratory supplied field reagent blank per day. The field reagent blank sample is brought to the site in a laboratory-supplied sample bottle. Field staff transfer the laboratory-supplied reagent blank to an empty sample bottle. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel and should be placed in the same cooler as the other PFAS samples.

10.4 Matrix Spikes (optional in some cases)

QA/QC sampling includes submitting a sample to be used as a matrix spike if the project requires it. If a separate sample bottle is required, an additional sample will be collected immediately after the initial sample of which it is a duplicate into a separate laboratory-supplied sample bottle.

10.5 Laboratory Analytical QA/QC

- Arcadis recommends that any request for PFAS analysis in groundwater or soil should be conducted by an ELAP-accredited method compliant with QSM 5.1 Table B-15. Requirements laid out in Table B-15 strictly govern acceptable laboratory data quality for PFAS analysis in environmental samples. **For all data collection efforts at DoD sites, PFAS data must be obtained using a method that is DoD ELAP-accredited under QSM 5.1 or later.**
- Laboratory QA/QC should consist of one laboratory blank and one laboratory control sample (or blank spike) per batch of samples, and additional QA/QCs as indicated by the laboratory QA/QC procedures.
- Isotope dilution should be used for quantification with isotope-labeled surrogate standards, as available, according to the guidelines of QSM 5.1 Table B-15. USEPA Method 537 does not allow for isotope dilution in their PFAS drinking water method.

- For drinking water, groundwater, and surface water samples, laboratories must extract the entire sample and include a solvent rinse of the bottle for analysis. Aqueous samples should generally not be sub-sampled prior to analysis, unless they are high concentration and require serial dilution (US DoD 2017).
- Soil samples should be analyzed in their entirety or thoroughly homogenized before extraction and analysis.
- As part of the internal QA/QC of laboratory results, relative percent difference (RPD) should be calculated between samples and corresponding field or laboratory duplicates. The laboratory quality assurance portion of the laboratory certificates should be reviewed to verify that all calculations/recoveries were within acceptable limits as established by the laboratory method and guidelines in Table B-15 of QSM 5.1 or later (USDoD 2017).

11 REFERENCES

Arcadis Australia. 2017. Soil and Concrete Sampling for PFAS. April.

Arcadis. 2010. Monitoring Well Development, Rev. #2.2. March 22.

Arcadis. 2009. Investigation-Derived Waste Handling and Storage, Rev. #2. March 6.

Arcadis. 2011. Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells, Rev. #4. February 2.

ASTM. 2002. ASTM D6771-02 - Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations (Withdrawn 2011). Available at: https://www.astm.org/Standards/D6771.htm.

Department of Environment Regulation (DER). Government of Western Australia. 2016. Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS). Contaminated Sites Guidelines. February.

Massachusetts Department of Environmental Protection (MassDEP). 2017. DRAFT Fact Sheet, Guidance on Sampling and Analysis for PFAS at Disposal Sites Regulated under the Massachusetts Contingency Plan. January.

New Hampshire Department of Environmental Services (NHDES). 2016. Perfluorinated Compound (PFC) Sample Collection Guidance. November.

United Nations Environment Programme (UNEP). 2015. PFAS analysis in water for the Global Monitoring Plan of the Stockholm Convention, Set-up and guidelines for monitoring. Jana Weiss, Jacob de Boer, Urs Berger, Derek Muir, Ting Ruan, Alejandra Torre, Foppe Smedes, Branislav Vrana, Fabrice Clavient, and Heidelore Fiedler. Division of Technology, Industry and Economics. Geneva. April.

United States Army Corps of Engineers (USACE). 2016. DRAFT – Standard Operating Procedure 047: Per/Poly Fluorinated Alkyl Substances (PFAS) Field Sampling. Revision: 1. March.

U.S. Army Corps of Engineers – Omaha District. 2016. Chemistry Requirements – PFAS.

U.S. Department of Defense (DoD). 2017. Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.1. In conjunction with the U.S. Department of Energy. January.

U.S. Environmental Protection Agency. 2009. USEPA Method 537: Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS), version 1.1, September. National Exposure Research Laboratory, Office of Research and Development.

U.S. Environmental Protection Agency. 2010. Low Stress (Low Flow) purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells. Available at:

https://www.epa.gov/quality/low-stress-low-flow-purging-and-sampling-procedure-collection-groundwater-samples-monitoring.

Transport Canada. February 2016, Per-and Polyfluorinated Alkyl Substances (PFAS) Field Sampling Guidance.

TGI - STANDARD GROUNDWATER SAMPLING FOR MONITORING WELLS

Rev #: 0

Rev Date: October 8, 2018

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	October 8, 2018	All	Updated and re-written as a TGI	Marc Killingstad

APPROVAL SIGNATURES

Prepared by:		10/08/2018
	Christopher Keen	Date:
Technical Expert Reviewed by:		10/08/2018
	Marc Killingstad (Technical Expert)	Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) describes the methods to be used to collect groundwater samples using traditional purging and sampling techniques. For low-flow purging techniques, please refer to the *TGI - Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells*. For no-purge/passive sampling techniques such as passive diffusion bag (PDB), HydraSleeve™ and bailer-grab groundwater sampling please refer to: *TGI – Passive Diffusion Bag Sampling, TGI – Groundwater Sampling with HydraSleeves*™, and *TGI - Bailer-Grab Groundwater Sampling*.

NOTE: *Monitoring wells will not be sampled until the well has been properly developed. Monitoring wells must be appropriately developed after installation and at least one (1) week prior to groundwater sample collection (refer TGI – Monitoring Well Development). Project teams will consider the last time the wells were developed and if additional development may be required to ensure adequate communication with the surrounding formation and collection of representative groundwater samples.*

During precipitation events, groundwater sampling will be discontinued until precipitation ceases or a cover has been erected over the sampling area and monitoring well.

Both filtered and unfiltered groundwater samples may be collected using this TGI. Filtered samples may be obtained using a 1.0-, 0.45-, or 0.1-micron disposable filter.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, the groundwater sampling team will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP)/field sampling plan, Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Additionally, the groundwater sampling team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

Ideally, Arcadis personnel directing, supervising, or leading groundwater sample collection activities will have a minimum of one (1) year of previous groundwater sampling experience. Field employees with less than six (6) months of experience will be accompanied by a supervisor (as described above) to ensure that proper sample collection techniques are employed.

4 EQUIPMENT LIST

The following materials will be available, as required, during groundwater sampling:

- Site-specific HASP and health and safety documents identified in the HASP
- Field Implementation Plan (FIP) that includes site map, well construction records (table or logs), sampling plan (sample analyses, sample volume required, and sample holding time), and prior groundwater sampling records (if available)
- Field notebook and/or smart device (smart phone or tablet)
- Groundwater sampling field forms (**Attachment A**)
- Appropriate personal protective equipment (PPE) (e.g., latex or nitrile gloves, safety glasses, etc.) as specified in the HASP
- Traffic cones, delineators, and caution tape as appropriate for securing the work area as specified in the Traffic Safety Plan (TSP)

- Photoionization detector (PID), flame ionization detector (FID) or other air monitoring equipment, as needed, in accordance with the HASP
- Dedicated plastic sheeting (e.g., Weatherall Visqueen) or other clean surface to prevent sampling equipment from coming in contact with the ground
- If bailers are to be used in sampling:
    - appropriate number of dedicated bottom-loading, bottom-emptying bailers (i.e., polyvinyl chloride [PVC], polyethylene, Teflon®, or stainless steel)
    - polypropylene or nylon rope
- If submersible pumps are to be used in sampling:
    - appropriate amount of dedicated tubing (polyethylene, Teflon®, Teflon®-lined polyethylene, Tygon®) and other equipment necessary for purging selected in accordance with the FIP/sampling plan/work plan
    - generator or battery for operation of pumps (if required)
    - a pump selected in accordance with the FIP/sampling plan/work plan (parameter-specific [e.g., submersible, bladder, peristaltic])
- Graduated buckets to measure purge water volume
- Electronic water-level indicator (e.g., Solinist Model 101) or oil/water interface probe with 0.01-foot accuracy (oil/water as appropriate, note that sampling will not be performed when sheen or light non-aqueous phase liquid [LNAPL] is present)
- Down-hole multiparameter water-quality sonde (temperature/pH/specific conductivity/oxidation reduction [ORP]/turbidity/dissolved oxygen) meter and flow-through measurement cell; for example:
    - YSI 6-Series Multi-Parameter Instrument
    - Horiba U-22 Multi-Parameter Instrument.
    - Hydrolab Series 3 or Series 4a Multiprobe and Display.
- Groundwater sample containers and labels (supplied by the laboratory) appropriate for the analytical method(s) with preservative, as needed (parameter-specific)
- Filter, as needed, in accordance with the analytical method and parameter, and as specified in the FIP/sampling plan
- Decontamination equipment (buckets, distilled or deionized water, cleansers appropriate for removing expected chemicals of concern, paper towels)
- Appropriate blanks (trip blank supplied by the laboratory), as specified in the FIP/sampling plan
- Ziploc-type freezer bags for use as ice containers;
- Appropriate transport containers (coolers) with ice and appropriate labeling, packing, and shipping materials

- Chain-of-custody forms
- Digital camera (or phone with camera)
- Keys to wells and contingent bolt cutters for rusted locks and replacement keyed-alike locks
- Drums or other containers appropriate for purge water, as specified by the site investigation-derived waste (IDW) management plan and/or FIP/sampling plan and appropriate drum labels

5 CAUTIONS

Different USEPA regions and/or state regulatory agencies may stipulate deviations from this document. It is the responsibility of the Project Team (Project Manager and Technical Lead) to be fully aware of the requirements from the applicable regulatory framework.

If heavy precipitation occurs and no cover over the sampling area and monitoring well can be erected, sampling must be discontinued until adequate cover is provided. Rain water could contaminate groundwater samples.

Avoid extreme weather situations. Be aware that thermal currents and vertical mixing of cold and warm water inside the well casing could create a convection cell within the well and compromise data collection (e.g., biological mechanisms).

- Direct sunlight and hot ambient temperatures may cause the groundwater in the tubing or flow-through-cell to heat up and de-gas. This may result in the loss of volatile organic compounds (VOCs) and dissolved gases. Shade the equipment from direct sunlight, keep the tubing as short as possible, and avoid the hottest times of the day. Store and/or stage empty and full sample containers and coolers out of direct sunlight.
- Sampling during freezing conditions may adversely impact the data quality objectives. USEPA recommends low-flow sampling be conducted at air temperatures above 32°F (0°C) or taking special precautions to prevent groundwater from freezing in the equipment.

It may be necessary to field filter the groundwater for some parameters (e.g., metals) during collection, depending on preservation, analytical method, and project quality objectives. The task-kick-off notes and the FIP/sampling plan will list the samples that require field filtering.

To mitigate potential cross-contamination, groundwater samples are to be collected in a pre-determined order from least impacted to more impacted based on previous analytical data. If no analytical data are available, samples are to be collected in the following order:

1. First sample the upgradient well(s).
2. Next, sample the well located furthest downgradient of the interpreted or known source.
3. The remaining wells will be progressively sampled in order from downgradient to upgradient, such that the wells closest to the interpreted or known source are sampled last.

When using a gasoline generator, this power source will be set-up at least 30 feet downwind from the well to avoid exhaust fumes to contaminate samples.

Be careful not to over-tighten lids with Teflon® liners or septa (e.g., 40-mL vials). Over-tightening can cause the glass to shatter and/or impair the integrity of the seal.

NOTE: *Field logs and some forms are considered to be legal documents. All field logs and forms will be filled out in indelible ink. Do not use permanent marker or felt-tipped pens for labels on sample container or sample coolers. Permanent markers could introduce volatile constituents into the samples.*

NOTE: *An Arcadis employee that is appropriately trained at the correct level of internal hazardous materials/DOT (Department of Transportation) shipping must complete an Arcadis shipping determination to address applicable DOT and IATA (International Air Transport Association) shipping requirements. Review the applicable Arcadis procedures and guidance instructions for sample packaging and labeling. Prior to using air transportation, confirm air shipment is acceptable under DOT and IATA regulations.*

6 HEALTH AND SAFETY CONSIDERATIONS

The HASP will be followed, as appropriate, to ensure the safety of field personnel.

Appropriate personal protective equipment (PPE) will be worn at all times in line with the task and the site-specific HASP.

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work.

Access to wells may expose field personnel to hazardous materials such as contaminated groundwater or non-aqueous phase liquid (NAPL) (e.g., oil). Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g. ticks in long grass/weeds around well head), and potentially the use of sharp cutting tools (scissors, knife)—open well caps slowly and keep face and body away to allow to vent any built-up pressure; only use non-toxic peppermint oil spray for stinging insect nests; review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives, and use appropriate hand protection. Overtightening of lids with Teflon® liners can cause the glass to shatter and create a risk for hand injuries.

Generators and cord and plug equipment will employ an overcurrent protection device such as an integrated ground fault circuit interrupter (GFCI) cord. Grundfos pump controllers will not run properly with a GFCI, so the power source will be equipped with other overcurrent protection means.

If thunder or lighting is present, discontinue sampling until 30 minutes have passed after the last occurrence of thunder or lighting.

7 PROCEDURE

The general procedure for using traditional purging and sampling techniques to sample monitoring wells are outlined below:

1. Review equipment list (**Section 4** above) to confirm that the appropriate equipment has been acquired.
2. Don PPE as required in the HASP

   a. NOTE: *Depending on site-specific security and safety considerations, this often must be done prior to entering the work area*

3. Calibrate field instruments according to manufacturer procedures for calibration and document accordingly on the calibration logs, field form, and/or field logbook
4. All equipment will either be new or decontaminated in accordance with appropriate guidance document (*TGI – Groundwater and Soil Sampling Equipment Decontamination)* prior to use
5. Record site and monitoring well identification on the groundwater sampling log (**Attachment A**), along with date, arrival time, weather conditions, personnel present, equipment utilized, and other relevant data requested on the log.
6. Label all sample containers with indelible ink
7. Place plastic sheeting adjacent to the well for use as a clean work area, if conditions allow, otherwise, exercise care to prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity
8. Visually inspect the well to ensure that it is undamaged, properly labeled and secured
   a. Damage or other conditions that may affect the integrity of the well will be recorded in the Field Activity Daily Log and brought to the attention of the designated Field Manager and/or Project Manager
   b. Record well construction and conditions on the Groundwater Sampling Field Form (**Attachment A**)
9. Remove lock from well and if rusted or broken, replace with a new brass keyed-alike lock
10. Safely open well
    a. Unlock and open the well cover while standing upwind of the well
    b. Remove well cap and place on the plastic sheeting
    c. Insert the PID probe approximately 4 to 6 inches into the casing or the well headspace and cover it with a gloved hand
    d. Record the PID reading on the field log
    e. Perform air monitoring in the breathing zone according to the HASP and/or JSA
11. Set the sampling device, meters, and other sampling equipment on the plastic sheeting
    a. If a dedicated sampling device stored in the well is to be used, this may also be set temporarily on the plastic sheeting
    b. If a dedicated sampling device is stored below the water table, removing it may compromise water-level data, so water-level measurements will be taken prior to removing the device (see next step)
12. Obtain a water-level depth and bottom-of-well depth using an electric well probe prior to placing the pump and record on the groundwater sampling log using indelible ink

a. Make sure to decontaminate the probe(s) after each use in accord with the FIP/sampling plan or the equipment decontamination TGI

NOTE: *Water levels may be measured at all wells prior to initiating any sampling activities, depending on FIP requirements.*

13. Prepare for pump installation:
    a. For submersible and non-dedicated bladder pumps, decontaminate the pump according to site decontamination procedures
    b. Non-dedicated bladder pumps will require a new bladder and attachment of an air-line, sample discharge line, and safety cable prior to placement in the well
    c. Attach the air-line tubing to the air-port on the top of the bladder pump
    d. Attach the sample discharge tubing to the water port on the top of the bladder pump taking care not to reverse the air and discharge tubing lines during bladder pump setup, as this could result in bladder failure or rupture
    e. Attach and secure a safety cable to the eyebolt on the top of bladder pump (if present, depending on pump model used)
14. Slowly lower the pump, safety cable, tubing, and electrical lines into the well to a depth corresponding to the approximate center of the saturated screen section of the well
    a. Avoid twisting and tangling of safety cable, tubing, and electrical lines while lowering the pump into the well; twisted and tangled lines could result in the pump becoming stuck in the well casing
    b. Make sure to keep tubing and lines from touching the ground or other surfaces while introducing them into the well, as this could lead to well contamination
    c. If a peristaltic pump is being used, slowly lower the sample tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well
    d. The pump intake or sample tubing must be kept at least 2 feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well
15. If using a bladder pump, connect the air-line to the pump controller output port
    a. The pump controller will then be connected to a supply line from an air compressor or compressed gas cylinder using an appropriate regulator and air hose
    b. Tighten the regulator connector onto the gas cylinder (if used) to prevent leaks. Teflon® tape may be used on the threads of the cylinder to provide a tighter seal
    c. Once the air compressor or gas cylinder is connected to the pump controller, turn on the compressor or open the valve on the cylinder to begin the gas flow
    d. Turn on the pump controller power if an on/off switch is present and verify that all batteries are charged and fully operating before beginning to pump

16. Calculate the number of gallons of water in the well using the length of water column (in feet). Record the well volume on the groundwater sampling log using indelible ink
17. Remove the required purge volume of water from the well (measure purge water volume in measuring buckets)
    a. The required purge volume will be three to five well volumes (the water column in the well screen and casing) unless the well runs dry, in which case, the water that comes into the well will be sampled (USEPA, 1986)
    b. For wells screened across the water table, the well may be pumped dry and sampling can commence as soon as the volume in the well has recovered sufficiently to permit collection of samples
    c. For wells screened entirely below the water table, the well may be pumped until the drawdown is at a level slightly higher than top of the well screen
    d. Sampling may commence after one well volume has been removed and the well has recovered sufficiently to permit collection of samples
    e. In any case, the pumping rate will be decreased during sampling to limit the potential for volatilization of organics potentially present in the groundwater
18. Field parameter measurements will be periodically collected in accordance with FIP/sampling plan specifications
    a. Typical time intervals of field parameter measurement are (1) after each well volume removed, and (2) before sampling
    b. If the field parameters are being measured above-ground (rather than with a downhole probe), then the final pre-sampling parameter measurement will be collected at the reduced flow rate to be used during sampling
    c. Physical appearance of the purged water will be noted on the groundwater sampling log
    d. Water-level measurements will be collected and recorded to verify that the well purging is in accordance with the guidelines set forth in the previous step
19. Unless otherwise specified by the applicable regulatory agencies, all purge water will be containerized
    a. Containerized purge water will be managed in accordance with the FIP/sampling plan/work plan
    b. If historical concentrations in the well are less than federal- or state-regulated concentrations appropriate for current land use, *and permission has been granted by the oversight regulatory agency* to dispose of clean purge water on the ground next to the well(s), then purge water may be allowed to infiltrate into the ground surface downgradient from the monitoring well after the well is sampled—*this will be specified in the FIP/sampling plan*

20. After the appropriate purge volume of groundwater in the well has been removed, or if the well has run dry and allowed to recover, obtain the groundwater sample needed for analysis via the dedicated bailer or from the dedicated sample tubing, pour the groundwater directly from the sampling device into the appropriate container in the order of volatilization sensitivity of the parameters sampled, and tightly screw on the cap (snug, but not too tight)

    NOTE: *The suggested order for sample parameter collection, based on volatilization sensitivity, is presented below:*

    a. volatile organic compounds (VOCs);

    b. semi-volatile organic compounds (SVOCs);

    c. polychlorinated biphenyls (PCBs)/pesticides;

    d. metals; and

    e. *wet chemistry*.

    NOTE: *When sampling for volatiles, water samples will be collected directly from the bailer or dedicated tubing into 40-mL vials with Teflon®-lined septa*.

    NOTE: *For other analytical samples, sample containers for each analyte type will be filled in the order specified by the FIP/sampling plan. If a bailer is used, then the sample for dissolved metals and/or filtered PCBs will either be placed directly from the bailer into a pressure filter apparatus or pumped directly from the bailer with a peristaltic pump, through an in-line filter, into the pre-preserved sample bottle. If dedicated sample tubing is used, then the filter will be installed in-line just prior to filtered sample collection.*

    NOTE: *If sampling for total and filtered metals and/or PCBs, a filtered and unfiltered sample will be collected. Sample filtration for the filtered sample will be performed in the field utilizing a pump prior to preservation. Attach (clamp) a new 1.0-, 0.45-, or 0.1-micron filter to the discharge tubing of the pump (note the filter flow direction). Turn the pump on and allow 100 mL (or manufacturer recommended amount) of fluid to flow through the filter before sample collection. Dispense the filtered liquid directly into the laboratory sample bottles. If bailers are used for purging and sampling, a proper volume of purge water will be placed in a disposable or decontaminated polyethylene container and pumped through the filter and into the sample container using a peristaltic pump.*

21. As samples are collected, note the corresponding time on the sample label

22. Secure sample containers with packing material and maintain at approximately 4°C on wet ice contained in double Ziploc-type freezer bags stored in an insulated, durable transport cooler

23. Turn off the pump and air compressor or close the gas cylinder valve if using a bladder pump setup.

24. Slowly remove the pump, tubing, lines, and safety cable from the well

    a. If using dedicated tubing/lines, do not allow them to touch the ground or any other surfaces which could result in contamination

   b. If tubing is to be dedicated to a well, it will be folded to a length – without pinching it – that will allow the well to be capped and also facilitate retrieval of the tubing during later sampling events
   c. Use a length of rope or string to tie the tubing to the well cap
   d. Alternatively, if tubing and safety line are to be saved and reused for sampling the well at a later date, they may be coiled neatly and placed in a clean plastic bag that is clearly labeled with the well ID and tightly sealed before placing it in storage

25. Record the time sampling procedures were completed on the groundwater sampling field forms using indelible ink
26. Secure the well: replace the well cap and lock well or install a new lock if needed
    a. If new locks were installed, forward copies of the keys to the client Project Manager (PM) and Arcadis CPM at the end of the sampling activities
27. Complete the procedures for chain-of-custody, handling, packing, and shipping
    a. Chain-of-custody forms will be filled out and checked against the labels on the sample containers progressively after each sample is collected
28. Properly dispose of personal protective equipment (PPE) and disposable equipment—place all disposable sampling materials (e.g., plastic sheeting, disposable tubing or bailers, and PPE) in appropriate containers
29. Complete decontamination of sampling equipment (e.g., submersible or bladder pump) as appropriate (*TGI – Groundwater and Soil Sampling Equipment Decontamination*)
30. At the end of each day of the sampling event, perform calibration check of field instruments and record procedure and results in field log

8 WASTE MANAGEMENT

Investigation-Derived Waste (IDW), including purge water, decontamination liquids, and disposable materials (plastic sheeting, PPE, etc.) will be stored on site in appropriately labeled containers (disposable materials will be contained separately) and disposed of properly. Containers must be labeled at the time of collection and will include date, location(s), site name, city, state, and description of matrix contained (e.g., soil, PPE). Waste will be managed in accordance with the *TGI – Investigation-Derived Waste Handling and Storage,* the procedures identified in the FIP or QAPP as well as state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field log book.

9 DATA RECORDING AND MANAGEMENT

Management of the original documents from the field will be completed in accordance with the site-specific QAPP. Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

In general, sampling activities will be documented on appropriate field logs as well as in a proper field notebook. All field data will be recorded in indelible ink. Field forms, logs/notes (including daily field and calibration logs), digital records, and chain-of-custody records will be maintained by the field team lead.

Initial field logs and chain-of-custody records will be transmitted to the Arcadis CPM and/or Technical Lead at the end of each day unless otherwise directed by the CPM. The field team leader retains copies of the field documentation.

Additionally, all documents (and photographs) will be scanned and electronically filed in the appropriate project directory for easy access.

10 QUALITY ASSURANCE

Quality assurance procedures will be conducted in accordance with the Arcadis Quality Management System or the site-specific QAPP.

Field-derived quality assurance blanks will be collected as specified in the FIP/sampling plan, depending on the project quality objectives. Typically, field rinse blanks (equipment blanks) will be collected when non-dedicated equipment (e.g., submersible pump) is used during groundwater sampling. Field rinse blanks will be used to confirm that decontamination procedures are sufficient and samples are representative of site conditions. Trip blanks for VOCs, which aid in the detection of contaminants from other media, sources, or the container itself, will be kept with the coolers and the sample containers throughout the sampling activities and during transport to the laboratory.

In addition to the quality control samples to be collected in accordance with this TGI, the following quality control procedures will be observed in the field:

- Collect samples from monitoring wells, in order of increasing concentration, to the extent known based on review of historical site information if available
- Equipment blanks will include the pump and tubing (if using disposable tubing) or the pump only (if using tubing dedicated to each well)
- Collect equipment blanks after wells with higher concentrations (if known) have been sampled
- Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures
    - Calibrate instruments at the beginning of each day and verify the calibration at the end of each day
    - Record all calibration activities in the field notebook
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well following the procedures outlined for equipment decontamination

11 REFERENCES

United States Environmental Protection Agency (USEPA). 1986. RCRA Groundwater Monitoring Technical Enforcement Guidance Document (September 1986).

USEPA. 1991. Handbook Ground Water, Volume II: Methodology, Office of Research and Development, Washington, DC. EPA/625/6-90/016b (July 1991).

U.S. Geological Survey (USGS). 1977. National Handbook of Recommended Methods for Water-Data Acquisition: USGS Office of Water Data Coordination. Reston, Virginia.

12 ATTACHMENTS

Attachment 1 – Groundwater Sampling Field Form

ATTACHMENTS 1

Groundwater Sampling Field Form

GROUNDWATER SAMPLING FORM

ARCADIS

Project No. ____________ Well ID ____________ Date ____________

Project Name/Location ____________ Weather ____________

Measuring Pt. Description ____________ Screen Setting (ft-bmp) ____________ Casing Diameter (in.) ____________ Well Material ____ PVC ____ SS

Static Water Level (ft-bmp) ____________ Total Depth (ft-bmp) ____________ Water Column (ft) ____________ Gallons in Well ____________

MP Elevation ____________ Pump Intake (ft-bmp) ____________ Purge Method: ____________ Sample Method ____________

Pump On/Off ____________ Volumes Purged ____________ Centrifugal ____________ Submersible ____________ Other ____________

Sample Time: Label ____________ Gallons Purged ____________

Purge Start ____________ Replicate/ Code No. ____________ Sampled by ____________

Purge End ____________

Time	Minutes Elapsed	Rate (gpm)/(mL/min) 200mL/min +	Depth to Water (ft) -0.3	Gallons Purged	pH ± 0.1	Cond. (μMhos)/(mS/cm) ± 3%	Turbidity (NTU) ± 10%	DO (mg/L) ± 10%	Temp. (°C)/(°F) ± 3%	Redox (mV) ± 10mV	Appearance Color	Appearance Odor
Stabilization Calculations (±)												
Stabilization Criteria					**± 0.1 s.u.**	**±3%**	**± 10% or within 1 NTU (1)**	**± 10%**	**±3%**	**±10 mV**		

(1) **Turbidity** < 50 NTU and ±10% or within 1 NTU of a previous reading when <10 NTU

Constituents Sampled	**Container**	**Number**	**Preservative**

Comments ____________

Well Casing Volumes

Gallons/Foot	*1" = 0.04*	*1.5" = 0.09*	*2.5" = 0.26*	*3.5" = 0.50*	*6" = 1.47*
	1.25" = 0.06	*2" = 0.16*	*3" = 0.37*	*4" = 0.65*	

Well Information

Well Location: ____________ Well Locked at Arrival: Yes / No

Condition of Well: ____________ Well Locked at Departure: Yes / No

Well Completion: Flush Mount / Stick Up Key Number To Well:

TGI - INDOOR OR AMBIENT AIR SAMPLING AND ANALYSIS VIA USEPA METHOD TO-15

Rev #: 1

Rev Date: August 19, 2016

SOP VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
1	8/19/2016	All	Updated Rev0	Mitch Wacksman

APPROVAL SIGNATURES

Margaret Bartee

Prepared by: ________________________________ Date: 8/19/2016

Margaret Bartee

Mitch Wacksman

Reviewed by: ________________________________ Date: 8/19/2016

Mitch Wacksman

I. INTRODUCTION

This Technical Guidance Instruction (TGI) document describes the procedures to conduct a building survey prior to indoor air sampling.

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

II. SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) document describes the procedures to collect indoor air or ambient air samples in passivated stainless steel canisters (e.g., SUMMA®) for the analysis of volatile organic compounds (VOCs) using United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15).

III. PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. Arcadis field sampling personnel will be competent in the relevant procedures and possess the required skills and experience necessary to successfully complete the desired field work. Arcadis personnel responsible for directing indoor air and/or ambient air sample collection activities must have previous indoor air sampling experience and be able to complete the field work without direct supervision.

IV. EQUIPMENT LIST

The equipment required for indoor air sample collection is presented below:

- 6-liter, stainless steel passivated canisters (e.g., SUMMA®). Request one canister for each sampling location, plus duplicate canisters per project-specific requirements. If feasible, order extra canisters at a rate of 10 to 20% of the total number of sampling canisters (including duplicates).
- Flow controllers with in-line particulate filters and vacuum gauges. Flow controllers are pre-calibrated by the laboratory to the sampling duration [e.g., 8 hours] specified by the project team). Vacuum gauges are also generally supplied by the laboratory.
- Open-end wrench. Typical canister caps require 9/16-inch wrenches.
- Chain-of-custody (COC) form.
- Sample collection log (attached).
- Box, chair, tripod, or similar to hold canister above the ground surface at approximate breathing height (3-5 feet).
- Camera (optional, if photography is permitted at sampling locations).
- Hand-held weather meter (optional)

For abnormal situations (i.e., sumps, crawlspaces with no access, where canisters must be hidden, etc.), Teflon tubing may be used to collect an air sample. In these situations, ¼-inch Swagelok fittings (including nut, front sleeve, and back sleeve) or other methods may be appropriate to affix tubing to canister.

V. CAUTIONS

Care must be taken to minimize the potential for introducing interferences during the sampling event. As such, keep canisters away from heavy pedestrian traffic areas (e.g., main entranceways, walkways), if possible. Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens (sharpies), wear/apply fragrances, or smoke cigarettes before and/or during the sampling event.

Specify sample collection duration with the laboratory when ordering equipment, and confirm with the laboratory upon equipment receipt. Sample integrity can be compromised if sample collection is extended to the point that the canister reaches atmospheric pressure. Sample integrity is maintained if sample collection is terminated prior to the target sample duration and a measurable vacuum (e.g., 5 inches Hg) remains in the canister when sample collection is terminated.

VI. HEALTH AND SAFETY CONSIDERATIONS

All sampling personnel should review the appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task.

VII. PROCEDURE

Preparation of Passivated Canister and Collection of Sample

1. Record the following information on the sampling form (use a hand-held weather meter, contact the local airport or other suitable information source [e.g., weatherunderground.com] to obtain the following information):
   - ambient temperature
   - barometric pressure
   - wind speed
   - relative humidity
   - significant recent precipitation
   - snow/ice cover
2. For indoor air sampling, note whether the heating, ventilation, and air conditioning (HVAC) system is operational and record settings.
3. Choose the sampling location in accordance with the project sampling plan. If a breathing zone sample is required, place the canister on a box, chair, tripod, or other similar stand to locate the canister orifice 3 to 5 feet above the ground or floor surface. The canister may be affixed to wall/ceiling support with nylon rope or placed on a stable surface. In general, areas near windows, doors, air supply vents, and/or other potential sources of “drafts” shall be avoided.
4. Record canister serial number and flow controller number on the sampling log and COC form. Assign sample identification (ID), and record on canister ID tag, sample collection log (Attachment A), and COC form.
5. Remove the brass dust cap from the canister with the wrench. Attach the flow controller and vacuum gauge to the canister with the wrench. Tighten with fingers first, then gently with the wrench (roughly a quarter turn). Use caution not to over tighten fittings.
6. Open the canister valve to initiate sample collection. Record the date and local time (24-hour basis) of valve opening on the sample collection log and COC form. Collection of duplicate samples will include collecting two samples side by side at the same time.
7. Check the initial canister pressure using the vacuum gauge. Record the initial pressure in the canister on the sample log and COC form. The initial pressure reading should be evaluated with respect to project-specific and jurisdictional requirements. If the initial pressure registers less

than -25 inches of Hg, then the canister is not appropriate for use, and another canister should be used.

8. Photograph the canister and surrounding area, if photography is permitted at sampling locations.
9. If feasible, check the canister approximately half-way through the sample duration and note progress on sample logs.

Termination of Sample Collection

1. Arrive at the sampling location at least 1 to 2 hours prior to the end of the sampling interval (e.g., 6 hours following sample initiation for an 8-hour sampling duration).
2. Stop collecting the sample by turning the valve on the canister when the canister pressure reaches approximately -5 inches of Hg or when the desired sample time has elapsed, whichever comes first. Leaving some vacuum in the canister provides a way to evaluate whether the canister leaks before it reaches the laboratory.
3. Record the final canister pressure. Record the date and local time (24-hour basis) of valve closing on the sample collection log and COC form.
4. Remove the flow controller from the canister, re-install brass cap on canister fitting, and tighten with the wrench.
5. Package the canister and flow controller in accordance with Department of Transportation regulations available on the Transportation Health and Safety's Team Site on the Source for return shipment to the laboratory. The canister does not require preservation with ice or refrigeration during shipment.
6. Complete the forms and sample labels provided by the laboratory as directed (e.g., affix card with string).
7. Complete COC form; copy, photograph, or scan a version for the project file (if possible); and place the form in the shipping container. Close the shipping container and affix the custody seal to the container closure. Transmit canisters via courier delivery service (e.g., Federal Express or UPS) to laboratory for analysis.

VIII. WASTE MANAGEMENT

No specific waste management procedures are required.

IX. DATA RECORDING AND MANAGEMENT

Notes will be recorded on the sampling log form (attached), with notations of project name, sample date, sample time, and sample location (e.g., description and GPS coordinates if available) sample start and finish times, canister serial number, flow controller number, initial vacuum reading, and final vacuum reading. Sampling logs and COC records will be transmitted to the Task Manager or Project Manager and stored in the project file consistent with client and project requirements.

X. QUALITY ASSURANCE

Conduct quality assurance as required by the project-specific work plan and/or Quality Assurance Project Plan (QAPP).

TGI - SUB-SLAB SOIL VAPOR OR SOIL VAPOR SAMPLING USING WHOLE AIR CANISTERS ANALYZED VIA USEPA METHOD TO-15

Rev #: 1

Date: September 18, 2016

SOP VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
1	9/18/2016	All	Updated Rev0	Mitch Wacksman

APPROVAL SIGNATURES

Prepared by: ______________________ Date: 9/18/2016
Eric Cathcart

Reviewed by: ______________________ Date: 9/18/2016
Mitch Wacksman (Technical Expert)

I. INTRODUCTION

This Technical Guidance Instruction (TGI) document describes the procedures to conduct a building survey prior to indoor air sampling.

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

II. SCOPE AND APPLICATION

This document describes the procedures for collecting exterior soil vapor or sub-slab soil vapor (herein referred to as "soil vapor") samples using whole air canisters for the analysis of volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15). This document assumes a sample port – either sub-slab or exterior soil vapor – has already been installed. This document covers the above ground assembly and sampling methods.

Method TO-15 uses a 1-liter 3-liter or 6-liter SUMMA® passivated stainless steel canister to collect a whole-air sample. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide typical compound detection limits of 0.5 parts per billion volume (ppbv).

The following sections list the necessary equipment and detailed instructions for collecting soil vapor samples for VOC analysis.

III. PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), as needed. Arcadis field sampling personnel will be well versed in the relevant technical guidance instructions (TGIs) and possess the required skills and experience necessary to successfully complete the desired field work. Arcadis personnel responsible for leading soil vapor sample collection activities must have previous soil vapor sampling experience.

IV. EQUIPMENT LIST

The equipment required for soil vapor sample collection is presented below:

- 1,3, or 6 – liter stainless steel SUMMA® canisters (order at least one extra, if feasible) (batch certified canisters or individual certified canisters as required by the project);
- Flow controllers with in-line particulate filters and vacuum gauges; flow controllers are pre-calibrated to specified sample duration (e.g.,5-, 10, or 30- minutes) or flow rate (e.g., < 200 milliliters per minute [mL/min]); confirm with the laboratory that the flow controller comes with an in-line particulate filter and pressure gauge (order at least one extra, if feasible);
- 1/4-inch OD tubing (Teflon®, or similar);
- Extra 1/4-inch Swagelok front and back compression sleeves
- Decontaminated stainless steel Swagelok or comparable “T” fitting and ball or needle valve for isolation of purge leg of sample train;
- Stainless steel duplicate “T” fitting provided by the laboratory (if collecting duplicate [i.e., split] samples);
- 60-mL syringe equipped with a three-way leur lock valve;
- Appropriate equipment and materials for quality assurance testing as laid out in the respective quality assurance TGIs (i.e., helium leak testing, water dam testing, methane testing);
- Appropriate-sized open-end wrench (typically 9/16-inch and ½”);
- Tedlar® bag to collect purge air for venting outside a structure if working inside;
- Portable weather meter, if appropriate;

- Chain-of-custody (COC) form;
- Sample collection log (attached);
- Nitrile gloves;
- Work gloves; and
- Field notebook

V. CAUTIONS

The following cautions and field tips should be reviewed and considered prior to installing or collecting a soil vapor sample.

- Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens (sharpies), wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.

- Ensure that the flow controller is pre-calibrated to the proper sample collection duration (confirm with laboratory). Sample integrity can be compromised if sample collection is extended to the point that the canister reaches atmospheric pressure. Sample integrity is maintained if sample collection is terminated prior to the target duration and a measurable vacuum (e.g., 3 -7 – inches Hg) remains in the canister when sample collection is terminated.

- The integrity of the sample train will be tested in accordance with the project specific requirements. These procedures are contained in their own TGI documents and include helium leak testing, water dam testing, and methane screening.

- It is important to record the canister pressure, start and stop times, and sample identification on a proper field sampling form. You should observe and record the time/pressure at the start, and then again one or two hours after starting the sample collection. It is a good practice to lightly tap the pressure gauge with your finger before reading it to make sure it is not stuck. If the canister is running correctly for a 24-hour period, the vacuum will have decreased slightly after one or two hours (for example from 29 inches to 27 inches). Consult your project manager, risk assessor or air sampling expert by phone if the SUMMA canister does not appear to be working properly.

- Ensure that there is still measurable vacuum in the SUMMA® after sampling. Sometimes the gauges sent from labs have offset errors, or they stick.

- When sampling carefully consider elevation. If your site is over 2,000’ above sea level or the difference in elevation between your site and your lab is more than 2,000’ then pressure effects will be significant. If you take your samples at a high elevation they will contain less air for a given ending pressure reading. High elevation samples analyzed at low elevation will result in more dilution at the lab, which could affect reporting limits. Conversely low elevation samples when received at high elevation may appear to not have much vacuum left in them. http://www.uigi.com/Atmos_pressure.html.

- If possible, have equipment shipped a two to three days before the scheduled start of the sampling event so that all materials can be checked. Order replacements if needed.

- Requesting extra canisters and flow controllers from the laboratory should also be considered to ensure that you have enough equipment on site in case of an equipment failure.

- Check the seal around the soil vapor sampling port by using a tracer gas (e.g., helium) or other method established in the appropriate guidance document. See TGI library and project specific instructions for appropriate TGIs.

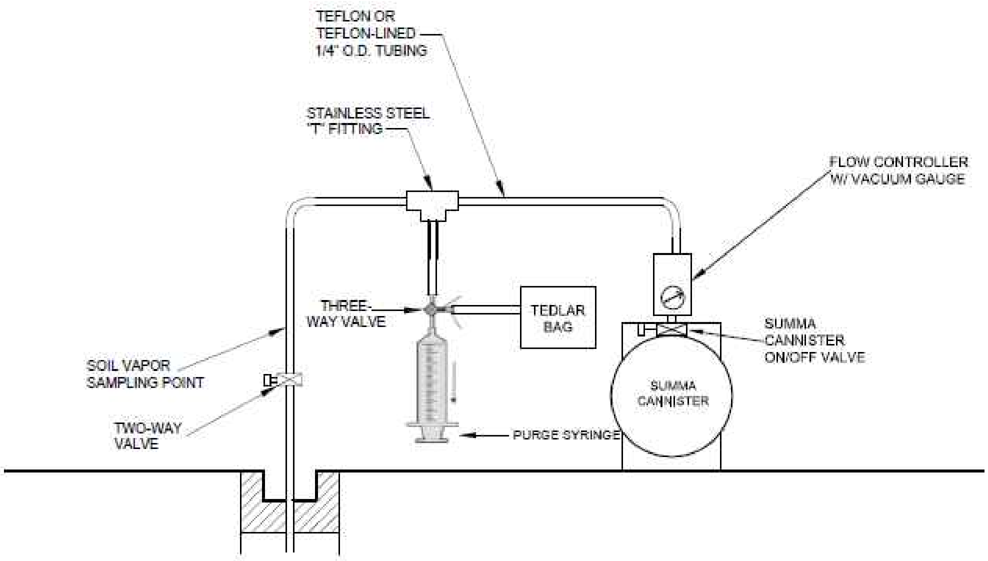
VI. HEALTH AND SAFETY CONSIDERATIONS

All sampling personnel should review the appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. Field sampling must be carefully performed to minimize the potential for injury and the spread of hazardous substances.

VII. SOIL VAPOR SAMPLE COLLECTION

Sample Train Assembly

The following procedures should be used to collect a soil vapor sample using a whole air canister (i.e., SUMMA canister). These methods can be used for both exterior soil vapor samples and interior sub-slab soil vapor samples collected from both permanent or temporary sample points installations. A schematic of the suggested sample train set up is included below



1. Assemble the sample train by removing the cap from the SUMMA canister and connecting the flow controller with in-line particulate filter and vacuum gauge. The flow controller attaches directly to the canister and dictates the sample duration. This piece will come preset from the laboratory.

2. Attach the canister and flow controller assembly to a stainless steel T-fitting using a short length of 1/4-inch OD Teflon tubing. This T-fitting adds a leg to the sample train that will be used to purge "dead" air from the sample train in order to collect a more representative sample.

3. Connect the purge syringe with three-way valve to one of the free ends of the T-fitting using a length of Teflon sample tubing, Swagelok compression fittings and silicon tubing.

4. Attach the Swagelok two-way valve to the remaining free end of the T-fitting using a short length of ¼-inch OD Teflon tubing. The two-way valve will be immediately adjacent to the sample point in the train assembly. This valve is used to isolate the sample train from the sample point prior to sampling in order to test the sample train's integrity.

5. When collecting duplicate or other quality assurance/quality control (QA/QC) samples as required by applicable regulations and guidance, couple two SUMMA canisters using stainless steel Swagelok duplicate sample T-fitting supplied by the laboratory. Attach flow controller with in-line particulate filter and vacuum gauge to duplicate sample T-fitting provided by the laboratory.

6. Attach the terminal end of the two-way Swagelok valve to the sample port as appropriate. This may be done using the options below:

a. Use a section of silicon tube to connect the Teflon sample tubing to the barbed fitting of a Vapor Pin™ port.

b. Use Swagelok compression fittings to connect Teflon tubing to sampling port. Teflon tape should never be used on Swagelok compression fitting connections.

c. Wrap the Teflon tubing with Teflon tape to seal around the slab then use VOC free clay to further seal around the slab if using temporary points.

Sample Documentation

1. Record on the sample log and COC form the flow controller number with the appropriate SUMMA® canister number.

2. Record the following information on the sample log, if appropriate (contact the local airport or other suitable information source [e.g., site-specific measurements, weatherunderground.com] to obtain the information):

    a. wind speed and direction;

    b. ambient temperature;

    c. barometric pressure; and

    d. relative humidity.

3. Take a photograph of the SUMMA® canister and surrounding area.

Sample Collection

1. Perform a leak-down-test by closing the two-way valve to the sample port. Open the three-way valve to the syringe and pull a vacuum. Quickly close the three-way valve and record the pressure indicated on the gauge connected to the canister. If there are no leaks in the system this vacuum should be held. If vacuum holds proceed with sample collection; if not attempt to rectify the situation by tightening fittings.

2. Open the two-way valve and purge the soil vapor sampling port and tubing with the portable sampling pump. Purge approximately three volumes of air from the soil vapor sampling port and sampling line using a flow rate of 200 mL/min. Purge volume is calculated by the following equation “purge volume = 3 x Pi x inner radius of tubing^2 x length of tubing. Purge air will be collected into a Tedlar bag to provide that VOCs are not released into interior spaces. Perform quality control method tests concurrently, as appropriate

3. Close the three-way valve to the syringe in order to isolate this leg of the sample train.

4. Open the SUMMA® canister valve to initiate sample collection. Record on the sample log (attached) the time sampling began and the canister pressure.

   If the initial vacuum pressure registers less than -25 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.

5. Check the SUMMA canister approximately half way through the sample duration and note progress on sample logs.

Termination of Sample Collection

1. Arrive at the SUMMA® canister prior to the end of sample collection.

2. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valves. The canister should have a minimum amount of vacuum (approximately 5 inches of Hg or slightly greater).

3. Record the date and local time (24-hour basis) of valve closing on the sample collection log and COC form.

4. Disconnect sample tubing from the sample port; replace any coverings or abandon as appropriate to mitigate tripping hazards.

5. Remove the particulate filter and flow controller from the SUMMA® canister, re-install the brass plug on the canister fitting, and tighten with the appropriate wrench.

6. Package the canister and flow controller per Department of Transportation regulations for return shipment to the laboratory. These regulations can be found at the Transportation Safety Program's Team Site on the Source. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.

7. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with a string).

8. Complete the COC form and place the requisite copies in a shipping container. Close the shipping container and affix a custody seal to the container closure. Ship the container to the laboratory via overnight carrier (e.g., Federal Express) for analysis.

VIII. WASTE MANAGEMENT

No specific waste management procedures are required.

IX. DATA RECORDING AND MANAGEMENT

Measurements will be recorded on the sample log at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location (e.g., GPS coordinates, distance from permanent structure [e.g., two walls, corner of room]), canister serial number, flow controller serial number, initial vacuum reading, and final pressure reading. Field sampling logs and COC records will be transmitted to the Project Manager.

X. QUALITY ASSURANCE

Duplicate samples should be collected in the field as a quality assurance step per project requirements. Generally, duplicates are taken from 10% of samples, but project specific requirements should take precedence.

XI. REFERENCES

DiGiulio et. al. 2003. Draft Standard Operating Procedure (SOP) for Installation of Sub-Slab Vapor Probes and Sampling Using EPA TO-15 to Support Vapor Intrusion Investigations. http://www.cdphe.state.co.us/hm/indoorair.pdf (Attachment C)

Di Giulio et. Al. 2006. Assessment of Vapor intrusion in Homes Near the Raymark Superfund Site Using Basement and Sub-Slab Air Samples. USEPA. EPA/600/R-05/147.

New York State Department of Health (NYSDOH). 2005. DRAFT “Guidance for Evaluating Soil Vapor Intrusion in the State of New York” February 23, 2005.

APPENDIX B

Field Standard Operating and Calibration Procedures

DUSTTRAK™ II
AEROSOL MONITOR
MODEL 8530/8530EP/8532

OPERATION AND SERVICE MANUAL

P/N 6001893, REVISION U
NOVEMBER 2019

DustTrak II 8530 Desktop and 8532 Handheld

DustTrak II 8530EP Monitor

START SEEING THE BENEFITS OF REGISTERING TODAY!

Thank you for your TSI instrument purchase. Occasionally, TSI releases information on software updates, product enhancements and new products. By registering your instrument, TSI will be able to send this important information to you.

http://register.tsi.com

As part of the registration process, you will be asked for your comments on TSI products and services. TSI's customer feedback program gives customers like you a way to tell us how we are doing.

UNDERSTANDING, ACCELERATED

TSI Incorporated - Visit our website **www.tsi.com** for more information.

USA	**Tel:** +1 800 874 2811	**India**	**Tel:** +91 80 67877200
UK	**Tel:** +44 149 4 459200	**China**	**Tel:** +86 10 8219 7688
France	**Tel:** +33 1 41 19 21 99	**Singapore**	**Tel:** +65 6595 6388
Germany	**Tel:** +49 241 523030		

Address

TSI Incorporated / 500 Cardigan Road / Shoreview, MN 55126 / USA

Fax No.

(651) 490-3824

Limitation of Warranty and Liability (effective April 2014)

(For country-specific terms and conditions outside of the USA, please visit www.tsi.com.)

Seller warrants the goods, excluding software sold hereunder, under normal use and service as described in the operator's manual, shall be free from defects in workmanship and material for twenty-four (24) months, or if less, the length of time specified in the operator's manual, from the date of shipment to the customer. This warranty period is inclusive of any statutory warranty. This limited warranty is subject to the following exclusions and exceptions:

a. Hot-wire or hot-film sensors used with research anemometers, and certain other components when indicated in specifications, are warranted for 90 days from the date of shipment;
b. DustTrak internal pump for Models 8530 and 8533 is warranted for two (2) years or 4000 hours, whichever comes first;
c. DustTrak external pump for Models 8530EP and 8533EP is warranted for two (2) years or 8760 hours, whichever comes first;
d. DustTrak internal pump for Models 8530 and 8533 is warranted for operation within ambient temperatures between 5–45°C. Warranty is void when the internal pump is operating outside of this temperature range;
e. Parts repaired or replaced as a result of repair services are warranted to be free from defects in workmanship and material, under normal use, for 90 days from the date of shipment;
f. Seller does not provide any warranty on finished goods manufactured by others or on any fuses, batteries or other consumable materials. Only the original manufacturer's warranty applies;
g. This warranty does not cover calibration requirements, and seller warrants only that the instrument or product is properly calibrated at the time of its manufacture. Instruments returned for calibration are not covered by this warranty;
h. This warranty is **VOID** if the instrument is opened by anyone other than a factory authorized service center with the one exception where requirements set forth in the manual allow an operator to replace consumables or perform recommended cleaning;
i. This warranty is **VOID** if the product has been misused, neglected, subjected to accidental or intentional damage, or is not properly installed, maintained, or cleaned according to the requirements of the manual. Unless specifically authorized in a separate writing by Seller, Seller makes no warranty with respect to, and shall have no liability in connection with, goods which are incorporated into other products or equipment, or which are modified by any person other than Seller.

The foregoing is **IN LIEU OF** all other warranties and is subject to the **LIMITATIONS** stated herein. **NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE**. **WITH RESPECT TO SELLER'S BREACH OF THE IMPLIED WARRANTY AGAINST INFRINGEMENT, SAID WARRANTY IS LIMITED TO CLAIMS OF DIRECT INFRINGEMENT AND EXCLUDES CLAIMS OF CONTRIBUTORY OR INDUCED INFRINGEMENTS. BUYER'S EXCLUSIVE REMEDY SHALL BE THE RETURN OF THE PURCHASE PRICE DISCOUNTED FOR REASONABLE WEAR AND TEAR OR AT SELLER'S OPTION REPLACEMENT OF THE GOODS WITH NON-INFRINGING GOODS.**

TO THE EXTENT PERMITTED BY LAW, THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF SELLER'S LIABILITY FOR ANY AND ALL LOSSES, INJURIES, OR DAMAGES CONCERNING THE GOODS (INCLUDING CLAIMS BASED ON CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) SHALL BE THE RETURN OF GOODS TO SELLER AND THE REFUND OF THE PURCHASE PRICE, OR, AT THE OPTION OF SELLER, THE REPAIR OR REPLACEMENT OF THE GOODS. IN THE CASE OF SOFTWARE, SELLER WILL REPAIR OR REPLACE DEFECTIVE SOFTWARE OR IF UNABLE TO DO SO, WILL REFUND THE PURCHASE PRICE OF THE SOFTWARE. IN NO EVENT SHALL SELLER BE LIABLE FOR LOST PROFITS, BUSINESS INTERRUPTION OR ANY SPECIAL, INDIRECT, CONSEQUENTIAL OR INCIDENTAL DAMAGES. SELLER SHALL NOT BE RESPONSIBLE FOR INSTALLATION, DISMANTLING OR REINSTALLATION COSTS OR CHARGES. No Action, regardless of form, may be brought against Seller more than 12 months after a cause of action has accrued. The goods returned under warranty to Seller's factory shall be at Buyer's risk of loss, and will be returned, if at all, at Seller's risk of loss.

Buyer and all users are deemed to have accepted this LIMITATION OF WARRANTY AND LIABILITY, which contains the complete and exclusive limited warranty of Seller. This LIMITATION OF WARRANTY AND LIABILITY may not be amended, modified or its terms waived, except by writing signed by an Officer of Seller.

Service Policy

Knowing that inoperative or defective instruments are as detrimental to TSI as they are to our customers, our service policy is designed to give prompt attention to any problems. If any malfunction is discovered, please contact your nearest sales office or representative, or call TSI's Customer Service department at (800) 680-1220 (USA) or (001 651) 490-2860 (International) or visit www.tsi.com.

CONTENTS

These Application Notes can also be found on TSI's web site:
http://www.tsi.com

EXPMN-001 DustTrak II Theory of Operation.pdf
EXPMN-003 DustTrak II Impactor.pdf

Safety Information

I M P O R T A N T

There are no user serviceable parts inside the instrument. Refer all repair and maintenance to a qualified factory-authorized technician. All maintenance and repair information in this manual is included for use by a qualified factory-authorized technician.

Laser Safety

- The Model 8530/8532 DustTrak II monitor is a Class I laser-based instrument.
- During normal operation, you will ***not*** be exposed to laser radiation.
- Precaution should be taken to avoid exposure to hazardous radiation in the form of intense, focused, visible light.
- Exposure to this light may cause blindness.

Take these precautions:

- ***DO NOT*** remove any parts from the DustTrak II monitor unless you are specifically told to do so in this manual
- ***DO NOT*** remove the housing or covers. There are no serviceable components inside the housing.

W A R N I N G

The use of controls, adjustments, or procedures other than those specified in this manual may result in exposure to hazardous optical radiation.

W A R N I N G

There are no user-serviceable parts inside this instrument. The instrument should only be opened by TSI or a TSI approved service technician.

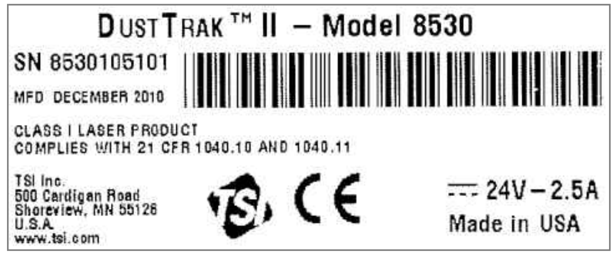
W A R N I N G

If the DustTrak monitor is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

When operated according to the manufacturer's instruction, this device is a Class I laser product as defined by U.S. Department of Health and Human Services standards under the Radiation Control for Health and Safety Act of 1968. A certification and identification label like the one shown below is affixed to each instrument.

Labels

Advisory labels and identification labels are attached to the instrument.

1. Serial Number Label (bottom)	
2. Laser Radiation Label (internal)	**DANGER!** VISIBLE LASER RADIATION WHEN OPEN. AVOID DIRECT EXPOSURE TO BEAM WARNING: NO USER SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED PERSONNEL
3. Battery label	 or 
4. European symbol for non-disposable item. Item must be recycled.	

Description of Caution/Warning Symbols

Appropriate caution/warning statements are used throughout the manual and on the instrument that require you to take cautionary measures when working with the instrument.

Caution

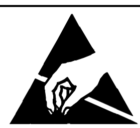
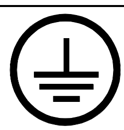
C A U T I O N
Failure to follow the procedures prescribed in this manual might result in irreparable equipment damage. Important information about the operation and maintenance of this instrument is included in this manual.

Warning

W A R N I N G
Warning means that unsafe use of the instrument could result in serious injury to you or cause damage to the instrument. Follow the procedures prescribed.

Caution and Warning Symbols

The following symbols may accompany cautions and warnings to indicate the nature and consequences of hazards:

	Warns that the instrument contains a laser and that important information about its safe operation and maintenance is included in the manual.
	Warns that the instrument is susceptible to electro-static discharge (ESD) and ESD protection should be followed to avoid damage.
	Indicates the connector is connected to earth ground and cabinet ground.

Reusing and Recycling

As part of TSI Incorporated's effort to have a minimal negative impact on the communities in which its products are manufactured and used:

- **DO NOT** dispose of used batteries in the trash. Follow local environmental requirements for battery recycling.
- If instrument becomes obsolete, return to TSI for disassembly and recycling.

(This page intentionally left blank)

Chapter 1

Unpacking and Parts Identification

Carefully unpack the Model 8530/8532 DustTrak™ II Aerosol Monitor from the shipping container. Use the tables and illustrations below to make certain that there are no missing components. Contact TSI immediately if anything is missing or damaged.

NOTE
If you purchased a DustTrak II Model 8530-NA (no accessories) Aerosol Monitor, it only comes with the following items: • DustTrak II Model 8530 Aerosol Monitor • Operations manual • TrakPro™ Data Analysis Software CD • One-year calibration certificate • Service paperwork • 2-year warranty All accessories for the DustTrak II Model 8530 Aerosol Monitor are sold separately. Contact TSI at (800) 680-1220 for information on accessories and how to purchase them through a TSI sales representative.

(continued on next page)

Unpacking the DustTrak II Aerosol Monitor

Compare all the components you received with those listed in the table below. If any parts are missing, contact TSI.

Item	Qty	Part Number	Description
 *or*	1	8530	Desktop II
		8532	Handheld II
	1	801670	Desktop II Carrying Case
		801669	Handheld II Carrying Case
	1	1090014	Data Analysis Software CD-ROM
	1	800663	Zero Filter

Item	Qty	Part Number	Description
 *or*	1	801680	7800 mAH Lithium Ion Rechargeable Battery (Desktop)
		801681	Rechargeable lithium ion battery (Handheld)
	1	1303740	USB cable
	1	801652	Analog/alarm output cable (Desktop models only)
	1	6001893	Operation and Service Manual
	1	N/A	Calibration Certificate

Item	Qty	Part Number	Description
	1	801688	Conductive Tubing
	1	801668	Filter removal tool (Spanner Driver)
	4	801673	Spare Internal Filter Elements Desktop Model Only
	2		37-mm filter includes: Filter body top Filter body bottom Mesh screen
	1		Comes with 37-mm cartridge opening tool
	8	801666	Spare Internal Filters Handheld Model Only
	1	801667	Impactor Kit
		PM$_{2.5}$ assembled Top Bottom Impaction Plate PM$_{1.0}$ Top PM$_{4.0}$ Top PM$_{10}$ Top Extra Impaction Plate	
	1	801691	Dorr-Oliver Cyclone

Item	Qty	Part Number	Description
	1	801684	Power Supply – Desktop
		801694	Power Supply – Handheld
	2	N/A	Stylus
		When shipped, one stylus will be in the accessory bag, the second stylus attached to instrument.	
	1	3012094	Screwdriver, dual ended. (For Handheld Models only)
	1	801674	Impactor Oil
	2	801698	Inlet cap
		When shipped, one inlet will be in the accessory bag, the second inlet attached to instrument.	
	1	801675	External Pump Kit *for 8530EP only*

Item	Qty	Part Number	Description
	1	801797	External Pump Power Cable (to DustTrak monitor) *for 8530EP only*
	1	801798	External Pump Flow Tube (to DustTrak monitor) *for 8530EP only*
	1		Exhaust Adapter, DustTrak monitor *for 8530EP only*

Optional Accessories

The following photos and table list optional accessories. If you ordered optional accessories, make certain they have been received and are in working order.

Accessories	Qty	Part Number	Description
	1	801675	External Pump Kit
	2	801795	DustTrak II/DRX External Pump Service Kit for 8530EP only. Contains two filters for External Pump
	1	801685	Battery Charger, 2-Bay, Battery 801680 for Desktop DustTrak monitor
	1	801686	Battery Charger, Battery 801681 for Handheld DustTrak monitor

Parts Identification for the DustTrak II Desktop Aerosol Monitor Models 8530

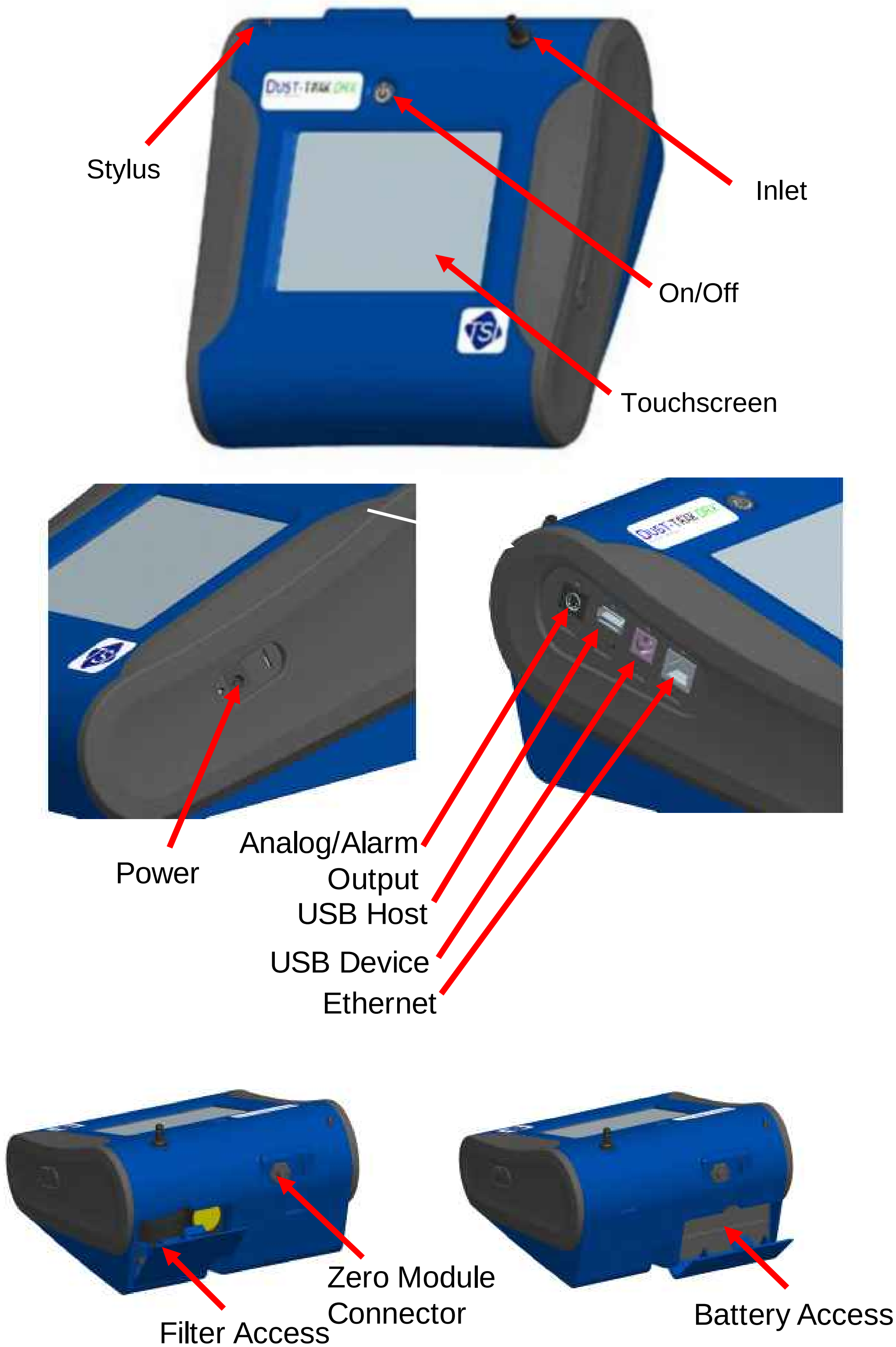
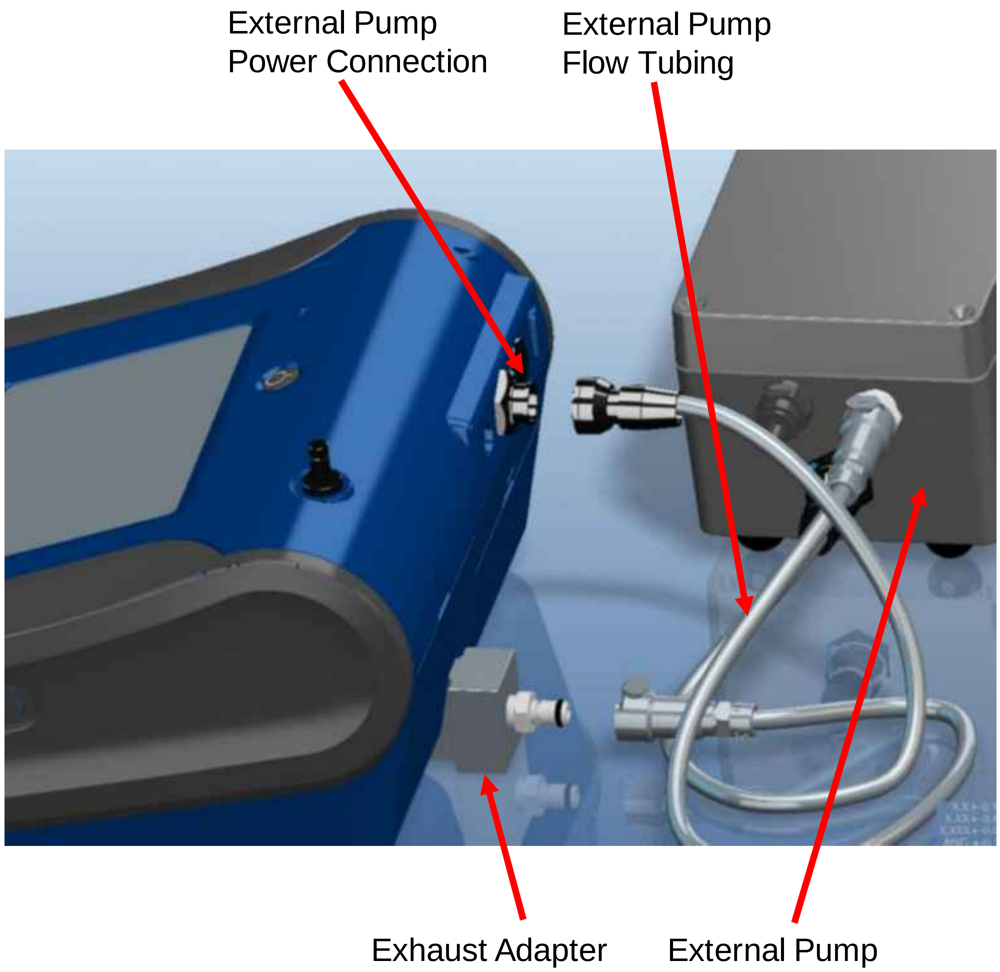


Figure 1-1: Features on Desktop Model 8530

Parts Identification for the DustTrak II Desktop Aerosol Monitor Model 8530EP



External Pump Module (8530EP only)

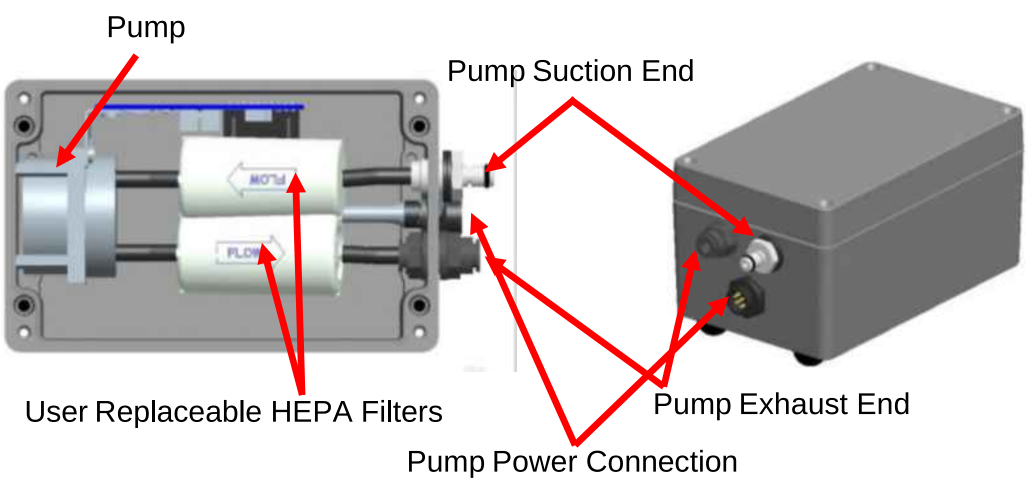


Figure 1-2: Features on Desktop Model 8530EP

Parts Identification for the DustTrak II Handheld Aerosol Monitor Model 8532

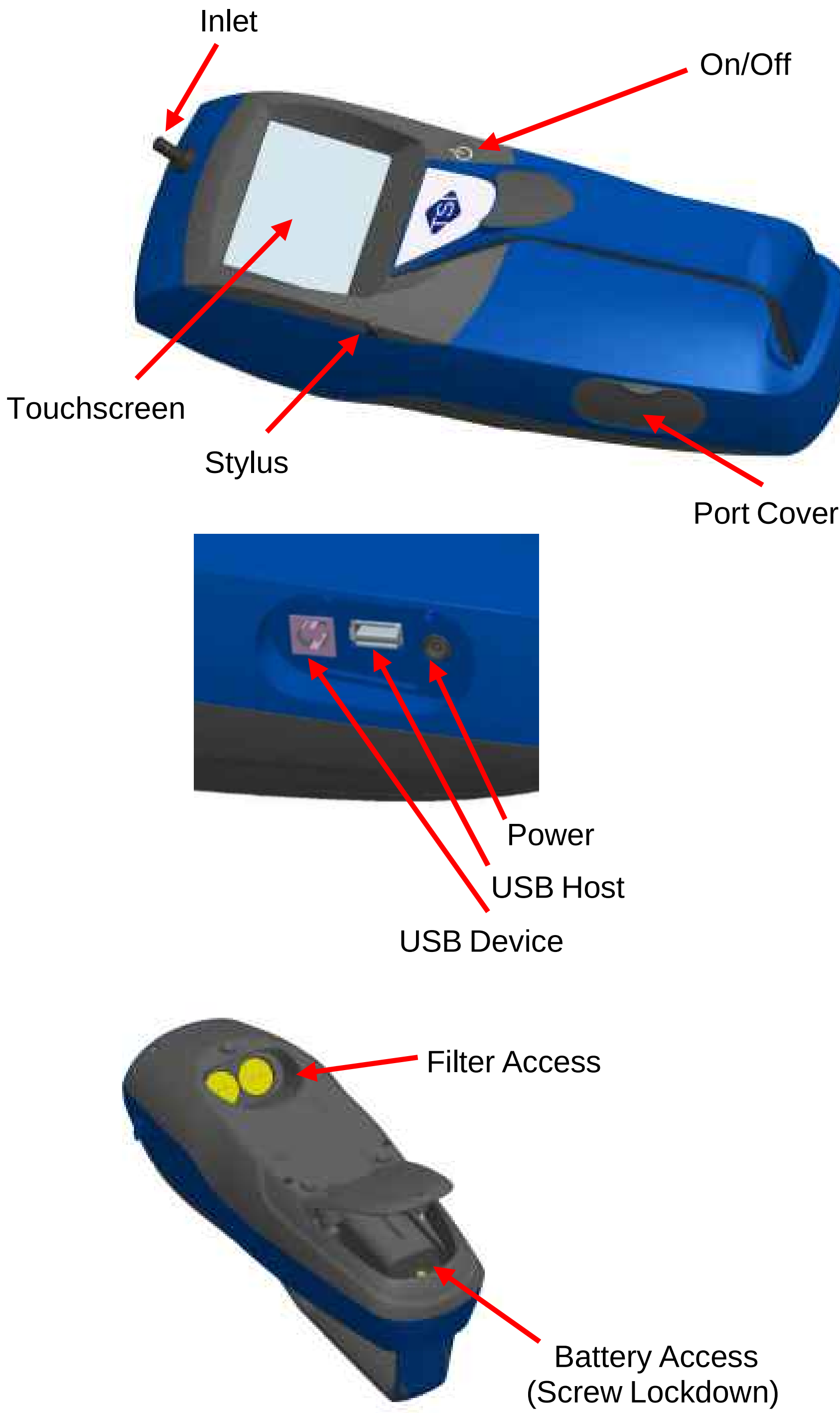


Figure 1-3: Features on Handheld Model

Chapter 2

Setting Up

Supplying Power to the DustTrak II Aerosol Monitor

The DustTrak II Aerosol Monitor must be powered by either batteries or using the external AC adapter.

W A R N I N G

The instrument has been design to be used with batteries supplied by TSI. **DO NOT** use a substitute.

Disposing of old batteries must be recycled in accordance with the local environmental regulations.

W A R N I N G

DO NOT use non-rechargeable batteries in this instrument. Fire, explosions, or other hazards may result.

Installing the Batteries in Model 8530/8530EP Desktop

Remove the battery cover and slide one or two batteries into the battery slots. A single battery can be put into either slot. Orient the batteries with the label side facing up (see Figure 2-1).

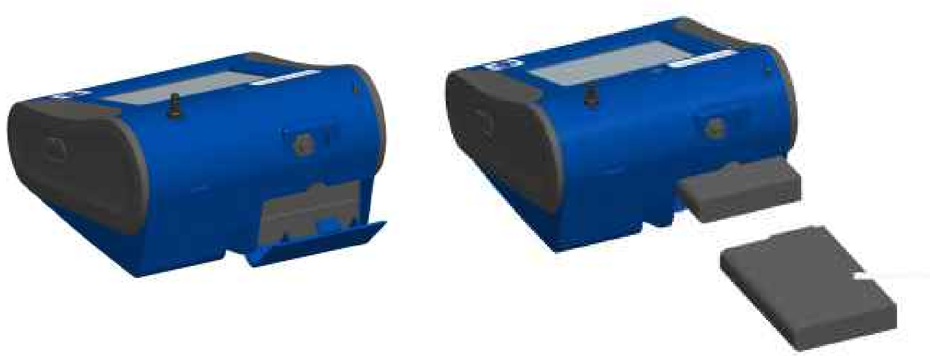


Figure 2-1: Batteries into Desktop Unit

Installing the Batteries in Model 8532 Handheld

Remove the battery cover by loosening captured screw on the bottom of the unit. Orient battery with brass connectors facing forward. Insert battery into cavity and slide forward to engage into pins. Replace the battery cover and secure by tightening screw (see Figure 2-2).

Figure 2-2: Batteries into Handheld Unit

Connecting the External Pump to DustTrak Model 8530EP

The Model 8530EP is a Desktop DustTrak monitor with an external pump. This DustTrak has no internal pump and will not work with any other external pump other than the one provided by TSI (P/N 801675). The Model 8530EP is intended for applications where the DustTrak is operated continuously over extended periods (several days to months) under wide temperature fluctuations (0 to 50°C). The external pump is designed to be more robust for 24/7 operation of the DustTrak monitor and is warranted to operate continuously for one full year or 8760 hours. The Model 8530EP is ideal for fugitive dust monitoring.

The pump and the DustTrak monitor come separately and require assembly. Follow the steps below to connect the pump with the Model 8530EP DustTrak monitor.

WARNING
Turn the DustTrak monitor OFF before connecting the external pump. Turn the DustTrak monitor ON only after connecting the External Module.

1. Connect the pump end of the quick connect to the pump module (see Figure 2-3).

Figure 2-3: Connect Pump End of Quick Connect to Pump Module

2. Likewise, plug one end of the power connector to the pump module as shown above. Turn the power connector until it clicks and locks in place. This prevents the connector from disconnecting due to vibration or movement.

Figure 2-4: Connect Exhaust Adapter to Exhaust of DustTrak Monitor

3. Connect the exhaust adapter to the exhaust of the DustTrak monitor (see Figure 2-4).

4. Connect the other end of the flow tubing to the exhaust adapter of the DustTrak monitor.

5. Connect the other end of the power connector to the DustTrak monitor (see Figure 2-5).

Figure 2-5: Connect Power Connector to DustTrak Monitor

WARNING
The Pump module design does not allow for installation outdoors without any protection from the elements. Always operate it within an enclosure.

The DustTrak external pump module does not require an A/C adapter. It is always powered off the DustTrak monitor.

NOTES

1. The power connector and the flow quick connect “click” when securely connected. The power connector must be rotated clockwise past the locking pin.
2. **DO NOT** hot-plug the External Pump Module when the DustTrak monitor is turned ON. Always connect the External Pump module first and then turn the DustTrak monitor ON.
3. TSI recommends that the DustTrak monitor with the external pump be operated in the Model 8535 Environmental Enclosure.
4. TSI recommends that the pump module be operated when mounted on its feet and avoid operating at other orientations as much as possible.
5. Pump module and the DustTrak monitor should be at the same electrical potential.
6. The additional port on the external pump module is where the pump exhausts the flow. For applications where the DustTrak monitor is sampling from a chamber or a duct at pressures significantly different from the ambient, TSI recommends plumbing the exhaust of the external pump back in to the chamber/duct.

Using the AC Adapter to Run Instrument

The AC adapter allows you to power the DustTrak monitor from an AC wall outlet. When using the AC adapter, the batteries (if installed) are bypassed.

Battery Charging

This instrument will charge the Lithium Ion battery packs. Insert the batteries into the battery compartment, plug the instrument into AC power, and turn the instrument on. Batteries will charge only when the instrument is on and in stand-by mode. Batteries will not charge if the instrument is turned off or is actively taken measurements. Charging will stop when the batteries are fully charged.

WARNING
When Charging Battery the ambient temp **MUST NOT** exceed 42°C.

Inlet Cap

When using the DustTrak monitor to sample environmental air, the inlet cap should be put over the instrument. This cap will keep large objects from dropping into and plugging the inlet. The cap will also keep direct light from shinning into the chamber and skewing the results.

The inlet cap can simply be pressed onto the instruments inlet.

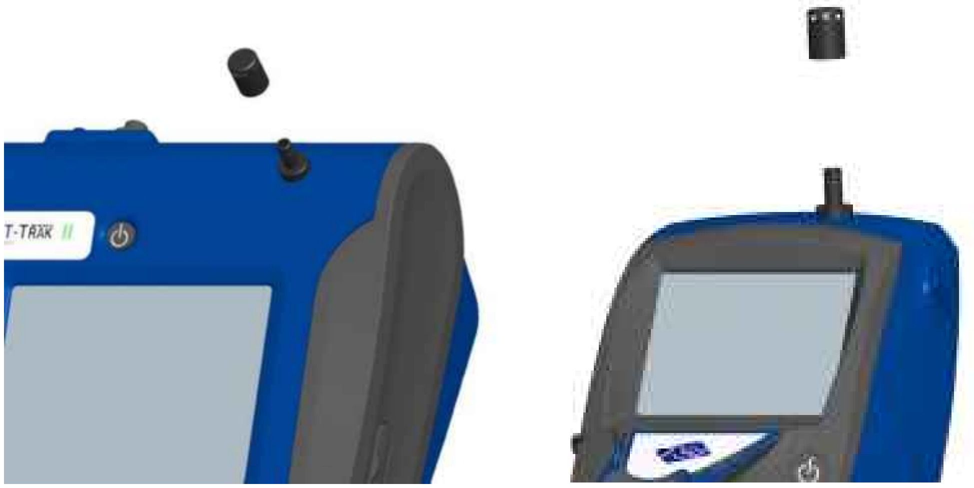


Figure 2-6: Putting on Inlet Cap

Size-Selective Impactors

Size-selective impactors can be attached to the inlet of the DustTrak II instruments. Size-selective impactors can be used to pre-condition the size range of the particles entering the instrument. PM_1, $PM_{2.5}$, PM_4 (Respirable) and PM_{10} impactors are available. **The instrument must run at the factory default setting of 3.0 L/min for the impactors to achieve the correct cut points.**

The size-selective impactor is composed of three parts; the cap, impaction plate and bottom. Selection of the cap will determine cut size of the impactor. Each cap is labeled with the particle cut size (1 µm, 2.5 µm, 4.0 µm or 10 µm). The same impaction plate and bottom are used on all impactor sizes.

The impactor assembly is attached to the instrument in place of the inlet cap. The inlet cap does not need to be used if an impactor is being used. See Chapter 4, "Maintenance," for instructions on how to add oil to the impaction plate.

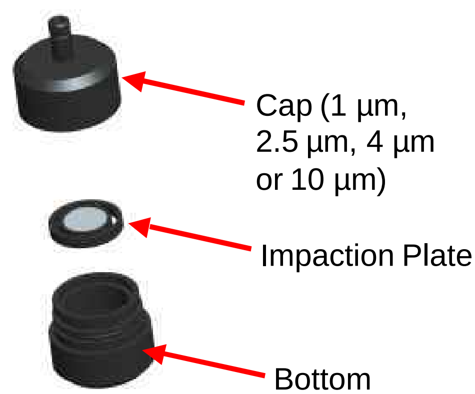


**Figure 2-7:
Size-Selective Impactor**

Dorr-Oliver Cyclone

A Dorr-Oliver cyclone is shipped with the instrument. The Dorr-Oliver cyclone removes particles over 4.0 µm in size. The Dorr-Oliver cyclone is attached to the instrument by sliding the cyclone clip over the protruding catch. The tube from the Dorr-Oliver cyclone needs to be routed to the inlet of the instrument.

Figure 2-8: Installing Door-Oliver Cyclone

Do not use Inlet attachments (impactors or inlet cap) when using the Dorr-Oliver Cyclone. **The instrument flow rate must be changed to 1.7 L/min when using the Dorr-Oliver Cyclone in order to achieve a 4 µm (respirable) cut-point.** See the Flow Cal instructions in the Operations chapter for instructions on how to change the instruments flow rate.

Instrument Setup

The DustTrak II monitor can be connected to a computer to download data and upload sampling programs.

Connecting to the Computer

Connect the USB host port of a Microsoft Windows®-based computer to the USB device port on the side of the DustTrak monitor.

Installing TrakPro™ Data Analysis Software

TrakPro software can preprogram the DustTrak monitor, download data, view and create raw data and statistical reports, create graphs, and combine graphs with data from other TSI instruments that use TrakPro software. The following sections describe how to install the software and set up the computer.

NOTE
To use TrakPro software with the DustTrak Aerosol Monitor, the PC must be running Microsoft Windows® and the computer must have an available Universal Serial Bus (USB) port.

®Windows is a registered trademark of Microsoft Corporation.
®Microsoft and Windows are registered trademarks of Microsoft Corporation.

1. Insert the TrakPro Data Analysis Software CD into the CD-ROM drive. The install screen starts automatically.

NOTE
If the software does not start automatically after a few minutes, manually run the program listed on the label of the CD using the **Run** command on the Windows Start Menu.

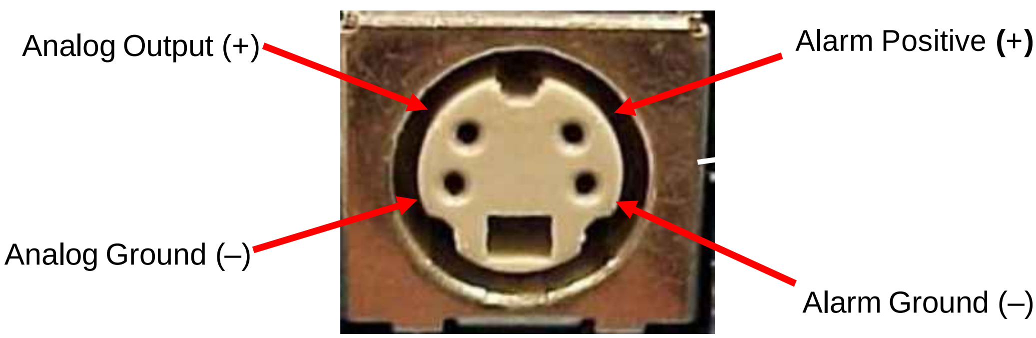
2. Follow the directions to install TrakPro software.

TrakPro software contains a comprehensive installation guide. TSI recommends printing out this guide prior to starting the TrakPro software installation on your computer, so it may be consulted during the installation. The TrakPro Software manual is located in the "Help" file in TrakPro software. There is no separately printed TrakPro Data Analysis software manual.

Connecting Analog/Alarm Output

The Analog/Alarm Output Cable plugs into the alarm connection on the side of the instrument. This feature is on the desktop model 8530 only.

The cable contains a 4-pin, mini-DIN connector. The pin-outs for the connector and the wiring for the cable are shown below.



4-pin miniDIN connector

Cable Wiring Diagram	
Brown Wire	Analog Ground
Orange Wire	Analog Out
Red Wire	Alarm (+)
White Wire	Alarm (-)
Black Wire	Shield

Figure 2-9: Cable Wiring Diagram

Wiring the Analog Output

System specifications:

- Output voltage: 0 to 5 VDC. With a maximum output of 15 mA.
- Output Current 4 mA to 20 mA with a maximum load impendence of 250 ohms.
- Correct polarity must be observed (see pin-outs above).

The output cable supplied by TSI (P/N 801652) is labeled with the pin-out wiring diagram. Additional equipment may be needed for making connections to the system that TSI does not supply. It is your responsibility to specify and supply all additional equipment.

Wiring the Alarm

System specifications:

- Maximum voltage: 15 VDC (**DO NOT USE AC POWER**)
- Maximum current: 1 Amp
- Correct polarity must be observed (see pin-outs above)
- The alarm switch, located inside the DustTrak monitor must be located on the ground side of the alarm system.

WARNING

The DustTrak monitor Alarm Output function **SHOULD NOT** be used to detect hazardous conditions or to provide an alarm for protecting human life, health or safety.

CAUTION

The alarm switch **MUST NOT** be wired to AC power! Failure to install the user alarm properly could damage the DustTrak instrument and/or void the instrument warranty! Please read and follow all instructions before wiring or operating the user alarm.

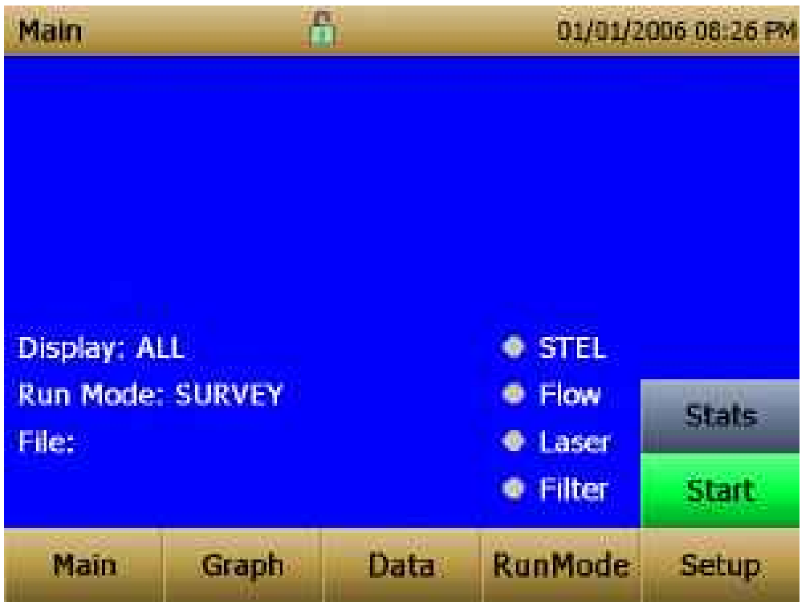
WARNING

When connected to the analog out and alarm out connector, you **MUST** use safety certified equipment and/or power sources.

Operation

Getting Started

The **START UP** screen is displayed initially when the instrument is turned on, following the initial TSI logo splash screen.



Use a stylus or fingertip, touch the "buttons" on the screen to activate different menus.

For Model DustTrak 8530EP only

W A R N I N G

Always setup and operate the DustTrak monitor with External Pump Module with the External Pump Module connected to the DustTrak monitor. Failure to do so will result in communication errors.

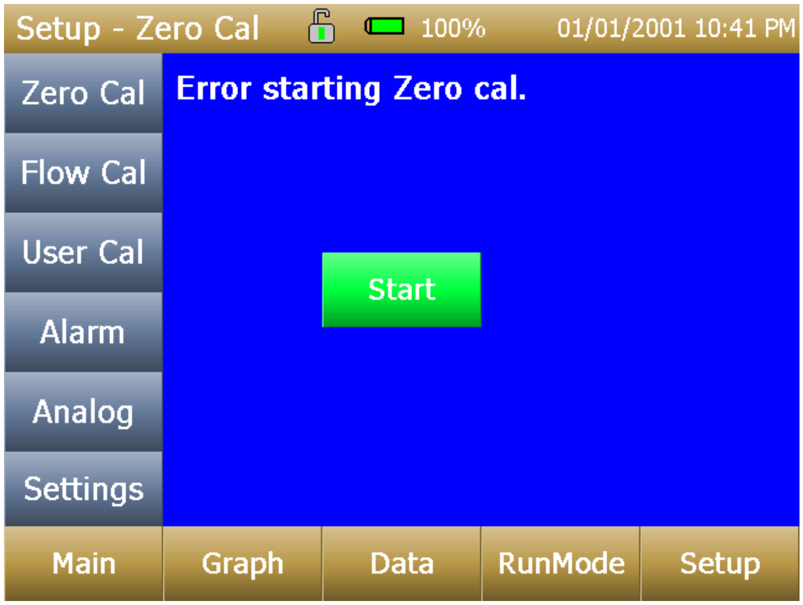
Communication errors take place under four different scenarios as follows:

1. When the unit is idle and is ***not*** connected to the External Pump Module, a warning displays on the Main screen.

NOTE
"No Pump is Connected" is a sticky error. Even after the warning message, if the External Pump Module is connected to the DustTrak, the error will not disappear until the screen is refreshed. Refresh the screen by going into a different menu and returning to the Main menu.

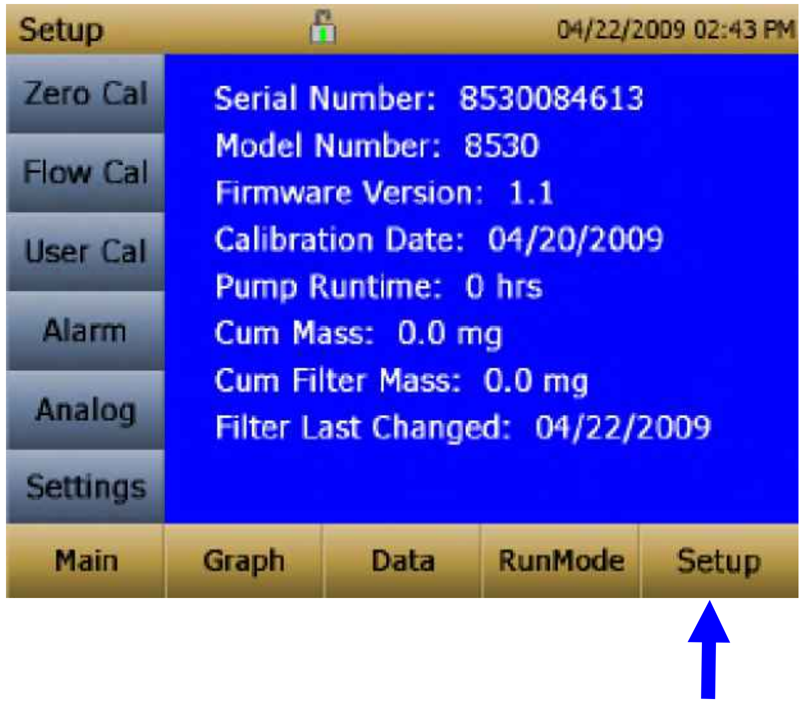
2. When the unit is ***not*** connected to the External Pump Module and an attempt is made to start a run by selecting "**Start**", an error appears on the Main screen.

3. If the pump is ***not*** connected while attempting to perform a Zero Cal, an error appears on the Setup screen.



4. If the pump is ***not*** connected while attempting to perform a Flow Cal, an error appears on the Setup screen.

Setup Menu



Pressing **Setup** activates the Setup Menu touchscreen buttons along the left edge of the screen. Setup is not accessible when the instrument is sampling.

The main screen of the **Setup** screen displays the following information:

Serial Number	The instruments serial number.
Model Number	The instruments model number.
Firmware Version	Instruments current version of firmware.
Calibration Date	Date of the last factory calibration.
Pump Run Time	Pump running time in hours.
Cum Mass Conc	Amount of mass run through instrument since its last calibration.
Cum Filter Conc	Amount of mass run through instrument since last filter change.
Filter Time	Date of last filter change.

Zero Cal

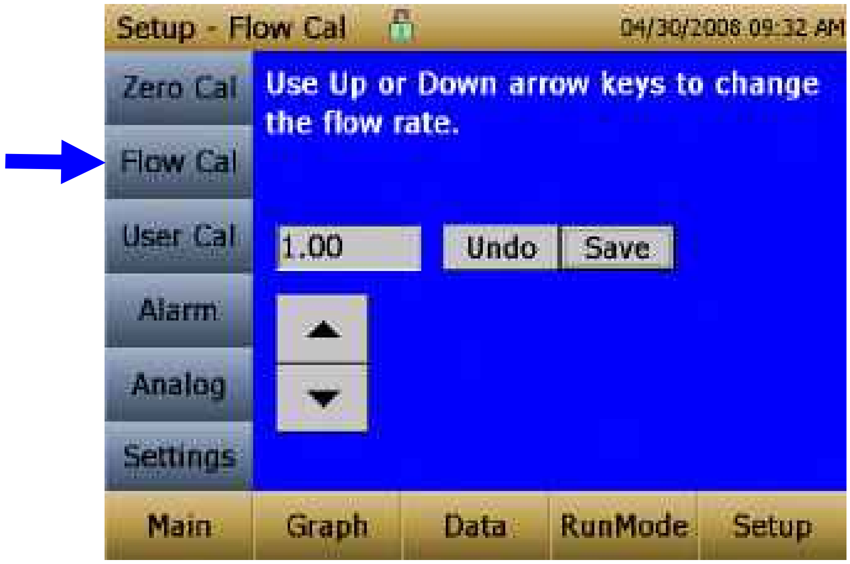
Run **Zero Cal** the first time the instrument is used and repeat prior to every use. Zero Cal requires that the zero filter be attached prior to running. Zero Cal must also be performed if the unit is reading negative concentrations. It is not possible for the DustTrak to read negative concentrations. Negative concentrations are a symptom of zero drift.

NEVER perform a zero cal without attaching a zero filter.

1. Press **Zero Cal** Button
2. Attach Zero Filter
3. Press the **Start** button to start Zeroing process.
4. A count-down clock will appear indicating the time remaining. The screen with indicate "**Zero Cal Complete"** when done.

Remove filter after zeroing has been completed. The instrument is now zero calibrated and ready for use.

Flow Cal



Run **Flow Cal** to change the flow set point. The flow set point is factory set to 3 L/min total flow. 2 L/min of the total flow is measured aerosol flow. 1 L/min of total flow is split off, filtered, and used for sheath flow. There is an internal ∆P flowmeter in the DustTrak II instrument that controls flow rate to ±5% of the factory setpoint. TSI recommends checking the flow with an external flow reference meter, especially when collecting data. The pump will automatically start when entering the Flow Cal screen.

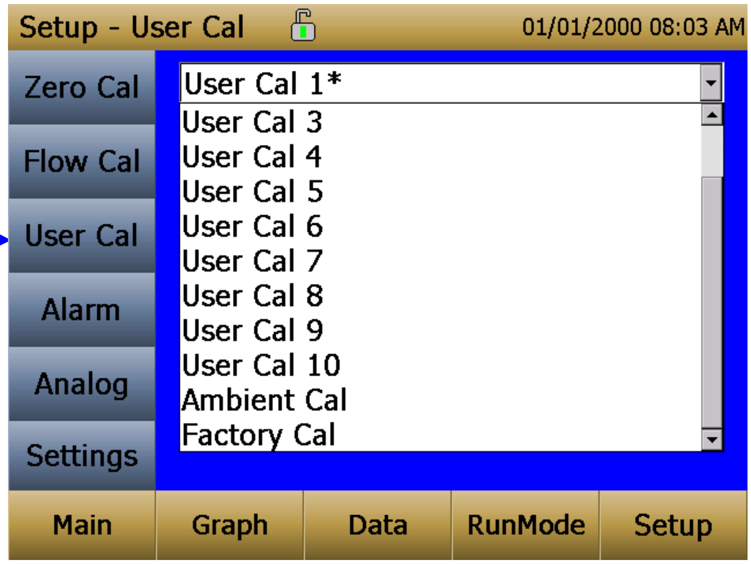
1. Attach a flow calibrator (reference flow meter) to inlet port. You may use a bubble buret, mass flow meter, dry piston or rotameter as flow measurement devices.

2. Move the arrows up or down to achieve desired flow rate on the reference flowmeter. Each up or down arrow will change the flow about 1%. Allow time between button presses to let pump change to the new flow rate.

   Select **Save** once the desired flow rate is achieved. Select **Undo** to return to the factory set point.

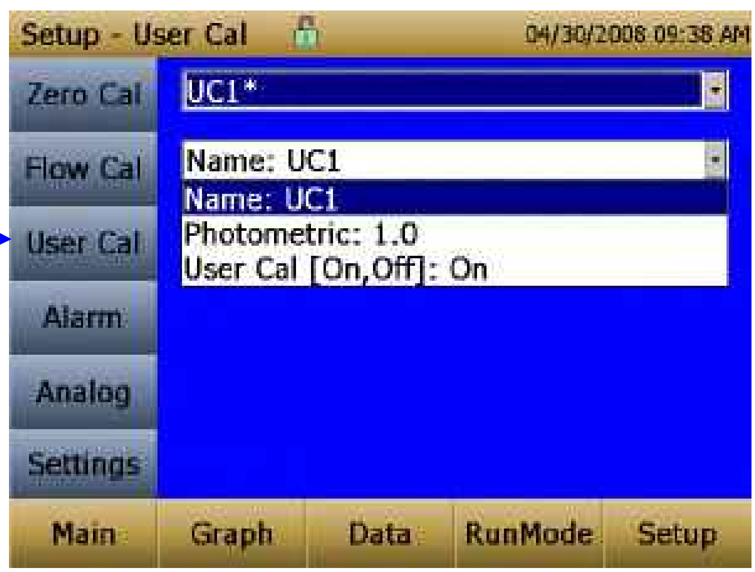
NOTE
The flow rate can be adjusted from approximately 1.5 to 4.0 L/min. If needed, this feature can be used to adjust the flow rate to a value other than the factory set point, allowing for the use with the provided Dorr-Oliver Cyclone (1.7 L/min required) or 3rd party size selective inlets (cyclones or impactors) that may require a different flow rate.

User Cal



User Cal allows you to store and use 10 different calibration factors. In addition, there are two factory defaults, one is the "Ambient Cal" and the other is the "Factory Cal". The "Ambient Cal" is appropriate for outdoor ambient dust or fugitive dust monitoring. The "Factory Cal" is the calibration to ISO 12103-1, A1 Arizona test dust for which a calibration certificate is provided with the instrument. The "Factory Cal" is appropriate for most workplace aerosol monitoring. The currently active user calibration is highlighted with an asterisk "*".

Four variables can be set for each user calibration.



Name	User can rename calibration to a description name.
Photometric	Changes the factory calibration of particle signal, based on Arizona Road Dust, to actual aerosol being measured. See below for sets to set this calibration.
User Cal [on,off]	Selecting **On** will activate current user calibration and deactivate the previously selected user calibration.

Taking a Gravimetric Sample Using the DustTrak Monitor

When sampling with the DustTrak monitor, you can simultaneously take a gravimetric sample either for custom calibration of the DustTrak monitor or for collecting the sample on to the gravimetric filter downstream of the DustTrak monitor without a need for additional gravimetric sampling pump and filter assembly. To accomplish this, follow the instructions given below:

1. Setup the DustTrak monitor to sample how long you want the sample run time to be. The following example shows a sample for 8 hours.
2. Under RunMode menu, put the instrument in Manual Log (Manual Logging is reviewed later in this section), which will enable you to start and stop the pump at any time you choose.
3. Set the logging interval. One minute (i.e., “01:00”) is a good choice.
4. Make sure you have a preweighed 37-mm gravimetric filter cassette loaded into the DustTrak monitor. See Chapter 4, “Replacing the Internal Filters” on how to access the filter (see figure 4-8) and replace it.

NOTE
Use only the conductive plastic filter cassette holder (SKC Part# 225-308).

5. Under the Setup Menu, make sure the DustTrak monitor is set to the desired flow rate. For DustTrak II Model 8530, the flow can be varied from 1.7 to 4 L/min for use with various inlet conditioners. For DustTrak DRX Model 8533, ***the flow cannot be changed*****.** The flows for DustTrak II monitor can be changed by changing the default flow calibration setpoint from 1.0 to any value between 0.5 to 1.5 in the span adjustment. An external flowmeter is needed to measure the total flow. Flow can be changed by clicking on the UP or DOWN arrow keys shown below:

6. Conduct a preflow calibration on the DustTrak monitor using the same kind of sample media you will sample with. Now, attach the sample media you intend to sample with and start sampling aerosol for the desired time. After the desired run time, stop the sampling. Remove the filter from the DustTrak monitor and follow your laboratory's criteria for filter post weight. Conduct a post-flow calibration with the same sample media done with the pre-flow calibration and determine if these flow calibrations are within ±5% of each other. If they are, use the following to calculate the actual flow rate for the DustTrak monitor. The laboratory will need the following information to calculate mass concentration in mg/m^3:

   - Total sample time in minutes.
   - Flow rate—flow rate of the DustTrak monitor used for gravimetric analysis is only $^2/_3$ the total flow since $^1/_3$ of the flow is used as sheath flow.
   - Total liters of air sampled = total sample time x flow rate.

7. Using this information the laboratory can determine the concentration using the following formula:

$$concentration, \frac{mg}{m^3} = \frac{Filter\ Post\ Weight\ (mg) - Filter\ Pre\ Weight\ (mg)}{\frac{2}{3} * \frac{DustTrak^{TM}\ Monitor\ Flow\ Rate\ (\frac{L}{min})}{1000} * Total\ Sample\ Time\ (\mathrm{min})}$$

NOTE
The flow rate used for gravimetric analysis is only $^2/_3$ the total flow since $^1/_3$ of the flow is used as sheath flow.

8. For instructions on how to calibrate the DustTrak monitor using this data, see section below on "Determining the Calibration Factor for a Specific Aerosol".

Photometric Calibration Factor

In most situations, the DustTrak monitor with its built-in data logging capability can provide very good information on how the concentration of an aerosol changes for different processes over time. Factory calibration to the respirable fraction of standard ISO 12103-1, A1 test dust is fairly representative of a wide variety of workplace aerosols. Because optical mass measurements are dependent upon particle size and material properties, there may be times in which a custom calibration would improve your accuracy for a specific aerosol.

Determining an aerosol specific photometric calibration requires that you determine a true mass concentration (e.g., gravimetric analysis) for the aerosol you want to measure. The true mass concentration is used to calculate the custom calibration factor for that aerosol. Once you have a custom calibration factor, you can reuse it each time you make measurements in the same aerosol environment.

Determining the Calibration Factor for a Specific Aerosol

The DustTrak II monitor is factory calibrated to the respirable fraction of standard ISO 12103-1, A1 test dust. The DustTrak monitor can be easily calibrated to any arbitrary aerosol by adjusting the custom calibration factor. The DustTrak monitor’s custom calibration factor is assigned the value of 1.00 for the factory calibration to standard ISO test dust. This procedure describes how to determine the calibration factor for a specific aerosol. Using the value of 1.00 will always revert back to the factory calibration.

To determine a new calibration factor you need some way of accurately measuring the concentration of aerosol, hereafter referred to as the reference instrument. A gravimetric analysis is often the best choice, though it is limited to nonvolatile aerosols. The internal 37 mm filter cartridge, in the desktop units, can be used to collect the reference gravimetric reference sample.

To make an accurate calibration you must simultaneously measure the aerosol concentration with the DustTrak monitor and your reference instrument.

1. Zero the DustTrak II monitor.
2. Put the instrument in Manual Log (Manual Logging is reviewed later in this section).
3. Set the logging interval. One minute (i.e., “01:00”) is often a good choice.
4. Co-locate the DustTrak II monitor and the reference sampler together so that they are measuring from the same area. The 37-mm filter cartridge in the desktop unit can be used to collect the particles to be weighed for the gravimetric reference.
5. Start sampling aerosol with both instruments at the same time.

NOTE
Greater accuracy will be obtained with longer samples. The time you permit for sampling often depends on the reference instrument and characteristics of the measured aerosol. It may take some time to collect sufficient aerosol onto a filter cassette for accurate gravimetric analysis. Refer to instructions of your reference instrument for sampling times.

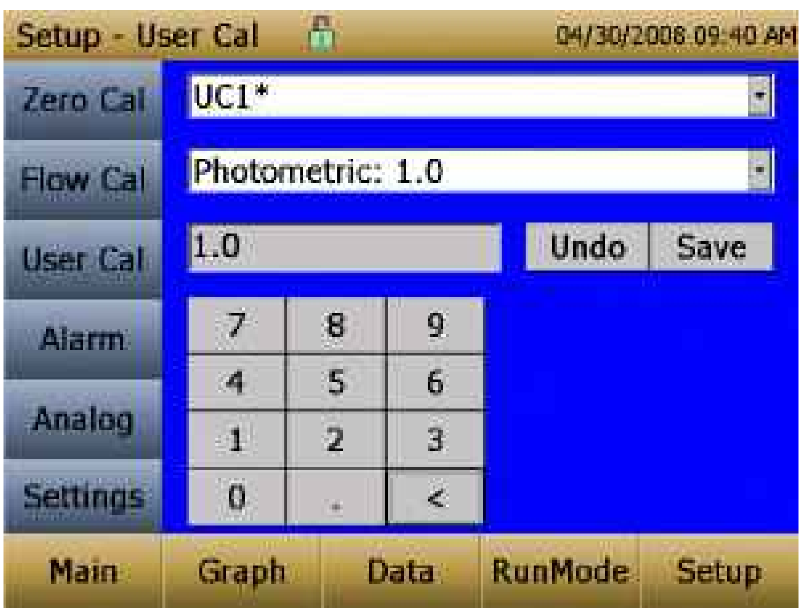
6. Stop sampling with both instruments at the same time.
7. Record the DustTrak monitor average concentration by viewing the sample average in the Data screen. (Data Screen is reviewed later in this chapter.)
8. Determine the mass concentration in mg/m^3 from your reference instrument. For gravimetric sampling this means weighing the gravimetric sample.

NOTE
If you used the internal gravimetric filter in the DustTrak Model 8530, the flow rate used to compute the concentration should be 2 L/min, not 3 L/min since only 2 L/min of aerosol flow reaches the filter.

9. Compute the new calibration constant, NewCal, using the following formula:

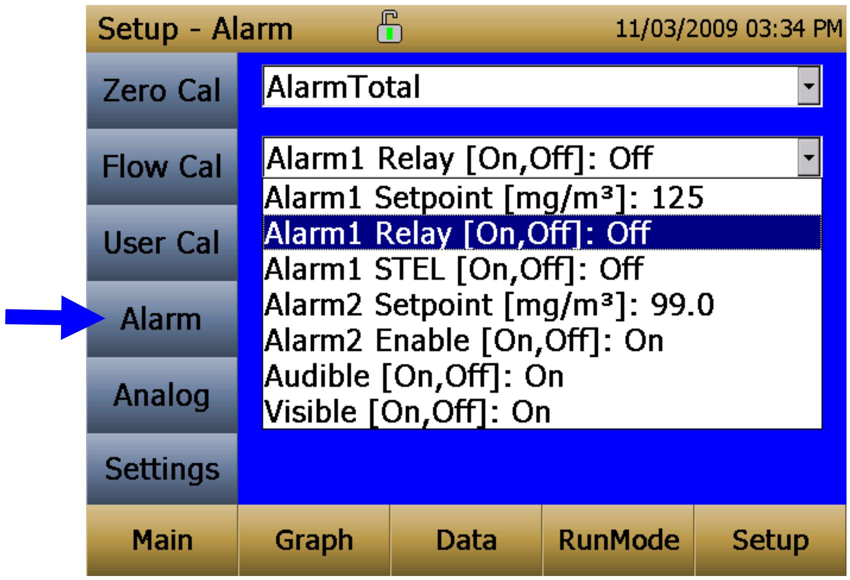
$$\text{NewCal} = \left(\frac{\text{Reference Concentration}}{\text{DustTrak Concentration}}\right) \cdot \text{CurrentCal}$$

10. Select **Photometric** from the User Cal drop down selection and enter the NewCal factor using the onscreen controls.



Alarm

Alarm allows you to set an alarm level that will be triggered if the instrument's reading goes above the setpoint. However, the alarm functioning is determined by the logging interval. The alarm will turn ON only if the average concentration over the logging interval exceeds the set point. If the logging interval is too long and the concentration exceeds the set point and stays at that level, the alarm will not turn ON until after the logging interval has passed. Likewise, the alarm will not stop until after the concentration has dropped below 5% of the threshold and after the logging interval has passed.



NOTE
The Alarm is dependent on the logging interval. For the DustTrak to alarm as soon as the Alarm Setpoint is exceeded, the logging interval must be set as low as possible (i.e., 1 second or 2 seconds). If a long test duration does not permit setting such a short logging interval, use the STEL alarm instead. The STEL is always based on 1 second concentrations and is independent of the logging interval. For more details on the STEL alarm, see section below on STEL. In Survey mode, the alarm is dependent on the time constant.

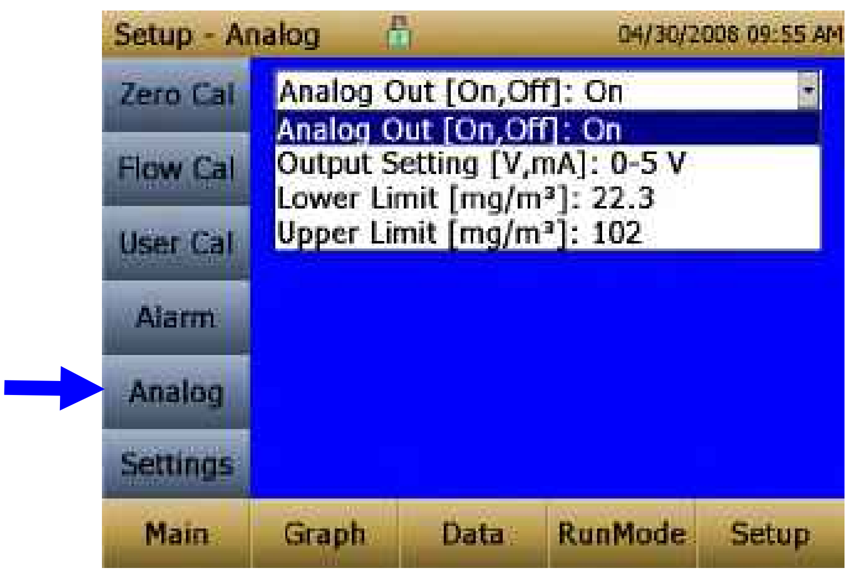
Alarm1 Setpoint [mg/m^3]	The alarm1 setpoint is the mass concentration level upon which the alarm1 is triggered. Alarm will trigger if the mass concentration, taken at the logging interval, rises above the setpoint. **NOTE** Alarm 2 must be lower than Alarm 1 when both alarms are enabled.
Alarm1 Relay [On, Off]	When the relay alarm is turned on, unit will close relay switch when Alarm1 level is surpassed. Relay selection is available on the 8530 desktop model only.
Alarm1 STEL [On, Off]	When the STEL alarm is turned on, STEL data will be collected when Alarm1 level is surpassed. STEL selection is available on the 8530 desktop model only. See STEL Note below.
Alarm2 Setpoint [mg/m^3]	The Alarm2 setpoint is the mass concentration level upon which the alarm2 triggers. Alarm triggers if the mass concentration, taken at the logging interval, rises above the setpoint. **NOTE** Alarm 2 must be lower than Alarm 1 when both alarms are enabled.
Alarm2 Enable [On, Off]	Enables Alarm2 to be logged and will activate the Audible or Visible alarms if they are enabled.
Alarm Audible [On, Off]	When the audible alarm is turned on, the instrument will activate internal beeper when Alarm1 or Alarm2 level is surpassed.
Alarm1 Visible [On, Off]	When the visible alarm is turned on, unit will show the alarm icon (Alarm1 , Alarm 2 ) in title bar when Alarm1 or Alarm2 level is surpassed.

STEL Alarm

STEL stands for **S**hort **T**erm **E**xposure **L**imit. When a STEL alarm is selected, the instrument will inspect the data on a second by second basis, independent from the selected logging interval. If the mass exceeds the STEL limit, then a STEL event triggers and the following actions will be taken.

STEL indicator	The STEL indicator  will show Red on the main screen.
Data	Data will be taken of the STEL alarm channel at a 1 minute logging interval for **15 minutes**. This data will be stored in a separate file named STEL_XXX, where XXX will be matched to the logged data file. The instrument will also continue to log the mass concentration data at the logging interval selected.
STEL Alarm repeat	If the instrument remains over the STEL limit after the 15 minute interval, or if the instrument exceeds the STEL limit later during the sample period, additional STEL files will be generated.

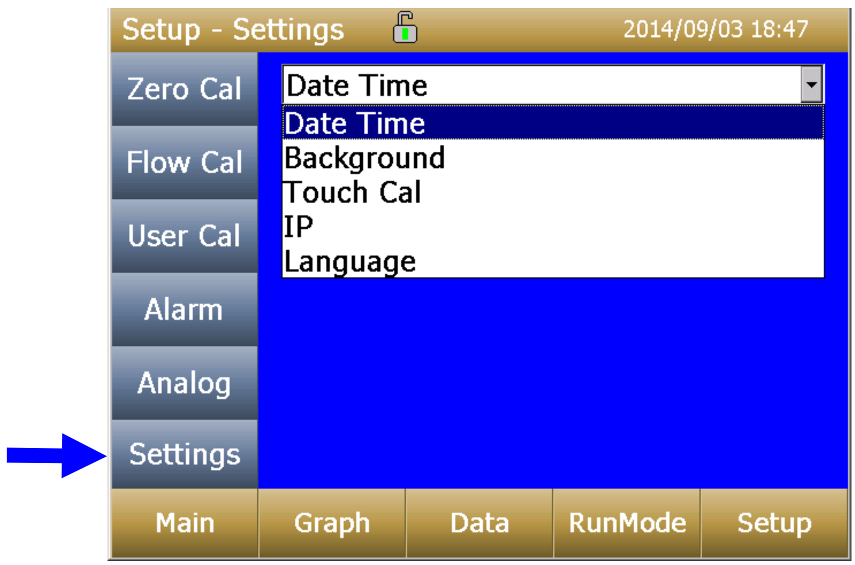
Analog



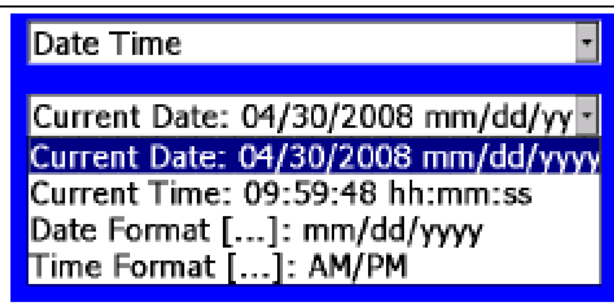
Analog setup screen sets the parameters that will drive the analog out port. Applies to the 8530 Desktop model only.

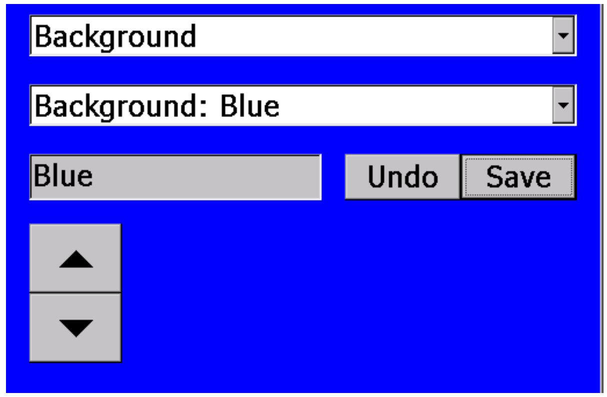
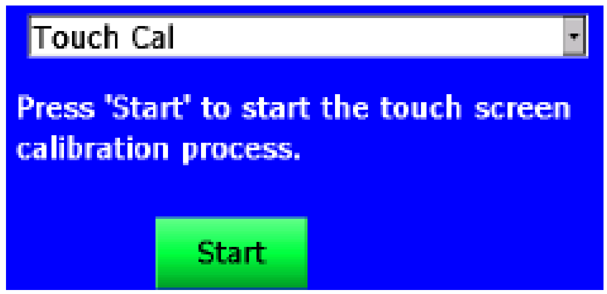
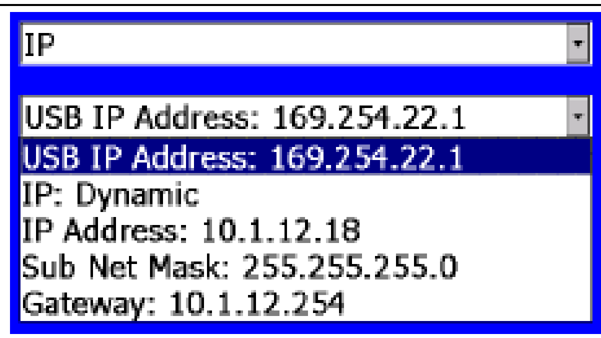
Analog out [On, Off]	Turns analog out port on.
Size Fraction	Selects the size channel that will drive the analog out.
Output Setting [V, mA]	Select between 0 to 5 V and 4 to 20 mA.
Lower Limit [mg/m^3]	Mass concentration reading of the selected channel that will correspond to 0 V or 4 mA.
Upper Limit [mg/m^3]	Mass concentration reading of the selected channel that will correspond to 5 V or 20 mA.

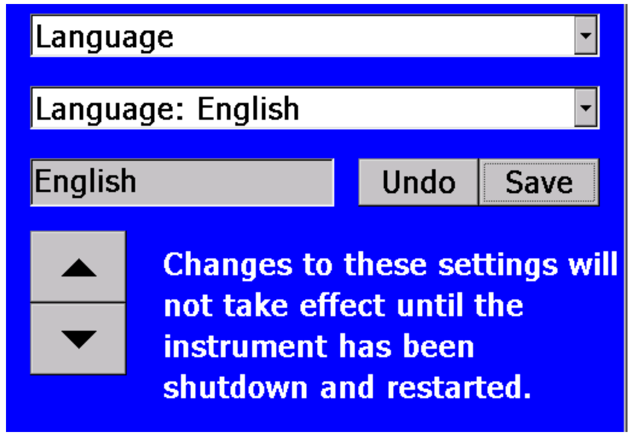
Settings



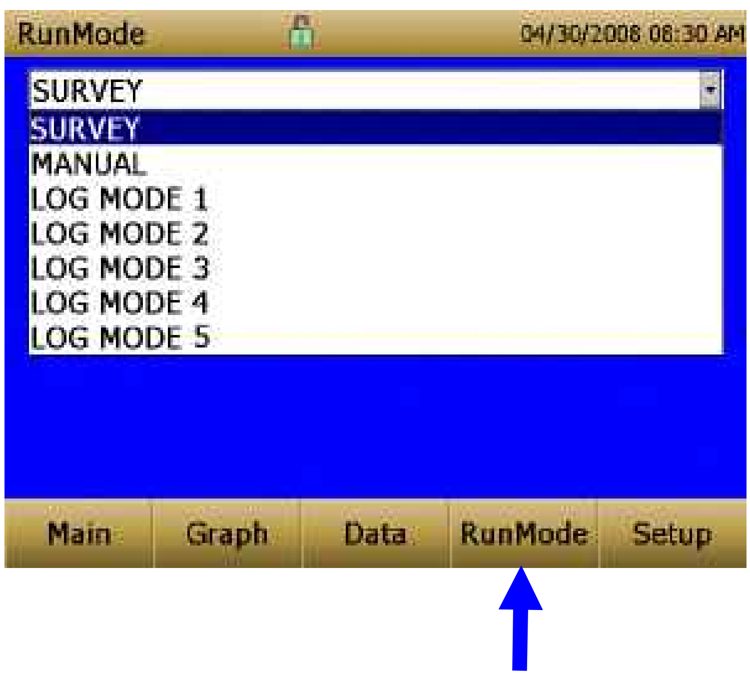
Settings screen sets basic unit parameters.

Date Time	 Sets current date, current time and date/time format. Time can be set in 12 or 24 hour format. Date can be set in yyyy/dd/mm, yyyy/mm/dd or yyyy/dd/mm.

Background	 Switches between blue and white backgrounds.
Touch Cal	 Calibrates the touch cal screen.
IP	 **USB PORT IP Address**: USB IP is the address assigned to the instrument by the NDIS driver. It is shown but cannot be changed. **Ethernet Port IP parameters**: (Model 8530 Desktop only.) IP method can be set to static or dynamic. For static IP, IP address, default gateway, and subnet mask can be set. For Dynamic, The IP assigned by the network is shown. This cannot be changed. See Note below.

	IP NOTE
	After changing the instrument to Dynamic or Static, reboot the instrument. In Dynamic Mode, the unit will show the IP to which is assigned (after being rebooted).
Language	 Switches between display languages. After changing the display language, reboot the instrument.

Run Mode

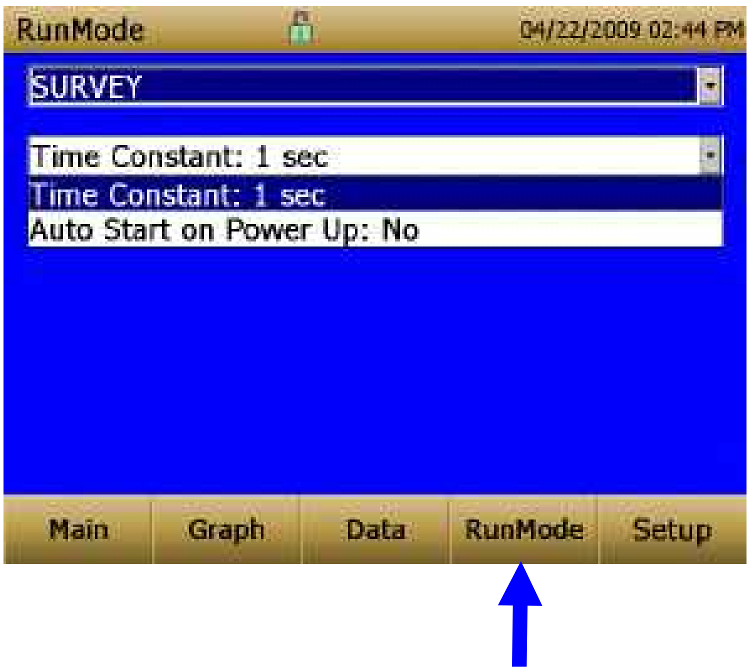


The **RunMode** tab brings up sampling mode options.

Sampling mode options include **Survey Mode**, **Manual Log**, and **Log Mode 1-5**.

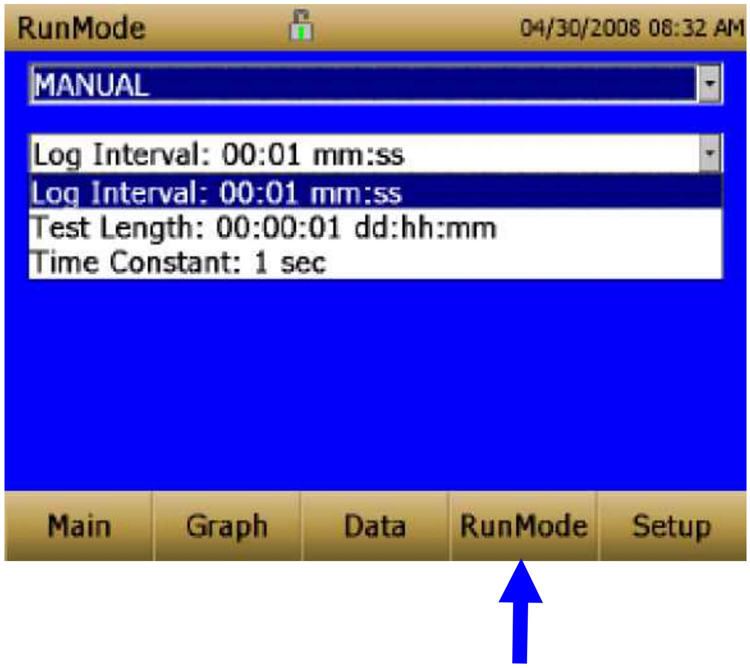
Survey	Survey Mode runs a real time, continuous active sample, but does not log data.
Manual	Manual Log sets the instrument to log data for a specified run time.
Log Modes	Log Mode starts and stops the instrument at specified times, run for a specified test length, and perform multiple tests of the same length with a specified time period between tests.

Survey Mode



Time Constant	Time Constant can be set from 1 to 60 seconds. This will control the update rate of the main screen. It is the rolling average of data displayed on the main screen and is not linked to logged data in either Manual or Program Log modes.
Auto Start on Power Up	When set to “Yes”, unit will start a measurement upon being powered on, if the unit was set to “Survey” when it was turned off. When set to “No”, the unit will be in idle when it is powered on.

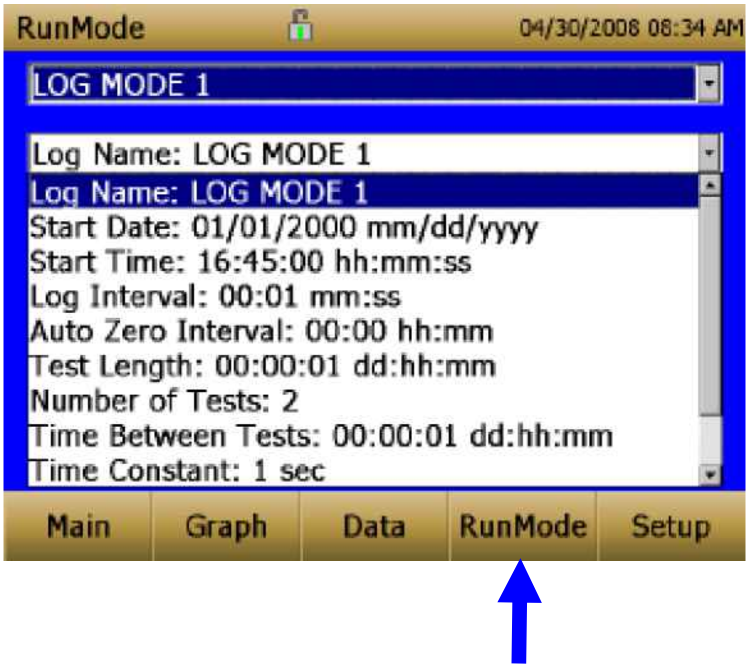
Manual Mode



Log Interval	The log interval can be set from 1 second to 60 minutes. It is the amount of time between logged data points.
Test Length	Test length can be set from 1 minute to the limit of the data storage.
Time Constant	Time Constant can be set from 1 to 60 seconds. This will control the update rate of the main screen. It is the rolling average of data displayed on the main screen and is not linked to logged data in either Manual or Program Log modes.

In Manual mode, data will be stored to a file named "*Manual_XYZ*" where *XYZ* is an incrementing integer.

Log Mode (1–5)



Log Name	Log Name, brings up a virtual keypad to name the Logged Data file.
Start Date	Start Date, select the date the test will start.
Start Time	Start Time, select the time the test will start.
Log Interval	The log interval can be set from 1 second to 60 minutes. It is the amount of time between logged data points.
Auto Zero Interval	Interval between re-zeroing the instrument using the Auto-Zero accessory. Model 8530 desktop only.
Test Length	From 1 minute to the limit of the data storage.
Number of Tests	Number of tests, 1 to 999.
Time between Tests	Time between tests, 1 minute to 30 days.
Time Constant	Time Constant can be set from 1 to 60 seconds. This will control the update rate of the main screen. It is the rolling average of data displayed on the main screen and is not linked to logged data in either Manual or Program Log modes.
Use Start Date	Use Start Date, option to use programmed start date or by pass programmed start date.
Use Start Time	Use Start Time, option to use programmed start time or bypass programmed start time.

In Log mode, data will be stored to a file named "*LogName_XYZ*" where *LogName* is the user entered log name and *XYZ* is an incrementing integer.

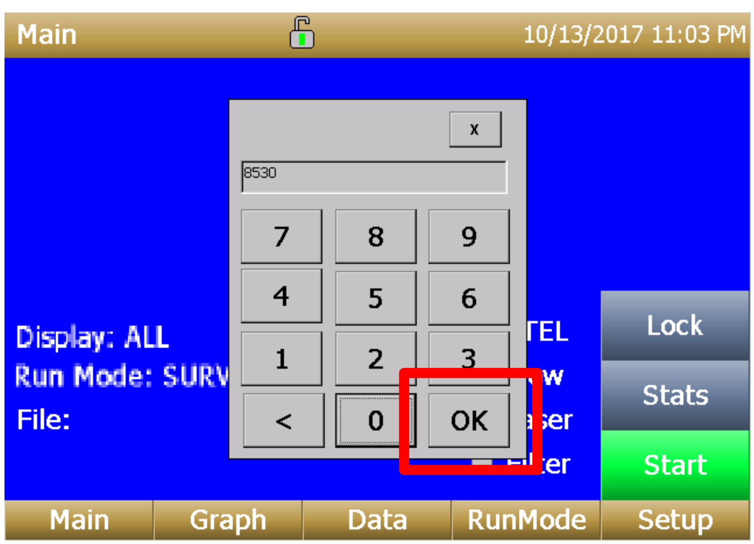
Locking Feature

The locking feature allows you to lock the screen at any time. This can be done during mass concentration measurements and while the instrument is idle.

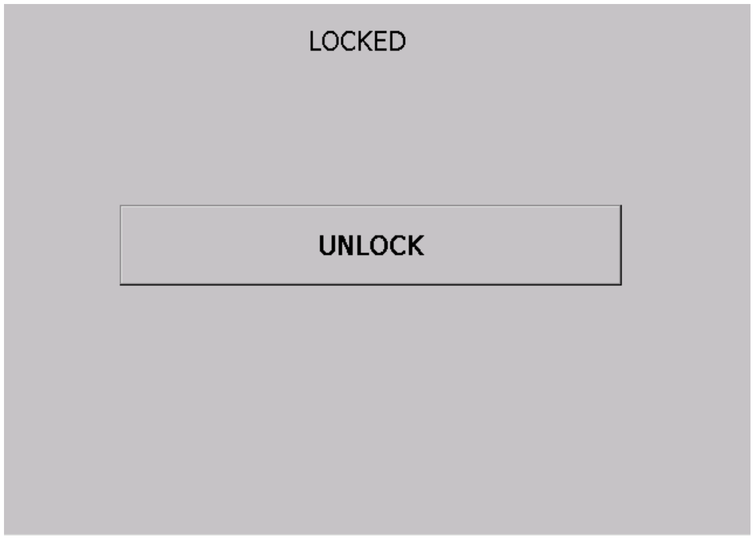
NOTE
This feature is only available on Desktop models. It is not available on Handheld models.

To enable this feature, touch the **Lock** button on the main screen.

Next enter the model of the instrument. For 8530EP models, 8530 should be used. After entering the model number, touch **OK**.



The screen is now locked.



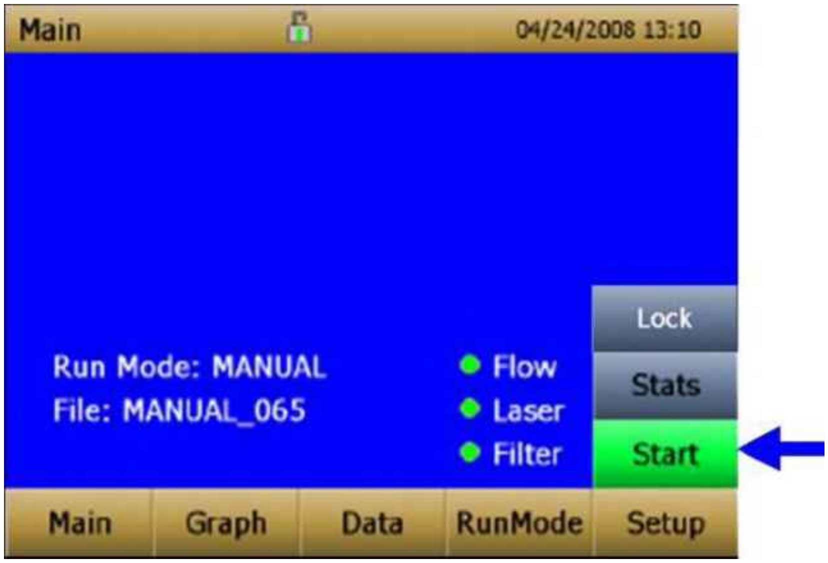
To unlock, touch **UNLOCK** and re-enter the model number. For 8530EP models, 8530 should be used. After entering the model number, touch **OK**.

NOTE
If you happen to enter the model number incorrectly and touch **OK**, you will be given another chance to enter it correctly. There is no limit to number of chances.

Taking Mass Concentration Measurements

Measurements are started and controlled from the main screen.

Prior to starting a measurement the instrument should be zeroed from the **Setup** screen and the run mode should be configured and selected from the **RunMode** screen.



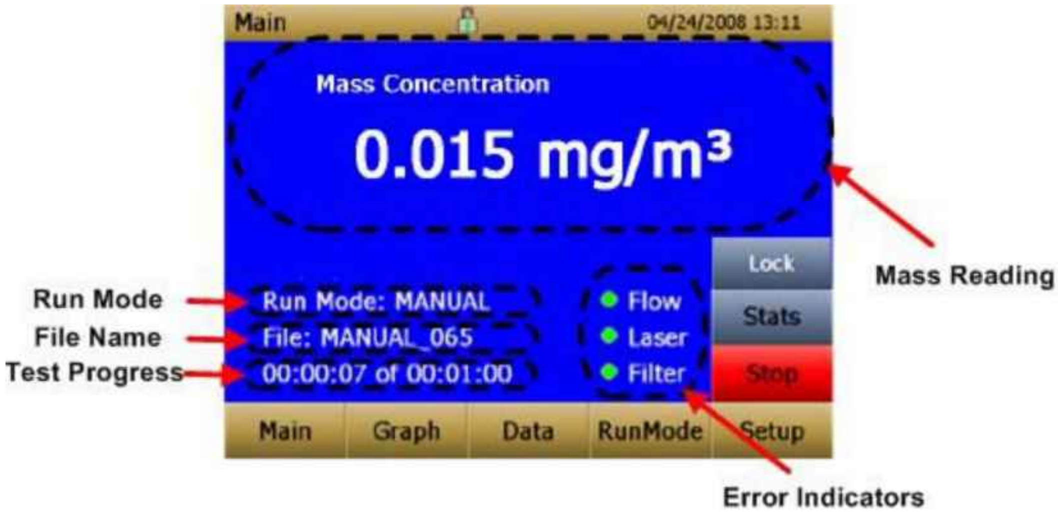
When the instrument is on, but not taking any mass measurements the start button will be green and instruments pump will not be running. To start taking a measurement, press the green **Start** button.

For the Model 8530EP DustTrak monitor with external pump, make sure the external pump is connected to the DustTrak monitor as described in Chapter 2. If the pump is not connected and the green start button is pressed, the DustTrak monitor will identify that the pump is not connected and a warning will be displayed as shown below:

Connect the External Pump Module to the DustTrak monitor and then try again. TSI recommends powering down the DustTrak monitor before connecting the External Pump Module to the DustTrak monitor. Connect the power cable and the flow tubing between the DustTrak monitor and the External pump module, as applicable.

While taking a measurement the screen will display the current measured mass concentration. The various regions of the screen are shown below.

Screen Regions



Mass Reading	Shows the instruments mass measurements.
Run Mode Region	Shows the run mode selected from the RunMode screen.
File Name Region	Displays the file name to which the data is currently being saved.
Test Progress Region	Shows the time-based progress of the test.
Error Indicator Region	Shows the current stats of the instrument STEL: Shows if STEL is in progress (desktop instruments only) Flow: Status of the flow control Laser: Status of the Laser Filter: Status of the Filter See Chapter 5, "Troubleshooting," to resolve any of these error conditions.

Stats

The Stats button shows the statistics of the mass measurement. When the Stats button is pressed, the main mass reading will reduce in font size, and the measurement statistics will show on the right side of the screen.

Graphing

During sampling, pressing the **Graph** button displays current readings in graphical form.

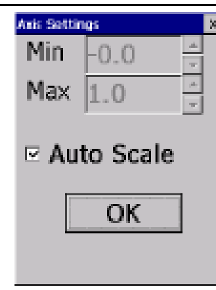
- During Survey Mode, five (5) minutes of running real-time data is displayed graphically.
- During Logging Mode, the entire log test time is displayed on the graph.

<table>
<tr>
<td>Time Display</td>
<td>Pressing the Time x-axis label on the graph screen switches between Time (s), Time (abs), and Time (rel).

Time (s): Elapsed time from first logged point (log interval) to the last logged point (test length).

Time (rel): Relative time from zero to last logged point (test length – log interval).

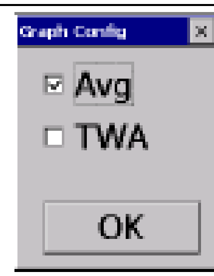
Time (abs): Absolute time from first logged point (test start + log interval) to last logged point (test stop).</td>
</tr>
<tr>
<td>Scale Display</td>
<td>Pressing in the Scale Display area will bring up a dialog that will allow changing between auto scaling and user scaling of the Y-axis.



</td>
</tr>
<tr>
<td>Data Region</td>
<td>Pressing the data region will bring up a dialog to show TWA or Average lines.

TWA: Will show a secondary line on the graph showing the time weighted average of the data. This line will not show if test time is less than 15 minutes.

Average: Show a secondary line on the graph of the running average of the data.



</td>
</tr>
</table>

In Graphing Mode, pressing **Main** returns the instrument to the Main Screen display.

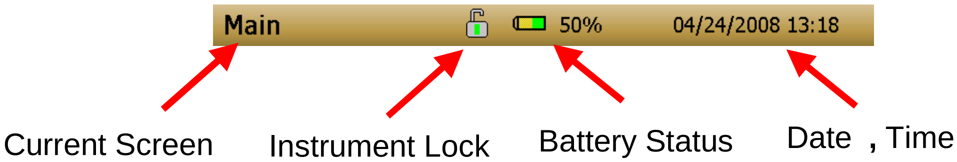
Viewing Data

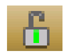
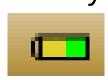
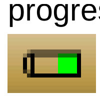
The **Data** button opens a list of data files for viewing.

Select File	Press the arrows on the right side of the screen to scroll up or down to the data file to be viewed.
Data Statistics	Statistics on the selected file ○ File Name ○ Sample Average ○ Sample TWA ○ Sample Maximum Reading ○ Sample Minimum Reading ○ Number of Data Points in the File
Save All Button	Downloads data to a USB thumb drive. The USB thumb drive must be attached to the USB host port. Data is saved as a .csv file that can be viewed in Microsoft® Excel® spreadsheet software.
Delete Button	Deletes the currently highlighted file.
Delete All Button	Deletes all the files stored on the instrument.
Graph Button	Data can also be viewed in graphical form by pressing the **Graph** button while the data file is highlighted.

Title Bar

The Title Bar shows common instrument information.



Current Screen	Title of the current screen that is being displayed.
Instrument Lock	Icon shows if the instrument touchscreen is in an unlocked or locked condition. **Unlocked**:  **Locked**:  To lock the touchscreen controls, touch the “lock” icon, immediately followed by three (3) quick touches on the current screen (**Main)** word along the top tool bar. Repeat the process to unlock the screen.
Battery Status	Show the current % life of the battery and show if the battery is currently being charged: **Charging**:  (unfilled portion of the icon is filled yellow as well as animated to indicate that the charging is in progress) **Not Charging**:  (unfilled portion of the icon transparent)
Date and Time	Indicates the instruments current date and time.
Alarm	If the instrument is in an alarm status, an alarm icon  will appear in the title bar.

Chapter 4

Maintenance

The DustTrak II aerosol monitor can be maintained in the field using the instructions below. Additionally, TSI recommends that you return your DustTrak II monitor to the factory for annual calibration. For a reasonable fee, we will quickly clean and calibrate the unit and return it to you in “as new” working condition, along with a Certificate of Calibration. This “annual checkup” helps ensure that the DustTrak II monitor is always in good operating condition.

W A R N I N G

There are no user-serviceable parts inside this instrument. The instrument should only be opened by TSI or a TSI approved service technician.

Maintenance Schedule

The DustTrak II Aerosol Monitor requires maintenance on a regular basis. Table 4–1 lists the factory recommended maintenance schedule.

Some maintenance items are required each time the DustTrak monitor is used or on an annual basis. Other items are scheduled according to how much aerosol is drawn through the instrument. For example, TSI recommends cleaning the inlet sample tube after 350 hours of sampling a 1 mg/m^3 concentration of aerosol. This recommendation should be pro-rated according to how the instrument is used. 350 hours at 1 mg/m^3 is the same amount of aerosol as 700 hours at 0.5 mg/m^3 or 175 hours at 2 mg/m^3, etc.

Table 4–1. Recommended Maintenance Schedule

Item	Frequency
Perform zero check	Before each use.
Clean inlet	350 hr. at 1 mg/m^3*
Clean 2.5 µm calibration impactor	Before every use.
Replace internal filters	350 hr. at 1 mg/m^3* or when indicated by the main screen filter error indicator.
Return to factory for cleaning and calibration (For 8530EP, TSI recommends that both the DustTrak and the External Pump Module be returned to TSI)	Annually
Replace the internal HEPA filters in the External Pump module	Annually

*Pro-rated, see discussion above.

The DustTrak monitor keeps track of the accumulated amount of aerosol drawn through it since its last cleaning. When the internal filter replacement is due, the filter error indicator will turn from green to red.

TSI recommends you perform a zero check prior to each use for the DustTrak monitor and certainly before running any extended tests, and after the instrument experiences a significant environmental change. Examples of significant environmental changes would be ambient temperature changes that exceed 15 °F (8 °C) or moving from locations with high aerosol concentrations to low concentrations.

Zeroing Instrument

1. Attach the zero filter to the inlet of the instrument.

Figure 4-1: Attach Zero Filter to Inlet

2. Follow zero calibration instructions detailed in the operations section of this manual.

Cleaning the Inlet

The inlet should be cleaned based on the schedule in Table 4–1.

1. Turn the DustTrak monitor off.
2. Unscrew the inlet nozzle from the instrument (Figure 4-2).

Figure 4-2: Unscrew Inlet Nozzle

3. Clean the inlet port. Use a cotton swab to clean the outside of the inlet port. You may dampen the swabs with water or a light solvent (e.g., isopropanol). Clean the inside of the sample tube by using a small brush, along with a light solvent. Dry the tube by blowing it out with compressed air, or let it air-dry thoroughly.

NOTE
Be *careful* NOT to blow particles into the DustTrak monitor inlet port.

Figure 4-3: DO NOT Blow into Instrument

4. Screw (hand-tighten) inlet back into instrument.

Cleaning and Oiling Impactors

The calibration impactor should be cleaned prior to every use, using it to perform a Standard Calibration (size correction) on the instrument, as described in the Operations section.

1. Unscrew Impactor. Check O-ring on the impactor base.
2. Clean outside and inside of Impactor and the impactor plate using a clean brush and a light solvent. Dry impactor parts by blowing it out with compressed air, or let it air-dry thoroughly.
3. Apply 2 drops of oil (included) to the impactor plate. **DO NOT** over-fill impaction plate.
4. Screw (hand-tighten) impactor back together.

Figure 4-4: Apply 2 Drops of Oil to Impactor Plate

Replacing the Internal Filters

Replace the internal filters based on the schedule in Table 4–1 or when the filter indicator on the main screen changes to red.

1. Turn the instrument off.
2. Remove old filters from the instrument.

Handheld Model

a. Use the enclosed filter removal tool (P/N 801668) tool to unscrew the two filter caps located on the bottom of the instrument.

b. Pull the old filters out of the two filter wells. If filter wells are visibly dirty, blow out with compressed air.

c. Put two (2) new filters (P/N 801666) into the filter wells and screw filter caps back into place.

Figure 4-5: Pull Filters Out of Two Filter Wells (Handheld Model)

NOTE
Replacement filters were shipped with the new instrument. Order additional filters from TSI under P/N 801666.

Desktop Model

a. Open filter access door on the back of the instrument.

b. Use the enclosed filter removal tool (P/N 801668) to unscrew filter cap.

c. Pull out single cylindrical filter from filter well. If filter well is visibly dirty, blow out with compressed air.

d. Put new filer (P/N 801673) back into filter well and screw filter cap back into place.

Figure 4-6: Pull out Single Cylindrical Filter from Filter Well (Desktop Model)

e. Open blue retention clip by pinching ends inward and pushing down.

Figure 4-7: Open Blue Retention Clip

f. Remove 37-mm filter cassette by pulling downward and outward.

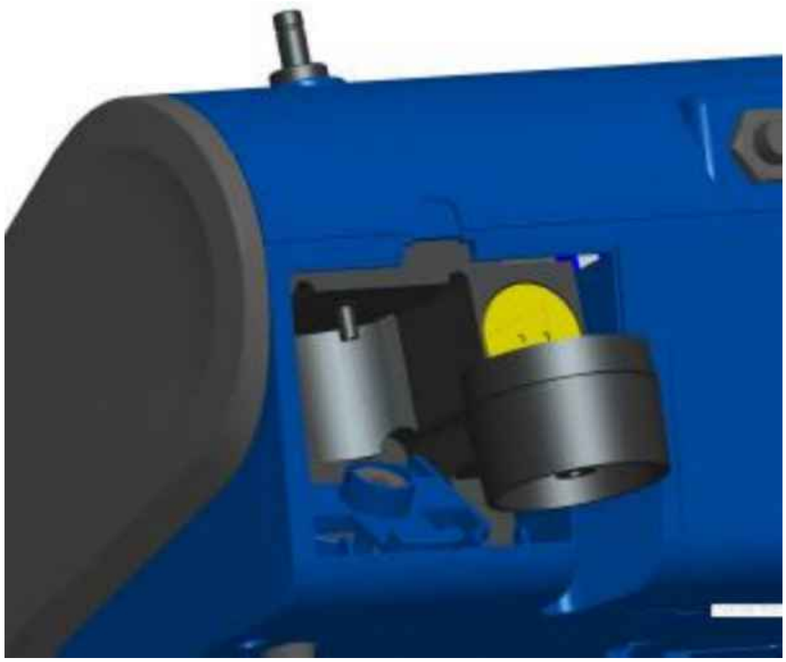


Figure 4-8: Remove 37-mm Filter Cassette

g. Open filter cassette using enclosed tool P/N 7001303.

h. Remove screen mesh from filter cassette and blow out using compressed air. Blow in reverse direction to remove captured particulate.

i. Replace mesh in filter cassette and press halves together. Make sure filter has been fully closed. The filter tool P/N 7001303 can be used to ensure the filter is fully closed.

j. Place filter cassette back into position and close blue retaining clip. Make sure retaining clip snaps back into place.

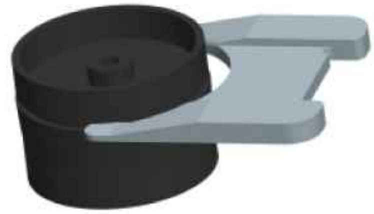


Figure 4-9: Open Filter using Enclosed Tool

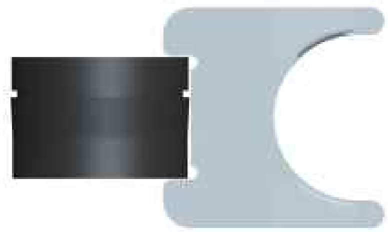


Figure 4-10: Replace Mesh in Filter Holder

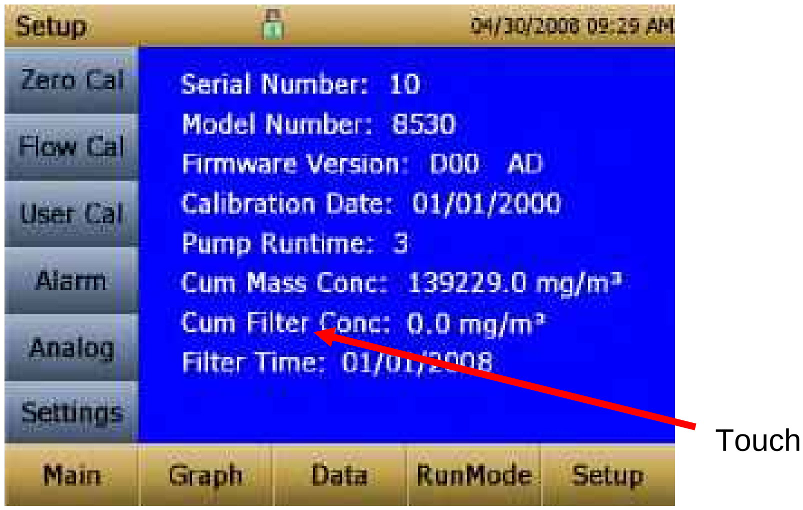
NOTEs
Replacement filters (HEPA and 37-mm Filter Cassette with mesh filter) were shipped with the new instrument. Order additional filters from TSI under P/N 801673. TSI ***does not*** supply any filter media for the filter cassette. Any commercially available 37-mm filter media may be used with the DustTrak II or DRX desktop instruments to collect gravimetric reference samples.

3. **It is important to reset the instruments filter counter after replacing filters. Resetting the counter will clear the filter error condition shown on the main screen.** Reset the counters by the following:

   a. Turn on the instrument.

   b. Press the **Setup** button to go into the setup screen.

   c. Touch the **Cum Filter Conc:** (live key) to reset the aerosol mass.



   d. *Replace user serviceable filters?* Dialog will appear. Press **OK**.

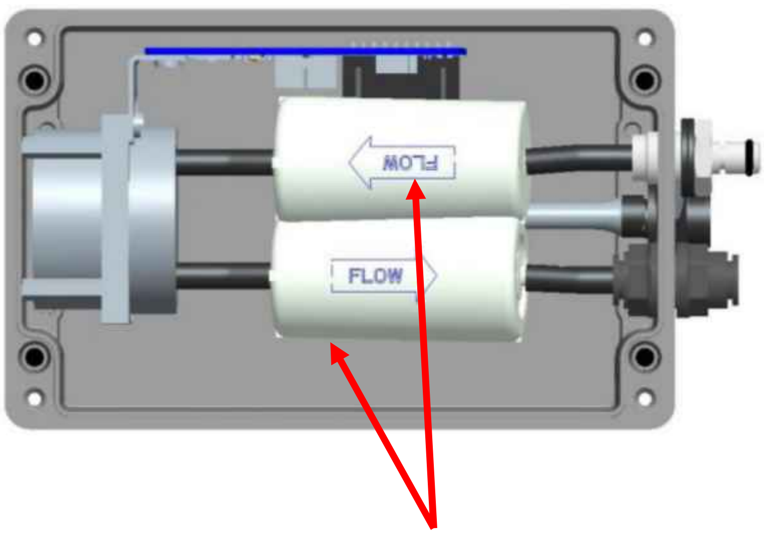
   e. *Reset filter concentration?* Dialog will appear. Press **Yes** to reset the cumulative filter concentration to zero.

   f. The Setup screen will now show zero for the **Cum Filter Concentration and** the current date for the **Filter Time**.

Replacing the Filters in the External Pump Module

The external pump module provided with Model 8530EP is designed to run continuously for about a year (8760 hours). There are two HEPA filters that protect the pump from contamination—one on the suction side of the pump and the other on the discharge side of the pump. The discharge side of the pump collects particles shedding from the vanes of the pump and will turn black over time. The HEPA filters will have to be replaced once a year.

To access the filters open the top cover of the pump module. The two HEPA filters are identified in the figure below. The two filters can be replaced by disconnecting the soft tubing between the filters, pump, and the casing connectors.



User Replaceable HEPA Filters

Caution
When replacing the HEPA filters, make sure they are oriented in the correction direction as shown in the picture above.

Storage Precautions

When storing the DustTrak monitor for more than 30 days, you should charge and remove the batteries. This prevents damage due to battery leakage.

This instrument must be stored in a location where the temperature remains between –20 and 60°C (–4 and 140°F).

Chapter 5

Troubleshooting

The table below lists the symptoms, possible causes, and recommended solutions for common problems encountered with the DustTrak II monitor.

Symptom	Possible Cause	Corrective Action
Erratic zero reading.	Leak	Check connections for leaks Replace zero filter
	Dirty inlet port and/or sample tube	Clean inlet port. Clean or replace tubing
	Internal filter(s) not installed properly (leaking)	Inspect internal filter wells to make certain the filters and O-rings are seated properly. Replace internal filters if necessary
DustTrak reading negative concentrations	Zero Drift	Perform Zero Cal
	Zero Cal was performed without the Zero Filter in-line	Perform Zero Cal again and make sure the Zero Filter is attached to the DustTrak inlet
Error completing Zero Cal	Too much light scatter in the optics chamber due to dust deposits	Clean the inlet nozzle. Attach the zero filter and sample for about 2 minutes. During sampling, pulse the flow going into the DustTrak monitor by intermittently plugging the zero filter. Any dust in the optics chamber will break loose during flow pulsations and will be cleared out by the pump Perform Zero Cal again. If the Zero Cal still cannot be performed, factory service may be required

Symptom	Possible Cause	Corrective Action
Severe/sudden increase or decrease in mass concentration (greater than or equal to ~.200 mg/m^3)	RF (radio frequency) signal transmitting in the area of the instrument causing electrical interference.	Determine the source and turn off the transmitter. Frequencies between 1.5GHz to 1.7GHz are known to interfere with the measurement. This spectrum includes aeronautical navigation aids, satellite communications, and radio telescopes. Relocate the instrument to a location where the interference is not present and normal operation resumes.
Run Mode Error: The start time has passed	The selected Run Mode program has “Use Start Date” selected, but the start date is prior to the current date	Correct or change the run mode program
Run Mode Error: The selected log mode will exceed the allowed number of samples	The selected Run Mode program is programmed to save more samples then is room in memory	Reduce the number of samples by reducing the test length or increasing the logging interval
Instrument runs slow	Large amount of data in memory	Large data files or many small data files will cause instrument to slow, due to need to read and display large amounts of data
No display	Unit not switched on	Switch unit on
	Low or dead batteries	Recharge the batteries or plug in the AC adapter

Symptom	Possible Cause	Corrective Action
No touch - screen response	Instrument currently busy	The instrument will take time to open large data files and save configuration information. During this time, the instrument will not respond to additional touchscreen touches
	Instrument Touchscreen is locked	If the lock in the title bar is red, unlock the instrument following the instructions in the Chapter 3, Operation: Title Bar section of this manual
Analog output does not work	Cable/connector not correctly installed	Make sure cable connector is fully seated
	Output wired with reverse polarity	Make sure analog out (+) and analog ground (-) are wired correctly to data-logger
Analog output is not in proportion to display	Analog output range in DustTrak monitor may be set incorrectly	Check analog output setting in the Setup->Analog screen. Make sure the channel of interest is selected. Make sure that the correct output (0 to 5V, 4 to 20 mA) is selected
	Data logger scaling factor may be set incorrectly	Review the scaling factor set in the Setup-Analog screen
Alarm output does not work	Alarm function not turned on	Turn the alarm function on in the Settings->Alarm screen
Alarm does not turn on correctly	Alarm setting incorrect	Check the alarm settings in the Settings->Alarm screen Make sure the logging interval and time constant are set as short as possible (30 seconds or lower)
	Alarm output wired with reverse polarity	Alarm wires are polarized. Voltage input must be wired to alarm input (+)
Instrument does not store new data	Memory is full	Delete or transfer historic data
	Instrument is in Survey mode	The instrument does not store data in survey mode. Can to manual or program log mode

Symptom	Possible Cause	Corrective Action
Flow Error is indicated on front screen	If sampling from a duct, instrument may have problems overcoming pressure differences	Attach both the input and the exhaust port into the duct
	Flow obstruction	Remove obstruction if still present. Press any key to bypass
	Internal pump failing, indicated by inability to adjust flow rate to full range	Factory service may be required
	Filter Cassette clogged or has mass loading	Replace the filter cassette. See the maintenance section of the manual
	External pump module (for Model 8530EP only) is not connected to the DustTrak monitor	Make sure both the External Pump cable and the flow tubing connector are connected to the DustTrak monitor and the External pump module. Lock the External Pump Cable in place by rotating the connector clockwise until you hear it snap in place Make sure the tubing between the DustTrak monitor and the External pump module is not kinked and is free of any sharp bends Make sure the exhaust adapter is connected to the exhaust of the DustTrak monitor Make sure the External Pump module filters are not clogged. If found dirty, replace the two HEPA filters
Laser Error indicated on front screen	Laser background is too high	Remove and clean inlet nozzle. Pay close attention to the tip of the nozzle that is inserted into the instrument to ensure it is clear of any contamination
	Laser is failing	Factory service may be required

Symptom	Possible Cause	Corrective Action
Filter Error indicated on front screen	Filters need to be replaced	Replaced the filters per instructions in the maintenance section of this manual. Make sure to reset the filter mass and date once the filters have been changed **NOTE** This is only a warning. The unit will continue to operate normally until the increase in pressure drop across the filter is so high that the pump can no longer maintain the set flow rate.
System Error has Occurred!	The processor did not receive the input it expected. This can also happen if the optics chamber is saturated with light, or the External Pump Cable is accidentally disconnected during the middle of sampling	Reboot the instrument. If the error does not go away, factory service is required

(This page intentionally left blank)

Appendix A

Specifications

Specifications are subject to change without notice.

Sensor Type	90° light scattering
Range............................	8530 Desktop: 0.001 to 400 mg/m^3 8532 Handheld: 0.001 to 150 mg/m^3
Resolution	±0.1% of reading or 0.001 mg/m^3, whichever is greater
Zero Stability	±0.002 mg/m^3 24 hours at 10 sec time constant
Particle Size Range.......	Approximately 0.1 to 10 µm
Flow Rate	3.0 L/min set at factory 1.4 to 3.0 L/min adjustable
Flow Accuracy...............	±5% of factory set point Internal flow controlled
Temperature Coefficient	+0.001 mg/m^3 per °C
Operational Temperature..................	0 to 50°C
Storage Temperature	-20 to 60°C
Operational Humidity.....	0-95% RH, non-condensing
Time Constant...............	Adjustable 1 to 60 seconds
Data Logging.................	45 days at 1 minute samples
Log Interval	1 second to 1 hour
Physical Size (HWD)	Handheld: 4.9 x 4.75 x 12.45 in. Desktop: 5.3 x 8.5 x 8.8 in. External Pump: 4.0 x 7.5 x 3.5 in.
Weight...........................	Handheld: 2.9 lb, 3.3 lb with battery Desktop: 3.45 lb, 4.45 lb – 1 battery, 5.45 lb – 2 batteries External Pump: 3.0 lb
Communications............	8530: USB (Host and Device) and Ethernet. Stored data accessible using thumb drive 8532: USB (Host and Device). Stored dada accessible using thumb drive.

Power—DC	Handheld: 12 VDC at 2A Desktop: 24 VDC at 2.5A
Battery..........................	8530: Up to 2 Removable Li-Ion External and Internal charging Life, 1 battery: >6.5 hours (9 hours typical for a new battery) for both internal and external pump Desktop DustTrak monitors Life, 2 battery: >13 hours 8532: 1 Removable Li-Ion External and Internal charging Life: 5 hours typical
Analog out....................	8530: User selectable output 0 to 5 V or 4 to 20 mA User selectable scaling
Alarm Out.....................	8530: Relay or sound buzzer Relay No latching MOSFET User selectable set point 5% deadband Connector 4-pin, Mini-DIN connectors 8532: Sound buzzer
Screen..........................	8530: 5.7” color touchscreen 8532: 3.5” color touchscreen
Gravimetric Sampling....	8530: Removable 37-mm Cartridge
EMI/RF Immunity	Complies with Emissions Directive Standard: EN50081-1:1992 Complies with Immunity Directive Standard: EN50082-1:1992*

*ESD Shock may require instrument reboot

Appendix B

Zero Module

The Zero Module (P/N 801690) allows for automatic re-zeroing of the DustTrak Instrument during long sampling runs. The Zero Module works only with the 8530 desktop models.

Attach the AutoZero module to the main instrument in two steps.

1. Place the Zero module over the instrument's inlet and press down. The Zero module has an O-ring seal that will engage with the instrument's inlet.

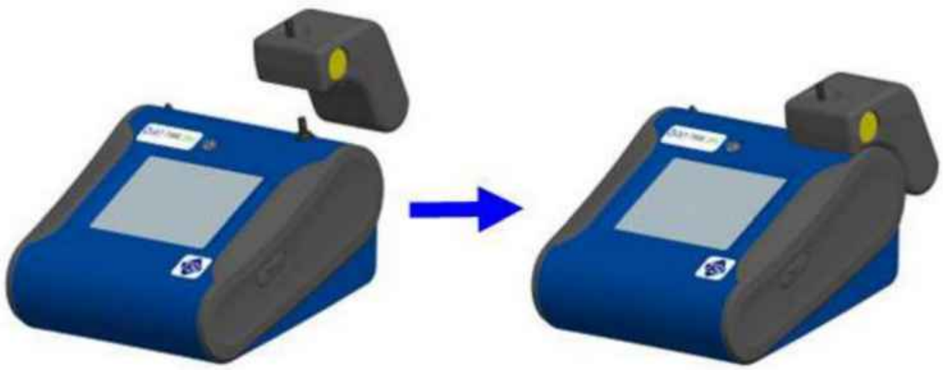


Figure B-1: Place Zero Module Over Inlet and Press Down

2. Attach the cable from the Zero module to the Zero module connector located on the back of the instrument.

Figure B-2: Zero Module Connector

The Zero Module can only be used in a program log mode. The Zero module function is controlled through these two program mode options:

Auto Zero Interval	Interval between re-zeroing the instrument using the Auto-Zero accessory.
Use Auto Zero	Select **Yes** to use the Zero Module. Select **No** to not use the Zero Module.

Important points on Zero Module operation:

- The Zero module will take one (1) minute to take a zero reading. The first 45 seconds of that period is used to clear the chamber of particles. Readings from last 15 second of the period, when the chamber is cleared of particles, will be averaged to determine the Zero offset.
- The log interval, when the Zero module is activated, must be two (2) minutes or greater. Data will not be recorded to the log file when the Zero module is activated.

Index

D

E

F

G

H

I–J

T

U

V

W–X–Y

Z

UNDERSTANDING, ACCELERATED

TSI Incorporated – Visit our website **www.tsi.com** for more information.

USA	**Tel:** +1 800 680 1220	**India**	**Tel:** +91 80 67877200
UK	**Tel:** +44 149 4 459200	**China**	**Tel:** +86 10 8219 7688
France	**Tel:** +33 1 41 19 21 99	**Singapore**	**Tel:** +65 6595 6388
Germany	**Tel:** +49 241 523030		

P/N 6001893 Rev. U Printed in U.S.A.

Arcadis ENV Quality Procedure	
TOPIC: **FIELD ACTIVITIES DOCUMENTATION**	
Revision Date: November 2016 **Revision Letter: C**	**QP#: 3.06**

STATEMENT OF POLICY:

It is Arcadis Environment Business Line (ENV) policy that field activities must be documented to facilitate the interpretation of data; show compliance with project plans, work plans, and contract terms; and to serve as evidentiary records. Documentation reflecting activities performed must be legible, organized, and complete. Applicable regulatory and client requirements should be considered when documenting field activities. Project-specific requirements for documentation typically should be described in the Work Plan, Field Sampling Plan (FSP), and/or in the Quality Assurance Project Plan (QAPP).

1. Purpose

The purpose of this Quality Procedure (QP) is to provide a standard procedure for the documentation of fieldwork activities. This documentation pertains to site-related projects, but is not limited to the collection of samples, subsurface information, and oversight of construction activities. Field documentation must include, at a minimum, project title and number, date and times of activities, the identification of the employee performing the work, and the specifics of the work being performed.

2. Responsibilities

Certified Project Manager (CPM) – is responsible for the project-related administration of this QP.

Quality Consultant – is responsible for providing quality assurance and quality control guidance to the CPM in implementing this procedure. Note that for federal projects, there are specific requirements and qualifications for the QA Officer assigned to the project.

Project Team Members – who are assigned to document field activities, are responsible for compliance with this procedure.

3. Terms and Definitions

Field Sampling Plan (FSP) – A document that describes the procedures and protocols necessary to complete field sampling and data collection activities.

Work Plan – A document that describes proposed project activities.

Quality Assurance Project Plan (QAPP) – A document that prescribes the quality assurance/quality control (QA/QC) procedures to be followed. Uniform Federal Policy (UFP) QAPPs are now frequently required for environmental projects by most federal regulatory agencies. A UFP QAPP includes Worksheets used to document the entire project plan developed following the systematic planning process. For more details on the UFP QAPP see http://www.epa.gov/fedfac/documents/qualityassurance.htm. Note that if the project QAPP is written following the UFP format, it will also contain a description of the sampling rationale and sampling locations as well as QA/QC requirements. The UFP QAPP format is designed to capture the entire systematic planning process. If a UFP QAPP is written for a project, a separate FSP is generally not required unless specified by the particular client or contract.

Standard Operating Procedure (SOP) and Technical Guidance Instruction (TGI) – Documents that describe a procedure and or protocol necessary to conduct a specific activity.

4. Related Forms

Forms used for documenting field activities may be included as attachments to the FSP or the QAPP and may include the following examples:

- Chain-of-custody (COC) form
- Sample data log
- Field modification form
- Sample receipt form
- Corrective action form
- Field activity log
- Calibration log
- Analysis request and chain-of-custody record
- Daily quality control reports
- Purge log
- Soil boring log.

Examples of SOPs and TGIs with field forms and check-lists can be found in the Arcadis Procedure Library at: https://arcadiso365.sharepoint.com/TEAMS/US_envsoplibrary/SitePages/Home.aspx.

DESCRIPTION OF PROCEDURE:

1. General Requirements

1.1 Documentation Format

Documentation of field activities provides an accurate and comprehensive record of the work performed sufficient for a technical peer to reconstruct the day's activities and confirm that necessary client, regulatory, contract, and work plan requirements were met. General requirements include:

- Use of field books (preferably bound) as the primary source for information collection and recording. Field books should be dedicated to the project and appropriately labeled.
- Use of personal digital assistant (PDA) to document select field sampling and data collection activities using Arcadis' electronic data gathering system (EDGE); examples include subsurface data, well/piezometer

installation, groundwater sampling, and water-level measurements. Use of PDAs with EDGE is optional but encouraged.

- Use of a Field Activity Log is suggested to formally document activities and events as a supplement to bound field books. The Field Activity Log can be a standard or project-specific form or a bound field book. Preprinted standard forms are available for many activities and should be used whenever possible. These forms will provide prompts and request additional information that may be useful and/or needed. Project-specific field forms may be generated or existing forms may be modified to meet specific project needs. Client-supplied forms may be substituted, as required.
- Appropriate header information is documented on the first page of notes for each day of fieldwork, including project title, project number, date, time, author, and relevant setting information such as weather conditions, topography, surface water conditions, observed site activities/uses, and other persons in field team. In addition, include on every page of notes the page number and date. Project-specific information depends on the nature of work being performed and should be discussed by the project team prior to commencing fieldwork. As appropriate, dedicated field logs/journals or forms should be used. When Field Activity Log Forms are used, information fields that are not applicable should be noted as such with the symbol "N/A" or other appropriate notation.
- Field documentation entries shall be made using indelible ink.
- Data entries shall be legible. A single line should be drawn through incorrect entries and the corrected entry written next to the original strikeout. Strikeouts are to be initialed and dated by the originator.
- Units of measurement shall be specified. The level of accuracy shall be indicated (e.g., observed estimate, quantified census from direct count, and electronic data collection).
- Field records are to be maintained in project files unless otherwise specified by a client or stipulated by a contract.
- Unless addressed specifically by a client or stipulated by a contract, site photographs should be taken to document the general setting and landscape as well as site-specific issues/resources of interest. Photo locations and the compass direction of view should be recorded in the notes with the photo number.

1.2 Documentation Entries

A chronology of field events should be recorded. General entry requirements include:

- Visitors to the site, including owner and regulatory agency representatives
- Summary of pertinent project communications with the client, regulators, or other site visitors during the fieldwork
- Other contractors or entities working on site
- A description of the day's field activities, generally in chronological sequence or in order of significance, using military time notation (e.g., 9:00 a.m. as 0900, and 5:00 p.m. as 1700)
- If applicable, calibration of measuring and test equipment and identification of the calibration standard(s) (use a Calibration Log, if available, with cross-reference entered into the field book)
- Field equipment identification, including information such as the type, manufacturer, model number, or other specific information

- If applicable sampling activities are being performed, weather information such as temperature, wind speed and direction, precipitation, time of measurement, and units
- Documentation of safety meeting (e.g., tailgates and tailboards) topics and attendees
- Verification of subsurface utility clearance in accordance with ENV ivision policy
- Safety and/or monitoring equipment readings, including time of measurements and units
- If applicable, specific forms used for collection of data are referenced in the field notebook
- Subcontractor progress and/or problems encountered
- Changes in the scope of work
- Other unusual events.

2. Specific Requirements

2.1 Sample Collection

Sample collection data are documented in a bound field book, PDA, and/or on a Field Activity Log. Where both are being used, information contained in one is cross-referenced to the other. Entries such as the following examples should be consistent with the requirements in the project-specific Work Plan, FSP, and QAPP:

- Sample identification number, location taken, depth interval, sample media, sample preservative, collection time, and date
- Sample collection method and protocol
- Physical description of the sample (using a standard classification system for soil)
- If a composite sample, include the number, location(s), and depth(s) of grab samples incorporated in the composite
- Quality-related samples (e.g., field duplicates, trip blanks, equipment rinse, blanks matrix spikes, and matrix spike duplicates)
- Container description and sample volume
- Pertinent technical data, such as pH, conductivity, temperature, and head-space readings
- Pertinent technical comments
- Identification of personnel collecting the sample.

2.2 Sample Labeling

Sample labels must be prepared and attached to sample containers. Labels are either provided by the laboratory performing the analyses or are generated internally. Labels should be indelible and securely attached to the container. The information to be provided may include:

- Sample identification number
- Sample date, initials or name of who collected the sample, and collection time
- Physical description of the sample (e.g., water, solid, gas, or other physical medium)
- Analytical parameters and method(s)

- Preservatives, if present
- Sample location and depth, if applicable
- Client.

Although this information is typically written out, it can also be recorded in an electronic tracking system if a bar code is used.

2.3 Analysis Request and Chain-of-Custody Record

A critical component of data collection is the documentation that the samples were obtained from specific locations and received by the laboratory or archive without alteration. Evidence of collection, shipment, laboratory receipt, and laboratory custody until disposal or archive must be properly documented. Documentation will be accomplished through a COC record that documents each sample and identifies the individuals responsible for sample collection, shipment, and receipt. A sample is considered in custody if at least one of the following criteria is met:

- The sample is in a person's actual possession
- The sample is in unobstructed view, after being in the person’s actual possession
- The sample is locked and only accessible by the custodian after having been in the person’s actual possession
- The sample is in a secured area, restricted to authorized personnel (e.g., laboratory).

An example COC form to be used by ENV personnel in collecting and shipping samples can be found on the corporate Intranet. A laboratory typically will not accept samples for analysis without a correctly prepared COC form. The COC must be signed by each individual who has the sample in his/her custody. Each sample shipped to a laboratory for analyses must be documented on the COC. Information on this form correlates with other supporting documentation, including the field log book, sample labels, and sample collection logs.

The COC documents the elapsed time and the custodians of the sample from the time of its collection. The individuals who have physically handled the sample(s) or witnessed initial sample collection and packaging (sample team member) must be identified on the form. A sample team member relinquishes the sample by signing the COC. Individuals who either relinquish or receive samples must include their complete names, company affiliation, and the date and time the sample(s) were relinquished. The times that the samples are relinquished and received by the next custodian should coincide, with the exception of transfer by commercial carriers. These carriers will not be required to sign the COC.

If a sample is to be stored for a period of time (e.g., overnight), measures are taken to secure the sample container in a manner that only provides access to the custodian of record. If samples are relinquished to a commercial carrier (i.e., UPS or Federal Express), the carrier waybill number is recorded, and a copy of the waybill is attached to the COC. These documents are maintained with other field documentation. The original COC is sealed inside a zip-top plastic bag and placed inside the shipping container with the samples.

If corrections are made to the COC, the corrections should be made (single line through the error, initial, and date) by the originator of the change, and, if necessary, an explanation of the change should be provided. The documentation should be of a level of detail that clearly documents the change to a third-party reviewer.

Guidance for choosing a laboratory and completing analyses requests and COC can be found in QP 2.09-Subcontracting Laboratory Services and on the corporate Intranet for the Arcadis Laboratory Program (ALP) and should also be described in the project-specific planning documents (i.e., Work Plan, FSP. or QAPP).

2.4 Subsurface Logs

Test pits, soil borings, monitoring wells or rock coreholes wells, and piezometer installations are to be recorded in bound field books or PDA and may be supplemented with prepared forms. Personnel completing the log are to supply the following information:

- Administrative and technical information included in the header.
- Types of equipment used (e.g., drill rig type, drilling tools used [including diameter and length], or backhoe model).
- Subcontractor/driller used.
- Descriptions of subsurface materials encountered and the number and type of samples collected, if any.
- Subsurface exploration depth and units of measure.
- For drilling, length of recovery.
- Sample type and sample number for geotechnical or analytical samples collected. These data are to be also entered on the sample collection log (if used) and the sample label.
- Classification standard protocol used, if any (e.g., ASTM International Standard Penetration Test).
- Narrative description of the soil, sediment, or bedrock (using standard classification system) and other pertinent information.
- Additional data, such as background and sample vapor/gas readings, observation of sheens, non-aqueous-phase liquid, depth to water (if encountered), presence of (but generally not description of) odors, changes in drilling conditions, and other pertinent information.
- Description of the materials used to seal the boring, unless it is completed as a well or piezometer.

2.5 Monitoring Well/Piezometer Installation

In addition to requirements in Section 2.4, subsequent well or piezometer development activities may involve transcription of field data from the field book onto a computer-based boring log. The field notebook or PDA is to be used to identify the chronology and major events of the installation activity, and the computer-based boring log is to be used to correlate the geologic strata to the major elements of the monitoring well construction. Information to be collected and recorded must meet the regulatory and client requirements and may include the following:

- Location identity
- Screen and riser type, length, diameter, and location

- Diameter
- Total depth
- Sump location and depth and diameter
- Materials of construction (e.g., stainless steel, polyvinyl chloride, or other material)
- Seal type(s) and or depth(s)
- Sand or gravel pack type, including materials (e.g., silica) and gradation
- Depth to water before and after installation.

2.6 Air Sampling Logs

At a minimum, air sampling documentation should include:

- Start and finish time of sampling
- Sampling location
- Sampling method/media
- Volume sampled.

2.7 Construction, Demolition, Abandonment, and Related Activities

Monitoring and documentation of construction and comparable activities shall be documented in bound field books and/or on appropriate company forms and should include similar information as specified above, including information such as:

- Project name and number
- Owner or client name
- Contractor or subcontractors performing the work
- Contractor or subcontractor superintendent(s) and personnel (as available) on site
- Chronological sequence and description of work activities performed, including workday start and completion times
- Reference to contract sections, work plans, or specifications describing work being performed
- Reference to relevant permit conditions and regulatory requirements and/or reference to regulatory guidance documents controlling work approach
- Listing of all trades performing work by contractor and subcontractor
- Hours worked per trade
- Work hours per day per shift, if applicable
- Equipment on site (e.g., description, model number, size, and type) and hours of use
- Listing of equipment on site being left idle
- Description and quantity of materials used or incorporated, with reference to contract or specification item number, if feasible; include simple sketch of excavation with approximate dimension, if applicable
- Calculations with dimensions for quantities of material used or incorporated

- Delineation of the work area and access routes (e.g., fencing, flagging, or staking), confirmation that activities occurred within the work area or description of work occurring outside the delineated work area and justification (as needed), and characterization of impacts outside the designated work area
- Documentation of compliance with speed limits, dust control, erosion control best management practices, and other basic elements of construction activities as dictated by project work plans and applicable permits and regulatory criteria.

2.8 Daily Safety Meeting

A Daily Safety Meeting is to be conducted and documented each workday prior to the initiation of field activities, with on-site ENV personnel, contractors, subcontractors, and visitors if possible. Safety topics discussed are entered on the Daily Safety Meeting Form (available on the corporate Intranet). Topics discussed should include site-specific conditions, procedures to be followed that day, and protective equipment. A printed listing of the attendees at the meeting and their signatures should be included. Other required data are:

- Identification of the individual conducting the meeting and his/her signature
- Identification of the project supervisor and project manager.

2.9 Calibration

Documentation of the calibration and calibration results shall be made for field equipment requiring calibration measuring and test equipment calibration data are recorded in the field book or on the Field Activity Log. Calibration data include the following:

- Unique identification of instrument being calibrated, including type, model, and serial number
- Date and time of calibration
- Standards used in the calibration, including standard identity, concentration, lot number, and manufacturer of the standard
- Instrument reading with respect to each calibration standard
- Comments, as necessary, regarding instrument performance.

2.10 Photographs and Videos

When the client allows, photographs and videos may be used to help document pre-, active, and post-field activities. In sensitive areas (e.g., secured or confidential), the client must be contacted to evaluate security procedures concerning use of photographs or videos. Photographic and video documentation should include project title, project number, date, time, and description of conditions. The time should also be documented if time is important to a sequence of photographs.

Photographs are documented by numbering digital photographs and identifying the number and subject on the Field Activity Log. Individual prints may be marked with a stamp or preprinted self-adhesive labels, or by writing the project number and sequential number of each photograph and referencing the numbers in the field book, the Field Activity Log, or a dedicated photo log. Videos used for field documentation are to be identified by project title, project number, and description.

2.11 Subcontractor Preparedness Checklist

Prior to starting work, a review is to be made and documented of a subcontractor's preparedness to perform specified activities. This review may be documented on the Field Activities Log or on checklists that may be developed according to requirements for subcontracted work activities. Particular emphasis should be on site-specific issues that may require special consideration such as health and safety, access, and unique settings. These should be discussed in advance with the CPM and the client in developing and implementing the Scope of Work.

— END OF PROCEDURE —

Geotech Bladder Pumps

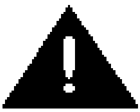
Installation and Operation Manual

Rev 1/14/2020 Part # 21150035

Table of Contents

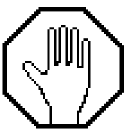
DOCUMENTATION CONVENTIONS

This document uses the following conventions to present information:



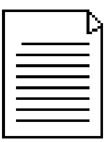
WARNING

An exclamation point icon indicates a **WARNING** of a situation or condition that could lead to personal injury or death. You should not proceed until you read and thoroughly understand the **WARNING** message.



CAUTION

A raised hand icon indicates **CAUTION** information that relates to a situation or condition that could lead to equipment malfunction or damage. You should not proceed until you read and thoroughly understand the **CAUTION** message.



NOTE

A note icon indicates **NOTE** information. Notes provide additional or supplementary information about an activity or concept.

Section 1: System Description

Function and Theory

Geotech's pneumatic Bladder Pumps operate with a unique air-driven action, ideal for both gentle low-flow sampling and high-flow rate purging. Timed ON/OFF cycles of compressed air alternately squeeze the flexible bladder to displace water out of the pump to the surface then exhaust the air allowing the pump to refill.

Fluid enters and fills the pump through the fluid inlet check valve at the bottom of the pump body via hydrostatic pressure. Once filled with fluid, compressed air enters the space between the bladder and the interior of the pump housing, squeezes the bladder, and pushes the fluid to the surface (see Figure 1-1). Operated by the BP Controller or Geocontrol PRO, this logic automatically repeats.
Air does not contact the sample. The bladder prevents contact between the pump driven air and the sample. All wetted pump parts are 316 Grade stainless steel to ensure the purity of the sample is maintained.

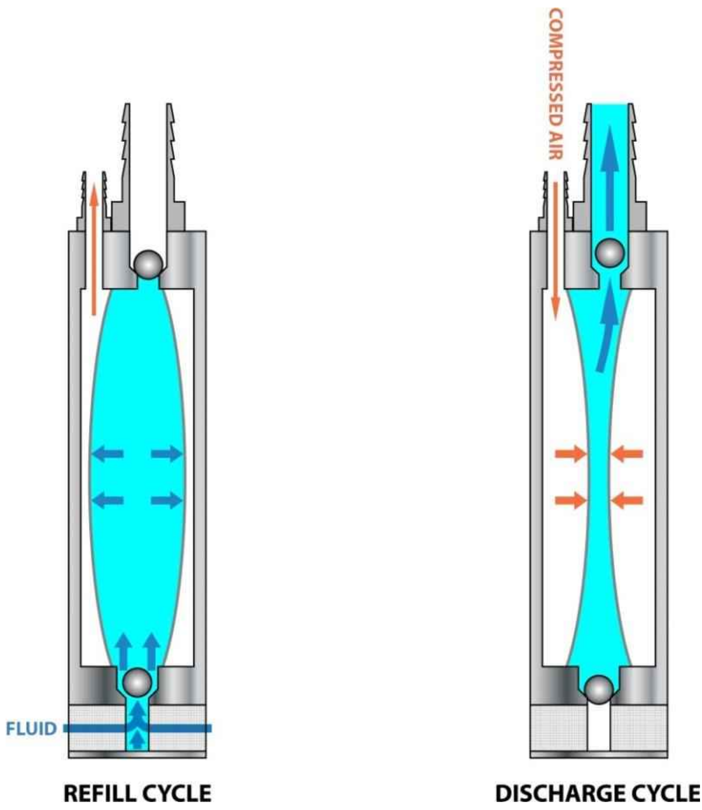


Figure 1-1: Bladder Pump Operation
Not to scale

Be sure to read and understand your portable generator and/or portable air compressor user manual for proper installation, operation, and Earth grounding instructions. If using portable compressed gas tanks, exercise caution, use safety protection devices as outlined by the supplier, and observe any additional safety requirements mandated by local jurisdiction.

System Components

The Geotech Bladder Pump features four accessible parts (see Figure 1-2):
- Intake Screen
- Pump Housing
- Air and Sample Line Connections
- Bladder Assembly

*Optional: Drop Tube Intake Assembly

Intake Screen

The intake filter screen is constructed of 316 Stainless Steel and is easily removed and disassembled for field maintenance. The intake filter screen is intended to protect and extend the life of the bladder material (see *The Warranty*).

Pump Housing

The Geotech Bladder Pump housing is constructed of electropolished 316 Stainless Steel. Viton O-rings provide the high-pressure seals between the end caps and the housing walls. Always lubricate the O-rings with deionized water before installing the housing and intake screen.

Air and Sample Line Connections

The 1.66” Bladder Pump is provided in both low and high-pressure configurations. The low-pressure model is equipped with hose barbs for air and sample line connections, whereas the high-pressure model is equipped with heavy-duty compression fittings. The .850” and .675” models are both considered low pressure. See *Section 6: System Specifications* for operating depths and pressures.

Bladder assembly

The bladders are extruded Polytetrafluoroethylene (PTFE) to provide a long life and to ensure undisturbed samples. The internal bladders are easily replaceable, see *Section 4: System Maintenance*.

Drop Tube Intake Assembly (Optional)

An optional drop tube can be used to sample from depths below the specified maximum sampling depth. The drop tube assembly connects a remote intake feature to the pump through a tube connected to the pump inlet. The intake depth can be any custom length of tubing. The pump assembly itself must still be submerged below the water level. This means the depth to water cannot exceed the maximum pumping depth of the pump.

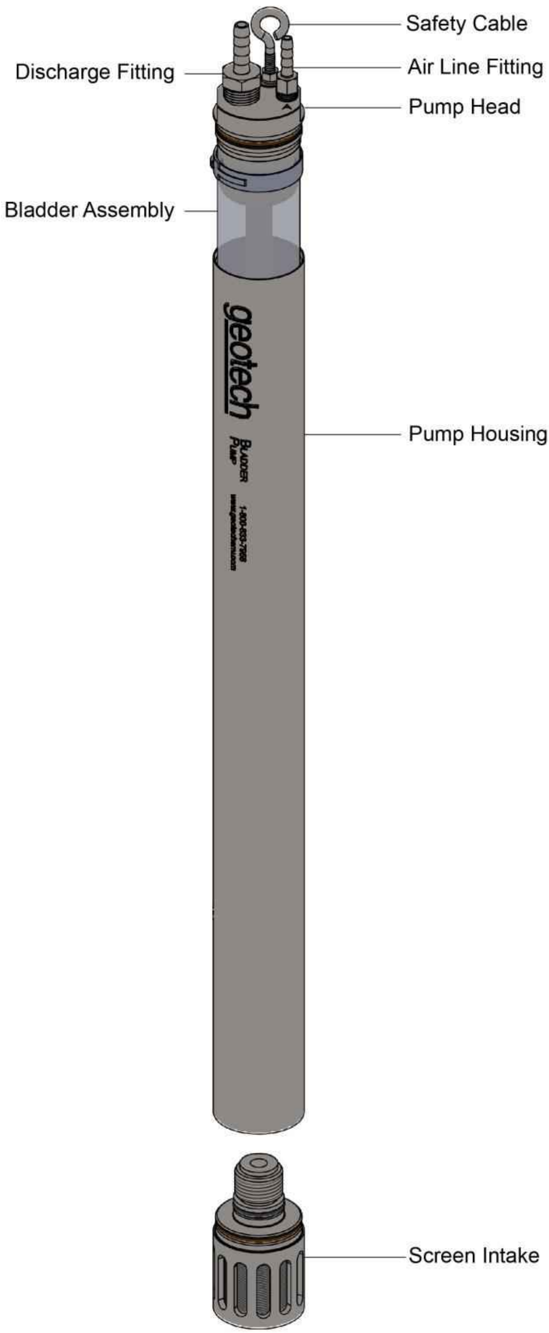


Figure 1-2: Basic* Bladder Pump Assembly

**Example above is based on 1.66" Low Pressure configuration*

Section 2: System Installation

Determine site-specific parameters such as water level, recharge rate and adherence to low flow purging guidelines. Speak with your Geotech Customer Service Representative to ensure the right equipment is being used.

Pump Controller

Geotech Bladder Pumps can be operated using a variety of controllers. Site requirements will determine the optimal control unit. Use the table below as a guide:

Controller	**Air Source**	**Max Operating Depth**
Geocontrol Pro	Internal compressor	180’ (55m)
BP Controller 300 PSI	Externally supplied	690’ (210m)
BP Controller 500 PSI	Externally supplied	1000’ (305m)

Pump Tubing Lines

Geotech’s Bladder Pumps are engineered for easy installation and use. Dedicated Bladder Pump systems are available with the tubing and well cap attached for ease of deployment. Well identifications (supplied by customer) are located on tags connected to the tubing, and on the tubing bags.

If not pre-attached, at the wellhead connect the airline tubing to air line connection at the top of the Bladder Pump (see Figure 1-2). The letter “A” has been stamped near the airline port on the top of each pump. See *Section 6: System Specifications* for air line system sizes.

Next, attach the discharge line to the discharge line connection at the top of pump (see Figure 1-2).

Failure to attach air and fluid lines to the appropriate ports could result in damage to the bladder.

Compression Fitting Installation

1. Ensure tubing is cut at a square, 90° angle.
2. Attach nut, back ferrule, and front ferrule to the tubing.
3. Ensure the front of the ferrule is touching the inlet, then slide the nut over the ferrule and tighten it finger-tight.
4. Mark the nut with a line.
    - This line will indicate the initial start point of the nut.
5. Hold the fitting body steady with a wrench. Turn the nut 1 ¼ turns.
    - Do not overtighten.
    - If re-installing compression fitting after repair/regular maintenance, turn the nut 1 turn after hand-tightening.

Safety Cable

Before deploying any sampling pump, secure a safety cable from an anchoring point at or near the wellhead to the top of the pump.

Carefully lower the Bladder Pump into the well using the Reverse Coil Method to avoid kinking, until the desired depth is achieved or until the well cap seats Reverse Coil Method

When lowering the pump into the well, it is important to reverse the natural bend of the coiled tubing so that the tubing straightens as it is lowered (see Figure 2-1). As the pump and tubing are lowered into the well, the direction of the bend should be reversed from the direction in which it is coiled. If the tubing is allowed to uncoil naturally and the natural bend not interrupted, the tubing will continue its coil into the well. Using the reverse coil method will avoid any difficulty while lowering the pump into the well, especially when the well is not completely vertical, or has come out of alignment for any reason.

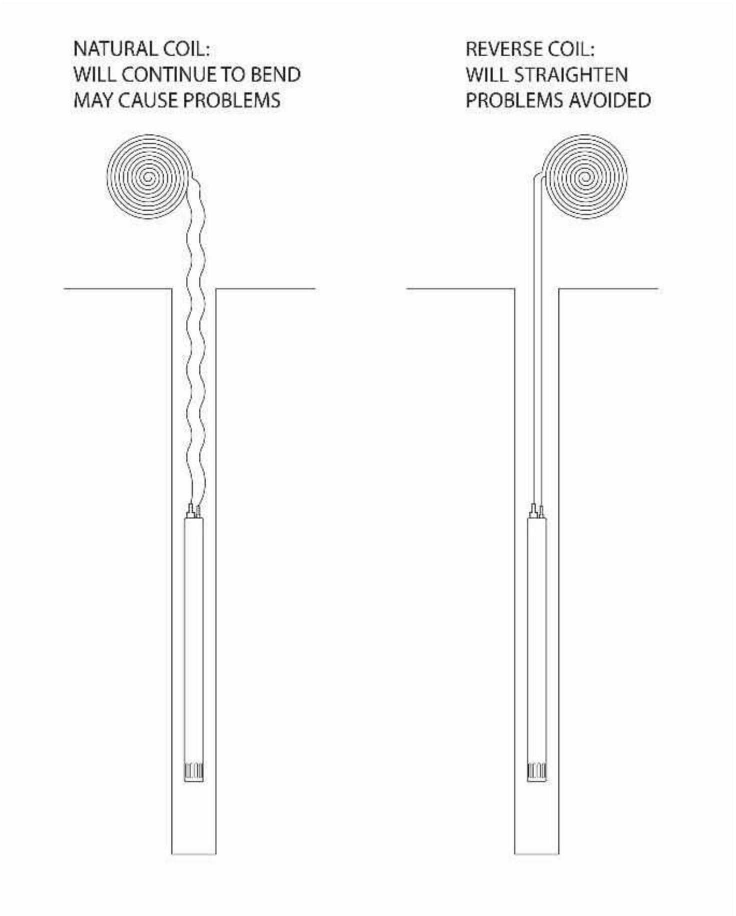


Figure 2-1: Reverse Coil Method

Optional Drop Tube Assembly

If a Drop Tube Intake Assembly is employed, a third tubing line is necessary to connect from the bottom of the bladder pump to the top of the drop tube intake.

For deployment of optional Drop Tube Intake Assembly, attach desired length of drop tube between the intake’s hose barb and hose barb on bottom of pump. For added security, a safety cable may be installed to support the drop tube intake to the bottom of pump.

Send the drop tube intake down the well followed by the drop tube tubing, then the pump, and finally the air and fluid discharge line.

Section 3: System Operation

Bladder Pump Operation

Fluid enters the pump through the fluid inlet check valve at the bottom of the pump body via hydrostatic pressure. The pump MUST be submerged to operate. The bladder then fills with fluid. Compressed air enters the space between the bladder and the interior of the pump housing. The intake check valve closes and the discharge check valve (top) opens. Compressed air squeezes the bladder, pushing the fluid to the surface. The discharge check valve prevents back flow from the discharge tubing.

Selecting an Air Source

Air consumption depends on the volume of tubing and the size of deployed Bladder Pump. Follow the general guidelines and examples below to calculate the air consumption for specific sampling configurations.

Air Volume of Tubing

	TUBING LENGTH					
TUBE I.D.	1 ft/ 0.3 m	10 ft/ 3 m	50 ft/ 15 m	100 ft/ 30 m	250 ft/ 76 m	500 ft/ 152 m
0.17 in/ 0.43 cm	0.3 in^3/ 5 cm^3	3 in^3/ 50 cm^3	15 in^3/ 246 cm^3	30 in^3/ 492 cm^3	75 in^3/ 1230 cm^3	150 in^3/ 2460 cm^3
0.25 in/ 0.64 cm	0.6 in^3/ 10 cm^3	6 in^3/ 100 cm^3	30 in^3/ 492 cm^3	60 in^3/ 984 cm^3	150 in^3/ 2460 cm^3	300 in^3/ 4920 cm^3

Air Volume of Bladder Pumps

BP DIAMETER	BP LENGTH	VOLUME (in^3)
1.66 in/ 4 cm	36 in/ 91 cm	78 in^3/ 1278 cm^3
1.66 in/ 4 cm	18 in/ 46 cm	39 in^3/ 640 cm^3
0.85 in/ 4 cm	18 in/ 46 cm	10 in^3/ 164 cm^3
0.675 in/ 4 cm	18 in/ 46 cm	6 in^3/ 100 cm^3

Calculation guideline:
Volume of Tubing (in^3/cm^3)
+ Volume of Bladder Pump (in^3/ cm^3)
= Air Consumption per cycle (in^3/ cm^3)

If planning to use an air compressor, use one with a reserve tank to insure proper air supply to the pump. If using a Nitrogen Tank, see Figure 3-1 for Nitrogen Tank Volume vs. Bladder Pump consumption.

Determining Operation Pressure

Determine the air pressure needed to operate the Bladder Pump based on the length of the air supply line to the pump (well depth).

Use the simplified formula:

> 0.5 PSI (per foot) + 10 PSI (to account for tubing friction) = required PSI
> 0.12 bar (per meter) + 0.7 bar (to account for tubing friction) = required bar

As mentioned above, the additional 10 PSI (0.7 bar) is to account for the pump itself and friction loss along the air line tubing. When the length of the airline is 50’ (15m) or less, there is no need for the additional pressure.

To determine minimum operating pressures for the specific Bladder Pump model you are using, consult the pump’s specifications. Typically, the minimum operating pressure will be 5 PSI (0.4 bar) above static head.

The formulas stated above are not absolute, and are meant to provide baseline information.

Flow Rates

Bladder Pump flow rates are influenced by pump size (diameter and length); pump depth and submergence, as well as controller selection (i.e. compressor performance, valve flow coefficient). Generally, a large pump at shallow depths will produce the most flow, and a small pump at maximum depths will produce the least amount of flow.

Example flow rates:

<table>
<tr><th rowspan="2">Pump Size:</th><th rowspan="2">Depth:
(3ft (0.9m)
submergence)</th><th colspan="2">Tubing Size</th><th rowspan="2">Flow Rate:</th></tr>
<tr><th>Air line:</th><th>Discharge:</th></tr>
<tr><td rowspan="2">1.66 x 36"</td><td>@ 275 ft
(84 m)</td><td>.17"ID x 1/4"OD
(4.3mm x 6.4mm)</td><td>1/4"ID x 3/8"OD
(6.4mm x 9.5mm)</td><td>22 oz/min
(0.7 L/min)</td></tr>
<tr><td>@ 500 ft
(152 m)</td><td colspan="2">1/4"ID x 3/8"OD
(6.4mm x 9.5mm)</td><td>17 oz/min
(0.5 L/min)</td></tr>
<tr><td rowspan="2">1.66 x 18"</td><td>@ 275 ft
(84 m)</td><td>.17"ID x 1/4"OD
(4.3mm x 6.4mm)</td><td>1/4"ID x 3/8"OD
(6.4mm x 9.5mm)</td><td>12 oz/min
(0.4 L/min)</td></tr>
<tr><td>@ 500 ft
(152 m)</td><td colspan="2">1/4"ID x 3/8"OD
(6.4mm x 9.5mm)</td><td>8 oz/min
(240 mL/min)</td></tr>
<tr><td>.850 x 18"</td><td>@ 150 ft
(46 m)</td><td colspan="2">.17"ID x 1/4"OD
(4.3mm x 6.4mm)</td><td>2 oz/min
(59 mL/min)</td></tr>
<tr><td>.675 x 18"</td><td>@ 150 ft
(46 m)</td><td colspan="2">.17"ID x 1/4"OD
(4.3mm x 6.4mm)</td><td>1 oz/min
(27 mL/min)</td></tr>
</table>

The above example flow rates are based on 3’ (0.9 m) of pump submergence. Typically, field environments will provide greater submergence (more than 10’ (3 m)), which will dramatically increase flow.

Factors that increase flow:

- increased submergence (depth of pump below water line)
- a strong compressor, like the Geocontrol PRO, will enable fast pressure build up in the air line tubing and pump cavity
- a clean intake screen will maximize the amount of water entering into the pump

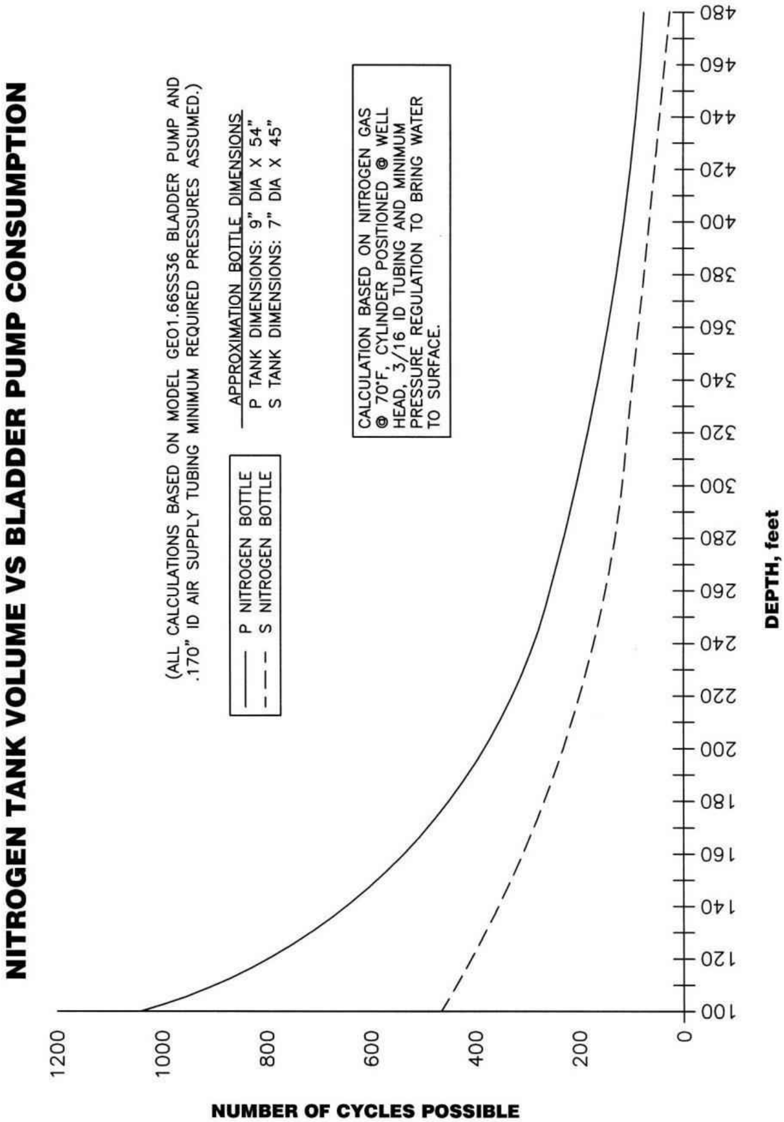


Figure 3-1: Tank Volume vs. BP Consumption

Section 4: System Maintenance

Bladder Pump

As with any pump, scheduled or periodic maintenance should be performed according to your sampling program and specific site conditions. Generally, the more turbid or sandy the water, the more maintenance and cleaning are required.

Replacement bladders, as well as other key components, can be found in *Section 7: Replacement Parts List*.

Disassemble Bladder Pump per instructions in this section, decontaminate or replace parts as needed, then reassemble.

Inspect O-rings and check balls for damage.
Replace Bladder if torn, ripped, or excessively worn.

Replacing the Bladder

<u>1.66” Models</u>

Pull pump from the well, it is not necessary to remove the air and sample lines from the pump. Take care, as the pump may be filled with fluid.

1. Hold the pump by its head with a towel or use the wrench flats, and turn the screen intake counter-clockwise to remove (see Figure 4-1).
    - The intake may be snug due to the high-pressure O-ring seal. Once the seal is broken, then intake should disengage easily.

2. Hold the pump by its head and slide or twist the housing off the pump body (see Figure 4-1).

3. Locate the Bladder clamps (see #3 on Figure 4-1).

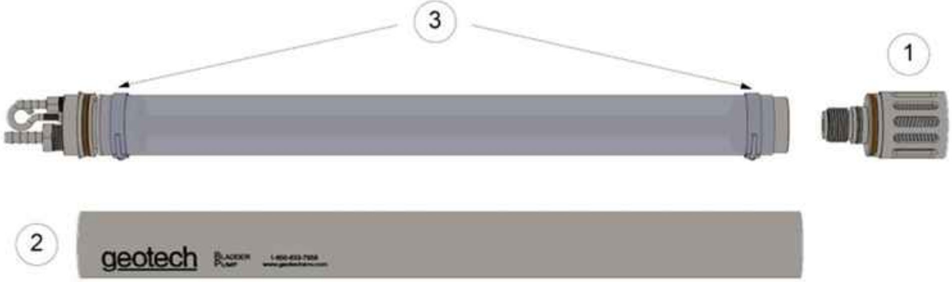


Figure 4-1: Accessing the Bladder Assembly

4. Obtain the clamp pincher tool (Geotech part # 11150031).

5. Pinch the tension hook and lift the end of the clamp until it releases from the retaining hooks (see Figure 4-2).

Figure 4-2: Removing the Bladder Clamp

6. Slide clamp off bladder.
   - Do this for both the top and the bottom bladder clamps.

7. Set the clamps aside, they are reusable.

8. Slide the bladder down over the pump body, decontaminate or replace as necessary.

9. Inspect O-rings for damage.

10. Replace O-rings as necessary.

<u>Reassemble the 1.66" Models:</u>

1. Slide the decontaminated or new bladder up the pump body and over the O-rings.

2. Ensure the O-rings are not dislodged and the bladder covers both O-rings with at least a 1/4" (.6cm) of clearance.

3. Slide the bladder clamps over the bladder and position each clamp over an O-ring, making sure the clamp and O-ring are aligned on center.

4. Using the clamp tool (Geotech part # 11150031). Pinch the tension hook and use your thumb to guide the end of the clamp over the retaining hooks until the clamp is locked in place (see Figure 4-4).

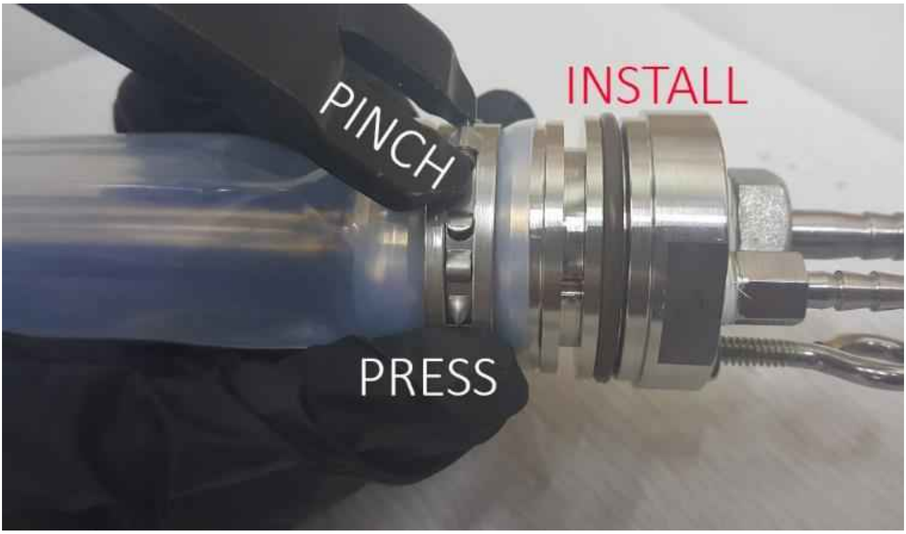


Figure 4-4: Installing the Bladder Clamp

5. Slide the housing over the pump body.

6. Lubricate the upper cap's O-ring using deionized water to ensure a pressure-ready installation.

7. Twist the housing on the body until it is flush with the upper cap.

8. Install the screen intake by lubricating the O-rings with deionized water and then turning clockwise into the pump's body.

9. Hold the pump by its head to ensure the screen intake is fully secured.
   - There should be no gaps between the outer housing and top or bottom caps.

10. Ensure the pump's fittings and safety cable are in good condition.

The pump is ready for service.

Remove the pump from the well. It is not necessary to remove the air and sample lines from the pump. Upon removal, the pump may be filled with fluid.

.850 and .675 Bladder Removal Steps

1. Remove the bottom intake assembly and outer housing by turning the housing counter-clockwise.
    - Use your hand or a strap wrench
    - DO NOT grip the hose barbs.
    - For .85 and .675 models, use a wrench that is one size bigger than the bolts on the hose barbs. (EX: use a 7/16 wrench on a .850 model)
        - Using a larger wrench will prevent the hose barbs from being removed. The tool should only be used for leverage to loosen the part.
    - If the bottom intake is difficult to remove, remove the snap ring, disc, and screen and then use a wrench for removal.

Figure 4-1: Removal of the bottom intake and outer housing

2. Remove the lower Compression Ring by pulling it off the end of the internal center tube assembly.

Figure 4-2: Removal of bottom Compression Ring

3. Remove the upper Compression Ring by sliding it over the bladder and over the end of the internal center tube assembly.

Figure 4-3: Removal of upper Compression Ring

4. Pulling from the lower end of the bladder, slide the bladder off the internal center tube weldment assembly.

Figure 4-4: Removal of Bladder

5. Remove all O-rings.
   - If needed, use a flat object to help the O-ring out of the groove on the center tube weldment assembly,
   - Do not over-stretch, damage, or puncture the O-rings in any way.

Figure 4-5: Removal of O-rings

6. Clean and prepare replacement parts as needed.

Bladder Reassembly

1. Install O-ring on the cap of the center tube weldment assembly.

Figure 4-10: Cap O-ring

2. Install O-ring on the upper end of the center tube weldment assembly.

Figure 4-11: Upper end O-ring

3. Install O-ring on the lower end of the center tube weldment assembly.

Figure 4-12: Lower O-ring

4. Slide bladder onto the internal center tube weldment assembly, over the O-ring on the bottom end of the center tube assembly, and then over the O-ring on the upper end of the center tube weldment assembly.
   - Do not to roll the O-rings.
   - If needed, use Deionized water or a silicone based lubricant on the O-ring seals to help the bladder slide over the O-rings.

Figure 4-13a: Sliding bladder on

Figure 4-13b: Bladder entirely on

5. Slide the Compression Ring over the bladder to the upper end of the center tube weldment assembly.

Figure 4-14a: Compression Ring on Bladder

Figure 4-14b: Compression ring secured

6. With the upper end of the bladder secured by the Compression Ring slide the second compression ring over the end of the bladder until the O-ring is visible in the middle of the Compression Ring.
   - Compression rings that are made from other materials (ex: PTFE), will not be clear. The O-ring will not be visible.

Figure 4-15: Bottom Compression ring with visible O-ring

7. An alternate way to assemble the bladder is to:
   a) Place both Compression Rings on the center tube weldment assembly

b) Slide the bladder over the bottom O-ring, through the compression rings, and over the top O-rings until the bladder is flush with the upper end of the center tube weldment assembly (see Figure 4-13b)

c) Slide the top compression ring to the upper end of the center tube weldment assembly (see Figure 4-14b)

d) Slide the bottom compression ring to the lower end of the center tube weldment assembly (see Figure 4-15)

8. Replace the outer housing.
   - Be sure the outer housing is sealed against the upper cap.

Figure 4-16a: Incorrect Installation

Figure 4-16b: Correct Installation

9. Replace the bottom intake assembly by screwing it into the bottom of the pump.
   - Reassemble bottom intake if previously disassembled by inserting the screen, disc, and snap ring into the lower cap.
   - Be sure the bottom intake assembly is sealed against the outer housing.

Figure 4-17a: Incorrect Installation

Figure 4-17b Correct Installation

Inspect O-rings and bladder for damage.
Replace if torn, ripped, or excessively worn.

Compression Fittings

Tubing can wear out over time if compression fittings are overtightened. After repair, ensure that compression fittings are “snug”. One full rotation after hand tightening of the nut should be enough to tighten the compression fitting.

Section 5: System Troubleshooting

Problem: Air is cycling through controller but will not pump.
Solutions

- Discharge and Fill times are not set correctly. Check and adjust Discharge and Fill cycle times (i.e. if Discharge time is too long or if Fill and Discharge time is too short).
- Possible compromise in air line tubing. Check airline pumps for leaks. If needed, repair using compression union or replace tubing.
- Check pump intake screen for blockage and clean as needed.

Problem: Controller is cycling but the pump stops producing water.
Solutions

- Check drawdown level of water in the well. Ensure the pump is fully submerged and off of the bottom of the well.
- Check air pressure at the regulator and adjust as necessary (See *Section 3: Determining Operation Pressure*.)
- Check for kinks in the discharge line.
- Check pump intake screen for obstructions.
- Discharge time is too long or Fill time is too short; causes pressure build up in pump, causing the pump not to fill.
- Check power source, assure a strong reliable power supply. If using old or weak battery, the control valves may not operate properly.

Problem: Getting air bubbles in sample line.
Solutions

- Overcharging pump. Reduce discharge cycle time so the discharge cycle ends as fluid discharge trails off. Inspect pump for compromised bladder or O-rings.
- Pump is being over pressurized. Reduce air pressure to what is necessary to overcome pumping head.
- Check discharge line for holes or kinks. Repair using compression union or replace tubing.
- Ensure Bladder clamps are properly installed.

Problem: Discharge line drains back into pump.
Solution

- Check valve at the top of the pump is compromised. Remove hose barb on pump discharge outlet. Check the check ball seat for debris. Clean and re-install.
- Check the upper ball for roundness, pitting or scaling.

Problem: Discharge sucks up water at sampling end, especially during fill cycle.
Solution
The compression fitting ferrule has cut into the tubing. Follow installation instructions in *Section 2: System Installation*.

If you are experiencing other problems than mentioned above, please call Geotech Technical Support for immediate assistance, (800) 833-7958.

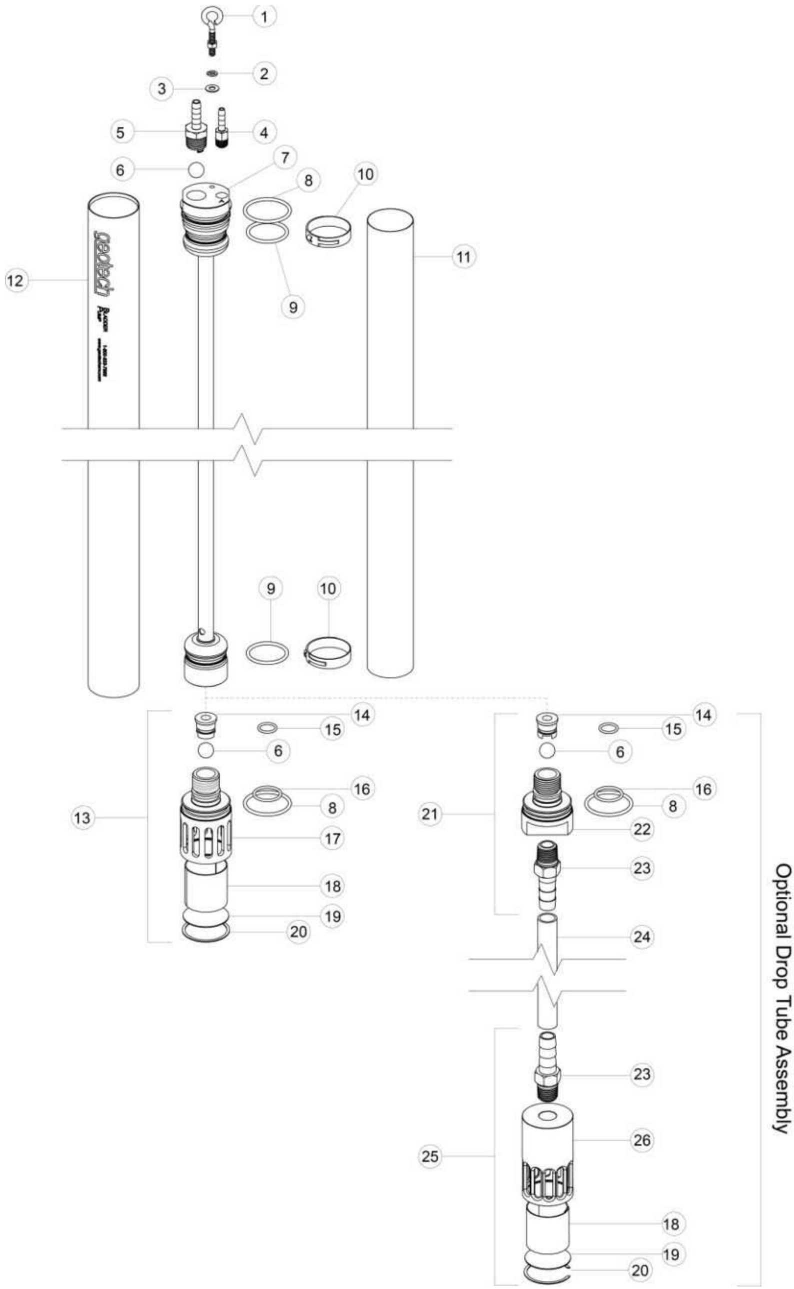
Section 6: System Specifications

	1.66 36"		1.66 18"		0.850"	0.675"
	High Pressure	Low Pressure	High Pressure	Low Pressure		
Pump Body	316 SS					
Fittings	316 SS					
Fitting Type	Compression	Hose barb	Compression	Hose barb	Hose barb	
Bladder Material	PTFE *Optional PE*					
Bladder Retainer	316 SS Clamp				PTFE Collar	
Pump O.D.	1.66" (4.2 cm)				.850" (2.2 cm)	.675" (1.7 cm)
Length	38" (96.5 cm)		20" (51 cm)		18 5/8" (47.3 cm)	18 3/4" (47.6 cm)
Weight	5.5 lbs. (2.5 kg)		3.5 lbs. (1.6 kg)		1.1 lbs. (0.5 kg)	.8 lbs. (0.4 kg)
Volume/ Cycle	22 oz. (650 mL)		11 oz. (325 mL)		1 oz. 29 mL	0.5 oz. 15 mL
Max Operating Temp.	PTFE Bladder: 32°F-212°F (0°C-100°C) *PE Bladder: 32°F -185°F (0°C -85°C)*					
Min. Well I.D.	2" (5 cm)				1" (2.5 cm)	.75" (1.9 cm)
Max. Sample Depth	1000 ft. (305 m)	290 ft. (88 m)	1000 ft. (305 m)	290 ft. (88 m)	200' (61 m)	
Min. Operating Pressure	5 psi ash* (.34 bar)					
Max. Operating Pressure	500 psi (34 bar)	125 psi (8.6 bar)	500 psi (34 bar)	125 psi (8.6 bar)	100 psi (7bar)	
Proof Pressure	675 psi (46 bar)	187 psi (13 bar)	675 psi (46 bar)	187 psi (13 bar)	150 psi (10 bar)	
Burst Pressure	1000 psi (69 bar)	300 psi (21 bar)	1000 psi (69 bar)	300 psi (21 bar)	300 psi (20 bar)	
Tubing Size (I.D. x O.D.)						
Air Line	1/4" x 3/8" (6 x 10 mm)	.17" x 1/4" (4 x 6 mm)	1/4" x 3/8" (6 x 10 mm)	.17" x 1/4" (4 x 6 mm)	.17" x 1/4" (4 x 6 mm)	
Discharge Line		1/4" x 3/8" (6 x 10 mm)		1/4" x 3/8" (6 x 10 mm)		

*ash = above static head

Section 7: Replacement Parts List

1.66 Bladder Pump Components (36” & 18” LOW Pressure Models)



Bladder Pump, 1.66, Stainless Steel, 36", Low Pressure - 81150120

Item	Qty	Description	Part No.
1	1	EYEBOLT, SS6, 10-24, 1" SHANK	16600347
2	1	WASHER, SS6, #10, LOCK	11150449
3	1	WASHER, SS6, #10	11150450
4	1	HOSEBARB, SS6, .170 x 1/8" MPT, AIR LINE	21150019
5	1	HOSEBARB, SS6, MOD, 1/4" x 3/8 MPT, DISCHARGE	21150145
6	2	BALL, SS6, 1/2"	17500082
7	1	CAP, UPPER WELDMENT, SS, 166x36"	21150143
8	2	O-RING, VITON, 2.5mm x 36mm, BROWN	11150318
9	2	O-RING, VITON, #123, BROWN	11200299
10	2	CLAMP, SS6, LOW PROFILE	11150444
11	1	BLADDER, PTFE, BP, 166SS36,DEDICATED	51150139
12	1	HOUSING, SS6, DED, 166x36"	51150142
13	1	ASSY, BOTTOM INTAKE, 166 BP	51150067
14	1	PLUG, BALL RETAINER, 166 BP	21150096
15	1	O-RING, VITON, #014, BROWN	17500119
16	1	O-RING, VITON, 2mmx20mm	11150332
17	1	CAP, LOWER, SS6, 166 BP	21150094
18	1	SCREEN, INTAKE, SS6, 166 BP	21150095
19	1	DISC, SS, 1.66, PBP	21150148
20	1	RING, SNAP, SS6, INTERNAL, 166 BP	11150051
21	§	ASSY,LOWER CAP,166 DROP TUBE WITH 1/2" HOSEBARB	51150128
22	§	DROPTUBE, CAP LOWER, SS6, 166	21150098
23	§	HOSEBARB, SS6, 1/2 x 3/8" MPT	16600217
24	§	TUBING, PE, 1/2 x 5/8"	87050504
25	§	ASSY, INTAKE, 166, DROP TUBE, WITH 1/2" HOSE BARB	51150071
26	§	INTAKE, DROPTUBE, SS6, 166	21150113
Not Shown:			
	1	MANUAL, BLADDER PUMPS	21150035
	§	TOOL, BLADDER PUMP, PINCER, 5mm	11150031
	§	KIT, 166 SS BP, O-RING SET, O-RING SERVICE SET [Item 8 (2), 9 (2), 15 (1), 16 (1)]	91150023

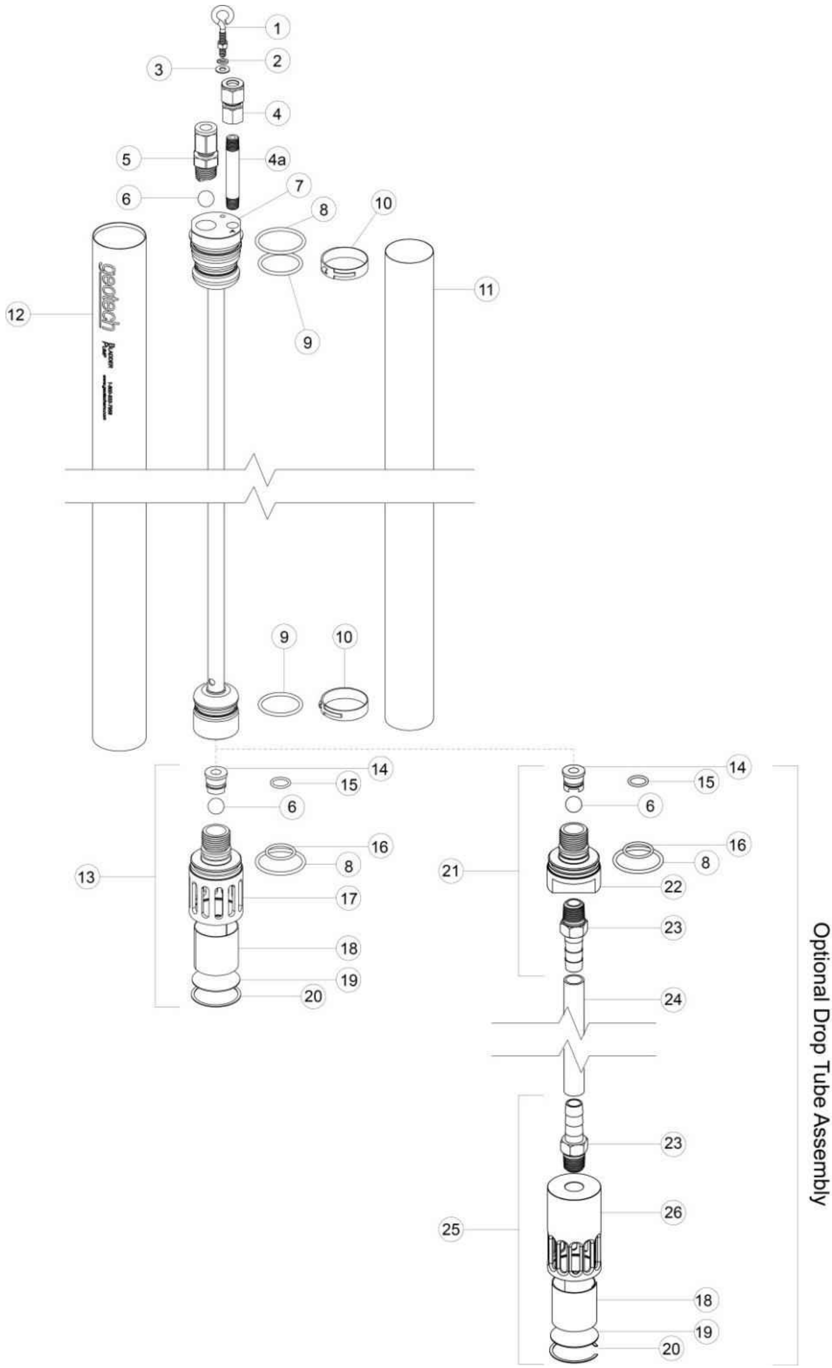
§ *= Sold Separately*

Bladder Pump, 1.66, Stainless Steel, 18", Low Pressure - 81150122

Item	Qty	Description	Part No.
1	1	EYEBOLT, SS6, 10-24, 1" SHANK	16600347
2	1	WASHER, SS6, #10, LOCK	11150449
3	1	WASHER, SS6, #10	11150450
4	1	HOSEBARB, SS6, .170 x 1/8" MPT, AIR LINE	21150019
5	1	HOSEBARB, SS6, MOD, 1/4 x 3/8" MPT, DISCHARGE	21150145
6	2	BALL, SS6, 1/2"	17500082
7	1	CAP, UPPER WELDMENT, SS, 166 x 18"	21150147
8	2	O-RING, VITON, 2.5mm x 36mm, BROWN	11150318
9	2	O-RING, VITON, #123, BROWN	11200299
10	2	CLAMP, SS6, LOW PROFILE	11150444
11	1	BLADDER, PTFE, BP, 166SS18, DEDICATED	51150140
12	1	HOUSING, SS6, DED, 166 x 18"	51150143
13	1	ASSY, BOTTOM INTAKE, 166 BP	51150067
14	1	PLUG, BALL RETAINER, 166 BP	21150096
15	1	O-RING, VITON, #014, BROWN	17500119
16	1	O-RING, VITON, 2mm x 20mm	11150332
17	1	CAP, LOWER, SS6, 166 BP	21150094
18	1	SCREEN, INTAKE, SS6, 166 BP	21150095
19	1	DISC, SS, 1.66, PBP	21150148
20	1	RING, SNAP, SS6, INTERNAL, 166 BP	11150051
21	§	ASSY,LOWER CAP,166 DROP TUBE WITH 1/2" HOSEBARB	51150128
22	§	DROPTUBE, CAP LOWER, SS6, 166	21150098
23	§	HOSEBARB, SS6, 1/2 x 3/8" MPT	16600217
24	§	TUBING, PE, 1/2 x 5/8"	87050504
25	§	ASSY, INTAKE, 166, DROP TUBE, WITH 1/2" HOSE BARB	51150071
26	§	INTAKE, DROPTUBE, SS6, 166	21150113
Not Shown:			
	1	MANUAL, BLADDER PUMPS	21150035
	§	TOOL, BLADDER PUMP, PINCER, 5mm	11150031
	§	KIT, 166 SS BP, O-RING SET, O-RING SERVICE SET [Item 8 (2), 9 (2), 15 (1), 16 (1)]	91150023

§ *= Sold Separately*

1.66 Bladder Pump Components (36” & 18” HIGH Pressure Models)



Bladder Pump, 1.66, Stainless Steel, 36", High Pressure - 81150119

Item	Qty	Description	Part No.
1	1	EYEBOLT, SS6, 10-24, 1" SHANK	16600347
2	1	WASHER, SS6, #10, LOCK	11150449
3	1	WASHER, SS6, #10	11150450
4	1	CMPRSN FITTING, SS6, 3/8 TUBE x 1/8 FPT	11150446
4a	1	NIPPLE, SS6, 1/8" NPT x 2.5"	11150447
5	1	CMPRSN FITTING, MOD, SS6, 3/8 TUBE x 3/8" MPT	21150144
6	2	BALL, SS6, 1/2"	17500082
7	1	CAP, UPPER WELDMENT, SS, 166 x 36"	21150143
8	2	O-RING, VITON, 2.5mm x 36mm, BROWN	11150318
9	2	O-RING, VITON, #123, BROWN	11200299
10	2	CLAMP, SS6, LOW PROFILE	11150444
11	1	BLADDER, PTFE, BP, 166SS36,DEDICATED	51150139
12	1	HOUSING, SS6, DED, 166x36"	51150142
13	1	ASSY, BOTTOM INTAKE, 166 BP	51150067
14	1	PLUG, BALL RETAINER, 166 BP	21150096
15	1	O-RING, VITON, #014, BROWN	17500119
16	1	O-RING, VITON, 2mmx20mm	11150332
17	1	CAP, LOWER, SS6, 166 BP	21150094
18	1	SCREEN, INTAKE, SS6, 166 BP	21150095
19	1	DISC ,SS, 1.66,PBP	21150148
20	1	RING, SNAP, SS6, INTERNAL, 166 BP	11150051
21	§	ASSY,LOWER CAP,166 DROP TUBE WITH 1/2" HOSEBARB	51150128
22	§	DROPTUBE, CAP LOWER, SS6, 166	21150098
23	§	HOSEBARB, SS6, 1/2 x 3/8" MPT	16600217
24	§	TUBING, PE, 1/2 x 5/8"	87050504
25	§	ASSY, INTAKE, 166, DROP TUBE, WITH 1/2" HOSE BARB	51150071
26	§	INTAKE, DROPTUBE, SS6, 166	21150113
Not Shown:			
	1	MANUAL, BLADDER PUMPS	21150035
	§	TOOL, BLADDER PUMP, PINCER, 5mm	11150031
	§	FERRULE SETS, SS6, 3/8"	57200010
	§	KIT, 166 SS BP, O-RING SET, O-RING SERVICE SET [Item 8 (2), 9 (2), 15 (1), 16 (1)]	91150023

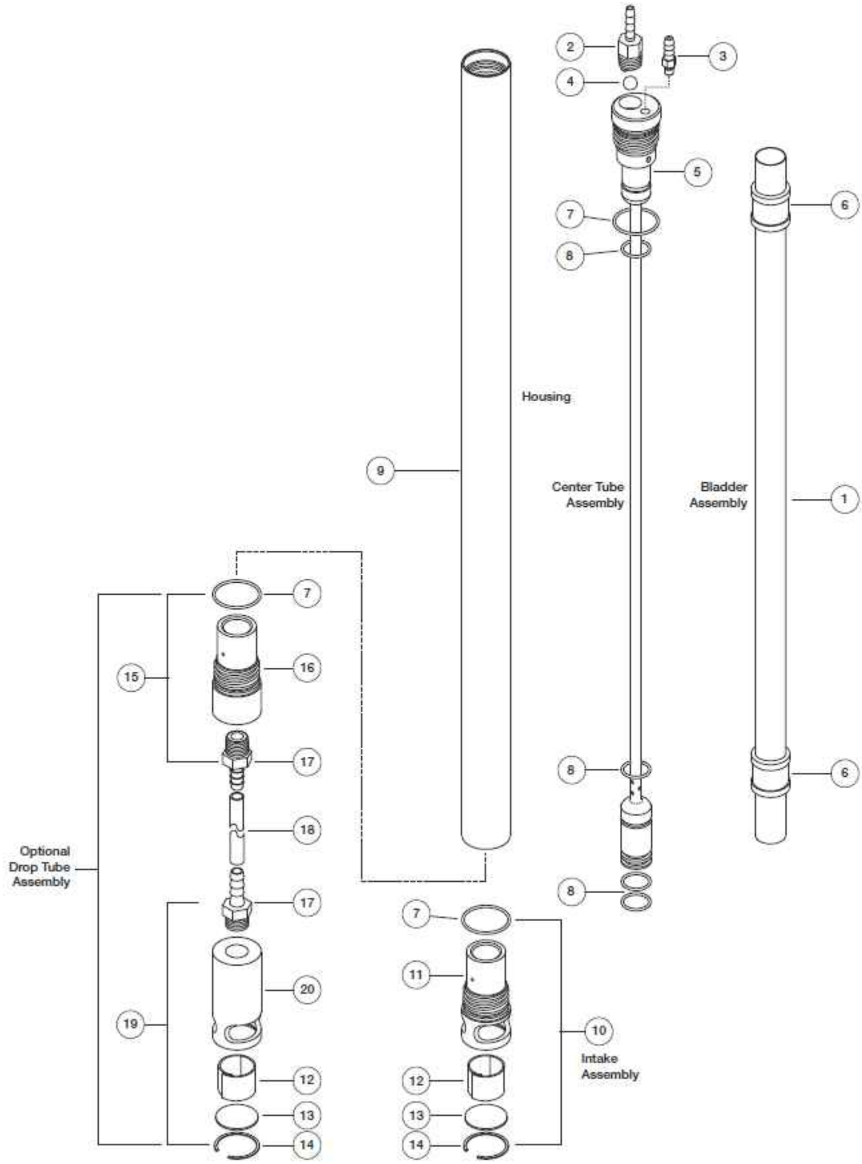
§ *= Sold Separately*

Bladder Pump, 1.66, Stainless Steel, 18", High Pressure - 81150121

Item	Qty	Description	Part No.
1	1	EYEBOLT, SS6, 10-24, 1" SHANK	16600347
2	1	WASHER, SS6, #10, LOCK	11150449
3	1	WASHER, SS6, #10	11150450
4	1	CMPRSN FITTING, SS6, 3/8 TUBE x 1/8 FPT	11150446
4a	1	NIPPLE, SS6, 1/8" NPT x 2.5"	11150447
5	1	CMPRSN FITTING, MOD, SS6, 3/8 TUBE x 3/8" MPT	21150144
6	2	BALL, SS6, 1/2"	17500082
7	1	CAP, UPPER WELDMENT, SS, 166x18"	21150147
8	2	O-RING, VITON, 2.5mm x 36mm, BROWN	11150318
9	2	O-RING, VITON, #123, BROWN	11200299
10	2	CLAMP, SS6, LOW PROFILE	11150444
11	1	BLADDER, PTFE, BP, 166SS18, DEDICATED	51150140
12	1	HOUSING, SS6, DED, 166x18"	51150143
13	1	ASSY, BOTTOM INTAKE, 166 BP	51150067
14	1	PLUG, BALL RETAINER, 166 BP	21150096
15	1	O-RING, VITON, #014, BROWN	17500119
16	1	O-RING, VITON, 2mmx20mm	11150332
17	1	CAP, LOWER, SS6, 166 BP	21150094
18	1	SCREEN, INTAKE, SS6, 166 BP	21150095
19	1	DISC, SS,1.66, PBP	21150148
20	1	RING, SNAP, SS6, INTERNAL, 166 BP	11150051
21	§	ASSY,LOWER CAP,166 DROP TUBE WITH 1/2" HOSEBARB	51150128
22	§	DROPTUBE, CAP LOWER, SS6, 166	21150098
23	§	HOSEBARB, SS6, 1/2 x 3/8" MPT	16600217
24	§	TUBING, PE, 1/2 x 5/8"	87050504
25	§	ASSY, INTAKE, 166, DROP TUBE, WITH 1/2" HOSE BARB	51150071
26	§	INTAKE, DROPTUBE, SS6, 166	21150113
Not Shown:			
	1	MANUAL, BLADDER PUMPS	21150035
	§	TOOL, BLADDER PUMP, PINCER, 5mm	11150031
	§	FERRULE SETS, SS6, 3/8"	57200010
	§	KIT, 166 SS BP, O-RING SET, O-RING SERVICE SET [Items 8 (2), 9 (2), 15 (1), 16 (1)]	91150023

§ *= Sold Separately*

.850 Stainless Steel Bladder Pump Components

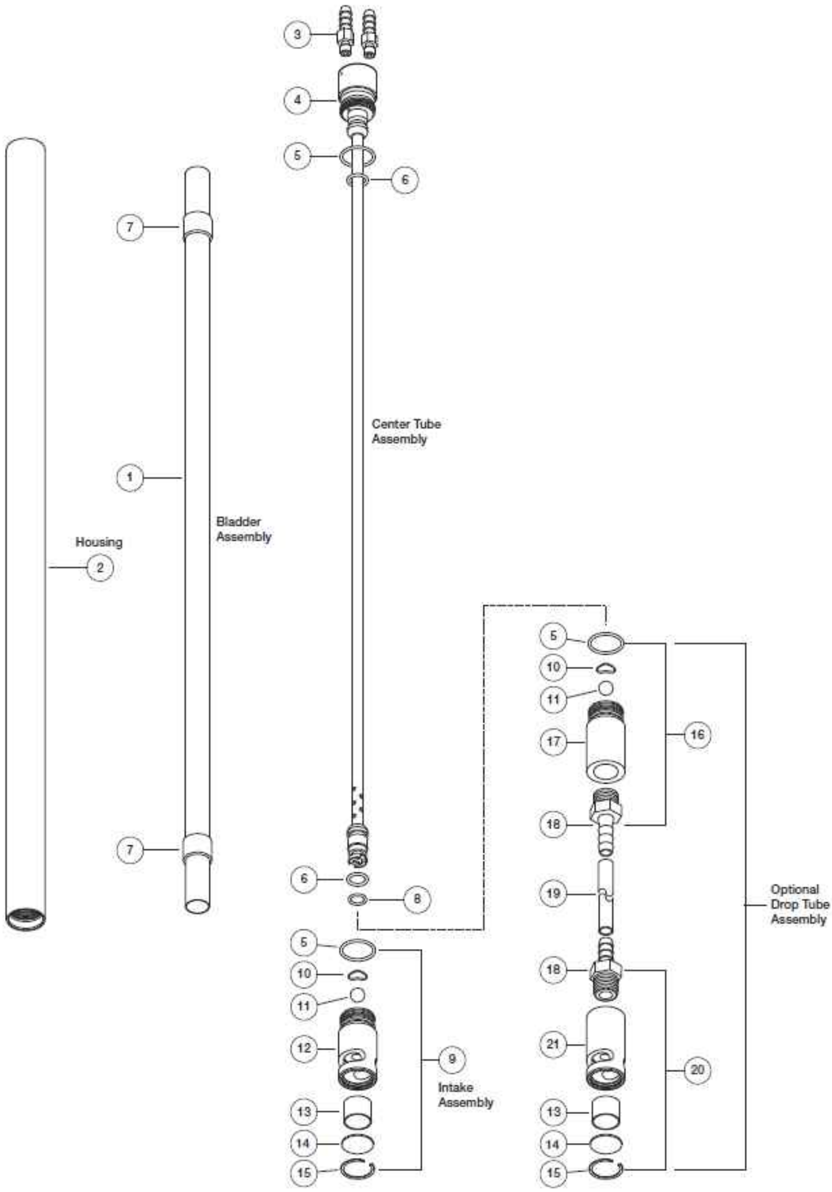


Bladder Pump, .850, Stainless Steel, Screened - 81150115

Item	Qty	Description	Part No.
1	1	BLADDER ,PTFE, .85 BP	51150051
1	§	BLADDER, PE, .85 BP, EA	21150100
1	§	BLADDER, PE, .85, CE, 12PK	21150099
2	1	HOSEBARB, SS6, MOD, .170 X 1/8 NPT DISCHARGE	11150118
3	1	HOSEBARB, SS6, .170 X 10/24 AIR	17200245
4	2	BALL, SS6, 1/4"	17500079
5	1	CAP UPPER WELDMENT, SS6, .85 BP	21150045
6	2	RING, COMPRESSION, PTFE, .850, CE, BP	21150048
7	2	O-RING, VITON, CS .0629, ID 17.1MM	17500112
8	4	O-RING, VITON, #012	17500111
9	1	HOUSING, SS6, .850, BP	21150047
10	1	ASSY, BOTTOM INTAKE, .85 BP	51150118
11	1	CAP, LOWER, SS6, .850, BP	21150046
12	1	SCREEN, INTAKE, SS6, .85 BP	21150050
13	1	DISC, SS, .85 BP	21150049
14	1	RING, SNAP, SS6, INTERNAL, .85 BP	11150053
15	§	ASSY, LOWER CAP, .850 BP, DROP TUBE, CE, W/ 1/4" HOSEBARB	51150129
16	§	DROP TUBE, CAP LOWER, .850 BP, CE SS	21150109
17	§	HOSEBARB, SS6, 1/4 X 1/8 MPT	17200072
18	§	TUBING, PE, 1/4 X 3/8, FT POLYETHYLENE	87050502
19	§	ASSY, INTAKE, .850 BP, DROP TUBE, CE, W/ 1/4" HOSEBARB	51150069
20	§	INTAKE, DROP TUBE, .850 BP, CE, SS	21150111
Not Shown:			
	1	MANUAL, BLADDER PUMPS	21150035
	§	SPARE PARTS KIT, .85, BP, CE [Items 4 (2), 6 (2), 7 (2), 8 (4), 12, 13, 14]	51150123
	§	KIT, .85 BP, O-RING SET, CE, O-RING SERVICE KIT [Items 7 (2), 8 (4)]	91150013

§ = *Sold Separately*

.675 Stainless Steel Bladder Pump Components



Bladder Pump, .675, Stainless Steel, Screened - 81150117

Item	Qty	Description	Part No.
1	1	BLADDER, PTFE, .675, BP, CE	51150126
1	§	BLADDER, PE, .675, EA	21150102
1	§	BLADDER, PE, .675, CE, 12PK	21150101
2	1	HOUSING, SS6, .675, BP	21150032
3	2	HOSEBARB, SS6, .170 X 10/24 AIR	17200245
4	1	WELDMENT, INNER, SS6, .675 BP	51150125
5	2	O-RING, VITON, #014	17500119
6	2	O-RING, VITON, #107	17500604
7	2	RING, COMPRESSION, PTFE, .675 BP, CE	21150106
8	1	O-RING, VITON, #009	17500113
9	1	ASSY, BOTTOM INTAKE, .675, BP	51150120
10	1	RETAINER, BALL, .675 BP, TACO	21150087
11	1	BALL, SS6, 1/4"	17500079
12	1	CAP, LOWER, SS6, .675 BP	21150031
13	1	SCREEN, INTAKE, SS6, .675 BP	11150317
14	1	DISC, SS, .675 BP	21150033
15	1	RING, SNAP, SS, .675 BP	11150182
16	§	ASSY, LOWER CAP, .675 BP, DROP TUBE, CE	51150130
17	§	DROP TUBE, CAP LOWER, .675 BP, CE SS	21150110
18	§	HOSEBARB, SS6, 1/4 X 1/8 MPT	17200072
19	§	TUBING, PE, 1/4 X 3/8, FT POLYETHYLENE	87050502
20	§	ASSY, INTAKE .675 BP, DROP TUBE CE	51150070
21	§	INTAKE, DROP TUBE, .675 BP, CE, SS	21150112
Not Shown:			
	1	MANUAL, BLADDER PUMPS	21150035
	§	SPARE PARTS KIT, .675, BP, CE [Items 5(2), 6 (2), 7(2), 8, 10, 11, 13, 14, 15]	51150124
	§	KIT, .675 BP, O-RING SET, CE O-RING SERVICE KIT [Items 5 (2), 6 (2), 8]	91150014

§ = *Sold Separately*

DOCUMENT REVISIONS		
Project#	DESCRIPTION	REV/DATE
1375	Release, SP	3/11/2014
EDCF # 1870	Corrected Replacement Parts List (Ch. 7) for 1.66 pump, SP	2/17/2015
0992	Updated Manual to show new style 1.66 pump, SP	1/11/2015
EDCF #2001	Updated part numbers and minor formatting, SR	10/27/16
1560	Adding temperature spec to Section 6: System Specifications. (185F/85C), PTFE to SS Disc in 1.66 models, StellaR	5/25/2017
1565	Added compression fitting instructions, StellaR	9/18/2017
1597	Added part # 91150023 – O-ring service kit, -StellaR	1/17/2018
1597	Clarified part list – notes between included and items sold separately from pump. Included items in O-ring service kit for 1.66 pumps – StellaR	1/22/2018
1749	Changed EDCF to Project in Document Revisions. Removed all "project". Indicated an EDCF where changes were made in an EDCF. Changed all PTFE disc description to SS. (.675 and .850 builds) – StellaR	3/18/2019
1918	Updated maintenance instructions with alternate way to reassemble bladder. Removed specified part numbers – StellaR	1/14/2020

The Warranty

For a period of one (1) year from date of first sale, product is warranted to be free from defects in materials and workmanship. Geotech agrees to repair or replace, at Geotech's option, the portion proving defective, or at our option to refund the purchase price thereof. Geotech will have no warranty obligation if the product is subjected to abnormal operating conditions, accident, abuse, misuse, unauthorized modification, alteration, repair, or replacement of wear parts. User assumes all other risk, if any, including the risk of injury, loss, or damage, direct or consequential, arising out of the use, misuse, or inability to use this product. User agrees to use, maintain and install product in accordance with recommendations and instructions. User is responsible for transportation charges connected to the repair or replacement of product under this warranty.

Equipment Return Policy

A Return Material Authorization number (RMA #) is required prior to return of any equipment to our facilities, please call 800 number for appropriate location. An RMA # will be issued upon receipt of your request to return equipment, which should include reasons for the return. Your return shipment to us must have this RMA # clearly marked on the outside of the package. Proof of date of purchase is required for processing of all warranty requests.

This policy applies to both equipment sales and repair orders.

FOR A RETURN MATERIAL AUTHORIZATION, PLEASE CALL OUR SERVICE DEPARTMENT AT 1-800-833-7958 OR 1-800-275-5325.

Model Number: ________________
Serial Number: ________________
Date: ________________

Equipment Decontamination

Prior to return, all equipment must be thoroughly cleaned and decontaminated. Please make note on RMA form, the use of equipment, contaminants equipment was exposed to, and decontamination solutions/methods used.

Geotech reserves the right to refuse any equipment not properly decontaminated. Geotech may also choose to decontaminate equipment for a fee, which will be applied to the repair order invoice.

Geotech Environmental Equipment, Inc.
2650 East 40th Avenue Denver, Colorado 80205
(303) 320-4764 ● **(800) 833-7958** ● FAX (303) 322-7242
email: sales@geotechenv.com website: www.geotechenv.com

Multi Water Quality Checker
U-50 Series

Instruction Manual

CODE:GZ0000144342C

Preface

This manual describes the operation of the Multi Water Quality Checker, U-50 Series.
Be sure to read this manual before using the product to ensure proper and safe operation of the instrument. Also safely store the manual so it is readily available whenever necessary.

Product specifications and appearance, as well as the contents of this manual are subject to change without notice.

■ Warranty and Responsibility

HORIBA warrants that the Product shall be free from defects in material and workmanship and agrees to repair or replace free of charge, at HORIBA's option, any malfunctioned or damaged Product attributable to HORIBA's responsibility for a period of one (1) year from the delivery unless otherwise agreed with a written agreement. In any one of the following cases, none of the warranties set forth herein shall be extended;

- Any malfunction or damage attributable to improper operation
- Any malfunction attributable to repair or modification by any person not authorized by HORIBA
- Any malfunction or damage attributable to the use in an environment not specified in this manual
- Any malfunction or damage attributable to violation of the instructions in this manual or operations in the manner not specified in this manual
- Any malfunction or damage attributable to any cause or causes beyond the reasonable control of HORIBA such as natural disasters
- Any deterioration in appearance attributable to corrosion, rust, and so on
- Replacement of consumables

HORIBA SHALL NOT BE LIABLE FOR ANY DAMAGES RESULTING FROM ANY MALFUNCTIONS OF THE PRODUCT, ANY ERASURE OF DATA, OR ANY OTHER USES OF THE PRODUCT.

■ Trademarks

Generally, company names and brand names are either registered trademarks or trademarks of the respective companies.

Conformable Directive

This equipment conforms to the following directives and standards:

Directives:	the EMC Directive 2004/108/EC
Standards:	[the EMC Directive] EN61326-1:2006 Class B, Portable test and measurement equipment

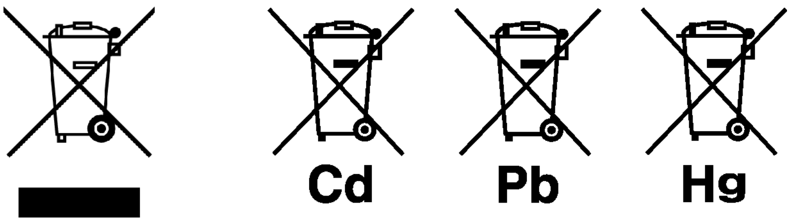
Information on Disposal of Electrical and Electronic Equipment and Disposal of Batteries and Accumulators

The crossed out wheeled bin symbol with underbar shown on the product or accompanying documents indicates the product requires appropriate treatment, collection and recycle for waste electrical and electronic equipment (WEEE) under the Directive 2002/96/EC, and/or waste batteries and accumulators under the Directive 2006/66/EC in the European Union.

The symbol might be put with one of the chemical symbols below. In this case, it satisfies the requirements of the Directive 2006/66/EC for the object chemical.

This product should not be disposed of as unsorted household waste.
Your correct disposal of WEEE, waste batteries and accumulators will contribute to reducing wasteful consumption of natural resources, and protecting human health and the environment from potential negative effects caused by hazardous substance in products.

Contact your supplier for information on applicable disposal methods.



FCC Rules

Any changes or modifications not expressly approved by the party responsible for compliance shall void the user's authority to operate the equipment.

WARNING

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

For your safety

Warning messages are described in the following manner. Read the messages and follow the instructions carefully.

● Meaning of warning messages

⚠ DANGER	This indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.
⚠ WARNING	This indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	This indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. Without safety alert indication of hazardous situation which, if not avoided, could result in property damage.

● Symbols

❗	Description of what should be done, or what should be followed
🛇	Description of what should never be done, or what is prohibited

■ Safety Precautions

This section provides precautions to enable you to use the product safely and correctly and to prevent injury and damage. The terms of DANGER, WARNING, and CAUTION indicate the degree of imminency and hazardous situation. Read the precautions carefully as it contains important safety messages.

⚠ WARNING
Do not disassemble or modify the meter. May cause overheating or fire, resulting in accidents.

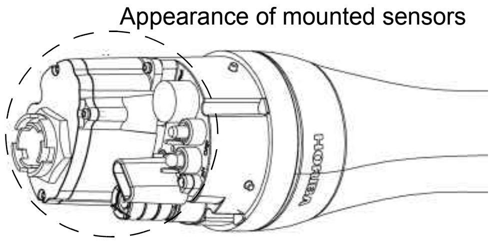
⚠ CAUTION
The pH and ORP sensors are made of glass. Handle them carefully to avoid breakage.
Do not ingest the DO, pH or ORP standard solutions. If it comes into contact with the eyes, rinse thoroughly with water. If swallowed, consult a physician.
Keep away from water when using USB communication. Improper use may result in fire or damage.

Points of concern

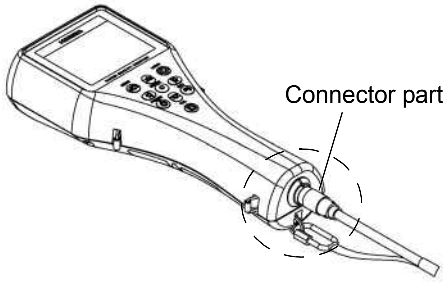
Use of the equipment in a manner not specified by the manufacturer may impair the protection provided by the equipment. It may also reduce equipment performance.

● Sensor probe

- Do not immerse the sensor probe in seawater or other samples with high salinity. Doing so may erode metallic parts. After use, promptly wash the sensor probe thoroughly in water.
- Do not immerse the sensor probe in alcohol, organic solvent, strong acid, strong alkaline, and other similar solutions.
- Do not subject to strong shocks.
- Do not perform measurement in environments of magnetic fields. Measurement errors may result.
- The sensor probe is no longer waterproof when the sensors are not mounted.

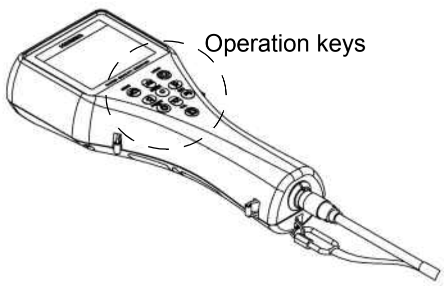


- Does not support measurement of samples containing fluorine.
- To disconnect the sensor cable or interface cable, pull them out with holding the connector part. Do not pull the cable part; it may cause breakage.



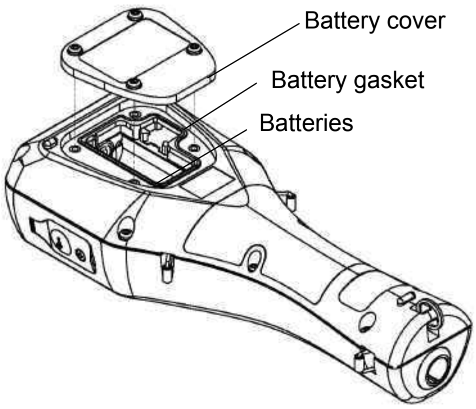
● Control unit

- Do not subject to strong shocks.
- The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.



- The control unit is no longer waterproof when the USB cable is connected.
- When operating the control unit only, protect the connector with the connector cap provided.

- Remove the batteries when not using the control unit for an extended period of time. Battery fluid leakage may cause equipment failure.
- Do not wipe the control unit with organic solvents or powder polish. The surface may deteriorate or its printing may disappear. If the display becomes dirty, wipe the dirt off with a soft cloth soaked in neutral detergent.
- Do not turn the power OFF or disconnect the cable during calibration or setting. Memory data may be erased.
- To perform measurement, connect the sensor probe cable before turning the power ON.
- Do not remove the battery gasket or twist it.
- When opening the battery case, make sure that no foreign matter is attached to the battery gasket.
- Do not use any unspecified batteries; it may cause breakage.



Measurement

- Do not pull the cable when lowering the sensor probe into the sample during measurement. Lower the sensor probe into the sample on a chain or string.
- Before lowering the sensor probe into the sample, do not connect the hook on the unit to a human body.
- The correct values are not displayed if the sensor is not mounted when the measurement display is activated.
- Perform DO measurement with no air bubbles in the internal solution.
- Do not reuse a membrane cap of DO sensor.
- Use the spanner for DO sensor provided to attach or remove the DO sensor.
- Avoid both U-53 and U-53G turbidity measurement in air, since the rubber wiper will quickly become damaged.
- Avoid turbidity measurement in direct sunlight, since the readout may be affected.

Calibration

During atmosphere calibration for the DO electrode with DO salinity compensation set to automatic, values are compensated based on electrical conductivity, but calibration is performed normally.

Location of use and storage

- Storage temperature: –10°C to 60°C
- Relative humidity: Under 80% and free from condensation

Store the meter in locations void of dust, strong vibrations, direct sunlight, corrosive gases, near air conditioners or windy areas.

Disposal of the product

When disposing of the product, follow the related laws and/or regulations of your country for disposal of the product.

Description in this manual

Note

This interprets the necessary points for correct operation and notifies the important points for handling the unit.

Reference

This indicates where to refer for information.

Tip

This indicates reference information.

Contents

1 About this Unit

The U-50 Series Multi Water Quality Checker features an integrated control unit and sensors. It is capable of making a maximum of eleven simultaneous measurements for various parameters, and is perfect for use in the field. The U-50 Series is designed with on-site ease-of-use in mind, provides a wide variety of functions, and can be used for water quality measurements and inspections of river water, groundwater, and waste water.

2 Device Information

2.1 Measurement parameters

Parameters	Model				
	U-51	U-52	U-52G	U-53	U-53G
pH (pH)	✓	✓	✓	✓	✓
pH (mV)	✓	✓	✓	✓	✓
Oxidation reduction potential (ORP)	✓	✓	✓	✓	✓
Dissolved oxygen (DO)	✓	✓	✓	✓	✓
Electrical conductivity (COND)	✓	✓	✓	✓	✓
Salinity (SAL) [expressed as electrical conductivity]	✓	✓	✓	✓	✓
Total dissolved solids (TDS) [expressed as electrical conductivity]	✓	✓	✓	✓	✓
Seawater specific gravity (SG) [expressed as electrical conductivity]	✓	✓	✓	✓	✓
Water temperature (TEMP)	✓	✓	✓	✓	✓
Turbidity (TURB) [LED transmission/front 30° scattering method]	–	✓	✓	–	–
Turbidity (TURB) [tungsten lamp 90° transmission/scattering method] with wiper	–	–	–	✓	✓
Water depth (DEP)	–	–	✓	✓	✓
GPS	–	–	✓	–	✓

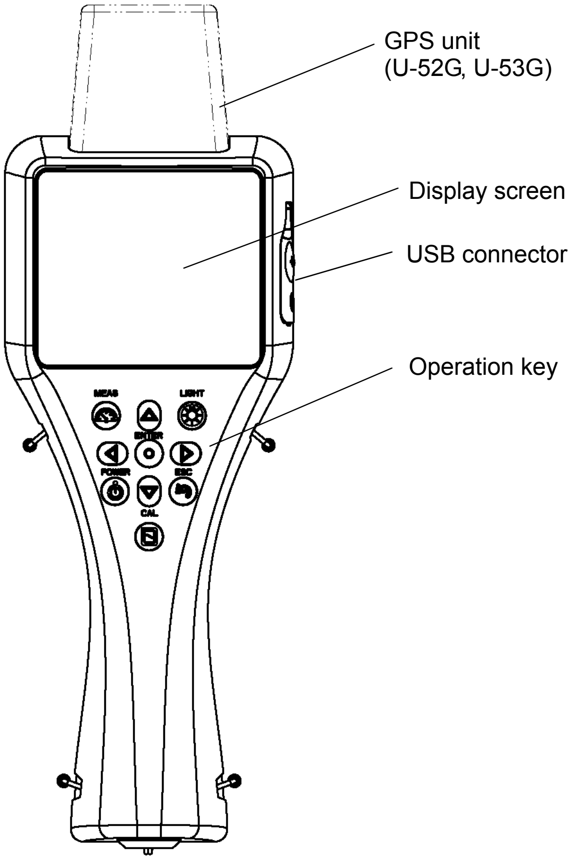
"✓" indicates a measurable parameter.

2.2 Packing list

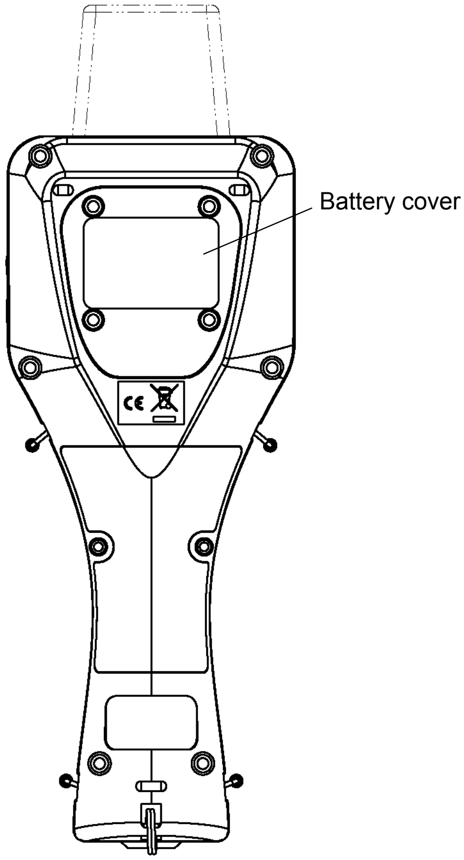
Parts Name	Quantity	Note
Control unit	1	
Sensor probe	1	
pH sensor (#7112)	1	
ORP sensor (#7313)	1	
Reference electrode (#7210)	1	
DO sensor (#7543)	1	
Turbidity sensor (#7800)	1	With U-52/U-52G only. Attached to the sensor probe.
Turbidity sensor (#7801)	1	With U-53/U-53G only. Attached to the sensor probe.
pH 4 standard solution (#100-4)	1	500 mL
pH reference internal solution (#330)	1	250 mL
DO sensor internal solution set (#306)	1	Internal solution (50 mL), Sandpaper (#8000, #600), Syringe
DO Membrane spare parts set	1	
Spanner for DO sensor	1	
Cleaning brush	1	
calibration cup	1	transparent calibration cup, black calibration cup
Back pack	1	
Strap	1	
Alkaline batteries	4	LR14
Silicon grease	1	
Instruction manual	1	

2.3 Parts name and functions

● Display

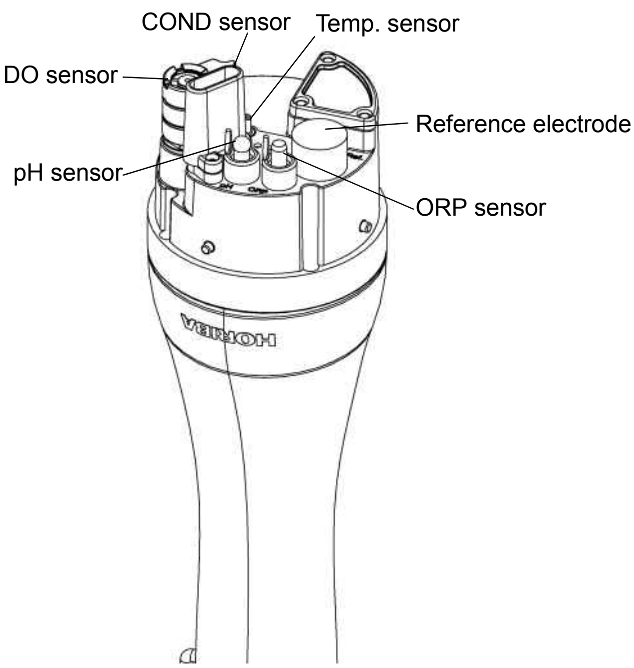


Front view

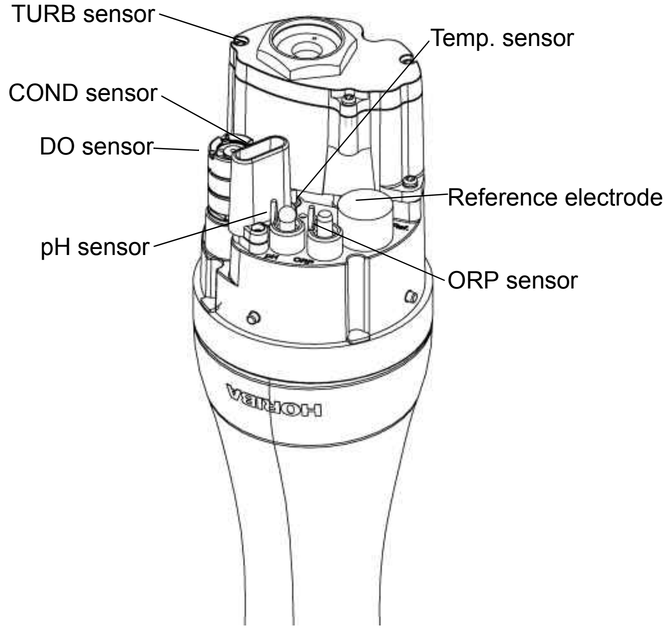


Back view

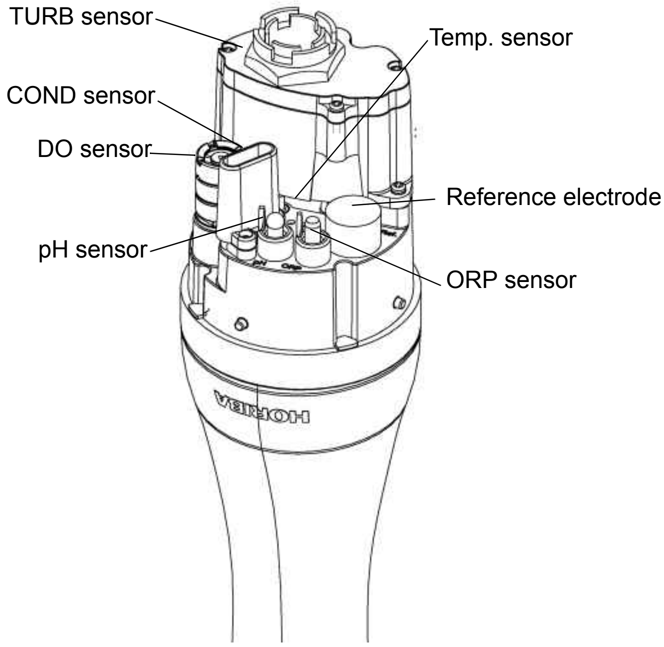
● Sensor probe (U-51)



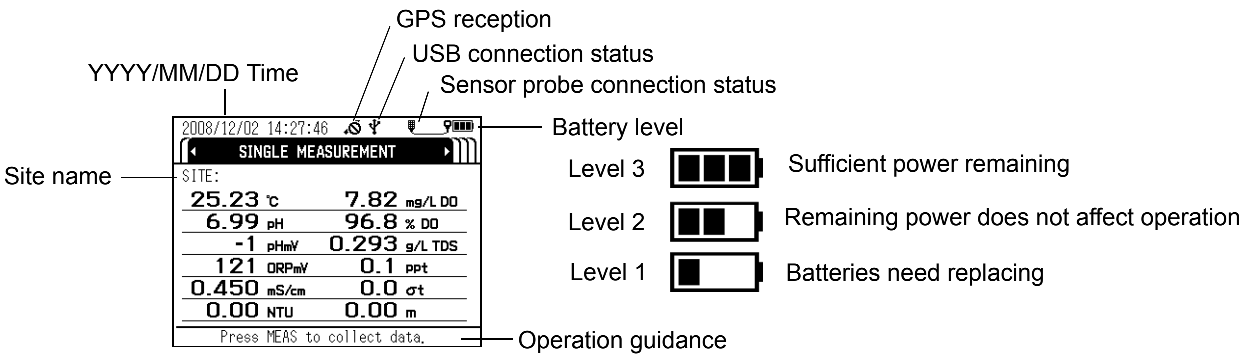
● Sensor probe (U-52)



● Sensor probe (U-53)



● Display screen



● Operation key

	Key name	description
POWER 	POWER key	Turns the system’s power ON/OFF. The initial screen appears immediately after turning the power ON. Press and hold down the POWER key for about 3 seconds to turn the power ON and OFF.
MEAS 	MEAS key	When pressed in the measurement screen, used to set the measurement values of all the measurement parameters. Measurement values flash until the data stabilizes. When pressed in the setting, calibration or data operation screen, returns to the measurement screen.
ENTER 	ENTER key	Used to execute functions, set entered values or store data in memory.
CAL 	CAL key	Switches to the calibration screen.
ESC 	ESC key	Returns to the immediately preceding operation.
LIGHT 	LIGHT key	Turns the backlight ON/OFF. ● Using the backlight shortens battery life. ● The backlight does not light for about 3 seconds after power ON. ● When the sensor probe is connected while the display's backlight is lit, the backlight goes out for about 3 seconds.
	Left key	Moves the cursor to the left.
	Right key	Moves the cursor to the right.
	Up key	Moves the cursor up.
	Down key	Moves the cursor down.

2.4 Setting menu items

Menu	Items	Reference
Measurement	Single measurement Interval measurement	“ 3.2.1 Setting measurement methods ” (page 18)
Site	Select site Create new site Delete site	“ 3.2.2 Setting sites ” (page 20)
Unit for report	TEMP (temperature) TURB (turbidity) DO (dissolved oxygen) COND (electrical conductivity) SG (seawater specific gravity) Depth (water depth) SALT (salinity)	“ 3.2.3 Unit for report ” (page 23)
Sensor selection	TEMP (temperature) pH pH mV ORP COND (electrical conductivity) TURB (turbidity) DO (dissolved oxygen) TDS (total dissolved solids) SALT (salinity) SG (seawater specific gravity) DEPTH (water depth)	“ 3.2.4 Sensor selection ” (page 25)
Compensation	DO salinity compensation DO atmospheric pressure compensation Electrical conductivity temperature coefficient TDS	“ 3.2.5 Compensation ” (page 26)
System	Language Version Date/time Auto power OFF Display contrast Initialize GPS locate* GPS locating accuracy*	“ 3.2.6 System settings ” (page 32) *Only on models with a GPS unit.

2.5 Calibration menu items

Menu	Items	Reference
Auto calibration	pH COND (electrical conductivity) TURB (turbidity) DO (dissolved oxygen) DEPTH (water depth)	“ 3.3.1 Auto calibration ” (page 39)
Manual calibration	TEMP (temperature) pH ORP COND (electrical conductivity) TURB (turbidity) DO (dissolved oxygen) DEPTH (water depth)	“ 3.3.2 Manual calibration ” (page 42)

2.6 Data operation menu items

Menu	Items	Reference
Data operation	View data Delete data Check data memory Calibration record GPS information*	“ 3.5 Data operations ” (page 64) *Only on models with a GPS unit.

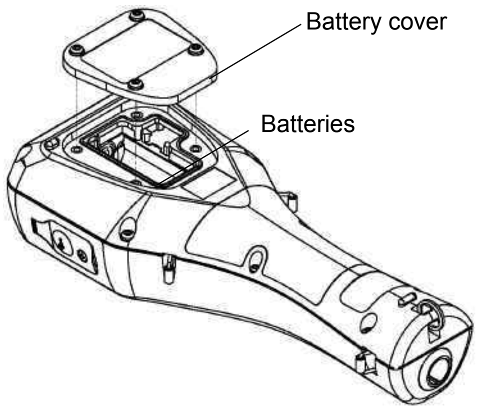
3 Basic Operation

3.1 System setup

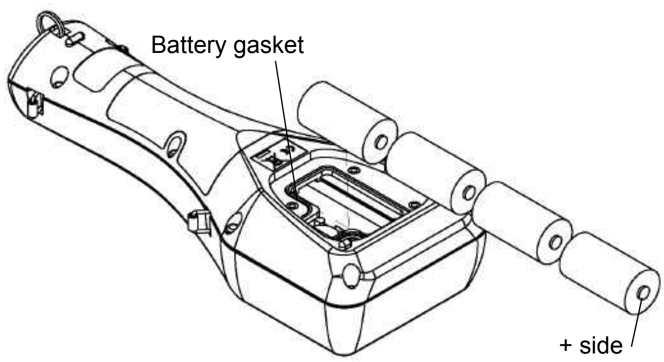
3.1.1 Inserting and replacing the batteries

The control unit is shipped without batteries. Follow the steps below to insert the batteries when using the system for the first time or replacing old batteries.

1. **Loosen the 4 screws on the battery cover by using No. 2 Phillips head screwdriver and remove the cover.**



2. **If replacing the batteries, discard the old batteries.**
3. **Insert new batteries in the control unit.**
   Check that the battery gasket is not dirty or twisted.



4. **Replace the battery cover and fasten it with the 4 screws.**
   Tighten the screws to less than 0.5 N·m.

Note

- **Data and settings will not be lost when the batteries are replaced.**
- **If dirty or twisted, the battery gasket will fail to keep the batteries dry. Check its condition before closing the cover.**
- **To ensure long service life, replacing the battery gasket periodically (once a year) is recommended.**

Precautions when using dry cell batteries

- **Batteries to use: LR14 alkaline dry cell batteries (C-size dry cell batteries) or rechargeable nickel-metal hydride dry cell batteries (C-size)**
  Do not use manganese batteries.
- **Dry cell batteries used incorrectly may leak or burst. Always observe the following**
  - Orient the batteries correctly (positive and negative ends in correct positions).
  - Do not combine new and used batteries, or batteries of different types.
  - Remove the batteries when not using the system for a prolonged period.
  - If batteries leak, have the system inspected at your nearest Horiba service station.

● Battery life

- The battery life for continuous operation when using C-size alkaline dry cell batteries is about 70 hours.
- Using the backlight consumes a proportionate amount of battery power, shortening battery life.
- Searching position information using the GPS unit consumes a proportionate amount of battery power, shortening battery life.
- Nickel-metal hydride secondary batteries can be used, but the battery life is not guaranteed since it will vary according to usage (number of times data is saved, number of charges and amount of each charge). In general, secondary batteries have one-half to one-third the life of C-size alkaline batteries.
- The 70-hour battery life figure applies to a control unit operating temperature of 20°C or more. The battery characteristics shorten the battery life at operating temperatures lower than 20°C, so check the remaining battery level, and replace the batteries before it reaches Level 1.
- The batteries packed with the system at the time of shipment are for checking operation. Their life is not guaranteed.
- The 70-hour battery life figure is the amount of operating time the batteries can provide until the system stops operating. The system may fail during operation if the remaining battery level is low, so it is a good idea to check the remaining battery level and replace the batteries with new ones well before the batteries run out completely.

U-51/52

Battery life: 70 hours (backlight off)

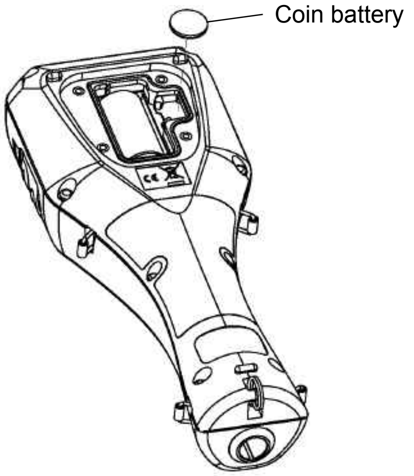
U-53

Battery life: 500 measurements (backlight off)

- Since U-53 is designed for turbidity measurement with wiper, its battery life is estimated in terms of the number of turbidity measurement sequences performed.
- Battery power is also consumed by measurement operations other than turbidity measurement.
- The battery life when turbidity measurement is not performed is about 70 hours.

3.1.2 Replacing the coin battery

- Coin battery to use: CR-2032
- The coin battery is only for the clock. It will provide problem-free operation for three years, but when using the clock continuously, it should be replaced every two years as a precaution.
- When replacing the coin battery for the clock, leave the control unit ON. If the coin battery is replaced when the control unit is turned OFF, the clock will be reset to the default settings.



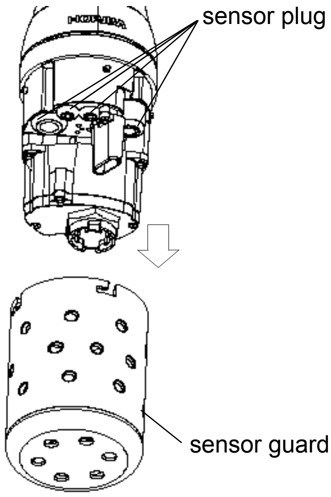
3.1.3 Attaching sensors

Note

- **When attaching or replacing a sensor, wipe any moisture off the sensor probe and sensor.**
- **Be sure to keep water out of sensor connectors. If moisture comes in contact with a sensor connector, blow-dry it with dry air.**
- **The sensor probe is not waterproof when the sensor is not mounted.**
- **Take care not to tighten the sensor too much.**

Attaching the pH sensor

1. **Remove the sensor guard.**

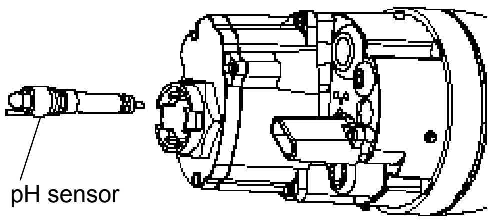


2. **Remove the sensor plug.**
3. **Coat the pH sensor O-ring with a thin layer of silicon grease (part No. 3014017718).**

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

4. **Make sure there is no moisture on the sensor probe's sensor connector (marked "pH").**
5. **Fasten the pH sensor securely by hand.**



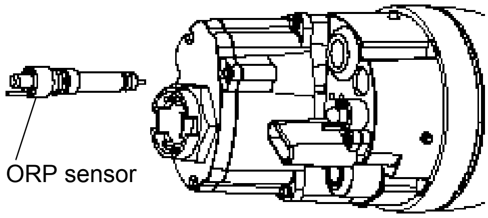
6. **Clean the sensor with an alcohol-soaked cloth.**

- **Attaching the ORP sensor**
  1. **Remove the sensor guard.**
  2. **Remove the sensor plug.**
  3. **Coat the ORP sensor O-ring with a thin layer of grease (part No. 3014017718).**

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

  4. **Make sure there is no moisture on the sensor probe's sensor connector (marked "ORP").**
  5. **Fasten the ORP sensor securely by hand.**



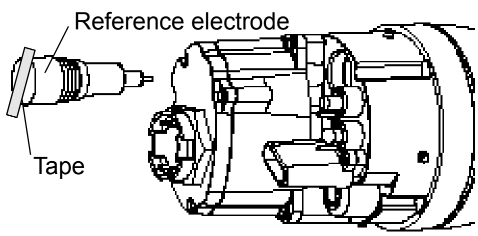
  6. **Clean the sensor with an alcohol-soaked cloth.**

- **Attaching the reference electrode**
  1. **Remove the sensor guard.**
  2. **Remove the sensor plug.**
  3. **Coat the reference electrode O-ring with a thin layer of grease (part No. 3014017718).**

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

  4. **Make sure there is no moisture on the sensor probe's sensor connector (marked "REF").**
  5. **Fasten the reference electrode securely by hand.**
  6. **Remove the tape from the liquid junction part of the reference electrode.**



Attaching the dissolved oxygen (DO) sensor

1. **Remove the membrane cap mounted on the DO sensor beforehand, and replace it with the new membrane cap provided. Replace the internal solution with fresh solution. The main component of the internal solution is potassium chloride (KCl), so the old solution can be disposed of down a sink or other drain.**

Reference

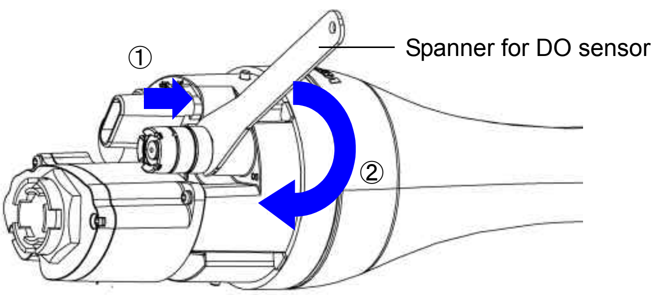
" 4.5 Replacing the membrane cap " (page 87)

2. **Screw in the DO sensor to attach it, allowing the internal solution to overflow slightly.**
3. **Use a soft cloth to wipe off the internal solution that overflowed onto the DO sensor.**
4. **Remove the sensor guard.**
5. **Remove the sensor plug.**
6. **Coat the DO sensor O-ring with a thin layer of grease (part No. 3014017718).**

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

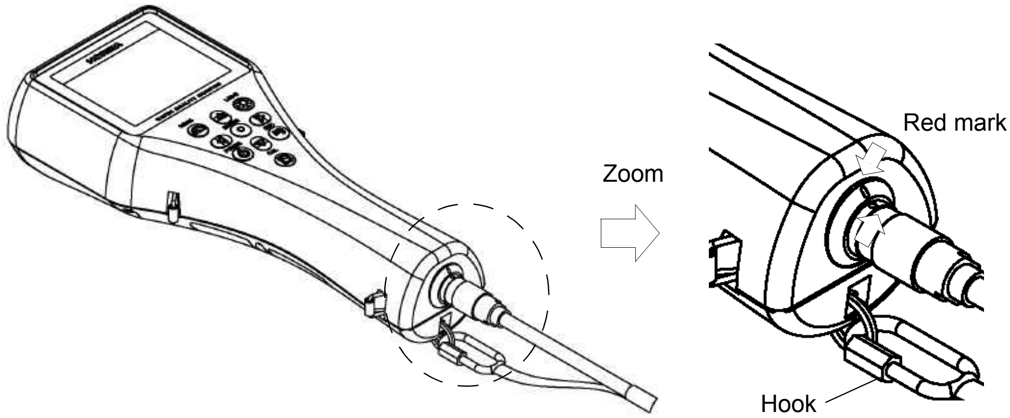
7. **Make sure there is no moisture on the sensor probe's sensor connector (marked "DO").**
8. **Fasten the DO sensor securely using the spanner for DO sensor.**
   - Hold the DO sensor with the provided spanner for DO sensor and push the sensor down. (Step 1 in figure below)
   - Screw the DO sensor in place. (Step 2 in figure below)



3.1.4 Connecting the control unit and sensor probe

Note

Connect the control unit with its power OFF.

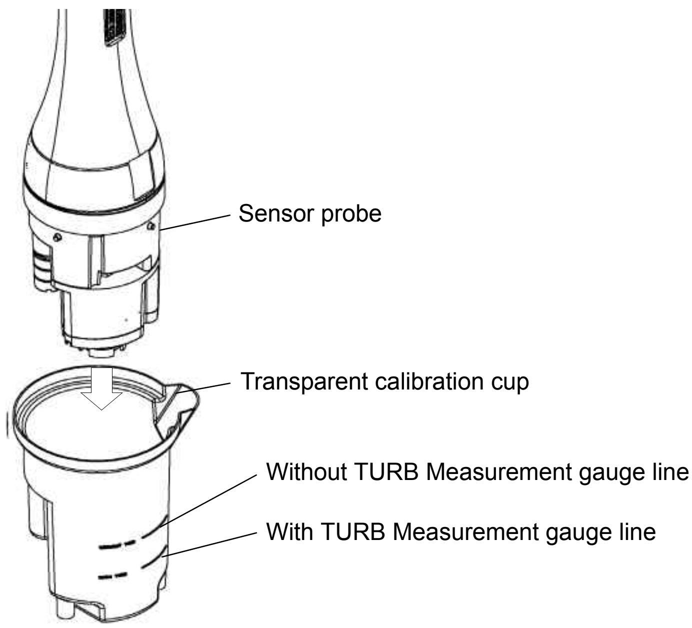


1. **Align the red mark on the connector, and press the connector in until you hear it click.**
2. **Connect the cable's hook to the display.**

3.1.5 Conditioning

Carry out the steps below when using the unit for the first time or when the system has not been used for 3 months or longer.

1. **Fill the transparent calibration cup to the line with pH 4 standard solution.**
   The transparent calibration cup has With TURB Measurement and Without TURB Measurement gauge lines.
2. **Insert the sensor probe in the transparent calibration cup.**



Note

Check that all sensors are attached.

3. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON. Leave the unit for at least 20 minutes to condition the sensors.**

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

Tip

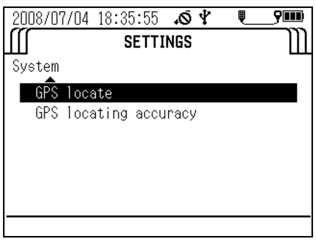
- The procedure for immersing the sensor probe in the pH standard solution is the same as that described in " 3.3.1 Auto calibration " (page 39).
  Auto calibration can be performed using the same pH 4 standard solution that was used in the conditioning procedure.
- Immersing the sensor in the standard solution is generally required for sensor conditioning, but a voltage supply is required for DO sensor conditioning. Turning ON the power of the control unit is necessary during sensor conditioning.

3.1.6 GPS (U-52G, U-53G)

The GPS position measurement precision is proportional to the GPS position measurement time. When the position measurement precision increases, the position measurement time also increases. See " ● GPS locating accuracy" (page 17) for how to set the position measurement precision. See " ● GPS locate" (page 15) below for how to check acquired GPS data.

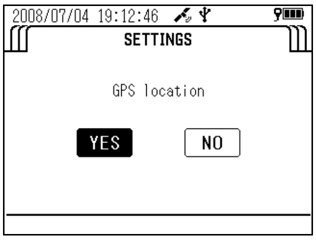
● GPS locate

1. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
2. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**
3. **Press the down (▽) key to move the cursor to "GPS locate", then press the ENTER key.**

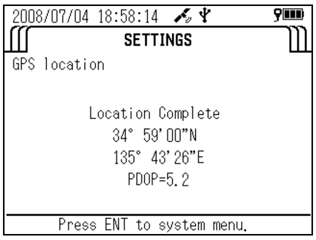


4. **The message "Press ENT key to start position measurement." appears. Press the ENTER key.**

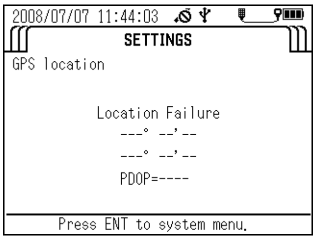
5. **The message "Execute GPS position measurement?" appears. Move the cursor to "YES", then press the ENTER key.**



6. **The message "Warming up. Please wait." appears. Wait until the system has finished warming up (about 10 seconds).**
   - Position measurement starts automatically when warmup has finished. Position measurement is performed up to 10 times.
   - The GPS location complete screen appears after successful position measurement.



   - The GPS location failure screen appears after position measurement has failed. Redo the measurement in a location free from obstacles, or wait for the meteorological conditions to improve before redoing the measurement.

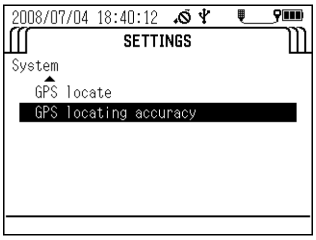


● GPS locating accuracy

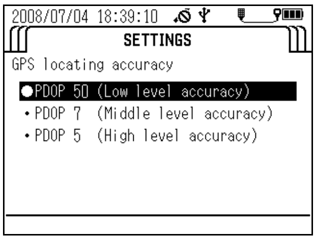
1. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

2. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**

3. **Press the down (▽) key to move the cursor to "GPS locating accuracy", then press the ENTER key.**



4. **The screen below appears. Move the cursor to the locating accuracy, then press the ENTER key. The black circle (●) indicates the currently set precision.**



3.2 Settings

3.2.1 Setting measurement methods

This section describes how to set the measurement method.

● Measurement methods

● U-51/U-52

Single measurement	Pressing the MEAS key acquires the 5-second average for the selected measurement parameter.
Interval measurement	Pressing the MEAS key acquires and saves the 5-second average for the selected measurement parameter in the set interval. The measurement interval can be set to any value between 10 seconds and 24 hours.

● U-53

The U-53 turbidity sensor uses a tungsten lamp. The lamp lights for about 10 seconds, and the average measurement value acquired during this interval is displayed.

Single measurement	Pressing the MEAS key acquires the 5-second average for the selected measurement parameter after wiper operation. The 10-second average is acquired when measuring turbidity.
Interval measurement	Pressing the MEAS key acquires and saves the 5-second average for the selected measurement parameter in the set interval. The 10-second average is acquired when measuring turbidity. The measurement interval can be set to any value between 10 seconds (final check of this value required; 30 seconds may be better for U-52) and 24 hour.

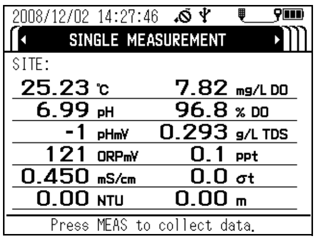
Reference

“ 3.4 Measurement ” (page 61)

● Operation method

1. **Press and hold down the control unit’s POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.

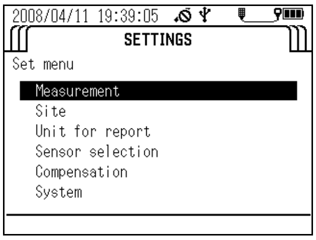


Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

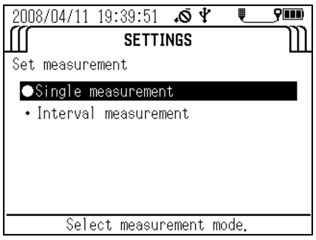
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

3. **Press the down (▽) key to move the cursor to "Measurement", then press the ENTER key.**



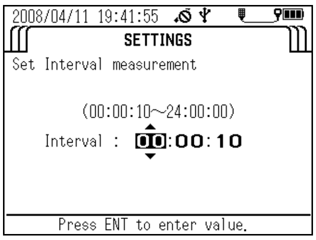
4. **Press the down (▽) key to move the cursor to the desired measurement mode. Press the ENTER key to save the setting.**

The black circle (●) indicates the currently selected measurement mode.



5. **If you selected "Interval measurement", the display switches to the screen used to set the measurement interval. Press the up (△) and down (▽) keys to set the measurement interval.**

The measurement interval can be set to any value between 10 seconds and 24 hours in the case of the U-51 and U-52, or between 30 seconds and 24 hours in the case of the U-53.



3.2.2 Setting sites

The site function allows position data to be connected to corresponding measurement data. Sites have the following specifications and features:

Site names: Text data consisting of up to 20 one-byte alphanumeric characters, spaces, etc.
Site names can be used for control unit searches and as labels for computer processing.
Site names allow measurement data to be saved with a name corresponding to the actual location where it was measured.

You can use site information as a search key when viewing data uploaded by a PC or data saved in the control unit (see " 3.5 Data operations " (page 64)).

● Selecting sites

You can select previously created sites. The black circle (●) indicates the name of the currently selected site. No sites are created at new purchasing or after initialization. Select a site after first creating one from the "Create new site" menu.

● Creating new sites

You can create and save new sites. Up to 20 site names can be registered.

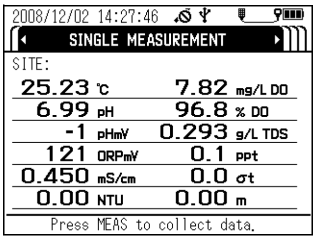
● Deleting sites

You can select a previously created site and delete it.

● Operation methods

● Selecting a site

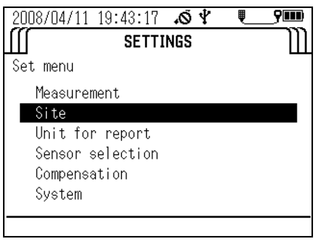
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



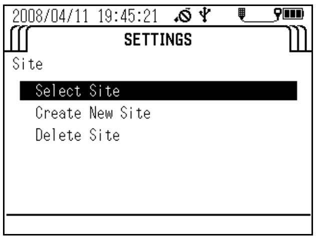
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

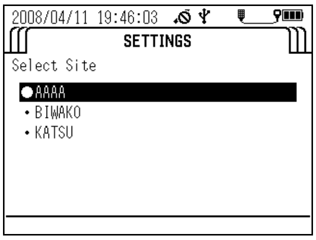
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Site", then press the ENTER key.**



4. **Press the down (▽) key to move the cursor to "Select Site", then press the ENTER key to display the names of the currently saved sites.**

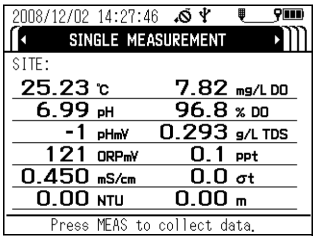


The black circle (●) indicates the currently selected site.



● **Creating a new site**

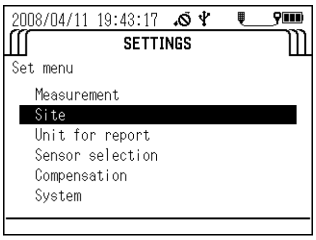
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



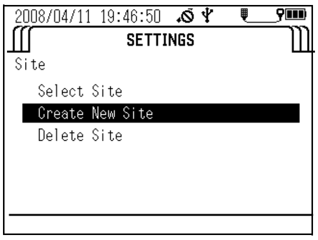
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

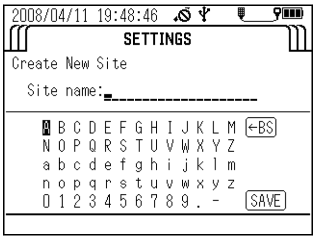
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Site", then press the ENTER key.**



4. **Press the down (▽) key to move the cursor to "Create New Site", then press the ENTER key.**
   Enter the desired site name (up to 20 alphanumeric non-Asian width characters).

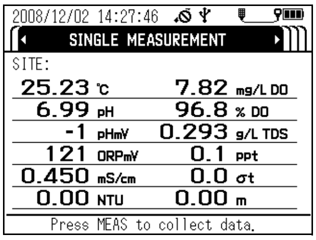


5. **Press the up (△), down (▽), right (▷), and left (◁) keys to move the cursor to each letter or number to use in the name, then press the ENTER key to confirm the entered characters. To delete incorrectly entered characters, move the cursor to "BS" and press the ENTER key to start deleting from the last character. When you have finished entering the name, save it by moving the cursor to "SAVE" and pressing the ENTER key.**



● **Deleting a site**

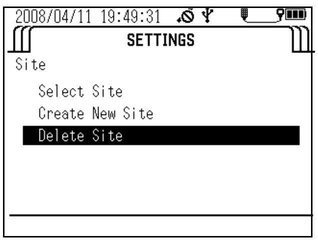
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

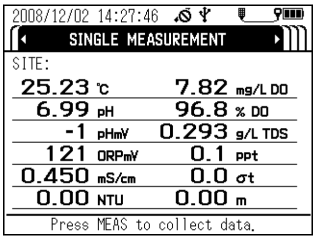
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**



3. **Press the down (▽) key to move the cursor to "Site", then press the ENTER key.**

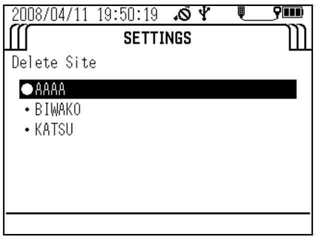
4. **Press the down (▽) key to move the cursor to "Delete Site", then press the ENTER key.**

   A list of the currently saved sites appears. The black circle (●) indicates the currently selected site.



5. **Press the down (▽) key to move the cursor to the site to delete, then press the ENTER key to delete it.**

   The currently selected site can be deleted after a different site has been selected from the site selection menu or after all unselected sites have been deleted. The same site name cannot be registered more than once.



3.2.3 Unit for report

Note

Units can only be selected when the sensor probe is connected.

Follow the steps below to set the measurement units of measurement parameters. No units are displayed if a measurement parameter has not been selected in the measurement parameter selection screen (see “ 3.2.4 Sensor selection ” (page 25)).

1. **Press and hold down the control unit’s POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.

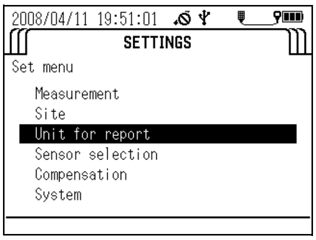
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

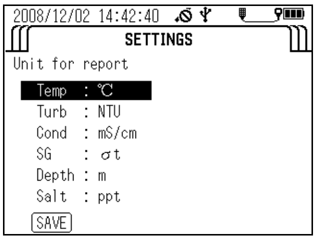
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

3. **Press the down (▽) key to move the cursor to "Unit for report", then press the ENTER key.**

A list of the currently selected measurement parameters and their units appears. Note that measurement parameters not selected (in the measurement parameter selection screen) are not displayed.

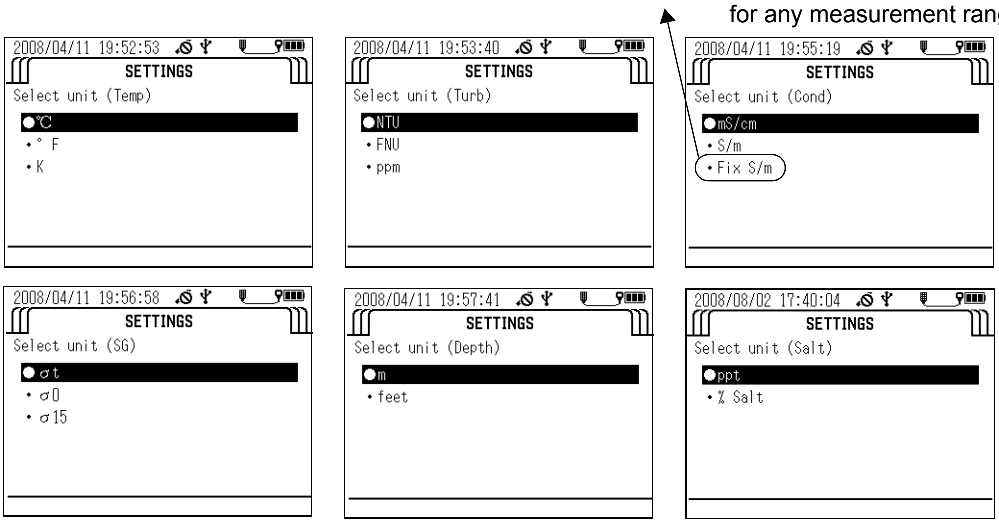


4. **Press the up (△) and down (▽) keys to move the cursor to the item to change, then press the ENTER key.**

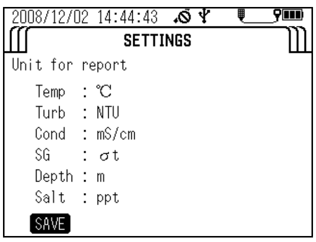


5. **A list of the units that can be selected appears. The black circle (●) indicates the currently selected unit. Press the up (△) and down (▽) keys to move the cursor to the desired unit, then press the ENTER key.**

Fix S/m: Fixes S/m with no auxiliary units for any measurement range.



6. **To save the changes, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key. If you do not want to save the changes, press the ESC key.**



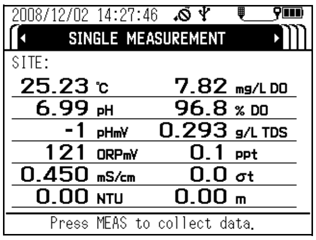
3.2.4 Sensor selection

Note

Measurement parameters can only be selected when the sensor probe is connected.

You can set between 1 and 11 measurement parameters to display in the control unit screen. Follow the steps below to select the desired measurement parameters.

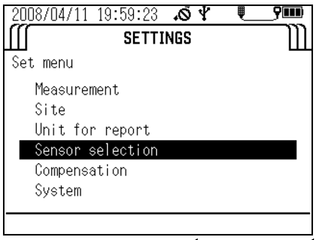
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



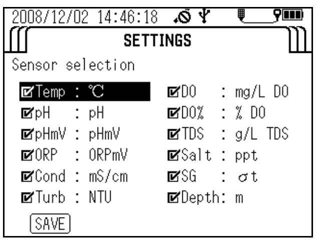
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Sensor selection", then press the ENTER key.**
   A list of the measurement parameters that can be set and the currently set units are displayed.



4. **Move the cursor to each measurement parameter to change, then press the ENTER key.**
   A check in the check box of a measurement parameter indicates it will be displayed.
5. **To save the changes, press the up (△), down (▽), left (◁) and right (▷) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the changes, press the ESC key.**



Note

Available measurement parameters differ according to product specifications.

3.2.5 Compensation

Note

Compensation settings can only be made when the sensor probe is connected.

U-50 series have following functions of compensation.

- Salinity compensation and atmospheric pressure compensation for dissolved oxygen (DO)
- Temperature compensation for conductivity (COND)
- Setting total dissolved solid (TDS) coefficient for TDS

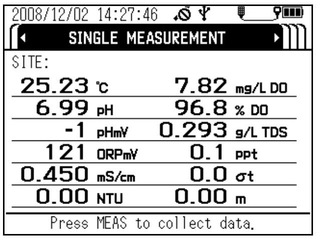
● Salinity compensation (DO)

The dissolved oxygen (DO) value is presented higher than actual value if salinity compensation is not added, because the increase of salinity gives higher DO value. To obtain correct value salinity compensation is needed. The following modes are available for calculation of salinity compensation.

AUTO: Salinity compensation is performed automatically with salinity converted from conductivity.

Value input: Press the up (△) and down (▽) keys to enter a setting value when the salinity is known.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
The "MEASUREMENT" screen appears after about 10 seconds.

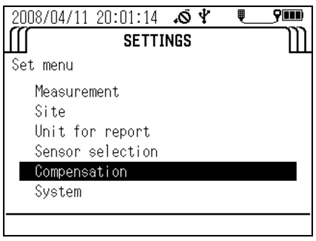


Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

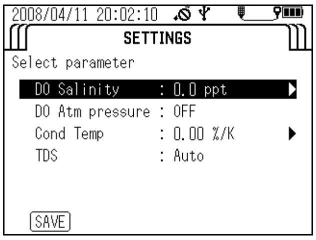
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

3. **Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.**

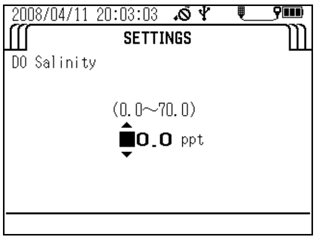


4. Press the down (▽) key to move the cursor to "DO Salinity", then press the ENTER key to toggle the setting between "Auto" and "Input mode".

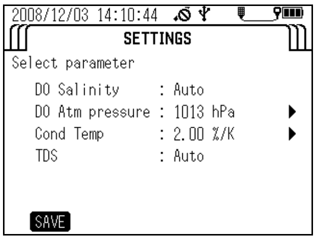
Default: Auto



5. If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.



6. To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the change, press the ESC key.

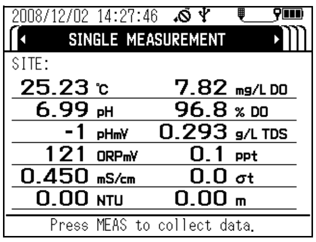


● **Atmospheric pressure compensation (DO)**

Differences in the atmospheric pressure of the measurement location influence the Dissolved Oxygen (DO) measurement. By setting (input) the actual atmospheric pressure of the measurement location into the control unit, it is possible to standardize the measured Dissolved Oxygen (DO) value to a value at the standard atmospheric pressure (1013 hPa).

1. Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.

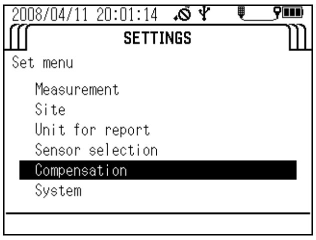
The "MEASUREMENT" screen appears after about 10 seconds.



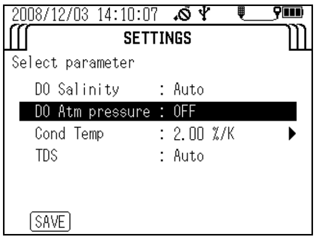
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

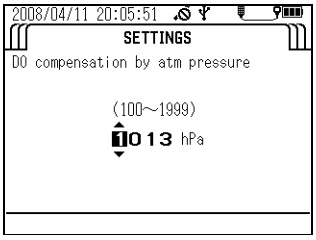
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.**



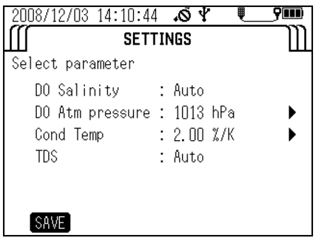
4. **Press the down (▽) key to move the cursor to "Cond Temp", then press the ENTER key to toggle the setting between "OFF" and "Input mode".**
   Default: OFF



5. **If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.**



6. **To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the change, press the ESC key.**

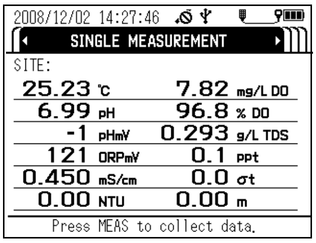


- **Temperature compensation for conductivity (COND)**

  Sample conductivity (COND) varies with temperature, and this control unit uses a temperature compensation coefficient to automatically standardize the conductivity (COND) at 25°C. The initial setting coefficient is 2%/K, which is the generally used.

  1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

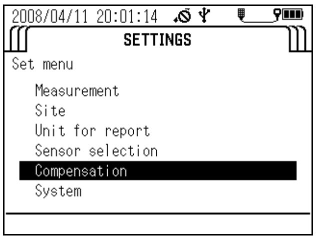
     The "MEASUREMENT" screen appears after about 10 seconds.



Note

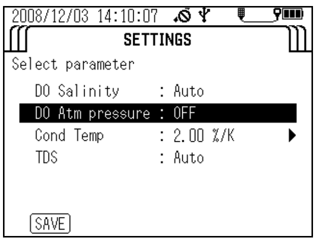
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.**

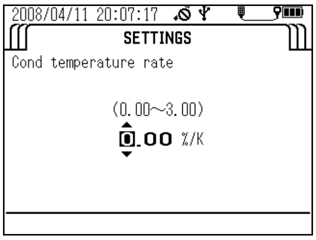


4. **Press the down (▽) key to move the cursor to "Cond Temp", then press the ENTER key to toggle the setting between "OFF" and "Input mode".**

   Default: 2.00%/K

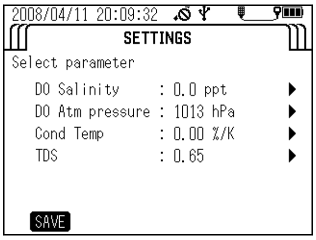


5. If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.



6. To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key.

If you don’t want to save the change, press the ESC key.

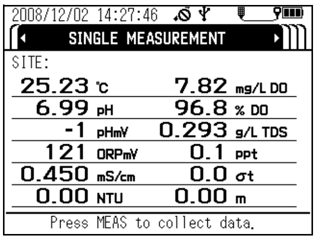


Setting a total dissolved solid (TDS) coefficient

The total dissolved solid amount (TDS) is a converted value obtained by multiplying the conductivity (COND) by a known coefficient. The coefficient initially set for the control unit is based on a conversion for KCl and $CaCO_3$ solutions and it depends on the conductivity (COND) value as shown below.

Conductivity (COND) (S/m)	Conversion coefficient
< 0.05	0.65
0.05 to 0.5	0.64
0.5 to 1	0.63
1 to 3	0.62
3 to 5	0.61
> 5	0.60

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.

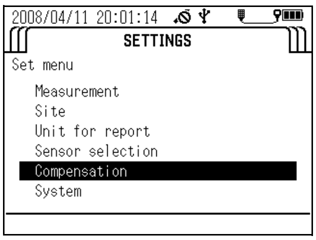


Note

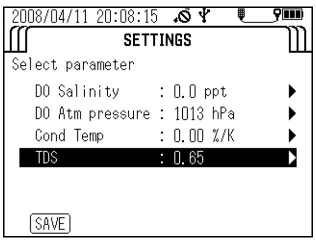
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

---

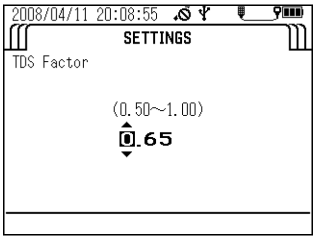
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.**



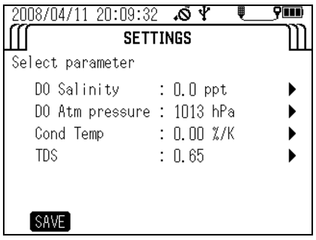
4. **Press the down (▽) key to move the cursor to "TDS", then press the ENTER key to toggle the setting between "AUTO" and "Input mode".**
   Default: Auto



5. **If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.**



6. **To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the change, press the ESC key.**



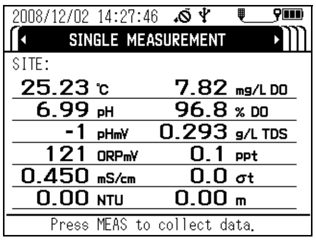
3.2.6 System settings

The system settings let you change the display language, check the system software version, set the date/time, set the auto power OFF time, set the display contrast, and initialize the settings.

● Display language

Follow the steps below to select either English or Japanese as the display language.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.

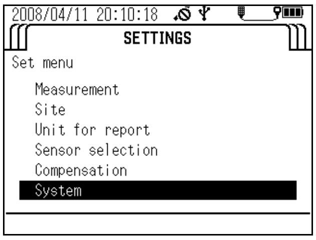


Note

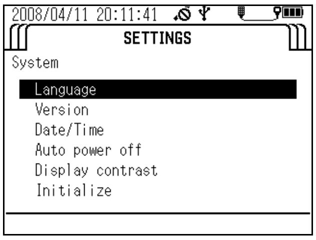
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

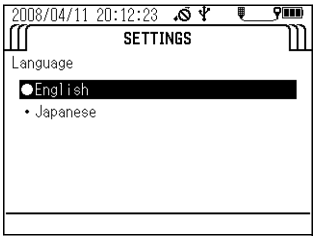
3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**



4. **Press the down (▽) key to move the cursor to "Language", then press the ENTER key.**



5. **A list of the supported display languages appears. Press the up (△) and down (▽) keys to move the cursor to the desired language, then press the ENTER key.**
   The black circle (●) indicates the currently selected display language.

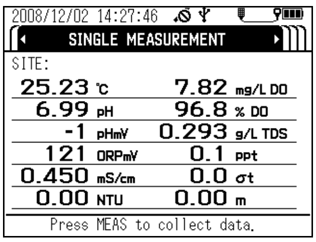


● Version

Follow the steps below to display the program No. and version of the control unit and sensor probe software.

The program No. and version of the sensor probe software will not be displayed if the sensor probe is not connected.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.

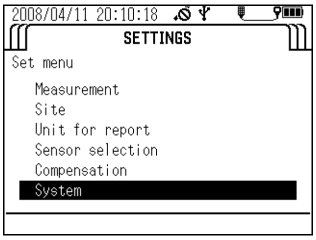


Note

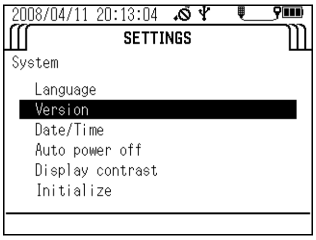
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

3. Press the down (▽) key to move the cursor to "System", then press the ENTER key.



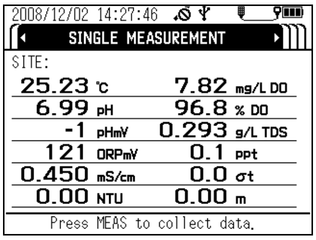
4. Press the down (▽) key to move the cursor to "Version", then press the ENTER key.
The program No. of the control unit and sensor probe software appears.



● Setting the date/time

Follow the steps below to set the date and time.

1. Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.
The "MEASUREMENT" screen appears after about 10 seconds.

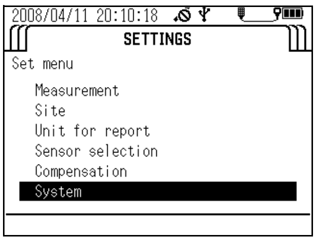


Note

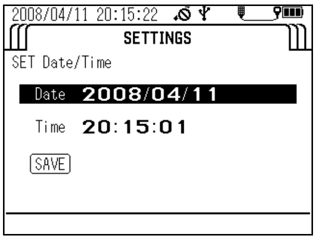
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. Press the right (▷) key to switch the display to the "SETTINGS" screen.

3. Press the down (▽) key to move the cursor to "System", then press the ENTER key.

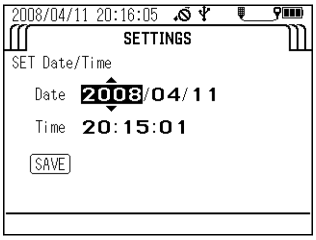


4. **Press the down (▽) key to move the cursor to "Date/time", then press the ENTER key.**

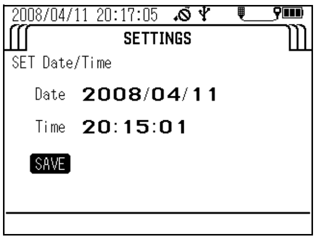


5. **Move the cursor to the date, then press the ENTER key.**

6. **Press the right (▷) key to move the cursor to the year, month, day, hour, minute and second, and press the up (△) and down (▽) keys to enter each value.**



7. **When finished entering settings, press the ENTER key to move the cursor to SAVE, then press the ENTER key again to save the settings.**

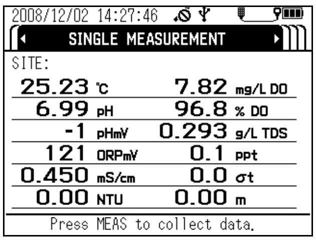


● **Setting the auto power OFF time**

Follow the steps below to set the time for the auto power OFF function (which turns the power OFF automatically when no operation is performed for the preset amount of time).

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

The "MEASUREMENT" screen appears after about 10 seconds.

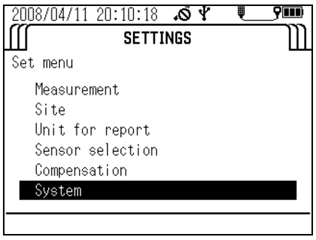


Note

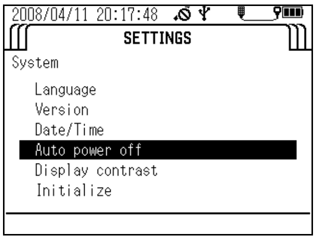
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**

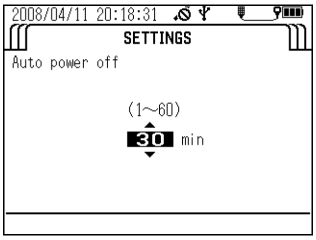


4. **Press the down (▽) key to move the cursor to "Auto power off", then press the ENTER key.**



5. **Press the up (△) and down (▽) keys to select the desired time setting, then press the ENTER key.**

You can select OFF, or settings of 1, 2, 5, 10, 20, 30 or 60 minutes.
Default: 30 minutes

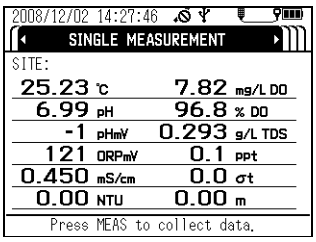


● Display contrast

Follow the steps below to adjust the display's contrast.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

The "MEASUREMENT" screen appears after about 10 seconds.

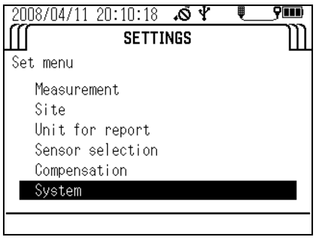


Note

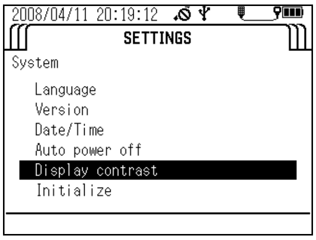
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

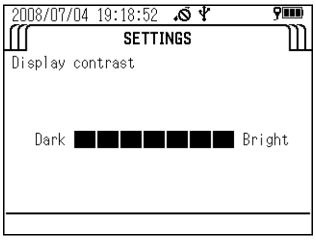
3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**



4. **Press the down (▽) key to move the cursor to "Display contrast", then press the ENTER key.**



5. **Press the left (◁) and right (▷) keys to adjust the contrast.**
Adjustment can be made in 26 steps.

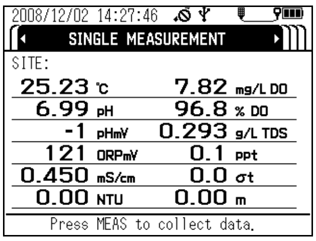


6. **Press the ENTER key.**

● **Initialization**

Follow the steps below to restore all the settings except date/time to their factory defaults. Factory default calibration data for the electrical conductivity and turbidity sensors will also be deleted at the same time.

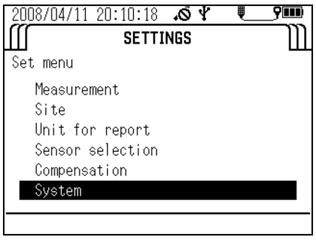
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
The "MEASUREMENT" screen appears after about 10 seconds.



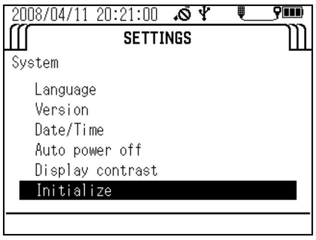
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

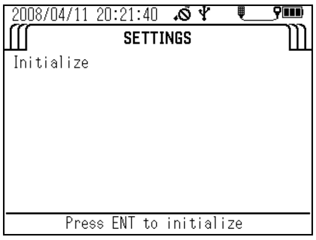
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**



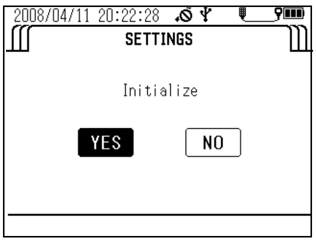
4. **Press the down (▽) key to move the cursor to "Initialize", then press the ENTER key.**



5. **Press the ENTER key again.**



6. **A confirmation message appears asking whether to execute initialization. Press the left (◁) key to move the cursor to YES, then press the ENTER key.**
   The message "Initialize Complete" appears to indicate the process has finished.



3.3 Calibration

To obtain correct measurement values, the sensors need to be calibrated using standard solution before measurement. You can select simultaneous auto calibration of the pH, COND and TURB sensors in pH4 standard solution and DO and DEP sensors simultaneously in air, or manual calibration of individual measurement parameters. You can check the result of the previous calibration using the procedure on “ 3.5.4 Checking the calibration record ” (page 70).

Note

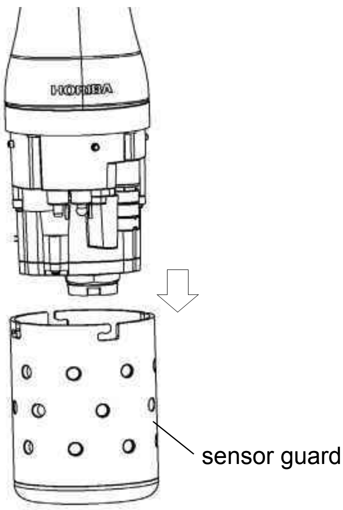
- **Wait at least 20 minutes after turning the system power ON before calibrating the DO sensor.**
- **Make the DO and COND compensation settings before calibration since these settings are applied during calibration.**
- **You can select only the desired parameters for calibration and calibrate just those parameters (see “ 3.2.4 Sensor selection ” (page 25)).**
- **Use about 200 mL of standard solution in the calibration cup.**
- **Calibration data is stored in the sensor probe.**

3.3.1 Auto calibration

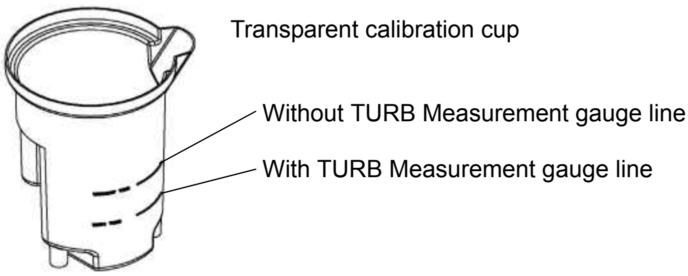
Tip

- **The following parameters are calibrated (at 25°C):**
  pH: Set to 4.01 (zero-point calibration); the span is adjusted to the factory default value.
  COND: 0.449 S/m (4.49 mS/cm, span calibration); the zero point is adjusted to the factory default value.
  TURB: 0 NTU (zero-point calibration); the span is adjusted to the factory default value.
  DO: 8.92 mg/L (span calibration); the zero point is adjusted to the factory default value.
  DEP: 0 m (zero-point calibration); the zero point is adjusted to the factory default value.
- **If the air temperature changes, the readout value may not be stable. Ensure that the ambient air temperature is the same temperature as the calibration solution, because the internal probe temperature sensor and external temperature sensor (in the calibration solution) are used for the auto calibration. Allow the probe and standard solution to equilibrate for 1 hour if a thermometer is not available to verify that these temperatures are the same.**
- **Do not hold the probe while performing the auto calibration. Body temperature may elevate the internal temperature sensor measurement creating DO calibration error.**

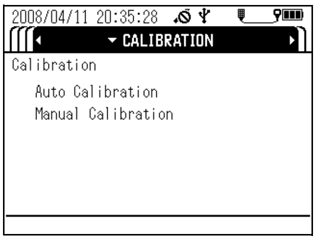
1. **Remove the sensor guard and wash the sensor probe 2 or 3 times with deionized water.**



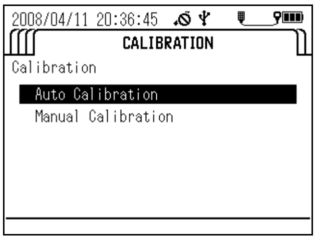
2. **Remove the transparent calibration cup.**
3. **Fill the transparent calibration cup to the line with pH 4 standard solution.**
   The transparent calibration cup has With TURB Measurement and Without TURB Measurement gauge lines.



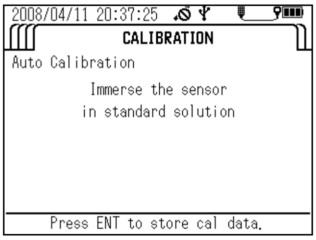
4. **Press the control unit's CAL key to set the calibration mode.**

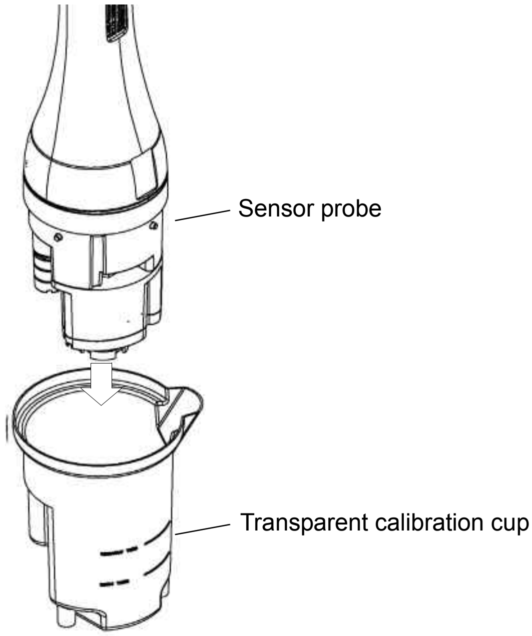


5. **Press the down (▽) key to move the cursor to "Auto Calibration", then press the ENTER key.**

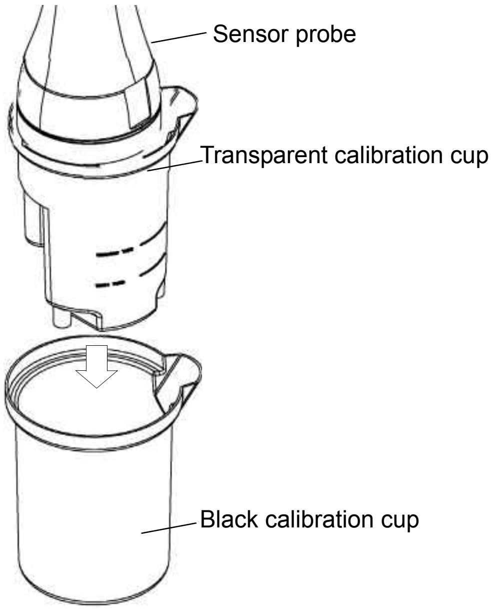


6. **Immerse the sensor probe in the transparent calibration cup.**
Check that the pH sensor, ORP sensor, reference electrode, COND sensor, TURB sensor and temperature sensor are submerged in the pH 4 standard solution and check that there are no air bubbles on the sensor.





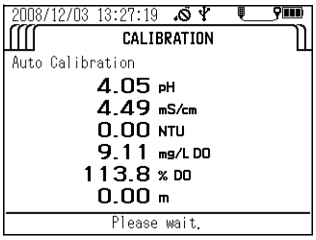
7. **With the sensor probe still in the transparent calibration cup, place the transparent calibration cup into the black calibration cup.**



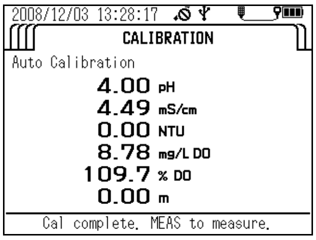
8. When all the sensor values have stabilized, press the ENTER key to start calibration.

Note

Do not remove the sensor probe from the calibration solution. U-53 turbidity data will display "----" until the calibration is completed.



Calibration is finished when the message "Cal complete. MEAS to measure." appears. Press the MEAS key to set the measurement screen, then start measurement.



If a calibration error occurs, start calibration after first resolving the issue according to the instructions in " 4.6 Troubleshooting " (page 89).

3.3.2 Manual calibration

The procedures below describe how to calibrate each sensor individually.

Note

The displayed units are the units set by selecting "Unit for report" in the "SETTINGS" screen.

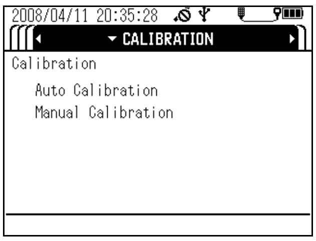
● **Temperature (TEMP) calibration**

1. Fill a bucket or similar container with water of a known temperature, and insert the sensor probe in it.

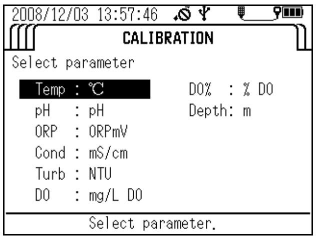
Wait 5 minutes before starting calibration to allow the sensor probe temperature to stabilize.

2. Press the control unit's CAL key to set the calibration mode.

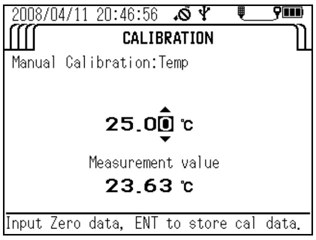
3. Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.



4. **In the parameter selection screen, move the cursor to "Temp", then press the ENTER key.**



5. **Press the up (△) and down (▽) keys to set the calibration value - the temperature of the water containing the submerged sensor probe.**



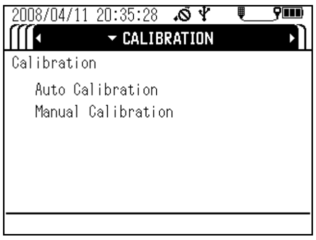
6. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
   Calibration is finished when the message "Cal complete. CNT to measure." appears.

● pH calibration

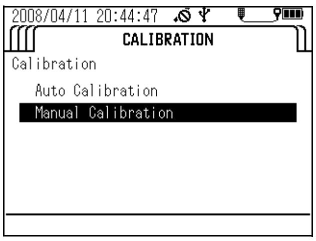
Note

You can select one calibration point (zero-point calibration) or two calibration points (zero-point calibration and span calibration). Carry out two calibration procedures to ensure good measurement precision throughout all measurement ranges.

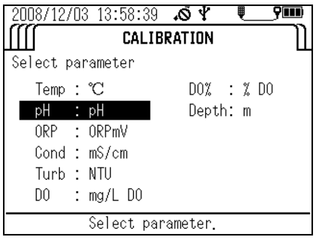
1. **Calibrate the zero point. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with pH 7 standard solution.**
2. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
3. **Press the control unit's CAL key to set the calibration mode.**



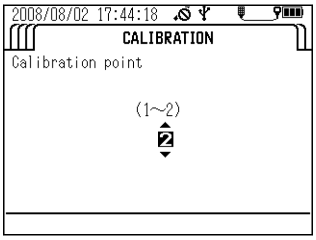
4. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



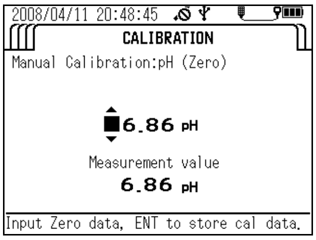
5. **In the parameter selection screen, move the cursor to "pH", then press the ENTER key.**



6. **Set the number of calibration points, then press the ENTER key.**



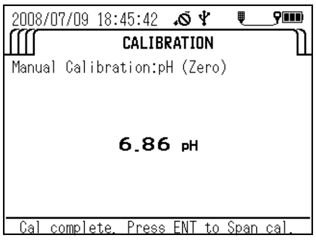
7. **Press the up (△) and down (▽) keys to set the pH value of the pH 7 standard solution containing the submerged sensor probe at the measurement temperature**



Temp. (°C)	pH 4 standard solution Phthalate	pH 7 standard solution Neutral phosphate	pH 9 standard solution Borate
0	4.01	6.98	9.46
5	4.01	6.95	9.39
10	4.00	6.92	9.33
15	4.00	6.90	9.27
20	4.00	6.88	9.22
25	4.01	6.86	9.18
30	4.01	6.85	9.14
35	4.02	6.84	9.10
40	4.03	6.84	9.07
45	4.04	6.84	9.04

8. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**

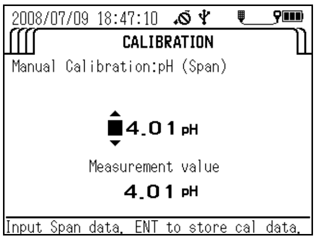
9. **Press the ENTER key to start the span calibration procedure when the message "Cal complete. Press ENT to Span cal." appears.**



10. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with pH 4 or pH 9 standard solution.**

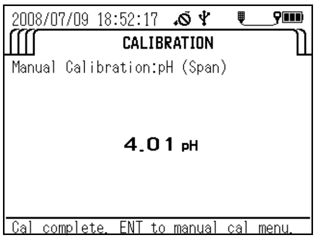
11. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**

12. **Press the up (△) and down (▽) keys to set the pH value of the pH 4 or pH 9 standard solution containing the submerged sensor probe at the measurement temperature.**



13. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**

14. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter**



● ORP calibration

Note

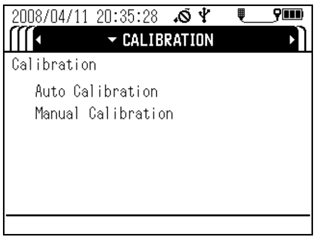
- **If the prepared ORP standard solution is left in open air for one hour or more, the solution may be transformed. For this reason ORP standard solution cannot be stored.**
  Calibrate within one hour of preparing the solution.
- **When measuring sample with low concentrations of oxidants and reductants after conducting an operational check using a standard substance, the measured values may not stabilize or the results of measurement might not be repeatable. If this is the case, start the measurement after immersing the sensors in the sample water sufficiently.**
- **Note that when measuring the ORP of solution with extremely low concentrations of oxidants and reductants, such as tap water, well water, or water treated with purifying equipment, there may be less responsiveness, repeatability, and stability, in general.**
- **When alkaline ion water is left for 5 minutes, its ORP undergoes changes significantly. Always measure alkaline ion water promptly.**

1. **Fill a clean beaker with one bag of ORP standard powder No. 160-22 or No. 160-51. Add 250 mL of deionized water and agitate the solution thoroughly (there will be some excess quinhydrone (a black powder) that floats on the surface when agitating the solution). Fill the transparent calibration cup to the reference line with this standard solution.**

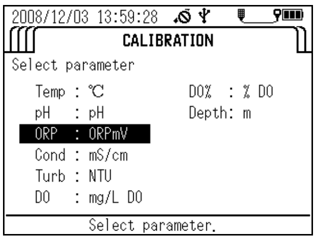
2. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**

3. **Press the control unit's CAL key to set the calibration mode.**

4. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



5. **In the parameter selection screen, move the cursor to ORP, then press the ENTER key.**



6. **Press the up (△) and down (▽) keys to set the mV value of the ORP standard solution containing the submerged sensor probe at the measurement temperature.**

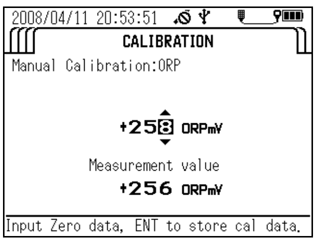


Table 1 Indicated value of ORP standard solution at various temperatures (mV)

Temperature	160-22	16051
5	+274	+112
10	+271	+107
15	+267	+101
20	+263	+95
25	+258	+89
30	+254	+83
35	+249	+76
40	+244	+69

7. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
8. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**

Conductivity (COND) calibration

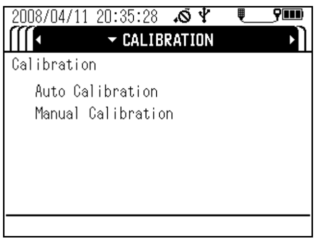
Note

- **To support a wide range of sample concentrations, electrical conductivity is divided into three measurement ranges: 0.0 mS/m to 99.9 mS/m, 0.090 S/m to 0.999 S/m, and 0.9 S/m to 9.99 S/m.**
- **When manually calibrating conductivity, you can select two calibration points (one zero-point calibration point and a span calibration point for one of the three measurement ranges) or four calibration points (one zero-point calibration point and span calibration points for all three measurement ranges). Carry out the four calibration points to ensure good measurement precision throughout all measurement ranges.**
- **Make the compensation setting before calibration since this setting is applied during calibration. (Refer to " 6.5.3 Temperature coefficient " (page 104)).**

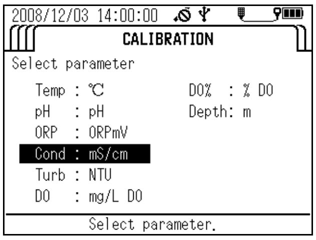
1. **Prepare the standard solution. Dry Potassium chloride (KCl) powder (high-grade commercially available) at 105°C for two hours, and leave it to cool in a desiccator.**
2. **Consult the following table and weigh potassium chloride (KCl), then prepare three standard potassium chloride (KCl) solutions following the procedure below.**

Potassium chloride (KCl) standard solution	Conductivity (COND) value	Potassium chloride (KCl) mass (g) at solution temperature of 25 °C	Calibration range
0.005 mol/L	71.8 mS/m (0.718 mS/cm)	0.373	0.0 mS/m to 99.9 mS/m (0.00 mS/cm to 0.999 mS/cm)
0.050 mol/L	0.667 S/m (6.67 mS/cm)	3.73	0.090 S/m to 0.999 S/m (1.00 mS/cm to 9.99 mS/cm)
0.500 mol/L	5.87 S/m (58.7 mS/cm)	37.2	0.9 S/m to 9.99 S/m (10.0 mS/cm to 99.9 mS/cm)

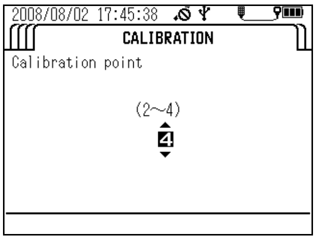
3. **Dissolve the weighed Potassium Chloride (KCl) in deionized water.**
4. **Put the dissolved Potassium Chloride (KCl) into a 1 L measuring flask, and fill to the 1 L mark with deionized water.**
5. **Calibrate the zero point. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then remove all moisture from the sensor probe (it will be calibrated in air).**
6. **Press the control unit's CAL key to set the calibration mode.**
7. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



8. **In the parameter selection screen, move the cursor to “Cond”, then press the ENTER key.**



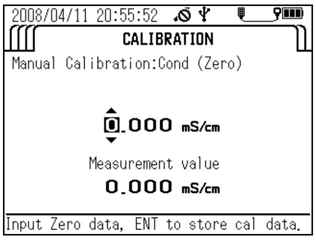
9. **Set the number of calibration points, then press the ENTER key.**



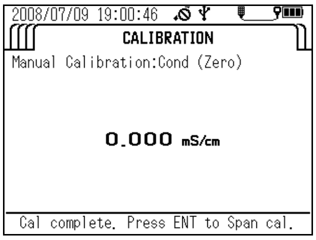
The instructions below assume that four calibration points have been set.

10. **Press the up (△) and down (▽) keys to set the "Cond" value to 0.0 mS/m (0.000 mS/cm).**

11. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**



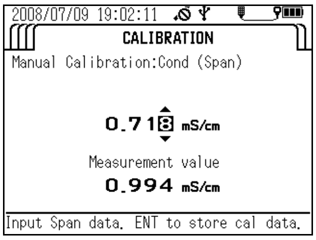
12. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the first span calibration procedure.**



13. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 71.8 mS/m (0.718 mS/cm) standard solution.**

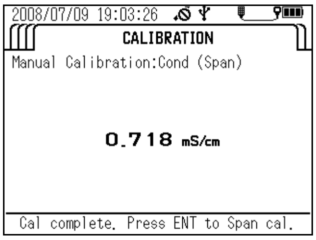
14. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**

15. **Press the up (△) and down (▽) keys to set the "Cond" value to 71.8 mS/m (0.718 mS/cm).**
Calibration range = 0 mS/m to 99.9 mS/m (0 mS/cm to 0.999 mS/cm)



16. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**

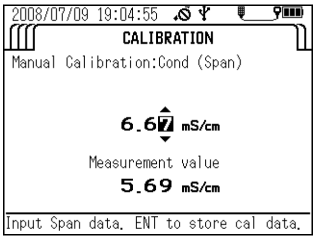
17. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.**



18. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 0.667 S/m (6.67 mS/cm) standard solution.**

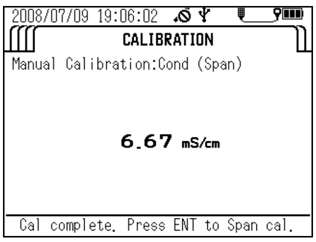
19. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**

20. **Press the up (△) and down (▽) keys to set the "Cond" value to 0.667 S/m (6.67 mS/cm).**
Calibration range = 0.100 S/m to 0.999 S/m (1.00 mS/cm to 9.99 mS/cm)

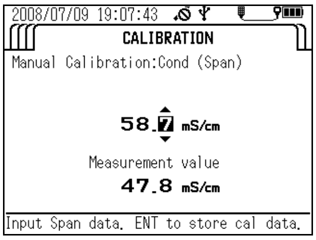


21. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**

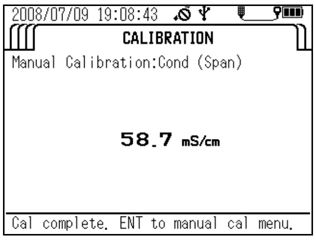
22. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.**



23. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 5.87 S/m (58.7 mS/cm) standard solution.**
24. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
25. **Press the up (△) and down (▽) keys to set the "Cond" value to 5.87 S/m (58.7 mS/cm).**
    Calibration range = 1.00 S/m to 10.00 S/m(10.0 mS/cm to 100.0 mS/cm)



26. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
27. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**



● Turbidity (TURB) calibration

Note

- **To support a wide range of sample concentrations, turbidity is divided into three measurement ranges: 0.0 to 9.9 NTU, 10 to 100 NTU, and over 100 NTU.**
- **When manually calibrating turbidity, you can select two calibration procedures (one zero-point calibration procedure and a span calibration procedure for one of the three measurement ranges), three calibration procedures (one zero-point calibration procedure and a span calibration procedure for two of the three measurement ranges) or four calibration procedures (one zero-point calibration procedure and span calibration procedures for all three measurement ranges). Carry out the four calibration procedures to ensure good measurement precision throughout all measurement ranges.**
- **Always use the calibration cup provided. Using other containers can create effects from ambient light that cause incorrect calibration.**

● Preparing the standard solutions

1. **Weigh out 5.0 g of hydrazine sulfate (commercial special grade or above), and dissolve it in 400 mL of deionized water. Dissolve 50 g of hexamethylene tetramine (commercial special grade or above) in 400 mL of deionized water in anther flask.**
2. **Mix the two solutions and add deionized water until the total solution volume is 1000 mL, and mix well. Store this solution at a temperature of 25°C ±3°C for 48 hours.**
   The turbidity value (TURB) of this solution is equivalent to 4000 NTU.
3. **Dilute 4000 NTU-solution 5 times (use a pipette to measure 50 mL of the 4000 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus)**
   The turbidity value (TURB) of this solution is equivalent to 800 NTU.
4. **Dilute 800 NTU solution 10 times (use a pipette to measure 25 mL of the 800 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus)**
   The turbidity value (TURB) of this solution is equivalent to 80 NTU.
5. **Dilute 80 NTU solution 10 times (use a pipette to measure 25 mL of the 80 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus)**
   The turbidity value (TURB) of this solution is equivalent to 8 NTU.

Note

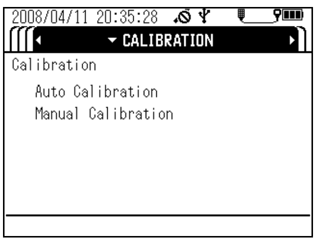
Instead of the standard solutions above, you can use other standard solutions of known concentration measured with other standard instruments.

● U-52, U-53 turbidity calibration

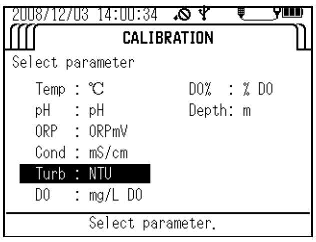
Set the number of calibration points.

You can set between 2 and 4 points.

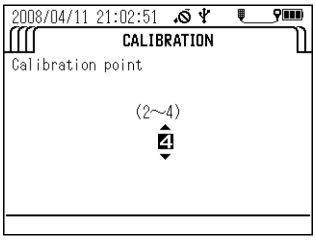
1. **Press the control unit's CAL key to set the calibration mode.**
2. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



3. **In the parameter selection screen, move the cursor to "Turb", then press the ENTER key.**

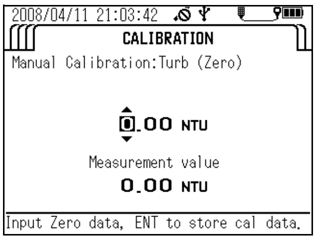


4. **Press the up (△) and down (▽) keys to set the number of calibration points, then press the ENTER key.**

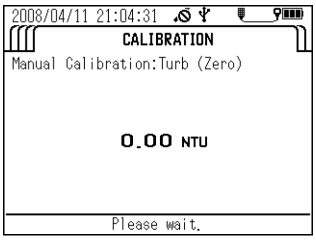


The instructions below assume that four calibration points have been set.

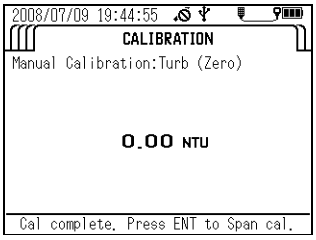
5. **Calibrate the zero point. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with deionized water.**
6. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
7. **Press the up (△) and down (▽) keys to set the "Turb" value to 0.0 NTU.**



8. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**



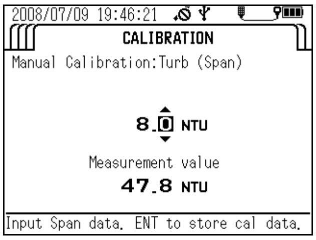
9. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the first span calibration procedure.**



10. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 8 NTU standard solution, or a standard solution of known concentration between 0.1 and 10 NTU.**

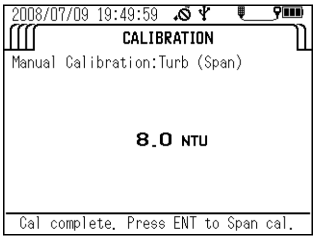
11. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**

12. **Press the up (△) and down (▽) keys to set the "TURB" value to 8 NTU, or to the known concentration of the standard solution between 0.1 and 10 NTU. (Input range = 0 NTU to 9.9 NTU (U-51) or 0 NTU to 9.99 NTU (U-52))**



13. **Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.**

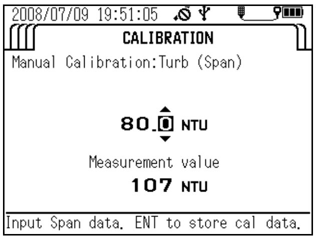
14. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.**



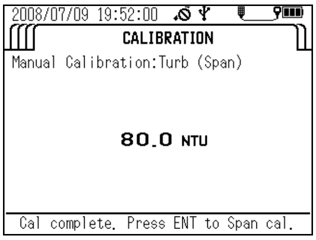
15. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 80 NTU standard solution, or a standard solution of known concentration between 10 and 100 NTU.**

16. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**

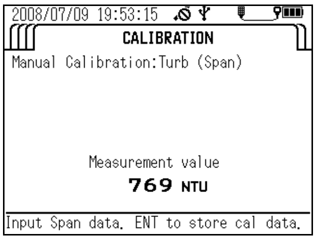
17. Press the up (△) and down (▽) keys to set the "Turb" value to 80 NTU, or to the known concentration of the standard solution between 10 and 100 NTU. (Input range = 10.0 NTU to 99.9 NTU)



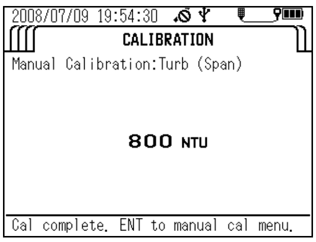
18. Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.
19. When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.



20. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 800 NTU standard solution, or a standard solution of known concentration 100 NTU above.
21. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.
22. Press the up (△) and down (▽) keys to set the "TURB" value to 800 NTU, or to the known concentration of the standard solution 100 NTU above.
(Input range = 100 NTU to 800 NTU (U-51), 100 NTU to 1000 NTU (U-52))



23. Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.
24. Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.



● Dissolved oxygen (DO) calibration

Note

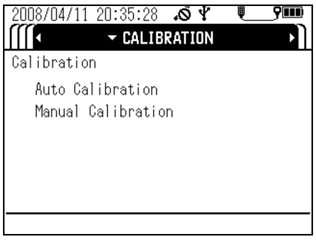
- **You can select one calibration procedure (span calibration) or two calibration procedures (zero-point calibration and span calibration). Carry out the two calibration procedures to ensure good measurement precision throughout all measurement ranges.**
- **It is necessary to prepare new solution before calibration of the Dissolved Oxygen (DO) sensor.**
- **The calibration cup (included) cannot be used to manually calibrate the DO sensor. Use a suitable bottle in which the DO sensor and the temperature sensor can be immersed.**
- **Wait at least 20 minutes after turning the system power ON before calibrating the DO sensor.**
- **Make the compensation setting before calibration since the setting is applied during calibration.**
- **The DO sensor is affected by flow. When performing span calibration with saturated dissolved oxygen water, move the cable slowly up and down (move the sensor probe at a rate of roughly 20 to 30 cm a second) or agitate the saturated dissolved oxygen water.**

1. **Prepare the standard solution.**

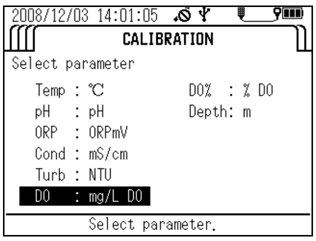
- Add about 50 g of sodium sulfite to 1000 mL of water (either deionized water or tap water) and stir the mixture to dissolve the sodium sulfite in it.
- Pour 1 to 2 liters of water into a suitable flask (either deionized water or tap water). Using a air pump, feed air into the water and aerate the solution until oxygen is saturated.

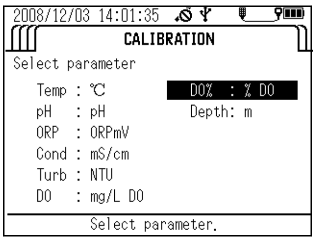
2. **First, calibrate the zero point. Press the control unit's CAL key to set the calibration mode.**

3. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**

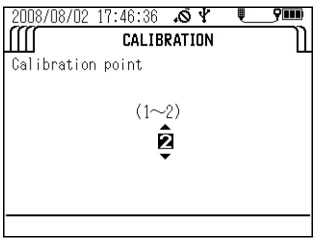


4. **In the parameter selection screen, move the cursor to DO or DO%, then press the ENTER key.**





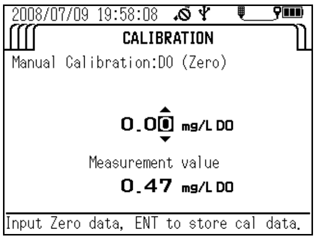
5. **Set the number of calibration procedures, then press the ENTER key.**

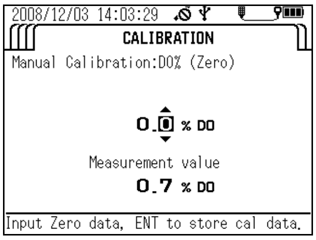


The instructions below assume that two calibration points have been set.

6. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the bottle.**

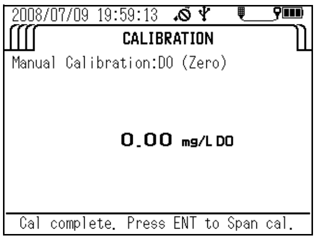
7. **Press the up (△) and down (▽) keys to set the DO value to 0.00 mg/L or 0.0%.**

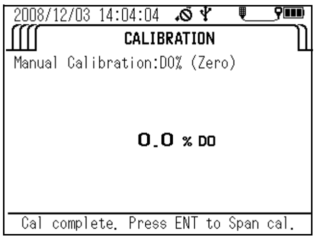




8. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**

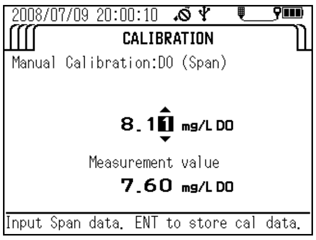
9. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the span calibration procedure.**

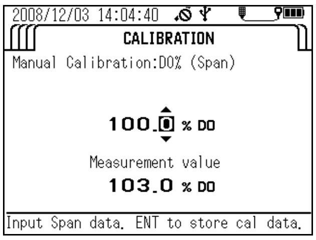




10. **Wash the sensor probe 2 or 3 times with deionized water to remove any dirt, then submerge the sensor probe in the container filled with the span solution.**

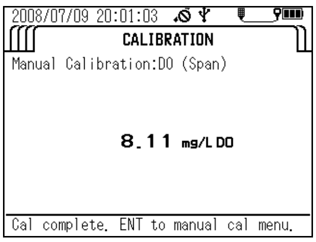
11. **Press the up (△) and down (▽) keys to set the DO value to the saturated dissolved oxygen value (mg/L) of the water at that temperature or the dissolved oxygen saturation ratio.**

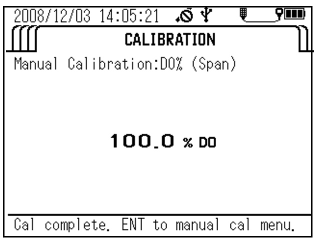




12. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**

13. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**





Amounts of saturated dissolved oxygen in water at various temperatures (salinity=0.0%)

JIS K0101

Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	14.16						
1	13.77	11	10.67	21	8.68	31	7.42
2	13.40	12	10.43	22	8.53	32	7.32
3	13.04	13	10.20	23	8.39	33	7.22
4	12.70	14	9.97	24	8.25	34	7.13
5	12.37	15	9.76	25	8.11	35	7.04
6	12.06	16	9.56	26	7.99	36	6.94
7	11.75	17	9.37	27	7.87	37	6.86
8	11.47	18	9.18	28	7.75	38	6.76
9	11.19	19	9.01	29	7.64	39	6.68
10	10.92	20	8.84	30	7.53	40	6.59

ISO5814

Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	14.62				
1	14.22	11	11.03	21	8.91
2	13.83	12	10.78	22	8.74
3	13.46	13	10.54	23	8.58
4	13.11	14	10.31	24	8.42
5	12.77	15	10.08	25	8.26
6	12.45	16	9.87	26	8.11
7	12.14	17	9.66	27	7.97
8	11.84	18	9.47	28	7.83
9	11.56	19	9.28	29	7.69
10	11.29	20	9.09	30	7.56

● Span setting values for calibration in air

The software should display these values when auto calibration is performed.
Use this table to input values for manual span calibrations in air.

Tip

The DO measurement value of "air-saturated water" and air are different.
Due to the pressure difference against the membrane in air versus the membrane in water, the measurement value in air is about 10% higher than the value of air-saturated water on average.

Amounts of saturated dissolved oxygen in air at various temperatures

Following tables are applicable only to the air calibration of the U-50 DO sensor. Do not use them for other purpose.

Air calibration value in adopting evaluation based on JIS K0101

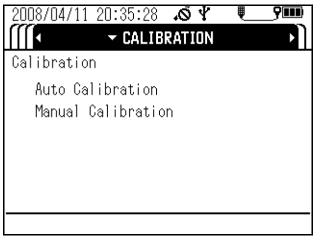
Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)
0	15.58						
1	15.15	11	11.74	21	9.55	31	8.16
2	14.74	12	11.47	22	9.38	32	8.05
3	14.34	13	11.22	23	9.23	33	7.94
4	13.97	14	10.97	24	9.08	34	7.84
5	13.61	15	10.74	25	8.92	35	7.74
6	13.27	16	10.52	26	8.79	36	7.63
7	12.93	17	10.31	27	8.66	37	7.55
8	12.62	18	10.10	28	8.53	38	7.44
9	12.31	19	9.91	29	8.40	39	7.35
10	12.01	20	9.72	30	8.28	40	7.25

Air calibration value in adopting evaluation based on ISO5814

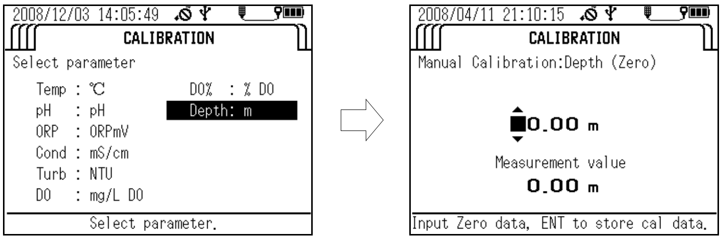
Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	16.08				
1	15.64	11	12.13	21	9.80
2	15.21	12	11.86	22	9.61
3	14.81	13	11.59	23	9.44
4	14.42	14	11.34	24	9.26
5	14.05	15	11.09	25	9.09
6	13.70	16	10.86	26	8.92
7	13.35	17	10.63	27	8.77
8	13.02	18	10.42	28	8.61
9	12.72	19	10.21	29	8.46
10	12.42	20	10.00	30	8.32

● Water depth (DEPTH) calibration

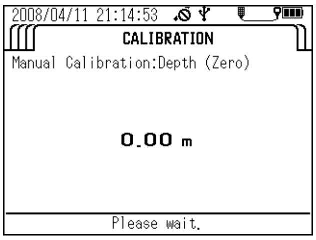
1. **Calibrate the zero point. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then remove all moisture from the sensor probe (it will be calibrated in air).**
2. **Press the control unit's CAL key to set the calibration mode.**
3. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



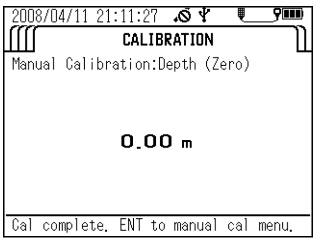
4. **In the parameter selection screen, move the cursor to "Depth", then press the ENTER key.**



5. **Press the up (△) and down (▽) keys to set the "Depth" value to 0.00 m.**
6. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**



7. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**



3.4 Measurement

You can perform measurement by either of the methods below.

- Storing data in memory manually with reference to the measurement value (single measurement)
- Having data stored in memory automatically and continuously
  U-51/U-52: Interval measurement (minimum memory interval of 10 seconds)
  U-53: Interval measurement (minimum memory interval of 30 seconds)

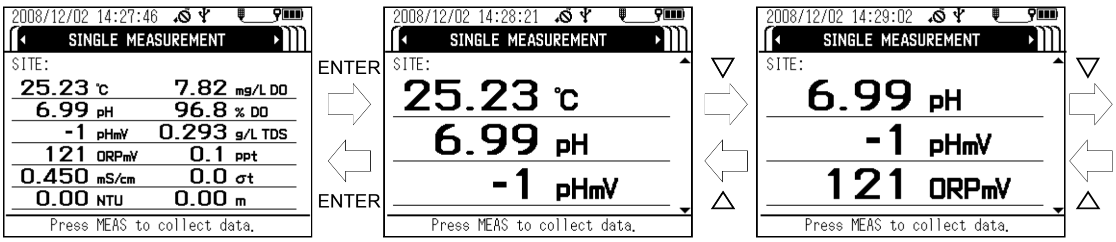
Select the measurement method that meets your requirements.

Note

- **Lower sensor probe slowly when submerging them in samples.**
- **Sensors may break if sensor probe are dropped from a height of 1 meter or more.**
- **Do not submerge sensor probe in water depths of over 30 meters. Sensor probe are only resistant to water pressure of up to 30 meters.**
- **After turning the power ON, check that the DO readout value has stabilized before starting measurement (takes around 20 minutes).**

Tip

- **When on the measurement screen, pressing the ENTER key enlarges the display and shows three measured values at a time.**
- **Pressing the up (△) and down (▽) keys scrolls through the measured values one item at a time.**
- **Pressing the ENTER key again reverts to the normal measurement screen display.**



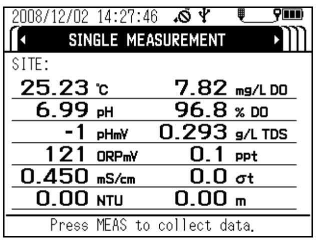
Measurement screen Normal Enlarged

3.4.1 Storing data in memory manually

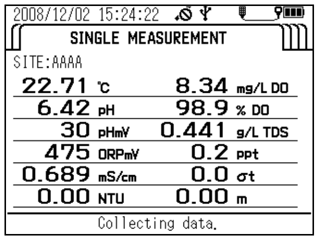
Follow the steps below to manually store data in memory while referring to the measurement value to check the readout value is stable.

● **U-51/U-52**

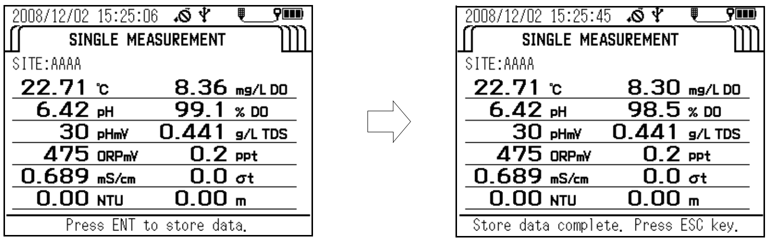
1. **Check that each sensor and sensor guard is mounted.**
2. **Check that "SINGLE MEASUREMENT" has been selected in the measurement screen.**



3. **Submerge the sensor probe in the sample, gently shaking them in the sample to remove any air bubbles from the sensors.**
   If the sample is non-flowing, move the cable slowly up and down (move the sensor probe at a rate of roughly 20 to 30 cm a second) to ensure that fresh sample is continuously supplied to the DO sensor.
4. **When the measurement values are stable, press the MEAS key to acquire the 5-second average.**



5. **Press the ENTER key to save the held measurement values, or press the ESC key to cancel the operation.**

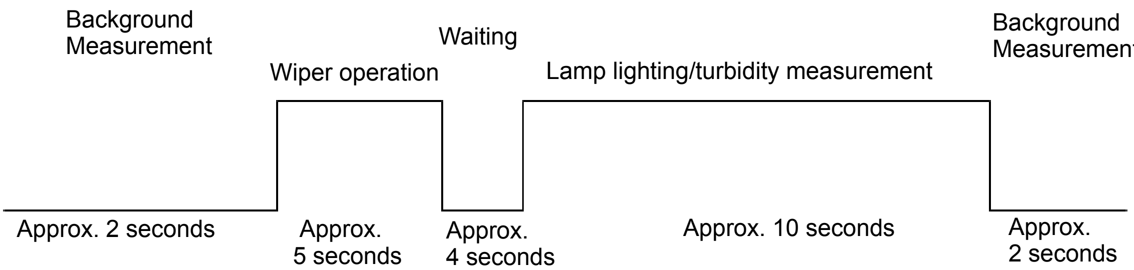


● **U-53**

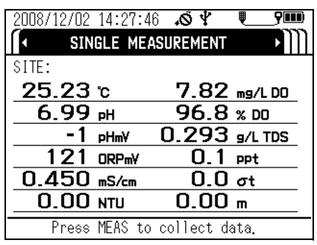
Note

Do not perform turbidity measurement in air as it may damage the wiper.

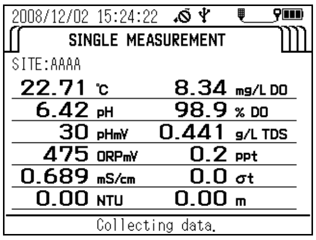
U-53 turbidity measurement follows the sequence below. The measurement values are held after each sequence.



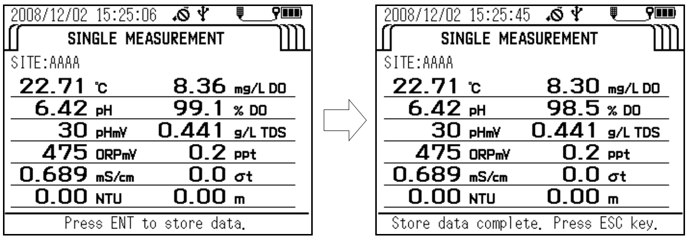
1. **Check that each sensor and sensor guard is mounted.**
2. **Check that "SINGLE MEASUREMENT" has been selected in the measurement screen.**



3. **Submerge the sensor probe in the sample, gently shaking them in the sample to remove any air bubbles from the sensors.**
   If the sample is non-flowing, move the cable slowly up and down (move the sensor probe at a rate of roughly 20 to 30 cm a second) to ensure that fresh sample is continuously supplied to the DO sensor.
4. **When the non-turbidity meter measurement values are stable, press the MEAS key to start the sequence above.**



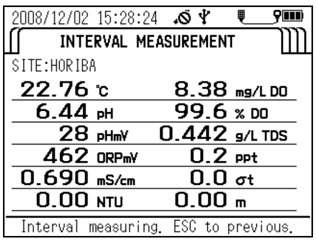
5. **When the sequence has finished, hold the measurement values. Press the ENTER key to store the held measurement values, or press the ESC key to cancel the operation.**



3.4.2 Automatic, continuous measurement

● **Interval measurement**

1. **Select the "Interval measurement" measurement setting (see “ 3.2.1 Setting measurement methods ” (page 18)).**
2. **Press the up (△) and down (▽) keys to set the interval value to the desired value (U-51/U-52: minimum interval: 10 seconds, U-53: minimum interval: 30 seconds), then press the ENTER key.**
   The measurement screen appears automatically, and the system becomes ready for measurement.
3. **Check that each sensor and sensor guard is mounted.**
4. **Submerge the sensor probe in the sample, gently shaking them in the sample to remove any air bubbles from the sensors.**
   If the sample is non-flowing, move the cable slowly up and down (move the sensor probe at a rate of roughly 20 to 30 cm a second) to ensure that fresh sample is continuously supplied to the DO sensor.
5. **Press the ENTER key to start measurement.**



3.5 Data operations

Use the procedures below to retrieve data stored in memory, delete all the data, check the remaining data memory capacity, and check the calibration record.

3.5.1 Displaying data

For maximum efficiency, there are 3 methods of displaying data.

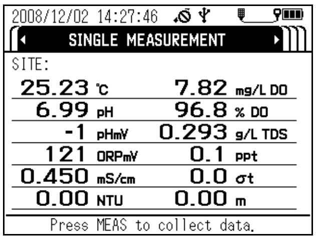
- Displaying the data for a specified site
- Displaying the data for a specified date/time
- Displaying all the data

Use the method that best suits your requirements.

● Displaying the data for a specified site

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

The "MEASUREMENT" screen appears after about 10 seconds.

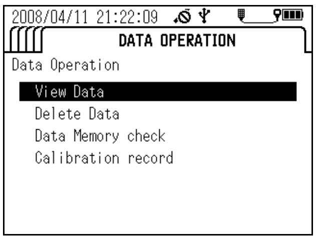


Note

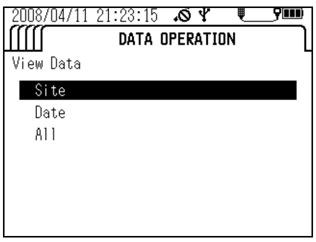
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**

3. **Press the down (▽) key to move the cursor to "View Data", then press the ENTER key.**

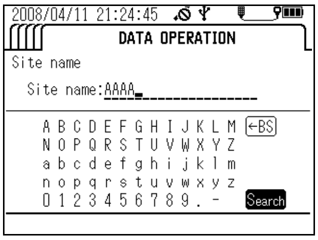


4. **Move the cursor to "Site", then press the ENTER key.**



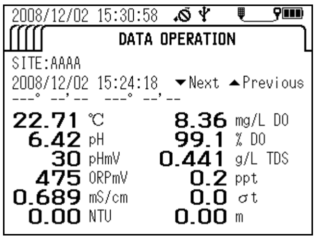
5. **Press the up (△), down (▽), left (◁) and right (▷) keys to enter the site to retrieve.**

6. Move the cursor to "Search", then press the ENTER key.



All site names that begin with the entered text are displayed.
The most recently measured data for the entered site is displayed.

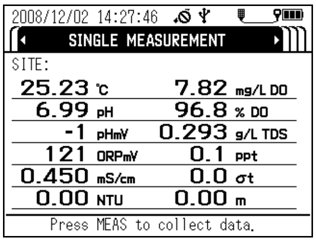
7. Press the up (△) and down (▽) keys to display earlier data.



● Displaying the data for a specified date/time

1. Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.

The "MEASUREMENT" screen appears after about 10 seconds.

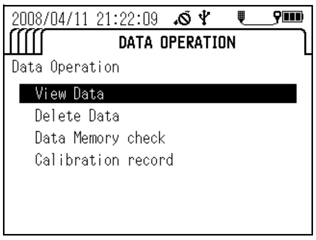


Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

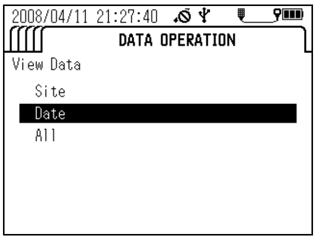
2. Press the right (▷) key 3 times to display the "DATA OPERATION" screen.

3. Press the down (▽) key to move the cursor to "View Data", then press the ENTER key.



4. Move the cursor to "Date", then press the ENTER key.

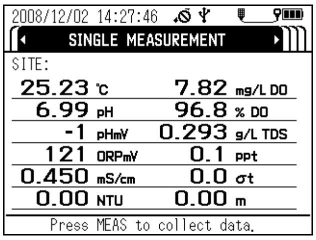
5. **With the cursor on the Date, press the ENTER key.**



6. **Press the up (△), down (▽), left (◁) and right (▷) keys to enter the desired date/ time, then press the ENTER key to apply the setting.**
7. **The cursor moves to "Search". Press the ENTER key to start the search.**
8. **Press the up (△) and down (▽) keys to display earlier data.**

● Displaying all the data

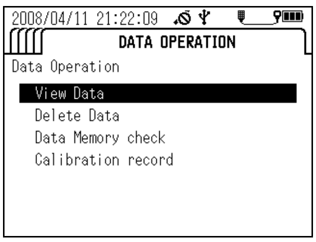
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



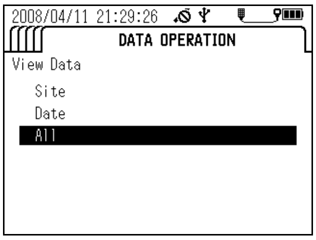
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "View Data", then press the ENTER key.**



4. **Move the cursor to "All", then press the ENTER key.**
The most recently measured data is displayed.

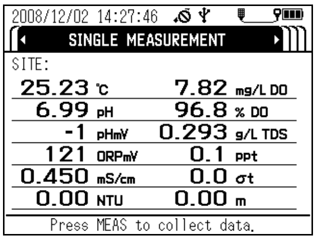


5. **Press the up (△) and down (▽) keys to display earlier data.**

3.5.2 Deleting data

Follow the steps below to delete all the data stored in memory.

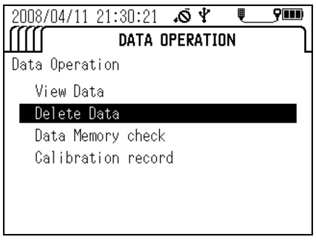
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



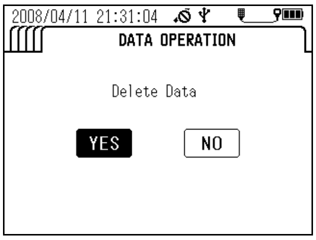
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "Delete Data", then press the ENTER key.**



4. **Press the left (◁) key to move the cursor to YES, then press the ENTER key.**
   All the data has been deleted when the indicator appears along with the message "No data exists".

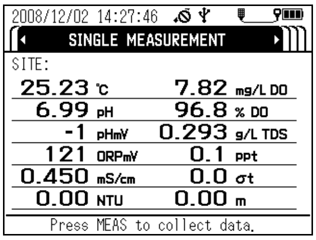


3.5.3 Checking the data memory

You can check the used data capacity and the remaining data capacity.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

The "MEASUREMENT" screen appears after about 10 seconds.

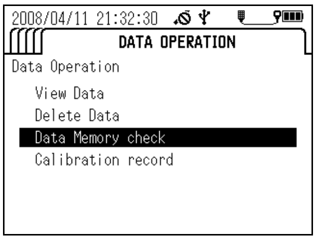


Note

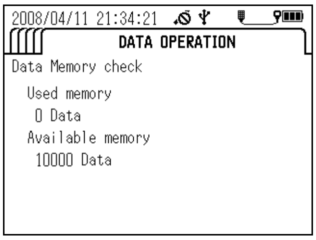
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**

3. **Press the down (▽) key to move the cursor to "Data Memory Check", then press the ENTER key.**



The amount of memory in use and amount of available memory are displayed.

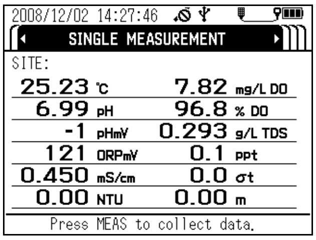


3.5.4 Checking the calibration record

Follow the steps below to check the latest calibration history.

1. **Press and hold down the control unit’s POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.



Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "Calibration record", then press the ENTER key.**

   The latest calibration record is displayed.

3.5.5 GPS data operations

The menu for GPS data operations appears on the display to which the GPS unit is mounted.

● GPS information

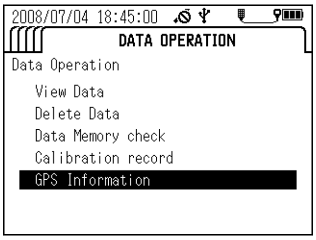
Follow the steps below to display acquired GPS information.

Note

Turning the power OFF erases the GPS information.

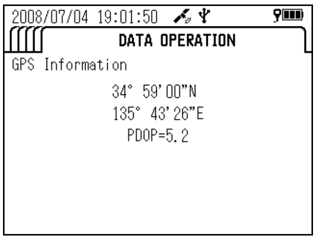
1. **Press the right (▷) key to switch the display to the "DATA OPERATION" screen.**

2. **the down (▽) key to move the cursor to "GPS Information", then press the ENTER key.**

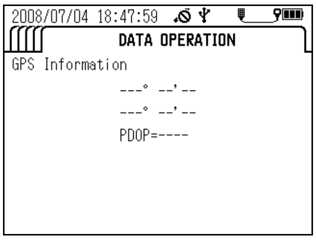


The last GPS information acquired is displayed.

● When received data exists

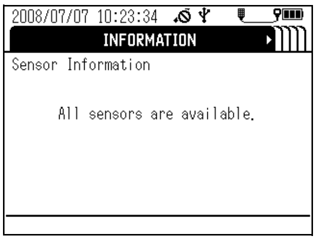


● When no received data exists

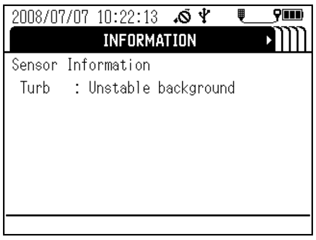


3.6 Sensor information

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.
2. **Press the left (◁) key once to display the "INFORMATION" screen.**
   The "Sensor Information" screen displays the sensor probe's status.
   - When the sensor probe is normal, the display below appears.



   - When there is a sensor probe problem, individual measurement parameters generate messages such as the one shown below. Follow the troubleshooting information to remove the problem before continuing to operate the system.

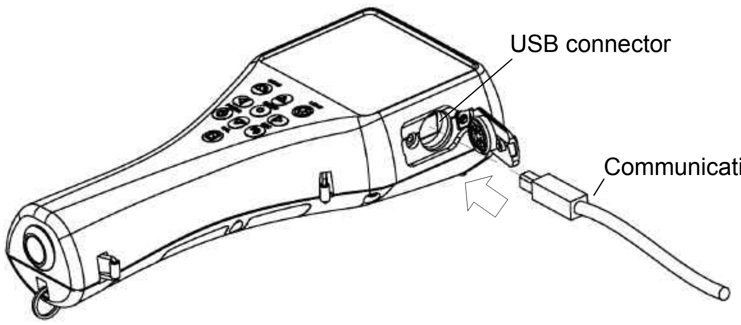


3.7 USB communication

The separately-sold, dedicated PC connection cable comes with data collection software. This software allows data to be downloaded from the control unit in CSV format.

This section contains instructions for communication commands used for USB communication.

● Connecting the cable



Dedicated cable

Part name: Communication cable (with data collection software)

Part no.: 3200174823

● Cautions when using USB communication

Take care to observe the following when using USB communication.

- Use the dedicated cable (with data collection software) or a commercially-available USB cable (A-B type) to connect to a PC.
- Be sure to match the transmission format on the control unit and the computer.
  The control unit uses the following transmission format:

Baud rate:	19200 bps
Number of stop bits:	1 bit
Data bit length:	8 bits
Parity:	None
Flow control:	None

Tip

If the transmission formats do not match, a communication error occurs and USB communication will not function normally. After changing the transmission format, restart the control unit and the computer.

- If received data is not sent back or an error occurs after a data request has been sent, adjust the program configuration so that it allows a little waiting time before a data request is sent again. This will enable more stable communication.
- The unit does not use DCD, CTS, or DSR signals. Take care of this when creating programs.

3.7.1 Communication settings

Baud rate:	19200 bps
Number of stop bits:	1 bit
Data bit length:	8 bits
Parity:	None
Flow control:	None

3.7.2 Commands

● Instant data requests

● Request command format

#	RD	@	XX	[CR]	[LF]
1	2	3	4		

1	Header	1 character
2	Command	2 characters
3	Delimiter character	1 character
4	Frame check sequence (FCS)	2 characters

The two ASCII-code characters created by converting the 8 bits of data created by successively combining the value of each character from # through @ in an exclusive OR (XOR) operation with the value of the next character.

Example: #RD@

(1)	0	XOR	35	(ASCII code of # symbol)	⇒	35
(2)	35	XOR	82	(ASCII code of R)	⇒	113
(3)	113	XOR	68	(ASCII code of D)	⇒	53
(4)	53	XOR	64	(ASCII code of @ symbol)	⇒	117 (decimal)
						↓
						75 (hex)
						↓
						Sets "75".

Example: 35 XOR 82 operation

35 in binary	⇒	0	0	1	0	0	0	1	1		
82 in binary	⇒	0	1	0	1	0	0	1	0		
XOR result		0	1	1	1	0	0	0	1	⇒	113 (decimal)

Note: Set "XX" if you do not want to test for communication frame errors with FCS.

● Response format

```
#   RD   AAAAAAAAAAAAAAAAAAAA   X   X   XXXX   XX   X   X   XXXXX   X
1   2    3                      4   5   6      7    8   9   10      11

XX   X    X    XXXXX   X    XX   X    X    XXXXX   X    XX   X    X    XXXXX   X
12   13   14   15      16   17   18   19   20      21   22   23   24   25      26
XX   X    X    XXXXX   X    XX   X    X    XXXXX   X    XX   X    X    XXXXX   X
27   28   29   30      31   32   33   34   35      36   37   38   39   40      41

XX   X    X    XXXXX   X    XX   X    X    XXXXX   X    XX   X    X    XXXXX   X
42   43   44   45      46   47   48   49   50      51   52   53   54   55      56
```

XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71

XX	XX	XX	XX	XX	XX	XX	XX	XX	X	X	XXX	XX	XX	X	X	@	XX	[CR]	[LF]
72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89		

1	Header		1 character
2	Command		2 characters
3	Site name	Upper- and lowercase letters, numbers, periods (.) hyphens (-) and spaces ( )	20 characters
4	Probe status	(3) Status code	1 character
5	Probe error	(4) Status error code	1 character
6	Unused		4 characters
7	Parameter 1 code	(1) Parameter code	2 characters
8	Parameter 1 status	(5) Parameter status code	1 character
9	Parameter 1 error	(6) Parameter error code	1 character
10	Parameter 1 data	5 characters including decimal point, right-justified with blanks filled	5 characters
11	Parameter 1 unit	(2) Unit code	1 character
12	Parameter 2 code	(1) Parameter code	2 characters
13	Parameter 2 status	(5) Parameter status code	1 character
14	Parameter 2 error	(6) Parameter error code	1 character
15	Parameter 2 data	5 characters including decimal point, right-justified with blanks filled	5 characters
16	Parameter 2 unit	(2) Unit code	1 character
17	Parameter 3 code	(1) Parameter code	2 characters
18	Parameter 3 status	(5) Parameter status code	1 character
19	Parameter 3 error	(6) Parameter error code	1 character
20	Parameter 3 data	5 characters including decimal point, right-justified with blanks filled	5 characters
21	Parameter 3 unit	(2) Unit code	1 character
22	Parameter 4 code	(1) Parameter code	2 characters
23	Parameter 4 status	(5) Parameter status code	1 character
24	Parameter 4 error	(6) Parameter error code	1 character
25	Parameter 4 data	5 characters including decimal point, right-justified with blanks filled	5 characters
26	Parameter 4 unit	(2) Unit code	1 character
27	Parameter 5 code	(1) Parameter code	2 characters
28	Parameter 5 status	(5) Parameter status code	1 character
29	Parameter 5 error	(6) Parameter error code	1 character
30	Parameter 5 data	5 characters including decimal point, right-justified with blanks filled	5 characters
31	Parameter 5 unit	(2) Unit code	1 character
32	Parameter 6 code	(1) Parameter code	2 characters
33	Parameter 6 status	(5) Parameter status code	1 character
34	Parameter 6 error	(6) Parameter error code	1 character

35	Parameter 6 data	5 characters including decimal point, right-justified with blanks filled	5 characters
36	Parameter 6 unit	(2) Unit code	1 character
37	Parameter 7 code	(1) Parameter code	2 characters
38	Parameter 7 status	(5) Parameter status code	1 character
39	Parameter 7 error	(6) Parameter error code	1 character
40	Parameter 7 data	5 characters including decimal point, right-justified with blanks filled	5 characters
41	Parameter 7 unit	(2) Unit code	1 character
42	Parameter 8 code	(1) Parameter code	2 characters
43	Parameter 8 status	(5) Parameter status code	1 character
44	Parameter 8 error	(6) Parameter error code	1 character
45	Parameter 8 data	5 characters including decimal point, right-justified with blanks filled	5 characters
46	Parameter 8 unit	(2) Unit code	1 character
47	Parameter 9 code	(1) Parameter code	2 characters
48	Parameter 9 status	(5) Parameter status code	1 character
49	Parameter 9 error	(6) Parameter error code	1 character
50	Parameter 9 data	5 characters including decimal point, right-justified with blanks filled	5 characters
51	Parameter 9 unit	(2) Unit code	1 character
52	Parameter 10 code	(1) Parameter code	2 characters
53	Parameter 10 status	(5) Parameter status code	1 character
54	Parameter 10 error	(6) Parameter error code	1 character
55	Parameter 10 data	5 characters including decimal point, right-justified with blanks filled	5 characters
56	Parameter 10 unit	(2) Unit code	1 character
57	Parameter 11 code	(1) Parameter code	2 characters
58	Parameter 11 status	(5) Parameter status code	1 character
59	Parameter 11 error	(6) Parameter error code	1 character
60	Parameter 11 data	5 characters including decimal point, right-justified with blanks filled	5 characters
61	Parameter 11 unit	(2) Unit code	1 character
62	Parameter 12 code	(1) Parameter code	2 characters
63	Parameter 12 status	(5) Parameter status code	1 character
64	Parameter 12 error	(6) Parameter error code	1 character
65	Parameter 12 data	5 characters including decimal point, right-justified with blanks filled	5 characters
66	Parameter 12 unit	(2) Unit code (6) Parameter error code	1 character
67	Parameter 13 code	(1) Parameter code	2 characters
68	Parameter 13 status	(5) Parameter status code	1 character
69	Parameter 13 error	(6) Parameter error code	1 character
70	Parameter 13 data	5 characters including decimal point, right-justified with blanks filled	5 characters
71	Parameter 13 unit	(2) Unit code	1 character
72	Year	00 to 99	2 characters

73	Month	01 to 12	2 characters
74	Day	01 to 31	2 characters
75	Hour	00 to 23	2 characters
76	Minute	00 to 59	2 characters
77	Second	00 to 59	2 characters
78	Longitude (degrees)	00 to 90 or "--" (no GPS data)	2 characters
79	Longitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
80	Longitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
81	Unused	1 character	1 character
82	North latitude/South latitude	N: North; S: South	1 character
83	Latitude (degrees)	000 to 180 or "---" (no GPS data)	3 characters
84	Latitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
85	Latitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
86	Unused		1 character
87	East longitude/West longitude	E: East; W: West	1 character
88	Delimiter character		1 character
89	Frame check sequence (FCS)		2 characters

● Memory data requests

● Request command format

#	RM	X	X	AAAAAAAAAAAAAAAAAAAA	XX	XX	XX	@	XX	[CR]	[LF]
1	2	3	4	5	6	7	8	9	10		

1	Header		1 character
2	Command		2 characters
3	Data specification*1	0: Start search; 1: Next data item; 2: Previous data item; 3: Request same data again	1 character
4	Search method specification	0: All data; 1: Site search; 2: Date search	1 character
5	Search site*2	Upper- and lowercase letters, numbers, periods (.) hyphens (-) and spaces ( )	20 characters
6	Search year*3	00 to 99	2 characters
7	Search month*3	01 to 12	2 characters
8	Search day*3	01 to 31	2 characters
9	Delimiter character		1 character
10	Frame check sequence (FCS)		2 characters

*1: When sending the RM command, first send 0 [Start search], then 1 [Next data item], 2 [Previous data item] or 3 [Request same data again].

*2: [Search site] is only needed when [Site search] is specified as the search method. If another search method is specified, fill this field with spaces.

*3: [Search year], [Search month] and [Search day] are only needed when [Date search] is specified as the search method. If another search method is specified, fill this field with spaces.

● **Response format**
(when data exists)

#	RM	AAAAAAAAAAAAAAAAAAAA	XX	X	X	XXXXX	X
1	2	3	4	5	6	7	8

XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38

XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
39	40	41	42	43	44	45	46	47	48	49	50	51	52	53

XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
54	55	56	57	58	59	60	61	62	63	64	65	66	67	68

XX	XX	XX	XX	XX	XX	XX	XX	XX	X	X	XXX	XX	XX	X	X	@	XX	[CR]	[LF]
69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86		

1	Header		1 character
2	Command		2 characters
3	Site name	Upper- and lowercase letters, numbers, periods (.) hyphens (-) and spaces ( )	20 characters
4	Parameter 1 code	(1) Parameter code	2 characters
5	Parameter 1 selection	0: No selection; 1: Selection made	1 character
6	Parameter 1 error	(6) Parameter error code	1 character
7	Parameter 1 data	5 characters including decimal point, right-justified with blanks filled	5 characters
8	Parameter 1 unit	(2) Unit code	1 character
9	Parameter 2 code	(1) Parameter code	2 characters
10	Parameter 2 selection	0: No selection; 1: Selection made	1 character
11	Parameter 2 error	(6) Parameter error code	1 character
12	Parameter 2 data	5 characters including decimal point, right-justified with blanks filled	5 characters
13	Parameter 2 unit	(2) Unit code	1 character
14	Parameter 3 code	(1) Parameter code	2 characters
15	Parameter 3 selection	0: No selection; 1: Selection made	1 character
16	Parameter 3 error	(6) Parameter error code	1 character
17	Parameter 3 data	5 characters including decimal point, right-justified with blanks filled	5 characters
18	Parameter 3 unit	(2) Unit code	1 character
19	Parameter 4 code	(1) Parameter code	2 characters
20	Parameter 4 selection	0: No selection; 1: Selection made	1 character

21	Parameter 4 error	(6) Parameter error code	1 character
22	Parameter 4 data	5 characters including decimal point, right-justified with blanks filled	5 characters
23	Parameter 4 unit	(2) Unit code	1 character
24	Parameter 5 code	(1) Parameter code	2 characters
25	Parameter 5 selection	0: No selection; 1: Selection made	1 character
26	Parameter 5 error	(6) Parameter error code	1 character
27	Parameter 5 data	5 characters including decimal point, right-justified with blanks filled	5 characters
28	Parameter 5 unit	(2) Unit code	1 character
29	Parameter 6 code	(1) Parameter code	2 characters
30	Parameter 6 selection	0: No selection; 1: Selection made	1 character
31	Parameter 6 error	(6) Parameter error code	1 character
32	Parameter 6 data	5 characters including decimal point, right-justified with blanks filled	5 characters
33	Parameter 6 unit	(2) Unit code	1 character
34	Parameter 7 code	(1) Parameter code	2 characters
35	Parameter 7 selection	0: No selection; 1: Selection made	1 character
36	Parameter 7 error	(6) Parameter error code	1 character
37	Parameter 7 data	5 characters including decimal point, right-justified with blanks filled	5 characters
38	Parameter 7 unit	(2) Unit code	1 character
39	Parameter 8 code	(1) Parameter code	2 characters
40	Parameter 8 selection	0: No selection; 1: Selection made	1 character
41	Parameter 8 error	(6) Parameter error code	1 character
42	Parameter 8 data	5 characters including decimal point, right-justified with blanks filled	5 characters
43	Parameter 8 unit	(2) Unit code	1 character
44	Parameter 9 code	(1) Parameter code	2 characters
45	Parameter 9 selection	0: No selection; 1: Selection made	1 character
46	Parameter 9 error	(6) Parameter error code	1 character
47	Parameter 9 data	5 characters including decimal point, right-justified with blanks filled	5 characters
48	Parameter 9 unit	(2) Unit code	1 character
49	Parameter 10 code	(1) Parameter code	2 characters
50	Parameter 10 selection	0: No selection; 1: Selection made	1 character
51	Parameter 10 error	(6) Parameter error code	1 character
52	Parameter 10 data	5 characters including decimal point, right-justified with blanks filled	5 characters
53	Parameter 10 unit	(2) Unit code	1 character
54	Parameter 11 code	(1) Parameter code	2 characters
55	Parameter 11 selection	0: No selection; 1: Selection made	1 character
56	Parameter 11 error	(6) Parameter error code	1 character
57	Parameter 11 data	5 characters including decimal point, right-justified with blanks filled	5 characters
58	Parameter 11 unit	(2) Unit code	1 character
59	Parameter 12 code	(1) Parameter code	2 characters

60	Parameter 12 selection	0: No selection; 1: Selection made	1 character
61	Parameter 12 error	(6) Parameter error code	1 character
62	Parameter 12 data	5 characters including decimal point, right-justified with blanks filled	5 characters
63	Parameter 12 unit	(2) Unit code	1 character
64	Parameter 13 code	(1) Parameter code	2 characters
65	Parameter 13 selection	0: No selection; 1: Selection made	1 character
66	Parameter 13 error	(6) Parameter error code	1 character
67	Parameter 13 data	5 characters including decimal point, right-justified with blanks filled	5 characters
68	Parameter 13 unit	(2) Unit code	1 character
69	Year	00 to 99	2 characters
70	Month	01 to 12	2 characters
71	Day	01 to 31	2 characters
72	Hour	00 to 23	2 characters
73	Minute	00 to 59	2 characters
74	Second	00 to 5	2 characters
75	Longitude (degrees)	00 to 90 or "--" (no GPS data)	2 characters
76	Longitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
77	Longitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
78	Unused		1 character
79	North latitude/South latitude	N: North; S: South	1 character
80	Latitude (degrees)	000 to 180 or "---" (no GPS data)	3 characters
81	Latitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
82	Latitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
83	Unused		1 character
84	East longitude/West longitude	E: East; W: West	1 character
85	Delimiter character		1 character
86	Frame check sequence (FCS)		2 characters

When no data exists, or memory is at capacity)

#	RM	@	XX	[CR]	[LF]
1	2	3	4		

1	Header	1 character
2	Command	2 characters
3	Delimiter character\	1 character
4	Frame check sequence (FCS)	2 characters

Memory data count request

Request command format

#	RN	@	XX	[CR]	[LF]
1	2	3	4		

1	Header	1 character
2	Command	2 characters
3	Delimiter character\	1 character
4	Frame check sequence (FCS)	2 characters

Response format

#	RN	XXXXX	@	XX	[CR]	[LF]
1	2	3	4	5		

1	Header		1 character
2	Command		2 characters
3	Total data count	0 to 10000	5 characters
4	Delimiter character\		1 character
5	Frame check sequence (FCS)		2 characters

Command parse failure response

#	??	X	XX	X	@	XX	[CR]	[LF]
1	2	3	4	5	6	7		

1	Header	1 character
2	Command	2 characters
3	Command parse failure reason*4	1 character
4	Received command*5	2 characters
5	(3) Status code for probe status*5	1 character
6	Delimiter character	1 character
7	Frame check sequence (FCS)	2 characters

*4: List of command parse failure reasons

1: Frame length error
2: FCS mismatch
3: Undefined command
4: Data error
5: Data out of range
6: No "@" delimiter character
7: No "#" header character
8: No [Carriage return] + [Line feed] footer
9: Cannot accept command in this timing.

*5: Only set for command parse failure reason 9, [Cannot accept command in this timing]. Otherwise this field is filled with spaces.

4 Maintenance

Tip

HORIBA recommends regular manufacturer maintenance checks in order to ensure a long product life.

4.1 Routine care

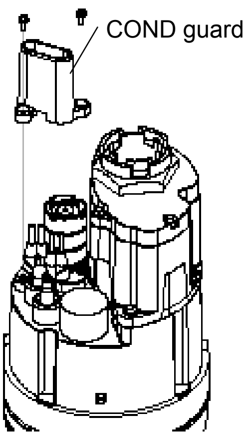
After measurement

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power OFF.**

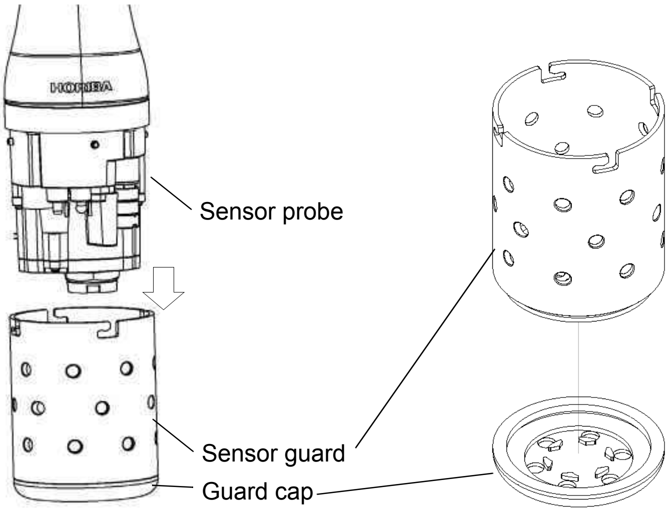
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Remove the sensor guard, and clean the sensor with tap water.**
3. **Clean the turbidity sensor with the cleaning brush provided.**
4. **Remove the two screws securing the COND guard, and the COND guard itself, and use a test tube brush to gently remove any dirt from the electrical conductivity electrode.**



5. **Wipe off any dirt with a soft cloth. If parts are very dirty, clean them with neutral detergent, then rinse them. If parts are contaminated by oil, wipe it off with a soft cloth soaked in alcohol.**
6. **Put the COND guard back in place.**
7. **Remove the sensor guard's guard cap, wash off any dirt with tap water, then put the guard cap back in place.**



4.2 Every 2 months maintenance

● Dissolved oxygen (DO) sensor

Note

- **The DO sensor's internal solution is potassium chloride (KCl). Although KCl is harmless, protective equipment such as gloves and goggles should be worn when working with it.**
- **Internal solution can be disposed of down a sink.**

- Replace the membrane cap.
- Polish the gold and silver electrodes when replacing the membrane cap.
  The gold electrode does not need to be polished if it is not dirty.

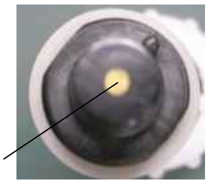
- **Silver electrode**

  Polish a silver electrode part with sandpaper (#500) and then wash metal electrode parts with water.

Silver electrode

- **Gold electrode**

  Polish a gold electrode part with sandpaper (#8000) and then wash metal electrode parts with water.



Gold electrode

Replace a membrane cap after clean metal electrodes parts.

Refer to “ 4.5 Replacing the membrane cap ” (page 87).

- **Reference electrode**

Note

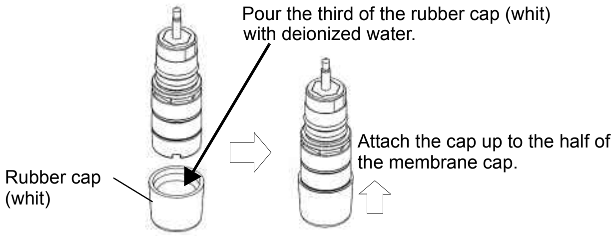
- **The pH reference internal solution is potassium chloride (KCl). Although KCl is harmless, protective equipment such as gloves and goggles should be worn when working with it.**
- **Internal solution can be disposed of down a sink.**

1. **Remove the rubber liquid junction plug from the reference electrode and dispose of the internal solution.**
2. **To prevent air entering, fill the reference electrode to the brim with its internal solution (No. 330).**
3. **Put the rubber liquid junction plug back in place.**

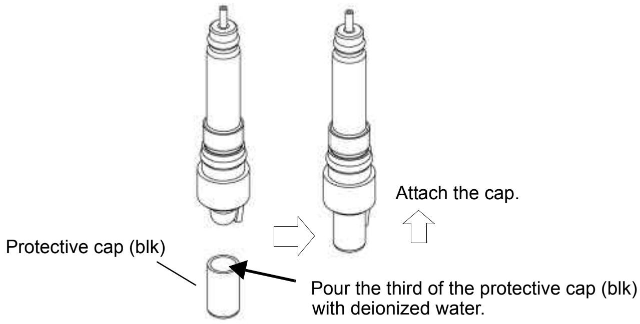
   If the rubber liquid junction plug is dirty, replace the liquid junctions (set of two; No. 9037005100). The reference electrode's internal solution will spill when replacing the liquid junctions. Rinse parts with tap water and dry them with a soft cloth.

4.3 Storage

- **Short-term (under 2 months) storage**
  - Before storing the DO sensor, pour the third of the rubber cap (whit) provided with deionized water and cover the DO sensor with them.



  - Before storing the pH sensor, pour the third of the protective cap (blk) provided with deionized water and cover the pH sensor with them.



Note

Before measuerment, remove the rubber cap (whit) and the protective cap (blk).

- **Long-term (2 months or more) storage**
  - Remove a membrane cap from DO sensor, and wash the gold electrode and silver electrode parts with water. Wipe off the moisture before storing DO sensor in the pack.
  - Prevent internal solution seeping out of the reference chip by taping over the point of seepage with electrical tape.
  - Before storing the system, remove the control unit's batteries to prevent battery leakage.

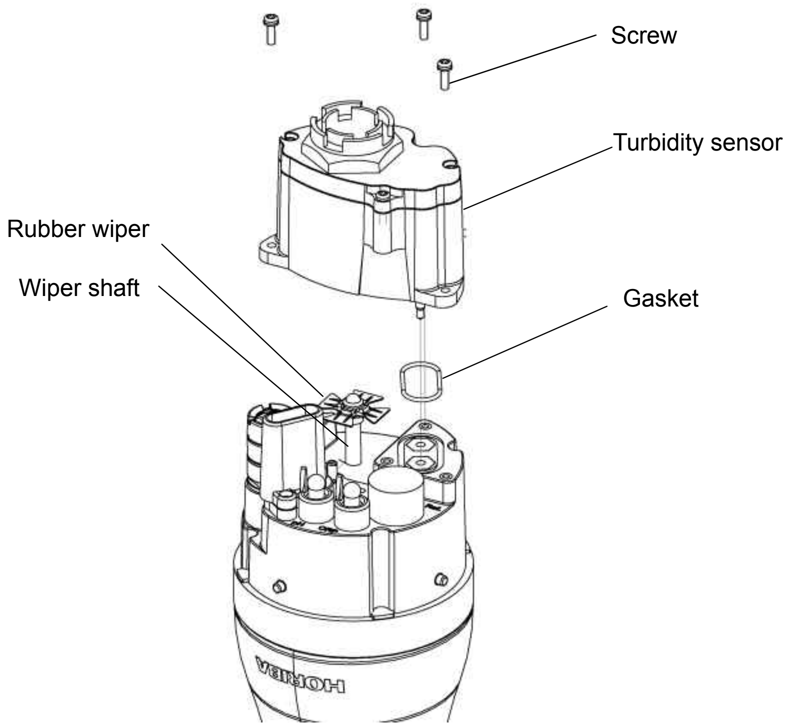
4.4 Replacing the turbidity sensor

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power OFF.**

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Remove the sensor guard, and clean the sensor probe with tap water.**
3. **Use dry air to blow away and dry off any moisture.**
4. **Remove the three screws holding the turbidity sensor by using No. 2 Phillips head screwdriver.**
5. **Pull out the turbidity sensor horizontally.**
6. **Remove the rubber wiper and gasket, and use a soft cloth to wipe off any dirt from the wiper shaft and turbidity sensor attachment. If parts are very dirty, use a soft cloth soaked in neutral detergent or alcohol.**
7. **Replace the rubber wiper and gasket with new ones. Coat the gasket with a thin layer of grease (No. 3014017718).**
8. **Attach the new turbidity sensor and fasten it in place with the three screws.**
9. **Perform four-point calibration before using the sensor.**



4.5 Replacing the membrane cap

● Replacement procedure

1. Prepare the DO sensor.

- Take a DO sensor out of pack (newly purchasing).
- Remove a DO sensor from the sensor probe (after use).

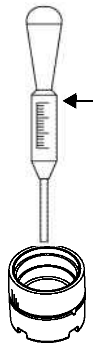

Newly purchasing


Undo a DO sensor from the sensor probe

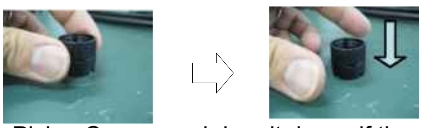
- Twist a membrane cap from DO sensor.
- Wash the gold electrode and silver electrode parts with water.

2. Replace the silicone gasket with a new one.

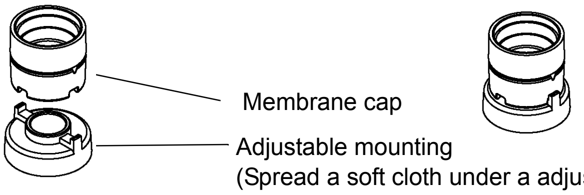
3. Pour internal solution into a membrane cap with a dropper.



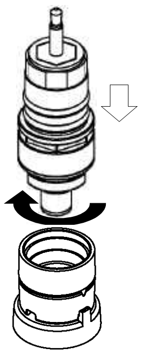
- Check air bubbles in a membrane cap.


Pick a Cap up and drop it down, if there is air bubbles in internal solution of it.

4. Set up a membrane cap on a adjustable mounting.



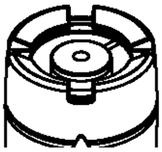
5. **Attach a membrane cap to DO sensor**



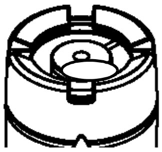
Twist a DO sensor
with holding a membrane cap tight.

6. **Check for membrane surface**

Check air bubbles in a membrane cap.



Good: Limited air bubbles



NG: Air bubbles of more than 5 mm in diameter

● NG → Replace a membrane cap again.
● Check that span calibration can be performed.

If the membrane cap is not attached correctly, sensitivity may be lost or response speed may decrease.

4.6 Troubleshooting

Note

If the sensor probe is removed while the control unit is indicating an error, errors cannot be canceled by using the ESC key. Either reconnect the sensor probe or restart the control unit.

4.6.1 Error displays

Error	Cause	Solution
Probe ADC error	Internal IC failure	Contact your nearest sales outlet to have the sensor probe repaired.
Probe EEPROM error/Factory	Internal IC failure	Turn the power OFF, then restart the system. If the error persists, initialize the system from the "System" menu. If the error still persists, contact your nearest sales outlet to have the sensor probe repaired.
Probe EEPROM error/User	Internal IC failure	Turn the power OFF, then restart the system. If the error persists, initialize the system from the "System" menu. If the error still persists, contact your nearest sales outlet to have the sensor probe repaired.
Turbidity sensor light source error	Turbidity sensor light source failure	Turn the power OFF, wipe off any water droplets on the probe, then remove the turbidity sensor. Check there are no water droplets around the turbidity sensor connector, then mount the sensor again. If the error persists, replace the turbidity sensor.
Turbidity sensor wiper motor error	The turbidity sensor wiper is not operating.	Press the ESC key. Check there are no obstacles near the wiper, then perform the measurement again. If the error persists, the motor will need to be replaced. Contact your nearest sales outlet to have the sensor probe repaired.
Probe capacitor error	Low battery voltage or internal IC failure	Turn the power OFF. Replace the display's batteries. If the error persists, contact your nearest sales outlet to have the sensor probe repaired.
Probe EEPROM error	Internal IC failure	Press the ESC key, then redo the operation. If the error persists, turn the power OFF, then restart the system (the current data will not be saved). If the error still persists, contact your nearest sales outlet to have the display repaired.
Probe board error	Probe board failure	Turn the power OFF. Contact your nearest sales outlet to have the sensor probe repaired.

Error	Cause	Solution
Zero-point calibration error	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	COND sensor 1. There is moisture on the sensor. 2. The sensor is dirty. 3. The COND sensor is broken.	COND sensor 1. Blow-dry the moisture off the sensor. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. There are air bubbles in the internal solution. 2. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the DO sensor.
	Water depth sensor 1. The water depth sensor is dirty. 2. The water depth sensor has failed.	Water depth sensor 1. Clean the water depth sensor. 2. Contact your nearest sales outlet.

Error	Cause	Solution
Span calibration error	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	ORP sensor 1. The ORP standard solution is contaminated. 2. The ORP electrode is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The ORP electrode has failed.	ORP sensor 1. Replace the standard solution with new solution. 2. Clean the ORP electrode. 3. Refil the reference electrode's internal solution. 4. Replace the ORP electrode.
	COND sensor 1. The calibration solution is not correct. 2. The sensor is dirty. 3. The COND sensor has failed.	COND sensor 1. Use the correct calibration solution for calibration. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. The diaphragm is torn. 2. There are air bubbles in the internal solution. 3. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 3. Replace the DO sensor.
	Temperature sensor The temperature sensor has failed.	Temperature sensor Contact your nearest sales outlet.
Calibration stability error	The calibration value of an individual parameter is not stable. 1. The sensor is dirty. 2. The sensor has not adjusted to the standard solution. 3. The temperature was unstable during calibration.	1. Clean the sensor. 2. Fill the transparent calibration cup with pH 4 standard solution, and wait for at least 20 minutes of conditioning before starting calibration. 3. Start calibration after the temperature has stabilized.
Turbidity calibration error	Error in turbidity measurement sequence	Turbidity calibration failed. Redo calibration after removing the displayed error.
Wet check	The cable connector is submerged.	Turn the power OFF and disconnect the cable connector. Wipe or blow-dry off all the water droplets on the probe. If the error persists, contact your nearest sales outlet to have the display and sensor probe repaired.
Power voltage error	The display's power board has failed.	This error could also be caused by poor cable contact. Turn the power OFF and disconnect the cable connector. Reconnect the connector and turn the power ON. If the error persists, contact your nearest sales outlet to have the display and sensor probe repaired.
Turbidity lamp power voltage error	The remaining battery level is low.	Turn the power OFF and replace the display's batteries with new ones.

Error	Cause	Solution
Display RTC error	The time display is incorrect.	Replace the coin battery.
Display FROM error	Internal IC failure	Contact your nearest sales outlet to have the control unit repaired.
Display EEPROM error	Internal IC failure	Contact your nearest sales outlet to have the control unit repaired.
Display save error	Insufficient memory space	Move data from the display, use the data operations screen to delete data, then redo the measurement.
Measurement sequence error	● When the measurement item is turbidity 1. The battery power is low. 2. The wiper is not operating normally. 3. The light source lamp is not lit. ● If items other than turbidity are also displayed 4. Board failure	1. Replace the batteries with new ones. 2. Check there are no obstacles near the wiper, then redo the measurement. If the error persists, the motor will need to be replaced. Contact your nearest sales outlet to have the sensor probe repaired. 3. Wipe off any water droplets on the probe, then remove the turbidity sensor. Check there are no water droplets around the turbidity sensor connector, then mount the sensor again. If the error persists, replace the turbidity sensor. 4. Contact your nearest sales outlet to have the sensor probe repaired.
Out of measurement range	The attempted measurement is outside the measurement range supported for that item.	The system must be used within its supported measurement ranges.
Last zero-point calibration invalid	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	COND sensor 1. There is moisture on the sensor. 2. The sensor is dirty. 3. The COND sensor has failed.	COND sensor 1. Blow-dry the moisture off the sensor. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. There are air bubbles in the internal solution. 2. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the DO sensor.
	Water depth sensor 1. The water depth sensor is dirty. 2. The water depth sensor has failed.	Water depth sensor 1. Clean the water depth sensor. 2. Contact your nearest sales outlet.
Out of measurement range Last zero-point calibration invalid	[See above.]	[See above.]

Error	Cause	Solution
Last span calibration invalid	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	ORP sensor 1. The ORP standard solution is contaminated. 2. The ORP electrode is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The ORP sensor glass is broken.	ORP sensor 1. Replace the standard solution with new solution. 2. Clean the ORP electrode. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	COND sensor 1. The calibration solution is not correct. 2. The sensor is dirty. 3. The COND sensor has failed.	COND sensor 1. Use the correct calibration solution for calibration. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. The diaphragm is torn. 2. There are air bubbles in the internal solution. 3. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 3. Replace the DO sensor.
	Temperature sensor ● The temperature sensor has failed.	Temperature sensor ● Contact your nearest sales outlet.
Out of measurement range Last zero-point calibration invalid	[See above.]	[See above.]
Last span calibration invalid	The calibration value of an individual parameter is not stable. 1. The sensor is dirty. 2. The sensor has not adjusted to the standard solution. 3. The temperature was unstable during calibration.	1. Clean the sensors. 2. Fill the transparent calibration cup with pH 4 standard solution, and wait for at least 20 minutes of conditioning before starting calibration. 3. Start calibration after the temperature has stabilized.
Out of measurement range Last zero-point calibration invalid	[See above.]	[See above.]
Calibration value is factory default value.	Internal IC failure	Turn the power OFF, then restart the system. If the error persists, initialize the system from the "System" menu. If the error still persists, contact your nearest sales outlet to have the sensor probe repaired.

Error	Cause	Solution
Sample is unstable.	1. The concentration of the sample is unstable. 2. External light disturbance has affected the sensor. 3. Water has entered the turbidity sensor's connector.	1. Use a stirrer to agitate the sample during measurement. 2. Perform measurement away from direct sunlight. 3. Turn the power OFF, wipe off any water droplets on the probe, then remove the turbidity sensor. Check there are no water droplets around the turbidity sensor connector, then mount the sensor again. If the error persists, replace the turbidity sensor.

4.6.2 Error displays in sensor information

Error display	Cause	Solution
Measurement sequence error	Measurement sequence error	Turn the power OFF, then restart the system. If the error persists, have the probe repaired.
Out of measurement range	The measurement value is outside the measurement range.	Samples for measurement must be within the measurement range.
Last calibration invalid	The last calibration failed.	Redo calibration.
Calibration invalid	The calibration value is the factory default value.	Redo calibration.
Background unstable	The U-53 turbidity sensor is exposed to direct light.	Mount the guard cap and sensor guard and perform measurement away from direct sunlight.
	The turbidity value changed rapidly during measurement.	Measure a sample that has stable turbidity.

5 Specifications

Specification		Basic value	Model				
			U-51	U-52	U-52G	U-53	U-53G
Sensor probe	Measurement temperature range	−10°C to 55°C	✓	✓	✓	✓	✓
	Maximum sensor outer diameter	Approx. 96 mm					
	Sensor length	Approx. 340 mm					
	Cable length	2 m (standard) 10 m/30 m (options)					
	Mass	Approx. 1800 g					
	Auto calibration function	Uses pH 4 standard solution.					
	Measurement depth	30 m max.	✓	✓	✓	✓	✓
	Wet-part materials[*3]	PPS, glass, SUS316L, SUS304, FKM, PEEK, Q, titanium, FEP membrane, POM					
	Waterproofing standard	IP-68					
Control unit	Outer dimensions (W × D × H)	115 × 66 × 283 mm	✓	✓	—	✓	—
		115 × 66 × 335 mm	—	—	✓	—	✓
	Mass	Approx. 800 g	✓	✓	✓	✓	✓
	LCD	320 × 240 mm graphic LCD (monochrome) with backlight	✓	✓	✓	✓	✓
	Memory data items	10000	✓	✓	✓	✓	✓
	Communication interface	USB peripheral	✓	✓	✓	✓	✓
	Batteries	C-size dry cells (×4)	✓	✓	✓	✓	✓
	Waterproofing standard	IP-67	✓	✓	✓	✓	✓
	GPS unit	● Reception method (12 channel parallel) ● Measurement precision [With PDOP (high precision): 30 m or less (2 drms)]	—	—	✓	—	✓
	Estimated battery life[*1]	—	70 hours (no backlight)			500 measurements (no backlight)	
	Storage temperature range	−10°C to 60°C	✓	✓	✓	✓	✓
	Ambient temperature range	−5°C to 45°C					

Specification		Basic value	Model				
			U-51	U-52	U-52G	U-53	U-53G
pH measurement Two calibration	Measurement method	Glass electrode method	✓	✓	✓	✓	✓
	Range	pH 0 to 14					
	Resolution	0.01 pH					
	Precision*2	±0.1 pH					
Dissolved oxygen measurement ● Salinity conversion (0 to 70 PPT, automatic) ● Automatic temperature compensation	Measurement method	Polarographic method	✓	✓	✓	✓	✓
	Film thickness	25 μm					
	Range	0 mg/L to 50.0 mg/L					
	Resolution	0.01 mg/L					
	Precision*2	0 mg/L to 20 mg/L: ±0.2 mg/L 20 mg/L to 50 mg/L: ±0.5 mg/L					
Electrical conductivity measurement ● Auto range ● Automatic temperature conversion (25°C)	Measurement method	Four-AC-electrode method	✓	✓	✓	✓	✓
	Range	0 S/m to 10 S/m (0 mS/cm to 100 mS/cm)					
	Resolution	0.000 mS/cm to 0.999 mS/cm: 0.001 1.00 mS/cm to 9.99 mS/cm: 0.01 10.0 mS/cm to 99.9 mS/cm: 0.1 0.0 mS/m to 99.9 mS/m: 0.1 0.100 S/m to 0.999 S/m: 0.001 1.00 S/m to 9.99 S/m: 0.01					
	Precision*2	1% of full-scale (midpoint of two calibration points)					
Salinity measurement	Measurement method	Electrical conductivity conversion	✓	✓	✓	✓	✓
	Range	0 PPT to 70 PPT (parts per thousand)					
	Resolution	0.1 PPT					
	Precision	±3 PPT					
TDS (total dissolved solid) measurement ● Conversion coefficient setting	Measurement method	Electrical conductivity conversion	✓	✓	✓	✓	✓
	Range	0 g/L to 100 g/L					
	Resolution	0.1% of full-scale					
	Repeatability	±2 g/L					
	Precision	±5 g/L					
Seawater specific gravity measurement ● σt, σ0, σ15 display	Measurement method	Electrical conductivity conversion	✓	✓	✓	✓	✓
	Range	0 σt to 50 σt					
	Resolution	0.1 σt					
	Precision	±5 σt					

Specification		Basic value	Model U-51	U-52	U-52G	U-53	U-53G
Temperature measurement	Measurement method	Platinum temperature sensor	✓	✓	✓	✓	✓
	Range	−10°C to 55°C					
	Resolution	0.01°C					
	Sensor	Platinum temperature sensor, JIS Class B (0.3 + 0.005 |t|)					
Turbidity measurement	Measurement method		–	LED forward 30° transmission/ scattering method		Tungsten lamp 90° transmission scattering method	
	Range			0 NTU to 800 NTU		0 NTU to 1000 NTU	
	Resolution			0.1 NTU		0.01 NTU	
	Precision*2			±5%of readout or ±1 NTU, whichever is larger		● ±0.5NTU (for 0 NTU to 10 NTU measurement range) ● 3% of readout or 1 NTU, whichever is larger (for 10 NTU to 1000 NTU measurement range)	
	Turbidity sensor wiper			–		✓	
Water depth measurement	Measurement method	Pressure method	–	–	✓	✓	✓
	Range	0 m to 30 m					
	Resolution	0.05 m					
	Precision*2	±0.3 m					
ORP (oxidation reduction potential) measurement	Measurement method	Platinum electrode method	✓	✓	✓	✓	✓
	Range	−2000 ~ +2000 mV					
	Resolution	1 mV					
	Precision*2	±15 mV					

*1: Battery life is estimated under following conditions.
- Continuous operation
- Using batteries: C-size alkaline dry cells
- Ambient temperature of the control unit: 20°C or more
- Backlight off

*2: The precision is defined by measuring the standard solution in the following cases.
- Turbidity and conductivity: after four point calibration
- pH and DO: after two point calibration
- Water depth and ORP: after one point calibration

*3: Metallic parts are made of stainless steel. Immersing in seawater may erode metallic parts.

6 Reference

6.1 Consumable parts

● Sensor

Name	Model	No.	Description
pH sensor	#7112	3014057312	Standard type pH sensor
pH sensor ToupH	#7113	3200170923	Tough glass type pH sensor
ORP sensor	#7313	3200170920	
DO sensor	#7543	3200170924	
Reference electrode	#7210	3200043582	
R bush unit	—	3200043587	Reference electrode liquid junction
TURB cell U-52	#7800	3200172803	For U-52/U-52G
TURB cell U-53	#7801	3200172800	For U-53/U-53G
Membrane cap	—	3200170194	For DO sensor

● Standard solution and inner solution

Name	Model	No.	Description
pH 4 (For automatic calibration) 500 mL	#100-4	3200043638	Standard solution for auto calibration. Also used for manual pH span calibration.
pH 4 (For automatic calibration) 4 L	#140-4	3200174430	
pH 7 500 mL	#100-7	3200043637	Standard solution for pH zero-point calibration.
pH 9 500 mL	#100-9	3200043636	Standard solution for pH manual span calibration.
Powder for ORP standard solution 10 packs	#160-51	3200043618	For ORP calibration.
Powder for ORP standard solution 10 packs	#160-22	3200043617	
Inner solution for DO sensor, 50 mL	#306	3200170938	Internal solution for DO sensor.
Internal solution for pH, 250 mL	#330	3200043641	Supplementary internal solution for pH reference electrode.

Others

Name	Model	No.	Description
Silicone grease	—	3014017718	Silicone grease for coating sensor O-ring.
Sponge brush unit	—	3200169531	Brush for cleaning sensor probe.
O-ring set for reference electrode	—	3200169376	O-rings for reference electrode.
O-ring set for DO sensor	—	3200169426	O-rings for DO sensor.
Rubber cap set for sensor guard	—	3200169428	Rubber caps used between sensor guard and sensor probe.
O-ring set for pH and ORP sensor	—	3200169520	O-rings for pH and ORP sensors.
Wiper unit	—	3200169789	Rubber wiper for U-53/U-53G turbidity sensors.
Protective cap (blk) for pH sensor	—	3200175019	Cap attached to tip of pH sensor for sensor probe storage.
Rubber cap (whit) for DO sensor	—	3200175020	Cap attached to tip of DO sensor for sensor probe storage.

6.2 Options sold separately

Name	Model	No.	Description
Bag	U-5030	3200174772	Storage bag for sensor probes and flow cell. Can be carried in one hand.
Flow cell assy	—	3200156570	Used when collecting measurement samples by pump.
Probe guard	—	3200167002	Used for taking measurements in locations where there is a current or where there is a thick layer of sludge.
Communication cable	—	3200174823	A PC connection cable. Comes with data collection software.

6.3 pH measurement

6.3.1 Principle of pH measurement

U-50 series use the glass electrode method for pH measurements. The glass electrode method measures a potential difference between the glass film for pH and the reference electrode. For more information, refer to “JIS Z 8802 pH measurement method”.

6.3.2 Temperature compensation

The electromotive force generated by the glass electrode changes depending on the temperature of the solution.

Temperature compensation is used to compensate for the change in electromotive force caused by temperature.

This function does not compensate the change in pH caused by the temperature of the solution. When pH is to be measured, the temperature of the solution must be recorded along with that pH value, even if a pH meter has automatic temperature compensation function. If the solution temperature is not recorded, the results of the pH measurement may be meaningless.

6.3.3 Standard solutions

When measuring pH, the pH meter must be calibrated using standard solution. There are five kinds of standard solutions specified in “JIS Z 8802 pH measurement”. For normal measurement, two of standard solutions with pH of 4, 7, and 9 are sufficient to accurately calibrate the meter.

For standard solutions, refer to “JIS Z 8802 pH measurement”.

pH 4 standard solution: (Phthalate) — 0.05 mol/L potassium hydrogen phthalate aqueous solution

pH 7 standard solutio: (Neutral phosphate) — 0.025 mol/L potassium dihydrogenphosphate, 0.025 mol/L disodium hydrogenphosphate aqueous solution

pH 9 standard solution: (Borate) — 0.01 mol/L sodium tetraborate aqueous solution

Table 2 pH values of pH standard solutions at various temperatures settings

Temp. (℃)	pH 4 standard solution Phthalate	pH 7 standard solution Neutral phosphate	pH 9 standard solution Borate
0	4.01	6.98	9.46
5	4.01	6.95	9.39
10	4.00	6.92	9.33
15	4.00	6.90	9.27
20	4.00	6.88	9.22
25	4.01	6.86	9.18
30	4.01	6.85	9.14
35	4.02	6.84	9.10
40	4.03	6.84	9.07
45	4.04	6.84	9.04

6.4 DO measurement

6.4.1 Principle of DO measurement

Dissolved oxygen (DO) refers to the amount of oxygen that is contained in water.
The concentration of dissolved oxygen is generally given as mg/L or as a percentage value (the dissolved oxygen saturation ratio).
Dissolved oxygen is essential for maintaining the self-purifying ability of rivers and seas and also for fish to live. The concentration of dissolved oxygen acts as an indicator of water quality. It is often measured when processing waste water and managing water quality. Fig. 1 provides an overview of the principles behind dissolved oxygen sensor measurement.

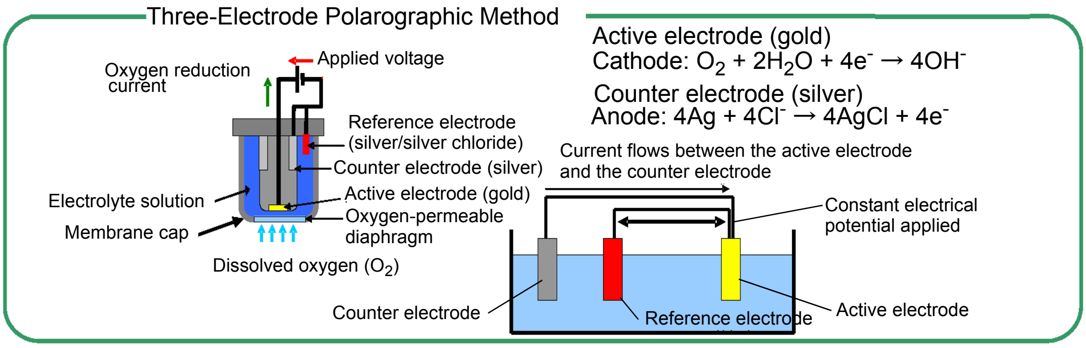


Fig. 1 Overview of principles behind dissolved oxygen sensor

The polarographic oxygen sensor is an enclosed sensor wherein voltage is applied to a cathode made of a precious metal (such as gold or platinum) and an anode also made of a precious metal (such as silver) via an external circuit, and a cap with an oxygen permeable diaphragm (membrane) is filled with electrolyte solution. As indicated in Fig. 1, the concentration of dissolved oxygen can be measured by measuring the current proportional to the amount of reduced oxygen when oxygen that has dispersed through the oxygen permeable diaphragm produces a reductive reaction on the surface of the active electrode (gold). The method of measuring dissolved oxygen based on the above principle is called the Membrane Electrode Method. Compared to the Chemical Analysis Method, which requires complicated pre-processing to alleviate the effect of reduced materials and oxidizing materials, this method allows dissolved oxygen to be measured very easily. It is also easy to remove undesired buildup from the silver electrode by polishing and cleaning if an insulator forms on it due to oxidation, making the method reusable.

6.4.2 Salinity calibration

When the solution and air come into contact and form an equilibrium (i.e. saturation), the relationship between the concentration of dissolved oxygen in the solution, C, [mol/L], and the partial pressure of oxygen in the air, Ps, [MPa/(mg/L)], can be represented by the following formula:

$C = Ps/H$

Where H [MPa/(mg/L)] is the Henry constant, a value that changes according to the composition of the solution. As H typically becomes larger as the salinity of the water increases, C becomes smaller.

The DO sensor detects the partial pressure of oxygen (Ps) in the above formula. Accordingly, if the DO sensor is immersed in deionized water saturated with air, or in an aqueous solution containing salt, the output current does not change, resulting in an erroneous measurement. For example, when salt is added to a sample, the amount of oxygen that can be dissolved in the solution decreases, but because the partial pressure of oxygen does not change, the value displayed by the control unit stays the same regardless of salt content. This concept is indicated in graph form below. (Fig. 2)

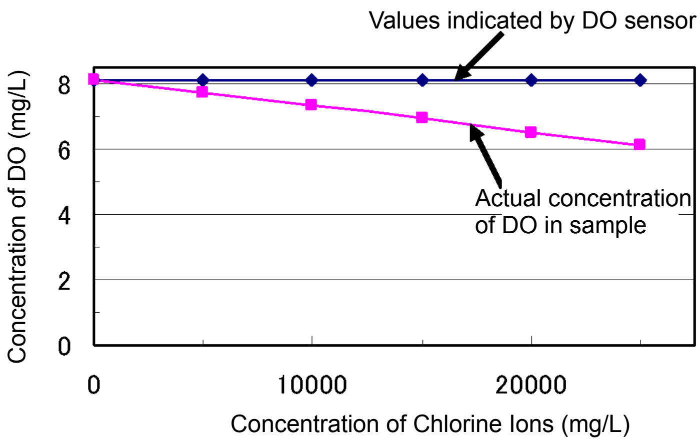


Fig. 2 Relationship between chlorine ion concentration and dissolved oxygen concentration

In samples with a high salt concentration, the solubility of oxygen is lower, but as the partial pressure of oxygen does not change, the value actually indicated on the control unit is higher than the actual value. In order to obtain a measurement of the concentration of dissolved oxygen in an aqueous solution that contains salt, it is therefore necessary to first perform salinity compensation. Conventionally, dissolved oxygen sensors have performed salinity compensation by inputting the salinity of the sample. This is fine as long as the salinity is already known. However, in most cases salinity is unknown, so even if dissolved oxygen sensors contained a salinity compensation function, it was of no practical use.

The U-50 Series can calculate and measure salinity in samples from electrical conductivity values, and can thus be used to automatically compensate for salinity.

6.5 Conductivity (COND) measurement

6.5.1 Four-AC-electrode method

Conductivity is an index of the flow of electrical current in a substance.

Salts dissolved in water are separated into cations and anions. Such solution is called electrolytic solution.

Electrolytic solution has the property of allowing the flow of current according to Ohm's law. This property is referred

to as ionic conductivity, since current flow is caused by ion movement in electrolytic solution.

Metals, on the other hand, allow the flow of current by means of electrons. This property is called electronic conductivity,

which is distinguished from ionic conductivity.

A cube with 1 m on each side, as shown in Fig. 3, is used to demonstrate an electrolytic solution. Two electrode plates are placed on opposite sides, and the cube is filled with solution. If the resistance between these two electrode plates is represented by r(Ω), the conductivity of the solution L($S \cdot m^{-1}$) is represented as L=1/r. S stands for Siemens, a unit of measurement of conductance.

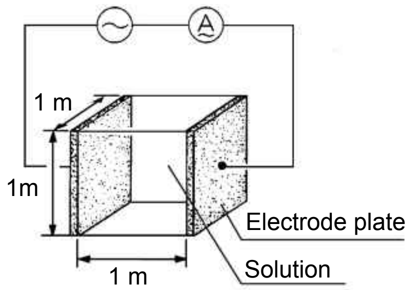


Fig. 3 Definition of conductivity

The most general method for measuring conductivity is based on the above principle, and is called the 2-electrode method.

In the 2-electrode method the influence of polarization cannot be ignored for solutions with high conductivity and conductivity cannot be measure accurately. In addition, contamination on the surface of the electrode increases apparent resistance, resulting in inaccurate measurement of conductivity.

The U-50 series has adopted the 4-electrode method to overcome these disadvantages of the the 2-electrode method.

As shown in Fig. 4, the U-50 series uses two voltage-detecting electrodes and two voltage-applying electrodes, for a total of four electrodes. The voltage-detecting electrodes are for detecting AC voltage, and the voltage-applying electrodes are for applying AC voltage.

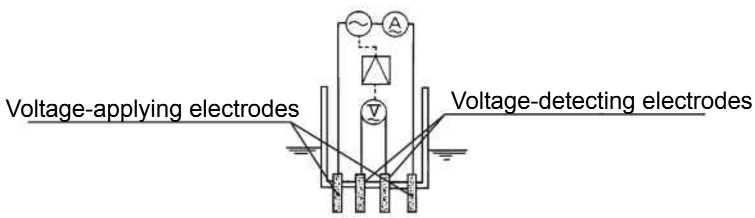


Fig. 4 Principle of the 4-electrode method

Let us assume that the current, I(A), flows in a sample of conductivity L – under automatic control of the voltage-applying electrodes – so that the voltage at the voltage-detecting-electrodes, E(V), remains constant at all times.

Then, the resistance of the sample, R(Ω), across the voltage-detecting electrodes is represented as R=E/I. The resistance, R, of the sample is inversely proportional to its conductivity, L. Accordingly, a measurement of current, Is,

of a standard solution of known conductivity, Ls, enables calculation of conductivity of a sample according to the formula L = Ls (I/Is) from the ratio L : Ls = I : Is.

Even in the 4-electrode method, polarization occurs, since AC current flows in the voltage-applying electrodes. The voltage-detecting electrodes are, however, free from the effects of polarization, since they are separated from the voltage-applying electrodes, and furthermore, current flow is negligible. Therefore, the 4-electrode method is an excellent method to enable measurement of conductivity covering a very high range.

6.5.2 SI units

New measurement units, called SI units, have been in use from 1996. Accordingly, the U-50 series also uses SI units. The following conversion table is provided for people who use the conventional kind of conductivity meter.

Note that along with the change in unit systems, the measurement values and cell counts have also changed.

	Former units	→	SI unit
Measurement value	0.1 mS/cm 1 mS/cm 100 mS/cm	→ → →	0.01 S/m 0.1 S/m 10 S/m

6.5.3 Temperature coefficient

In general, the conductivity of a solution varies largely with its temperature.

The conductivity of a solution depends on the ionic conductivity, described earlier. As the temperature rises, conductivity becomes higher since the movement of the ions becomes more active.

The temperature coefficient shows the change in % of conductivity per °C, with a certain temperature taken as the reference temperature. This is expressed in units of %/°C. The temperature coefficient assumes the premise that the conductivity of a sample changes linearly according to temperature.

Strictly speaking, with actual samples, however, conductivity changes along a curve. Furthermore, the cuve varies with the type of sample. In the ranges of smaller temperature changes, however, samples are said to have the temperature coefficient of 2%/°C (at reference temperature 25°C); this holds for most samples, except in certain special cases.

(The temperature coefficients for various types of solutions are listed on the next page.)

The U-50 series uses an automatic temperature conversion function to calculate conductivity at 25°C at a temperature

coefficient of 2 %/°C based on the measured value of the temperature. Results are displayed on the readout.

The U-50 series's temperature conversion function is based on the following formula.

$L_{25} = L_t / \{ 1 + K (t - 25) \}$

L_{25} : Conductivity of solution converted to 25°C

t : Temperature of solution at time of measurement (°C)

L_t : Conductivity of solution at t (°C)

K : Temperature coefficient (%/°C)

Conductivity and temperature coefficient for various solutions

Conductivity and related temperature coefficients of representative substances (at 25°C) are shown in the table below.

Substance	Temp. (ºC)	Conc. (wt%)	Cond. (S/m)	Temp.coef. (%/°C)	Substance	Temp. (ºC)	Conc. (wt%)	Cond. (S/m)	Temp.coef. (%/°C)
NaOH	15	5	19.69	2.01	NaCl	18	5	6.72	2.17
		10	31.24	2.17			10	12.11	2.14
		15	34.63	2.49			15	16.42	2.12
		20	32.70	2.99			20	19.57	2.16
		30	20.22	4.50			25	21.35	2.27
		40	11.64	6.48	Na_2SO_4	18	5	4.09	2.36
KOH	15	25.2	54.03	2.09			10	6.87	2.49
		29.4	54.34	2.21			15	8.86	2.56
		33.6	52.21	2.36	Na_2CO_3	18	5	4.56	2.52
		42	42.12	2.83			10	7.05	2.71
NH_3	15	0.1	0.0251	2.46			15	8.36	2.94
		1.6	0.0867	2.38	KCl	18	5	6.90	2.01
		4.01	0.1095	2.50			10	13.59	1.88
		8.03	0.1038	2.62			15	20.20	1.79
		16.15	0.0632	3.01			20	26.77	1.68
HF	18	1.5	1.98	7.20			21	28.10	1.66
		4.8	5.93	6.66	KBr	15	5	4.65	2.06
		24.5	28.32	5.83			10	9.28	1.94
HCl	18	5	39.48	1.58			20	19.07	1.77
		10	63.02	1.56	KCN	15	3.25	5.07	2.07
		20	76.15	1.54			6.5	10.26	1.93
		30	66.20	1.52			—	—	—
H_2S0_4	18	5	20.85	1.21	NH_4Cl	18	5	9.18	1.98
		10	39.15	1.28			10	17.76	1.86
		20	65.27	1.45			15	25.86	1.71
		40	68.00	1.78			20	33.65	1.61
		50	54.05	1.93			25	40.25	1.54
		60	37.26	2.13	NH_4NO_3	15	5	5.90	2.03
		80	11.05	3.49			10	11.17	1.94
		100.14	1.87	0.30			30	28.41	1.68
		—	—	—			50	36.22	1.56
HNO_3	18	6.2	31.23	1.47	$CuSO_4$	18	2.5	10.90	2.13
		12.4	54.18	1.42			5	18.90	2.16
		31	78.19	1.39			10	32.00	2.18
		49.6	63.41	1.57			15	42.10	2.31
		62	49.64	1.57	CH_3COOH	18	10	15.26	1.69
H_3PO_4	15	10	5.66	1.04			15	16.19	1.74
		20	11.29	1.14			20	16.05	1.79
		40	20.70	1.50			30	14.01	1.86
		45	20.87	1.61			40	10.81	1.96
		50	20.73	1.74			60	4.56	2.06

6.6 Salinity (SAL) conversion

The U-50 series is designed to calculate salinity as well as the other parameters.

Note that the “salinity” here is the salinity of sea water. There is a constant relation between conductivity and salinity at certain temperatures.

Therefore, if data on the conductivity and temperature are available, the corresponding salinity can be known. In other words, the salinity measurement of the U-50 series is based on the principle of calculating the salt content, making use of the measured values of conductivity and temperature.

Note therefore, that measured results of all substances whose conductivity is detected are displayed as salinity. For example, the measured result is displayed as NaCl concentration, even if in fact the sample component is, hydrochloric acid (HCl).

6.7 TDS conversion

TDS is short for Total Dissolved Solids and means the total dissolved solid amount.

The conductivity of a solution is affected by the amount of salinity, minerals, and dissolved gases. That is, conductivity is an index that shows the total amount of all substances in the solution. Of these substances, TDS indicates only the amount of dissolved solids.

TDS can be used for a comparison of the state of substances composed of a single component such as NaCl. However, the use of TDS for the comparison of solutions of different types causes serious errors.

Conductivity and TDS are expressed by the following formulas.

Conductivity in SI units (S/m) .... TDS(g/L) = L (S/m) $\times$ K $\times$ 10

TDS(g/L) = L (mS/m) $\times$ K $\div$ 100

Conductivity in the old units (mS/cm) .... TDS(g/L) = L (mS/cm)$\times$ K

K = TDS coefficient

Initial settings use the values listed in the table (Page 80) that generally uses TDS coefficients.

For accurate TDS comparisons, find the TDS coefficient from measured conductivity values. Then set the value thus obtained and make measurements.

6.8 σt conversion

● Specific gravity of seawater

The density and specific gravity of seawater are equal numerically and generally are not distinguished strictly. Since seawater density ρ is between 1.000 and 1.031, 1 is subtracted from ρ and σ is obtained by multiplying the value by 1000.

The resultant value is used as the specific gravity of seawater.

$\sigma = (\rho - 1) \times 1000$

The density of seawater ρ is expressed by function of temperature, hydraulic pressure, and salinity. The density of seawater under the atmospheric pressure is expressed as σ_t. The density of seawater under the atmospheric pressure is determined by temperature and salinity.

The U-50 Series models make salinity measurement through temperature measurements and conductivity conversion and find σ_t through calculations.

In Japan σ_{15} at 15°C is called a standard specific gravity and widely used while in foreign countries σ_0 at 0°C is employed. σ_{15} and σ_0 are determined by the function of salinity.

In ocean surveys, in particular, these values σ_t, σ_{15}, and σ_0 are more widely used than conductivity and salinity and, in the U-50 Series models, newly added as measurement components.

6.9 Turbidity (TURB) measurement

6.9.1 Principle of turbidity measurement

U-52 and U-53 sensors measure turbidity using the Transmitting and Scattering Method shown in Fig. 5. U-52 sensors use a pulse light LED (infra-red emitting diode) as a light source, and detect scattered light from a 30° angle off center. U-53 sensors use a tungsten lamp as a light source and detect scattered light from a 90° angle. Both models display turbidity as a ratio of scattered light to transmitted light to reduce the affect of the color of the sample. The U-53 method conforms to EPA Method 180.1, and employs wipers to reduce the affect of air bubbles.

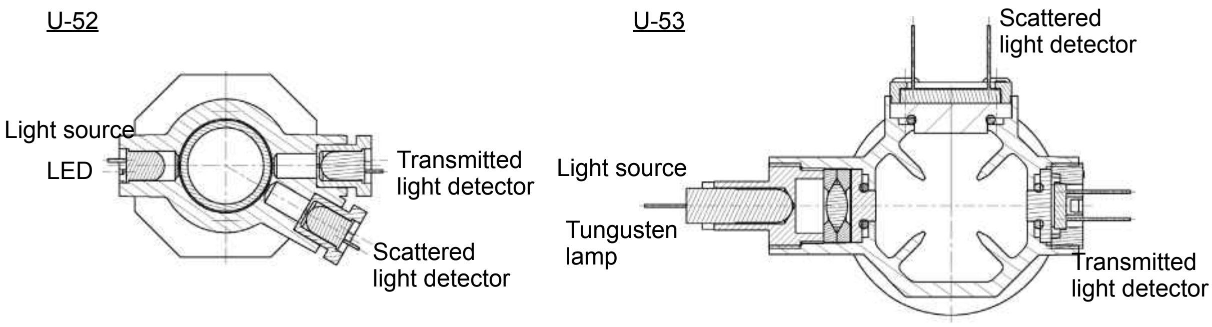


Fig. 5 Turbidity cell

6.9.2 Standard solution

U-50 series can perform calibration using formazin (NTU) or kaolin standard solutions as a turbidity standard solution. However, units for the solution used for calibration should be displayed in measurements. Do not use more than 400 mg/L of kaolin standard solution because it increases precipitation speed, resulting in measurement error.

6.10 Depth (DEPTH) measurement

6.10.1 Principle of depth measurement

For the W-22XD and W-23XD models, depth measurement can be made through use of a pressure gauge. The principle of the depth measurement uses the relation between depth and pressure.

Although the measurement with the depth sensor is affected by atmospheric pressure, the depth sensor, however, makes zero-point adjustments through the automatic calibration before measurements.

6.10.2 Influence of temperature and calibration

The depth sensor depends greatly on temperature. For a wide difference between the temperature at which the sensor has been automatically calibrated and the temperature of the measurement sample, the sensor can make depth measurements with a higher accuracy by the following method:

1. **Immerse the depth sensor of the sensor probe in the sample.**
2. **Keep the sensor immersed in the sample for about 30 minutes until the temperatures of the sensor and the sample are the same.**
3. **Then make the zero calibration of the sensor manually.**

6.11 Oxidation reduction potential (ORP) measurement

6.11.1 Principle of ORP measurement

ORP is an abbreviation for oxidation-reduction potential. ORP is the energy level (potential) determined according to the state of equilibrium between the oxidants (M^{Z+}) and reductants $M^{(Z-N)+}$ that coexist within a solution.

$$M^{Z+} + ne^{-} \Leftrightarrow M^{(Z-N)+} \qquad \cdots (1)$$

If only the solution, forming the ORP measuring system shown in Fig. 6. The difference of potential between two electrodes is generally expressed by the following equation.

$$E = E_0 - \frac{RT}{nF} \ln \frac{a_M{}^{(z-n)+}}{a_M{}^{z+}} \qquad \cdots (2)$$

E: Electric potential E_0 : Constant R: Gas constant T : Absolute temperature
n: Electron count F : Faraday constant a : Activity

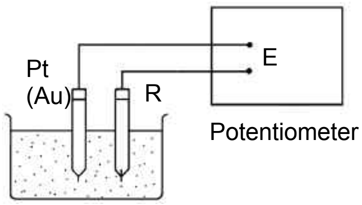


Fig. 6 Measuring mV

For example, for a solution in which trivalent iron ions coexist with bivalent iron ions, equations 1 and 2 would be as follows.

$$Fe^{3+} + e^{-} \Leftrightarrow Fe^{2+} \qquad \cdots (1)$$

$$E = E_0 - \frac{RT}{F} \ln \frac{a_{Fe}{}^{2+}}{a_{Fe}{}^{3+}} \qquad \cdots (2)$$

When only one type of state of equilibrium uniquely by equation (Fe^{3+}) and the reductant (Fe^{2+}) (using the equation $a_{Fe}{}^{2+}/ a_{Fe}{}^{3+}$). Actually, however many kinds of states of equilibrium exist simultaneously between various kinds of ions, in most solutions. This means that under actual circumstances, ORP cannot be expressed using the simple equation shown above and that the physical and chemical significance with respect to the solution is not very clear.

In this respect, the value of ORP must be understood to be only one indicator of the property of a solution. The measurement of ORP is widely used, however, as an important index in the analysis of solutions (potentiometric titration) and in the waste water treatment.

6.11.2 Standard electrode (reference electrode) types and ORP

The ORP is obtained comparing with corresponding reference electrode employed.

If different kinds of reference electrodes are used for measurement, the ORP value of the same solution may appear to be different. HORIBA's reference electrode uses Ag/AgCl with 3.33 mol/L KCl as inner solution. According to general technical literature, normal hydrogen electrodes (N.H.E.) are often used as the standard electrode.

The relationship between N.H.E. and the ORP that is measured using an Ag/AgCl with 3.33 mol/L KCl electrode is expressed by the following equation.

$E_{N.H.E.} = E + 206 - 0.7(t - 25)$ mV t = 0 - 60°C

$E_{N.H.E.}$: Measured ORP value using N.H.E. as the reference electrode

E: Measured ORP value using Ag/AgCl with 3.33 mol/L KCl as the reference electrode
Potential sign

Standard ORP is expressed in the following way, in literature related to electrochemistry and analytical chemistry.

A $Li^+ + e^- \rightarrow Li$
$E_0 = -3.024$ V VS N.H.E.

However, in some literature, the "+" and "-" signs are reversed.

B $Li \rightarrow Li^+ + e^-$
$E_0 = +3.024$ V VS N.H.E.

In expressions like B, above, the reaction is just reversed and there is no essential difference. But this kind of expression does invite confusion. The majority of the world, today, is consistent in its use of the signs as they are used in A, above.

For this reason, HORIBA, too, uses signs concerning ORP that are consistent with A, above.

HORIBA, Ltd.
2 Miyanohigashi, Kisshoin Minami-ku, Kyoto 601-8510 Japan
http://www.horiba.com

image/CE.tif @ 300 dpi 3
image/WEEE_and_Batteries.tif 3
image/W_Danger.tif @ 1200 dpi 4
image/W_Warning.tif @ 1200 dpi 4
image/W_Caution.tif @ 1200 dpi 4
image/W_ 強制 .tif @ 1200 dpi 4
image/W_ 禁止 .tif @ 1200 dpi 4
image/u53_probe.tif 6
image/controller_connector.tif @ 600 dpi 6
image/controller_connector.tif @ 600 dpi 6
image/controller_battery_lid2.tif 7
image/front-view.tif 4
image/back-view.tif 4
image/u51_probe.tif @ 600 dpi 4
image/u52_probe.tif @ 600 dpi 5
image/u53_probe.tif @ 600 dpi 5
image/1. 測定画面 .tif 5
image/ 電池残量 1.tif @ 500 dpi 5
image/ 電池残量 2.tif @ 500 dpi 5
image/ 電池残量 3.tif @ 500 dpi 5
image/POWER.tif 6
image/MEAS.tif 6
image/ENTER.tif 6
image/CAL.tif 6
image/ESC.tif 6
image/LIGHT.tif 6
image/CUR_L.tif 6
image/CUR_R.tif 6
image/CUR_U.tif 6
image/CUR_D.tif 6
image/controller_battery_lid2.tif 8
image/battery-4.tif 8
image/cr2032_x1.tif 10
image/p-guard.tif 11
image/U-50_attach_pH.tif 11
image/U-50_attach_orp.tif 12
image/U-50_attach_ref.tif 12
image/u50_do-spaner.tif 13
image/controller_connector.tif 14
image/ コネクタ _mk.tif 14
image/ 校正カップ 3.tif 14
image/ 設定 GPS 受信 E1.tif 15
image/ 設定 GPS 測位 E2.tif 16
image/ 設定 GPS 受信完了 E1.tif 16
image/ 設定 GPS 測位失敗 E1.tif 16
image/ 設定 GPS 精度 E1.tif 17
image/ 設定 GPS 精度 E2.bmp.tif 17
image/1. 測定画面 .tif 18
image/2. 設定画面測定設定 1.tif 19

image/校正CONDゼロ校正完了1e.tif @ 200 dpi 49
image/校正COND校正スパン1e.tif @ 200 dpi 50
image/校正COND校正スパン1完了e.tif @ 200 dpi 50
image/校正COND校正スパン2e.tif @ 200 dpi 50
image/校正COND校正スパン2完了e.tif 50
image/校正COND校正スパン3e.tif @ 200 dpi 51
image/校正COND校正スパン校正3完了e.tif 51
image/49. 校正画面.tif 52
image/67. 校正画面マニュアル校正14.tif 53
image/68. 校正画面マニュアル校正15.tif 53
image/69. 校正画面マニュアル校正16.tif 53
image/70. 校正画面マニュアル校正17.tif 53
image/校正TURBゼロ校正完了e.tif 54
image/校正TURB校正スパン1e.tif @ 200 dpi 54
image/校正TURB校正スパン1完了e.tif @ 200 dpi 54
image/校正TURB校正スパン2e.tif @ 200 dpi 55
image/校正TURB校正スパン2完了e.tif @ 200 dpi 55
image/校正TURB校正スパン3e.tif @ 200 dpi 55
image/校正TURB校正スパン3完了e.tif @ 200 dpi 55
image/49. 校正画面.tif 56
image/71. 校正画面マニュアル校正18.tif 56
image/画暴14_ENG.tif @ 200 dpi 56
image/校正画面DO校正点数選択_e.tif @ 200 dpi 56
image/校正DOゼロ校正e.tif @ 200 dpi 57
image/画暴15_ENG.tif @ 200 dpi 57
image/校正DOゼロ校正完了e.tif @ 200 dpi 57
image/画暴16_ENG.tif @ 200 dpi 57
image/校正DOスパン校正e.tif @ 200 dpi 57
image/画暴17_ENG.tif @ 200 dpi 57
image/校正DOスパン校正完了e.tif @ 200 dpi 57
image/画暴18_ENG.tif @ 200 dpi 57
image/49. 校正画面.tif 60
image/73. 校正画面マニュアル校正20.tif 60
image/74. 校正画面マニュアル校正21.tif 60
image/75. 校正画面マニュアル校正22.tif 60
image/76. 校正画面マニュアル校正23.tif 60
image/1. 測定画面.tif 61
image/拡大1_ENG.tif 61
image/拡大2_ENG.tif 61
image/1. 測定画面.tif @ 200 dpi 61
image/77. 測定画面1.tif 62
image/78. 測定画面2.tif 62
image/79. 測定画面3.tif 62
image/濁度シーケンス.tif @ 100 dpi 62
image/1. 測定画面.tif @ 200 dpi 62
image/77. 測定画面1.tif 63
image/78. 測定画面2.tif 63
image/79. 測定画面3.tif 63
image/測定画面インターバル測定_e.tif @ 200 dpi 63

image/1.測定画面.tif @ 200 dpi 64
image/80.データオペレーション画面1.tif 64
image/81.データオペレーション画面2.tif 64
image/82.データオペレーション画面３.tif 65
image/81.データ画面データ表示2.bmp.tif @ 200 dpi 65
image/1.測定画面.tif 65
image/80.データオペレーション画面1.tif 65
image/84.データオペレーション画面5.tif 66
image/1.測定画面.tif @ 200 dpi 66
image/80.データオペレーション画面1.tif 66
image/86.データオペレーション画面7.tif 67
image/1.測定画面.tif @ 200 dpi 68
image/87.データオペレーション画面8.tif 68
image/88.データオペレーション画面9.tif 68
image/1.測定画面.tif @ 200 dpi 69
image/90.データオペレーション11.tif 69
image/91.データオペレーション12.tif 69
image/1.測定画面.tif @ 200 dpi 70
image/校正履歴CONDe.tif @ 200 dpi 70
image/校正履歴DOE.tif @ 200 dpi 70
image/校正履歴ORPE.tif @ 200 dpi 70
image/校正履歴phE.tif @ 200 dpi 70
image/校正履歴tempE.tif @ 200 dpi 70
image/校正履歴TurbE.tif @ 200 dpi 70
image/校正履歴水深E.tif @ 200 dpi 70
image/画暴25_ENG.tif 70
image/データ操作GPS情報E10.tif 71
image/データ操作GPS情報成功E1.tif 71
image/データ操作GPS情報E1.tif 71
image/センサインフォメーション良好E.tif 72
image/センサインフォメーションNGE.tif 72
image/usb-connector.tif @ 400 dpi 73
image/COND-G.tif 82
image/s-guard_cap.tif 83
image/プローブガード.tif 83
image/隔膜5-s1.tif 84
image/隔膜5-s2.tif 84
image/隔膜5-g1.tif 84
image/隔膜5-g2.tif 84
image/DOセンサ_保護キャップ.tif 85
image/pH_chip=cap.tif @ 300 dpi 85
image/turb1.tif 86
image/隔膜3-1.tif 87
image/隔膜3-2.tif 87
image/DO_シリコンパッキン.tif 87
image/隔膜キャップ.tif 87
image/spoit.tif 87
image/隔膜4-3l.tif 87
image/隔膜4-3r.tif @ 600 dpi 87

image/隔膜キャップジグ 1.tif 87
image/隔膜キャップジグ 2.tif 87
image/隔膜キャップ取り付け 1.tif 88
image/隔膜キャップジグ 2.tif 88
image/隔膜確認 .tif 88
image/隔膜確認 .tif 88
image/DO_原理 _J.tif 101
image/DO_CL-ion_J.tif @ 300 dpi 102
image/cond_原理図 .tif @ 600 dpi 103
image/cond_原理図 _4 極 .tif @ 600 dpi 103
image/U-52_turb.tif 107
image/U-53_turb.tif 107
image/orp_原理図 .tif @ 600 dpi 108

LaMotte

2020t/i

Turbidity Meter
Medidor de turbidez
Turbidimètre

CE

Code/ Código 1974-T/1974-I

CONTENTS

CALIBRATION & ANALYSIS

TROUBLESHOOTING GUIDE

GENERAL OPERATING INFORMATION

MAINTENANCE

Refer to the **Quick Start Guide** for simplified Calibration and Analysis procedures.

Refer to the **Testing Guide** for detailed Calibration and Analysis procedures for improving the accuracy of low range turbidity measurements.

Refer to the **Quick Start Guide** for simplified Calibration and Analysis procedures.

Refer to the **Testing Guide** for detailed Calibration and Analysis procedures for improving the accuracy of low range turbidity measurements.

GENERAL INFORMATION

PACKAGING AND DELIVERY

Experienced packaging personnel at LaMotte Company assure adequate protection against normal hazards encountered in transportation of shipments.

After the product leaves LaMotte Company, all responsibility for safe delivery is assured by the transportation company. Damage claims must be filed immediately with the transportation company to receive compensation for damaged goods.

GENERAL PRECAUTIONS

READ THE INSTRUCTION MANUAL BEFORE ATTEMPTING TO SET UP OR OPERATE THE METER. Failure to do so could result in personal injury or damage to the meter. The meter should not be used or stored in a wet or corrosive environment. Care should be taken to prevent water from wet tubes from entering the meter chamber.

NEVER PUT WET TUBES IN THE METER.

SAFETY PRECAUTIONS

*WARNING: Reagents marked with an * are considered to be potential health hazards. To view or print a Safety Data Sheet (SDS) for these reagents go to www.lamotte.com.

Search for the four digit reagent code number listed on the reagent label, in the contents list or in the test procedures. Omit any letter that follows or precedes the four digit code number.

For example, if the code is 4450WT-H, search 4450. To obtain a printed copy, contact LaMotte by email, phone or fax.

Emergency information for all LaMotte reagents is available from Chem-Tel: (US, 1-800-255-3924) (International, call collect, 813-248-0585).

Ensure that the protection provided by this equipment is not impaired. Do not install or use this equipment in a manner that is not indicated in this manual.

LIMITS OF LIABILITY

Under no circumstances shall LaMotte Company be liable for loss of life, property, profits, or other damages incurred through the use or misuse of their products.

SPECIFICATIONS - 2020t/i

Mode	Nephelometric	Ratiometric	Attenuation
Unit of Measure **2020t**	NTU, ASBC, EBC	NTU, NTRU, ASBC, EBC	NTU, AU, ASBC, EBC
Unit of Measure **2020i**	NTU, FNU, ASBC, EBC	NTU, FNRU, ASBC, EBC	NTU, FAU, ASBC, EBC
Range	0-100 NTU/FNU 0-1,750 ASBC 0-25 EBC	0-1,000 NTRU/FNRU 0-17,500 ASBC 0-250 EBC	0-2,000 AU/FAU 0-70,000 ASBC 0-1,000 EBC

Resolution	0–10.99 NTU/FNU: 0.01 NTU/FNU, 11.0–100.0 NTU/FNU: 0.1 NTU/FNU	0–10.99 NTRU/FNRU: 0.01 NTRU/FNRU, 11.0–109.9 NTRU/FNRU: 0.1 NTRU/FNRU, 110–1000 NTRU/FNRU: 1 NTRU/FNRU	0–2000 AU/FAU: 1 AU/FAU
Accuracy	0-2.5 NTU/FNU: ±0.05 NTU/FNU, 2.5-100 NTU/FNU: ±2%	0-2.5 NTRU/FNRU: ±0.05 NTRU/FNRU, 2.5-100 NTRU/FNRU: ±2%, 100-1000 NTRU/FNRU: ±3%.	0-2000 AU/FAU: ±10 AU/FAU or 6% whichever is greater
Detection Limit	0.05 NTU/FNU	0.05 NTRU/FNRU	10 AU/FAU
Reproducibility	0.02 NTU/FNU or 1%	0.02 NTRU/FNRU or 1%	1%
Range Selection	Automatic		
Light Source	2020t: Tungsten lamp 2300 °K ±50 °K, 2020i: IR LED 860 nm ±10 nm, spectral bandwidth 50 nm		
Detector	2020t: Photodiode, centered at 90° and 180°, maximum peak 400-600 nm 2020i: Photodiode, centered at 90° and 180°		
Response Time:	<2 seconds		
Signal Averaging:	Yes		
Sample Chamber:	Accepts 25 mm flat-bottomed test tubes		
Sample:	10 mL in capped tube		
Display:	Graphic Liquid Crystal Display with Backlight		
Software:	Auto Shut-off: 5, 10, 30 min, disabled Calibration: Field adjustable, blank and 1 point Data Logging: 500 points		
Languages:	English, Spanish, French, Portuguese, Italian, Chinese, Japanese (Kana)		
Temperature:	Operation: 0–50 °C; Storage: -40–60 °C		
Operation Humidity Range:	0–90 % RH, non-condensing		
Auto Shut-off:	5, 10, 30 min, disabled		
Power Source:	USB wall adapter, USB computer connection or Lithium ion rechargeable battery		
Battery:	Charge Life: Approximately 380 tests with backlight on to 1000 tests with backlight off. (Signal averaging disabled). Battery Life: Approximately 500 charges.		
Electrical Ratings:	Rated voltage (5V), Rated power of input current (1.0A) at mini-USB input port		
Data Logger:	500 test results stored		
Waterproof:	IP67 with USB port plug in place.		
Dimensions:	(W x L x H) 8.84 x 19.05 x 6.35 cm; 3.5 x 7.5 x 2.2 inches		

Certifications:	CE Mark	Safety:	Low Voltage Directive (2006/95/EC) IEC 61010-1:2001, EN 601010-1:2001, 2nd edition
	EU	EMC:	EMC Directive (2004/108/EC) EN 61326-1:2006, EN 61000-4-2:1995 including A1:1998 and A2:2001, EN 61000-4-3:2002, EN 61000-4-4:2004, EN 61000-4-5:1995 including A1:2001, EN 61000-4-6:1996 and A1:2001, EN 61000-4-11:2004, EN 55011:2007, IEC 61000-3-2:2005, EN 61000-3-2:2006, IEC 61000-3-3:1994, EN 61000-3-3:1995 including A1:2001 and A2:2005
	US	EMC	CFR 47, Part 15 Subpart B:2007
	CAN	EMC	ICES-003, Issue 4, February 2004
	AU/NZ	EMC	AU/NZ: CISPR 11:2004
Weight:	362 g, 13 oz (meter only)		
USB Interface:	mini B		

STATISTICAL & TECHNICAL DEFINITIONS RELATED TO PRODUCT SPECIFICATIONS

Method Detection Limit (MDL): "The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte."[1] Note that, "As Dr. William Horwitz once stated, 'In almost all cases when dealing with a limit of detection or limit of determination, the primary purpose of determining that limit is to stay away from it.'"[2]

Accuracy: Accuracy is the nearness of a measurement to the accepted or true value.[3] The accuracy can be expressed as a range, about the true value, in which a measurement occurs (i.e. ±0.5 ppm). It can also be expressed as the % recovery of a known amount of analyte in a determination of the analyte (i.e. 103.5 %).

Resolution: Resolution is the smallest discernible difference between any two measurements that can be made.[4] For meters this is usually how many decimal places are displayed. (i.e. 0.01). Note that the resolution many change with concentration or range. In some cases the resolution may be less than the smallest interval, if it is possible to make a reading that falls between calibration marks. A word of caution, that resolution has very little relationship to accuracy or precision. The resolution will always be less than the accuracy or precision but it is not a statistical measure of how well a method of analysis works. The resolution can be very, very good and the accuracy and precision can be very bad! This is not a useful measure of the performance of a test method.

Repeatability: Repeatability is the within-run precision.[5] A run is a single data set, from set up to clean up. Generally, one run occurs on one day. However, for meter calibrations, a single calibration is considered a single run or data set, even though it may take 2 or 3 days.

Reproducibility: Reproducibility is the between-run precision.[6]

Detection Limit (DL): The detection limit (DL) for the 2020t/i is defined as the minimum value or concentration that can be determined by the meter, which is greater than zero, independent of matrix, glassware, and other sample handling sources of error. It is the detection limit for the optical system of the meter.

[1] CFR 40, part 136, appendix B
[2] Statistics in Analytical Chemistry: Part 7 – A Review, D. Coleman and L Vanatta, American Laboratory, Sept 2003, P. 31.
[3] Skoog, D.A., West, D. M., Fundamental of Analytical Chemistry, 2nd ed., Holt Rinehart and Winston, Inc, 1969, p. 26.
[4] Statistics in Analytical Chemistry: Part 7 – A Review, D. Coleman and L Vanatta, American Laboratory, Sept 2003, P. 34.
[5] Jeffery G. H., Basset J., Mendham J., Denney R. C., Vogel's Textbook of Quantitative Chemical Analysis, 5th ed., Longman Scientific & Technical, 1989, p. 130.
[6] Jeffery G. H., Basset J., Mendham J., Denney R. C., Vogel's Textbook of Quantitative Chemical Analysis, 5th ed., Longman Scientific & Technical, 1989, p. 130

CONTENTS & ACCESSORIES

	2020t Kit EPA Version/ Code 1974-T	**2020i Kit** ISO Version/ Code 1974-I
Contents	**Code**	**Code**
2020t/i Turbidimeter		
0 NTU Standard, 60 mL	1480	1480
1 NTU Standard, 60 mL	1441	
10 NTU/FNU Standard, 60 mL	1442	1447
100 FNU Standard, 60 mL		1444
Water Sample Bottle, 60 mL	0688	0688
Test Tubes, with Caps	0260 (6)	0260 (6)
Cable, USB	1720	1720
USB Wall Adapter	1721	1721
2020t/i Manual	1974-MN	1974-MN
2020t/i Quick Start Guide	1974-QG	1974-QG
2020t/i Testing Guide	1974-TG	1974-TG

Accessories	
Code	**Description**
0260-6	Test tubes, with Caps
1446	1 FNU Standard, 60 mL (ISO)
1443	100 NTU Standard, 60 mL (EPA)
6195-H	Formazin Standard Solution, 4000 NTU, 60 mL
3-0038	Replacement Chamber
0943	Syringe, 60 mL, plastic
2-2097	Filters, 0.1 micron, Pack of 50
5-0132	Car Charger

EPA COMPLIANCE

The 2020t meter meets or exceeds EPA design specifications for NPDWR and NPDES turbidity monitoring programs as specified by the USEPA method 180.1.

ISO COMPLIANCE

This 2020i meter meets or exceeds ISO design criteria for quantitative methods of turbidity using optical turbidimeters as specified by ISO 7027.

CE COMPLIANCE

This device complies with Part 15 of the FCC rules. 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.

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

IP67 COMPLIANCE

The 2020t/i meets IP67 standards for protection against dust and immersion only when the USB port plug is in place. Documentation is available at www.lamotte.com.

WARRANTY

LaMotte Company warrants this instrument to be free of defects in parts and workmanship for 2 years from the date of shipment. If it should become necessary to return the instrument for service during or beyond the warranty period, contact our Technical Service Department at 1-800-344-3100 for a return authorization number or visit www.lamotte.com for troubleshooting help. The sender is responsible for shipping charges, freight, insurance and proper packaging to prevent damage in transit. This warranty does not apply to defects resulting from action of the user such as misuse, improper wiring, operation outside of specification, improper maintenance or repair, or unauthorized modification. LaMotte Company specifically disclaims any implied warranties or merchantability or fitness for a specific purpose and will not be liable for any direct, indirect, incidental or consequential damages. LaMotte Company's total liability is limited to repair or replacement of the product. The warranty set forth above is inclusive and no other warranty, whether written or oral, is expressed or implied.

REGISTER YOUR METER

To register your meter with the LaMotte Service Department, go to www.lamotte.com and choose SUPPORT on the top navigation bar.

COMPUTER CONNECTION

OUTPUT

USB

■ COMPUTER CONNECTION

USB Type A, USB mini B, Order Cable Code 1720.

BATTERY/AC OPERATION

The 2020t/i may be operated on battery power or using the USB wall adapter or USB computer connection. If using the meter as a bench top unit, use the wall adapter if possible to extend the battery life. The meter will remain on when the USB adapter is used.

To charge the lithium ion battery with the wall adapter, plug the smaller end of the USB cable (USB mini B connector) into the meter and the larger end of the USB cable (USB Type A connector) into the wall adapter. Plug the wall adapter into an AC outlet. Reinsert the USB port plug after charging.

To charge the battery from a computer, plug the smaller end of the USB cable (USB mini B connector) into the meter and the larger end of the USB cable (USB Type A connector) into a USB port on a computer. Reinsert the USB port plug after charging.

The battery icon will show no bars and flash when the unit first turns on. Then the indicator will indicate the battery status by showing 0, 1, 2, 3 or 4 bars.

It will take 5 hours to fully charge a low battery. The battery icon will flash when the battery is charging. The battery icon will show four bars and stop flashing when it is fully charged. The charging circuit will automatically switch to a float charge when the battery is fully charged. The charger may remain connected. Some computers will NOT supply power to the USB ports during standby operation. The wall adapter will charge the unit continuously.

The battery icon will show no bars and continuously flash if the battery is getting low but the unit will still operate normally. A “Low Battery” message on the status bar of the display will replace the time when the battery voltage is too low for proper operation and accuracy may be degraded. A “Shutdown Low Batt” message on the display will appear for a few seconds before the power is switched off when the battery is too low to operate the unit.

To extend the battery life:

- Shut down the unit with the power switch when not taking measurements or use the **power save** option to have the unit automatically turn off after 5 minutes.
- Store the unit in a cool dry place.
- Fully charge the battery before storing the unit for extended periods of time.
- Limit backlight use. The unit consumes three times the normal power with the backlight on. Set the **backlight time** option to 10 seconds, or select “Button Control” and keep the backlight off.

Battery replacement: The lithium-ion battery used in this unit should last for many years with normal use. When it no longer powers the unit long enough to meet testing requirements it will need to be replaced. Lithium-ion batteries that are properly charged and stored do not usually lose all capacity; they just have less capacity after hundreds of charge cycles. This unit uses a custom battery assembly that is only available from LaMotte Company. Battery replacement must be performed at a LaMotte authorized repair facility. The water resistant housing of this meter should not be opened by the user. Contact LaMotte Company by phone (1-800-344-3100) or email (tech@lamotte.com) for a return authorization number.

TURBIDITY

■ WHAT IS TURBIDITY?

Turbidity is an optical property that results when light passes through a liquid sample and is scattered by particulate matter. The scattering of light results in a change in the direction of the light passing through the liquid. If the turbidity is low, the particles may be invisible to the naked eye and much of the light will continue in the original direction. As the quantity of particles increases in samples with greater turbidity, the light strikes particles in solution and is scattered backward, sideways and forward. Light scattered by the particles allows the particles in the solution to be "seen" or detected just as sunlight allows dust particles in the air to be seen. At high concentrations, turbidity is perceived as cloudiness, haze or an absence of clarity. Turbidity is not specific to the types of particles in the sample. The particles may be suspended or colloidal and can have inorganic, organic or biological origins.

In drinking water, turbidity may indicate a treatment problem or signal conditions with an increased risk of gastrointestinal diseases. Because pathogens such as *Cryptosporidium* and *Giardia* cause measurable amounts of turbidity, turbidity monitoring can hold the key to assuring adequate water filtration. In 1998, the EPA published the IESWTR (interim enhanced surface water treatment rule) mandating turbidities in combined filter effluent should read at or below 0.3 NTU. By doing so, the EPA hoped to achieve a 2 log (99%) removal of *Cryptosporidium*. There is presently consideration to lower this to 0.1 NTU. The trend has been to check the calibration of on-line turbidimeters used to monitor drinking water with hand-held field units. The optical design and low detection limit of the 2020t/i allows very accurate readings for such calibrations. Drinking water that is turbid is not always harmful to human health but does impart an unpalatable appearance.

Turbidity in environmental waters reduces the amount of beneficial sunlight that reaches submerged aquatic vegetation, raises surface water temperature, buries eggs and bottom dwelling creatures, and can carry sediment and pesticides through the water system.

■ HOW IS TURBIDITY MEASURED?

Turbidity is measured by detecting and quantifying the scattering of light in a solution. The amount of light that is scattered is influenced by particulate properties of color, shape, size and reflectivity. Turbidity can be measured by various methods including visual methods and instrumental methods. Visual methods are more suitable for samples with high turbidity. Instrumental methods can be used for samples with turbidity at all levels.

Examples of visual methods are the Secchi Disk method and the Jackson Candle method. The Secchi Disk method is often used in natural waters. A Secchi Disk with black and white quadrants is lowered into the water until it can no longer be seen. It is then raised until it can be seen again. The average of these two measurements is known as the "Secchi Depth". The Jackson Candle method uses a long glass calibrated tube placed over a standardized candle. Water is added or removed from the tube until the candle flame becomes indistinct. The height of the water in the tube is measured with a calibrated scale and is reported as Jackson Turbidity Units (JTU). The lowest level of turbidity that can accurately be determined with this method is about 25 JTU.

Instrumental methods for measuring turbidity involve a combination of detection angles and light sources to optimize accuracy in various samples and to meet regulatory requirements. The 2020t and 2020i turbidimeters offer the option of three calibration curves for measuring turbidity that is based on the characteristics of the sample.

In the nephelometric mode, which is the default mode, the detector that is located 90-degrees from the light source measures the scattered light from a light beam passing through a sample. In the 2020t, this configuration and the tungsten lamp, with a color temperature of 2,200–3,000 °K, meet the requirements of EPA method 180.1. The 2020i, which has an IR LED light source at 860 nm, uses the 90-degree detector to meet the requirements of the ISO 2027 Standard. The nephelometric mode is best used for meeting regulatory requirements on samples, such as drinking water, that are in the range of 0.00 to 40.00 Nephelometric Turbidity Units (NTU) for the 2020t or 0.00 to 10.00 Formazin Nephelometric Units (FNU) for the 2020i. A signal averaging option improves the stability of readings on low turbidity samples.

The ratiometric mode is typically used for natural waters and storm waters, or other samples in the 0 – 1000 NTU/FNU range, to minimize interference from color in the sample. The ratiometric mode takes readings from both the 90-degtree detector and the 180 degree detector. Results are reported as Nephelometric Turbidity Ratio Units (NTRU, 2020t) or Formazin Nephelometric Ratio Units (FNRU, 2020i).

In the attenuation mode, the detector is located 180-degrees from the light source. It measures the attenuation of the light beam due to absorption and scatter. This mode is best used to measure samples with high turbidity levels in the range of 40 – 4000 Attenuation Units (AU, 2020t) or Formazin Attenuation Units (FAU, 2020i).

■ TURBIDITY UNITS

Traditionally, turbidimeters designed for use in the United State were made to the specifications of EPA Method 180.1. This method defined the NTU, nephelometric turbidity unit, as a unit that measured turbidity in the range of 0 – 40 NTU using a nephelometer. According to the EPA a nephelometer was a turbidimeter that measures turbidity with a 90° detector. If a sample had a turbidity that was greater than 40 NTU, a dilution was necessary to bring the sample into the 0 – 40 NTU range. Today, many turbidimeters have additional detectors which increase the range of the turbidity measurement, eliminate interferences and generally improve the performance. Currently, many turbidimeters are capable of measuring above 40 NTU by using detectors other than a 90° detector. Even though they may use a 180° detector, which does not meet the definition of a nephelometer, the results are often be reported as NTU.

Since the position of the detector and the light source is important information to include when reporting and comparing turbidity results, there has recently been an effort by the ASTM to use turbidity units which include this information. For EPA compliant meters, measurements made with a 90° degree detector and an incandescent white light source are reported as Nephelometric Turbidity Units (NTU). When an attenuation measurement is made with a 180°detector, using the same light source, the results are reported as Attenuation Units (AU). If a ratio of the measurements from both detectors is used to calculate the turbidity, the results are reported in Nephelometric Turbidity Ratio Units (NTRU).

ISO Method 7027, which specifies an 860 nm light source, reports results in four turbidity units. When the 90° degree detector is used, the results are reported as Formazin Nephelometric Units (FNU). With an attenuation measurement made with a 180° detector, the results are reported as Formazin Attenuation Units (FAU). And results that are a ratio of measurements from the two angles are reported in Formazin Nephelometric Ratio Units (FNRU). It is also possible to report the readings from each of the three ISO modes in Nephelometric Turbidity Units (NTU).

It should be noted that all units are numerically equivalent if the meters are calibrated to formazin. The units differentiate which detector and light source was used to make the measurement. For example, 1 NTU = 1 AU = 1 NTRU = 1 FNU =1 FAU = 1 FNRU.

Each turbidity calibration mode has a default unit:

Nephelometric Mode: NTU (2020t) or FNU (2020i)

Ratiometric Mode: NTRU (2020t) or FNRU (2020i)

Attenuation Mode: AU (2020t) or FAU (2020i)

The meter will permit the user to choose to report results in any of the other available calibration units (NTU, FNU, AU, FAU, NTRU or FNRU) other than the default unit. It also allows the brewing industry to check process water in the nephelometric mode and choose to have results reported in American Society of Brewing Chemists (ASBC) or European Brewery Convention (EBC) units.

Acronyms	**Definitions**	**Notes**	**Regulatory Method**
NTU	Nephelometric Turbidity Units	Incandescent white light between 400 and 600 nm, 90° detection, 2020t	EPA 180.1
FNU	Formazin Nephelometric Units	IR LED (usually) 860 nm, bandwidth less than 60 nm, 90° detection, 2020i	ISO 7027
AU	Attenuation Units	Incandescent white light between 400 and 600 nm, 180° detection, 2020t	Not applicable
FAU	Formazin Attenuation Units	IR LED (usually) 860 nm, bandwidth less than 60 nm, 180° detection, 2020i	ISO 7027
NTRU	Nephelometric Turbidity Ratio Units	Incandescent white light between 400 and 600 nm, 90° and 180° detection, 2020t	EPA 180.1
FNRU	Formazin Nephelometric Ratio Units	IR LED (usually) 860 nm, bandwidth less than 60 nm, 90° and 180° detection, 2020i	Not applicable
ASBC	American Society of Brewing Chemists	2020t/i	Not applicable
EBC	European Brewery Convention	2020t/i	Not applicable

For more information see ASTM 07726-4 Standard Guide for the Use of Various Turbidimeter Technologies for the Measurement of Turbidity in Water.

■ TAKING TURBIDITY WATER SAMPLES

Clean plastic or glass containers may be used for turbidity samples. Ideally, samples should be tested soon after collection and at the same temperature as when collected.

SAMPLE DILUTION TECHNIQUES

If a test result is out of the range of the meter, as indicated by an over range message on the display, the sample must be diluted and retested.The following table gives quick reference guidelines for dilutions of various proportions.

Amount of Sample	Deionized Water to Bring Final Volume to 10 mL	Multiplication Factor
10 mL	0 mL	1
5 mL	5 mL	2
2.5 mL	7.5 mL	4
1 mL	9 mL	10
0.5 mL	9.5 mL	20

All dilutions are based on a final volume of 10 mL, so several dilutions will require small volumes of the water sample. Graduated pipets should be used for all dilutions. If volumetric glassware is not available, dilutions can be made with the colorimeter tube. Fill the tube to the 10 mL line with the sample and then transfer it to another container. Add 10 mL volumes of deionized water to the container and mix. Transfer 10 mL of the diluted sample to the colorimeter tube and follow the test procedure. Repeat the dilution and testing procedures until the result falls within the range of the calibration. Multiply the test result by the dilution factor. For example, if 10 mL of the sample water is diluted with three 10 mL volumes of deionized water, the dilution factor is four. The test result of the diluted sample should be multiplied by four.

OPTIONS & SET UP

FACTORY DEFAULT SETTINGS

Settings that have user options have been set at the factory to default settings.

The factory default settings are:

Turbidity Calibration Curve	Nephelometric (N)
Turbidity Units	Default
Turbidity Measurement	Turbidity-No Blank (NB)
Averaging	Disabled
Date Format	MM-DD-YYYY
Power Save	5 minutes
Backlight	10 seconds
Language	English

■ TURBIDITY OPTIONS

Three calibration curves are available: Nephelometric, Ratiometric and Attenuation. For the 2020t, Nephelometric is the default calibration curve and the available units are NTU, NTRU, ASBC and EBC. For the 2020i, Nephelometric is the default calibration curve and the available units are FNU, NTU, FNRU, ASBC and EBC for the 2020i.

The 2020t in Nephelometric mode with the default NTU units should be used for testing public drinking water for compliance with the EPA 180.1 rule.

Once a calibration curve and turbidity units have been selected, they will remain selected until the calibration curve and turbidity units are changed by performing the following procedures.

SELECTING A TURBIDITY CALIBRATION CURVE

Three calibration curves are available: Nephelometric, Ratiometric and Attenuation. The default calibration curve is Nephelometric. The calibration curve should be chosen that suits the type of sample being tested.

Nephelometric Mode:	**90° Detector**	**0 – 100 NTU/FNU Range, for Drinking Water Samples**
Ratiometric Mode:	**90° and 180° Detectors**	**0 – 1000 NTU/NTRU/FNRU Range, for Drinking Water, Natural Water Samples, Storm Water Samples, and Colored Samples**
Attenuation Mode:	**180° Detector**	**0 – 2000 NTU/AU/FAU Range, for High Turbidity Samples**

Ratiometric methods typically minimize color interference.

The 2020t in Nephelometric mode with the default NTU units should be used for testing public drinking water for compliance with the EPA 180.1 rule.

The Nephelometric mode will be used in the example. To change the calibration curve:

1. Press and briefly hold to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.	Main Menu Measure Data Logging Options 12:00:00 001/500
2. Press to scroll to **Options**.	Main Menu Measure Data Logging Options 12:00:00 001/500

3. Press ENTER to select **Options**.	Options Menu Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500
4. Press ENTER to select **Turbidity Options**.	Turbidity Options Turbidity Calibration Turbidity Units 12:00:00 001/500
5. Press ENTER to select **Turbidity Calibration**.	Turbidity Calibration Nephelometric NTU Ratiometric NTRU Attenuation AU 12:00:00 001/500
6. Scroll to the desired calibration option.	Turbidity Calibration Nephelometric NTU Ratiometric NTRU Attenuation AU 12:00:00 001/500

NOTE: Stablcal® standards below 50 NTU should not be used to calibrate the 2020t/i. The diluent has a different refractive index than traditional formazin standards and will affect the results.

7. Press ENTER to save the selection. The screen will display **Storing...** for about 1 second and return to the **Options** menu. Press EXIT to return to a previous menu.	Options Menu Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500

SELECTING TURBIDITY UNITS

The results for each calibration curve will be reported in the default units for that calibration curve unless different units are chosen. The default unit is shown after the calibration curve name. The default units are:

	Calibration Curve	Default Unit
2020t	Nephelometric	NTU (Nephelometric Turbidity Units)
	Ratiometric	NTRU (Nephelometric Turbidity Ratio Units)
	Attenuation	AU (Attenuation Units)
2020i	Nephelometric	FNU (Formazin Nephelometric Units)
	Ratiometric	FNRU (Formazin Nephelometric Ratio Units)
	Attenuation	FAU (Formazin Attenuation Units)

It is possible to choose to have the results reported in an alternative unit instead of the default unit for each mode. When ASBC (American Society of Brewing Chemists) and EBC (European Brewery Convention) units are desired the Nephelometric calibration curve should be used.

For the 2020t, the available units are: NTU, NTRU, AU, ASBC, EBC

For the 2020i, the available units are: FNU, NTU, FNRU, FAU, ASBC, EBC

NTRU, AU, FNU, FNRU and FAU are numerically equivalent to NTU. The units differentiate which detector and light source was used to make the measurement. See page 12 for the definition of turbidity units.

1. Press and briefly hold [power button] to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.	Main Menu Measure Data Logging Options 12:00:00 001/500
2. Press [down arrow] to scroll to **Options**.	Main Menu Measure Data Logging Options 12:00:00 001/500

3. Press ENTER to select **Options**.	**Options Menu** Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500
4. Press ENTER to select **Turbidity Options**.	**Turbidity Options** Turbidity Calibration Turbidity Units 12:00:00 001/500
5. Press to scroll to **Turbidity Units**.	**Turbidity Options** Turbidity Calibration Turbidity Units 12:00:00 001/500
6. Press ENTER to select **Turbidity Units**.	**Set Turbidity Units** Default NTU ASBC EBC 12:00:00 001/500
7. Press or to scroll to the desired units.	**Set Turbidity Units** Default NTU ASBC EBC 12:00:00 001/500

8. Press **ENTER** to save the selection. The screen will display **Storing...** for about 1 second and return to the **Options** menu. Press **EXIT** to return to a previous menu.	Options Menu Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500

■ AVERAGING

The averaging option allows the user to average multiple readings. This option will improve the accuracy of samples with readings that may tend to drift with time. When the two, five or ten measurement option has been selected the final average is displayed. The default setting is Disabled. To change the setting:

1. Press and briefly hold to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.	Main Menu Measure Data Logging Options 12:00:00 001/500
2. Press to scroll to **Options**.	Main Menu Measure Data Logging Options 12:00:00 001/500
3. Press **ENTER** to select **Options**.	Options Menu Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500

4. Press [down arrow] to scroll to **Averaging**.	Options Menu Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500
5. Press ENTER to select **Averaging**.	Averaging Menu Disabled 2 Measurements 5 Measurements 10 Measurements 12:00:00 001/500
6. Press [up arrow] or [down arrow] to scroll to the desired option.	Averaging Menu Disabled 2 Measurements 5 Measurements 10 Measurements 12:00:00 001/500
7. Press ENTER to save the selection. The screen will display **Storing...** for about 1 second and return to the **Options** menu. Press EXIT to return to a previous menu.	Options Menu Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500

NOTE: When the Averaging option is enabled, more time will be required to display a reading and more power will be used.

■ SETTING THE CLOCK

1. Press and briefly hold [power] to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.	Main Menu Measure Data Logging Options 12:00:00 001/500

2. Press to scroll to **Options**.	Main Menu Measure Data Logging Options 12:00:00 001/500
3. Press ENTER to select **Options**. Press to scroll to **Set Clock**.	Options Menu Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500
4. Press ENTER to select **Set Clock**. The date is displayed as month-day-year. The time is displayed as hours:minutes:seconds AM/PM. Press or to the appropriate character and press ENTER to select. The cursor will move to the next character. Set all characters in the same manner. This is a scrolling menu.	Set Time Date: 07-09-2018 Time: 02:09:08 PM 12:00:00 001/500
5. Press ENTER to select the final character. The time and date will be saved and the screen will return to the **Options Menu**.	Options Menu Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500

■ SETTING POWER SAVE

The power saving Auto Shutoff feature will turn the meter off when a button has not been pushed for a set amount of time. The default setting is 5 minutes. To change the setting:

6. Press and briefly hold ⏻ to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.	Main Menu Measure Data Logging Options 12:00:00 001/500
7. Press ∨ to scroll to **Options**.	Main Menu Measure Data Logging Options 12:00:00 001/500
8. Press ENTER to select **Options**.	Options Menu Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500
9. Press ∨ to scroll to **Set PWR Save.**	Options Menu Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500
10. Press ENTER to select **PWR Save**.	Auto Shutoff Disable 5 Minutes 15 Minutes 30 Minutes 12:00:00 001/500

11. Press or to scroll to desired setting.	Auto Shutoff Disable 5 Minutes 15 Minutes 30 Minutes 12:00:00 001/500
12. Press ENTER to save the selection. The screen will display **Storing...** for about 1 second and return to the **Options Menu**.	Options Menu Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500

SETTING THE BACKLIGHT TIME

The backlight illuminates the display for enhanced viewing. If Button Control is chosen the backlight button on the key pad will act as an on/off switch and the backlight will remain on or off when the meter is being used. When one of the other settings – 10, 20 or 30 seconds – is chosen, the display will be illuminated for the specified amount of time after any button is pressed. As a precaution, the backlight will not illuminate during turbidity measurements to avoid interference from stray light.

NOTE: The backlight feature uses a significant amount of power. The longer the backlight is on, the more frequently the battery will have to be charged if the USB/Wall Charger is not being used.

1. Press and briefly hold to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.	Main Menu Measure Data Logging Options 12:00:00 001/500
2. Press to scroll to **Options**.	Main Menu Measure Data Logging Options 12:00:00 001/500

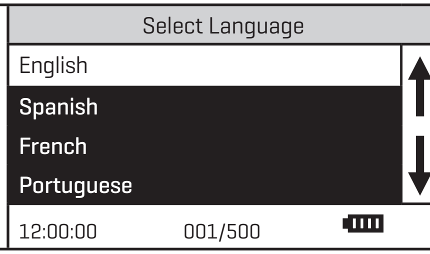
3. Press ENTER to select **Options**.	Options Menu Averaging Set Clock Set PWR Save Set Backlight Time 12:00:00 001/500
4. Press to scroll to **Set Backlight Time.**	Options Menu Averaging Set Clock Set PWR Save Set Backlight Time 12:00:00 001/500
5. Press ENTER to select **Set Backlight Time.**	Backlight Time Button Control 10 Seconds 20 Seconds 30 Seconds 12:00:00 001/500
6. Press or to scroll to desired setting.	Backlight Time Button Control 10 Seconds 20 Seconds 30 Seconds 12:00:00 001/500
7. Press ENTER to save the selection. The screen will display **Storing...** for about 1 second and return to the **Options Menu**.	Options Menu Averaging Set Clock Set PWR Save Set Backlight Time 12:00:00 001/500

SELECTING A LANGUAGE

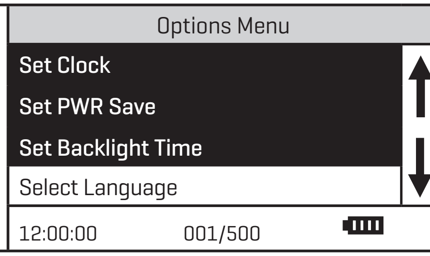
There are seven languages available in the 2020t/i: English, Spanish, French, Portuguese, Italian, Chinese, and Japanese (Kana).

1. Press and briefly hold ⏻ to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.	Main Menu Measure Data Logging Options 12:00:00 001/500
2. Press ∨ to scroll to **Options**.	Main Menu Measure Data Logging Options 12:00:00 001/500
3. Press ENTER to select **Options**.	Options Menu Turbidity Options Averaging Set Clock Set PWR Save 12:00:00 001/500
4. Press ∨ to scroll to **Select Language.**	Options Menu Set Clock Set PWR Save Set Backlight Time Select Language 12:00:00 001/500
5. Press ENTER to select to **Select Language**.	Select Language English Spanish French Portuguese 12:00:00 001/500

6. Press (up arrow) or (down arrow) to scroll to desired language.



7. Press ENTER to select desired language. The screen will momentarily display, **Storing...**for about 1 second and return to the **Options Menu**.



NOTE: If the meter unintentionally switches to another language, use the procedure above to reset the meter to the desired language. For example, to reset the meter to English:

1. Turn the meter on.
2. Press down arrow twice. Press ENTER.
3. Press down arrow six times. Press ENTER.
4. Press ENTER.

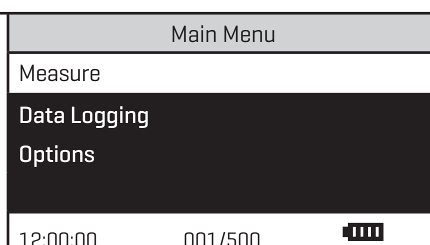
■ PC LINK

Run PC Link is used in the manufacturing of the meter. This menu is not for use by the operator in the field.

DATA LOGGING

The default setting for the data logger is enabled. The meter will log the last 500 data points. The counter in the center bottom of the display will show how many data points have been logged. The display will show 500+ when the data logger has exceeded 500 points and the data points are being overwritten.

1. Press and briefly hold (power) to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.



2. Press ▼ to scroll to **Data Logging**.	Main Menu Measure Data Logging Options 12:00:00 001/500
3. Press ENTER to select **Data Logging**.	Logging Display Test Log Enable Logging Disable Logging Erase Log 12:00:00 001/500
4. Press ENTER to display the last data point and the time that it was logged.	Record Number 2 Turbidity - WB (N) 655 AU 12:26:58 PM 08-03-2018 12:00:00 001/500
5. Press ▲ or ▼ to scroll through the data points in the log.	Record Number 1 Turbidity - WB (R) 95.4 NTU 12:26:44 PM 08-03-2018 12:00:00 001/500
6. Press EXIT to return to the **Logging** menu. Press ▲ or ▼ to scroll to disable the logging options or erase the log. Press ENTER to select the option. The screen will display **Storing...** for about 1 second and return to the **Logging Menu**.	Logging Display Test Log Enable Logging Disable Logging Erase Log 12:00:00 001/500

CALIBRATION

Turbidity Standards

Only use AMCO or formazin standards with the 2020t/i. StablCal® standards below 50 NTU should not be used to calibrate the 2020t/i .The diluent used in the StablCal® standards has a different refractive index than traditional formazin standards and will affect the results. The concentration of the calibration standard should be similar to the expected concentrations of samples that will be tested. The standard should never be poured from the tube back into the bottle. The standards will not have the same turbidity value in all three modes.

The following standards are available from LaMotte Company:

Mode Units	Nephelometric (N)	Nephelometric (N)	Ratiometric (R)	Ratiometric (R)
Meter	**2020t**	**2020i**	**2020t**	**2020i**
Code 1480	0 NTU	0 FNU	0 NTRU	0 FNRU
Code 1441	1 NTU	-	1 NTRU	-
Code 1446	-	1 FNU	-	1 FNRU
Code 1442	10 NTU	-	10 NTRU	
Code 1447	-	10 FNU	-	10 FNRU
Code 1444	-	100 FNU	-	100 FNRU

Standards may vary slightly from lot to lot for the ratiometric mode. Standard values for the nephelometric mode and ratiometric mode are located on the standard bottle label. **Use the value on the turbidity standard bottle label as the target value when calibrating the meter in the nephelometric mode and the ratiometric mode**. Standards for calibration in the attenuation mode should be prepared from Formazin.

Tubes

Use turbidity tubes (0260) that are free of scratches and imperfections in the light zone between the bottom of the tube and the fill line. Discard scratched tubes. When reading very low turbidity samples, do not use tubes or caps that have been used previously with high turbidity samples. See page 38 for additional information.

Turbidity Calibration Procedure

The default calibration curve is nephelometric as indicated by (N) in the Menu bar. The default units are NTU (2020t) and FNU (2020i). Other calibration curve options are ratiometric and attenuation. The ratiometric calibration curve is indicated by (R) and the attenuation calibration curve is indicated by (A). A user calibration should be performed for each mode with standards that are appropriate for the meter and range.

For the most accurate results, a user calibration should be performed over the smallest range possible. **Use a calibration standard that, along with the blank, brackets the range of the samples that will be tested**. For example, if the samples that are to be tested are expected to be below 1 NTU, more accurate results will be obtained by calibration with a blank and a 1 NTU standard as opposed to a blank and a 10 NTU standard.

The number of measuring ranges for each mode varies.

Mode	Nephelometric (N)	Ratiometric (R)	Attenuation (A)
Ranges	0-11 NTU/FNU 10-110 NTU/FNU	0-11 NTRU/FNRU 10-110 NTRU/FNRU 100-510 NTRU/FNRU 500-1000 NTRU/FNRU	0-1010 AU/FAU 1000-2000 AU/FAU

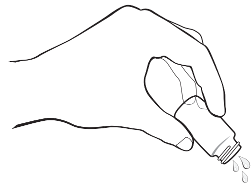
Each range can be calibrated with one point per range plus a blank. New calibration points will replace old calibration points independently for each range. If one range is recalibrated, the meter will retain the old calibration data for the other ranges. It is recommended that the meter be calibrated for each range that will be used. The value of the standards chosen for the calibration should not be at the extremes of the ranges. The meter is auto-ranging and will automatically select the appropriate range for the sample being tested.

It is recommended that the meter be calibrated daily.

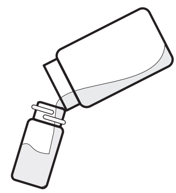
A 2020t in the nephelometric mode with NTU standards will be used in the following examples.

1. Press and briefly hold (power button) to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.	Main Menu Measure Data Logging Options 12:00:00 001/500
2. Press ENTER to select **Measure**.	Measure Menu (N) Turbidity - No Blank Turbidity - With Blank 12:00:00 001/500
3. Press (down arrow) to scroll to **Turbidity - With Blank.**	Measure Menu (N) Turbidity - No Blank Turbidity - With Blank 12:00:00 001/500
4. Press ENTER to select **Turbidity - With Blank.**	Turbidity WB (N) Scan Blank Scan Sample 12:00:00 001/500

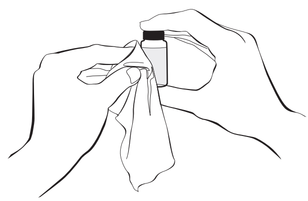
5. Rinse a clean tube (0260) three times with the blank. If samples are expected to read below 1 NTU the meter should be blanked with a 0 NTU Primary Standard or prepared turbidity-free (<0.1 NTU) water. For the most accurate results, use the same tube for the blank and the sample.



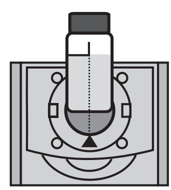
6. Fill the tube to the fill line with the blank. Pour the blank down the inside of the tube to avoid creating bubbles. Cap the tube.



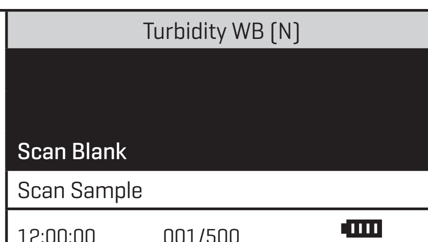
7. Wipe the tube thoroughly with a lint-free cloth.



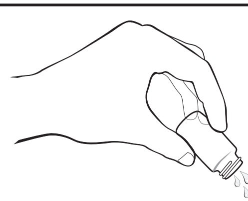
8. Open the meter lid. Insert the tube into the chamber. Align the index line on the tube with the index arrow on the meter. Close the lid.



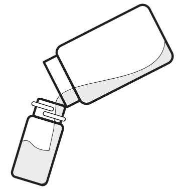
9. Press ENTER to select **Scan Blank** and scan the blank. The screen will display **Blank Done** for about 1 second and then return to the **Turbidity – With Blank Menu**.



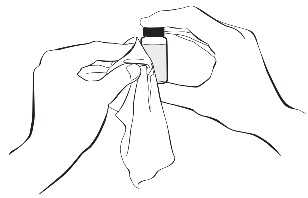
10. Rinse a clean tube (0260), or the same tube, three times with the turbidity standard.



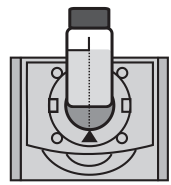
11. Fill the tube to the fill line with the turbidity standard. Pour the standard down the inside of the tube to avoid creating bubbles. Cap the tube.



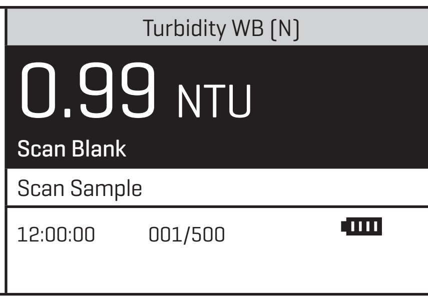
12. Wipe the tube thoroughly with a lint-free cloth.



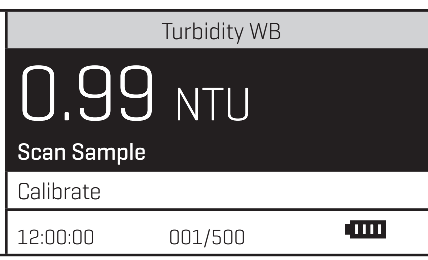
13. Open the meter lid. Insert the tube into the chamber. Align the index line on the tube with the index arrow on the meter. Close the lid.



14. Press ENTER to select **Scan Sample** and scan the standard. The screen will display **Reading** for about 1 second. The result will appear on the screen.
"Overrange" will be displayed if the reading is out of range. Dilute the sample or select a mode that is appropriate for the range of the sample.



15. Press ∨ to scroll to **Calibrate**.

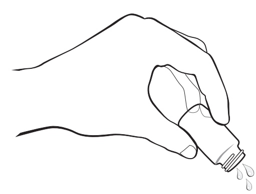
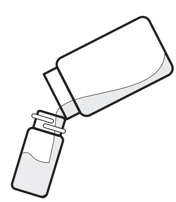


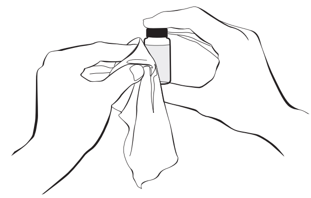
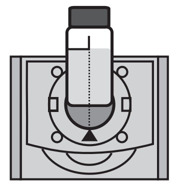
16. Press ENTER to select **Calibrate**. A reverse font (light background with dark characters) will appear to indicate that the reading can be adjusted.	Turbidity WB 0.99 NTU Scan Sample Calibrate 12:00:00 001/500
17. Press or to scroll to the concentration of the standard, 1.00 in the example. **Use the value on the turbidity standard bottle label as the target**. Note: The allowable adjustment is ±25%. If the allowable adjustment limit is reached, "overrange" wil be displayed.	Turbidity WB (N) 1.00 NTU Scan Sample Calibrate 12:00:00 001/500
18. Press ENTER to select **Calibrate**. Two menu choices will be offered, **Set Calibration** and **Factory Setting**.	Calibrate Menu (N) 1.00 NTU Set Calibration Factory Setting 12:00:00 001/500
19. Press ENTER to select **Set Calibration** and save the calibration. Press or to scroll and select **Factory Setting** to revert to the factory calibration. The meter will momentarily display **Storing...** and return to the **Turbidity-Without Blank** menu. The calibration has now been saved and the meter can be used for testing. The standard should never be poured from the tube back into the bottle.	Turbidity WB Scan Blank Scan Sample 12:00:00 001/500

NOTE: For the greatest accuracy during the calibration procedure, be sure that after the meter is blanked and the blank is scanned as a sample, the reading is 0.00. If not, reblank the meter and scan the blank again until it reads 0.00. When scanning the calibration standards as the sample, scan the calibration standard three times removing the tube from the chamber after each scan and reinserting the tube in the chamber with the same orientation. The readings should be consistent. Use the last consistent reading to calibrate the meter. If the readings are not consistent, avoid using an aberrant reading to calibrate the meter.

ANALYSIS WITHOUT BLANKING PROCEDURE

To obtain the most accurate results the meter should be blanked before measuring a sample. The blanking step is not as critical for samples above 10 NTU. The meter should always be blanked before reading samples below 10 NTU.

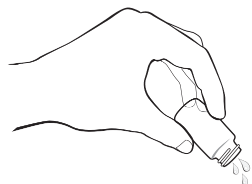
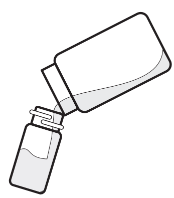
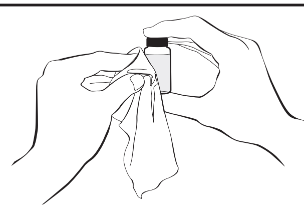
1. Press and briefly hold the power button to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.	Main Menu Measure Data Logging Options 12:00:00 001/500
2. Press ENTER to select **Measure**.	Measure Menu (N) Turbidity - No Blank Turbidity - With Blank 12:00:00 001/500
3. Press ENTER to select **Turbidity - No Blank**.	Turbidity NB (N) Scan Blank Scan Sample 12:00:00 001/500
4. Rinse a clean tube (0260) three times with the sample.	
5. Fill the tube to the fill line with the sample. Pour the sample down the inside of the tube to avoid creating bubbles. Cap the tube.	

6. Wipe the tube thoroughly with a lint-free cloth.	
7. Open the meter lid. Insert the tube into the chamber. Align the index line on the tube with the index arrow on the meter. Close the lid.	
8. Press ENTER to select **Scan Sample** and scan the sample. The screen will display **Reading** for about 1 second. The result will appear on the screen.	Turbidity NB (N) 10.22 NTU Scan Blank Scan Sample 12:00:00 001/500

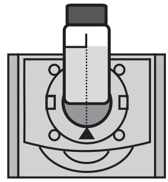
■ ANALYSIS WITH BLANKING PROCEDURE

To obtain the most accurate results the meter should be blanked before measuring a sample. The blanking step is not as critical for samples above 10 NTU. The meter should always be blanked before reading samples below 10 NTU.

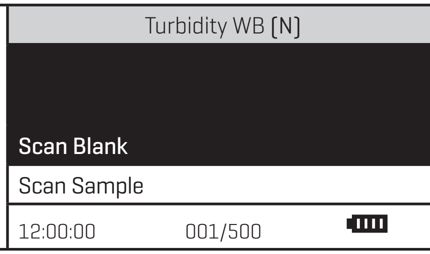
1. Press and briefly hold to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.	Main Menu Measure Data Logging Options 12:00:00 001/500
2. Press ENTER to select **Measure**.	Measure Menu (N) Turbidity - No Blank Turbidity - With Blank 12:00:00 001/500

3. Press ∨ to scroll to **Turbidity - With Blank.**	Measure Menu (N) **Turbidity - No Blank** Turbidity - With Blank
4. Press ENTER to select **Turbidity - With Blank.**	Turbidity WB (N) Scan Blank **Scan Sample** 12:00:00 001/500
5. Rinse a clean tube (0260) three times with the blank. If samples are expected to read below 1 NTU the meter should be blanked with a 0 NTU Primary Standard or prepared turbidity-free (<0.1 NTU) water. For the most accurate results, use the same tube for the blank and the sample.	
6. Fill the tube to the fill line with the blank. Pour the blank down the inside of the tube to avoid creating bubbles. Cap the tube.	
7. Wipe the tube thoroughly with a lint-free cloth.	

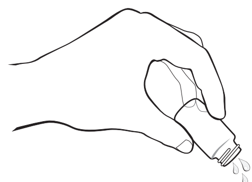
8. Open the meter lid. Insert the tube into the chamber. Align the index line on the tube with the index arrow on the meter. Close the lid.



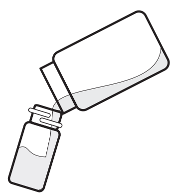
9. Press **ENTER** to select **Scan Blank** and scan the blank. The screen will display **Blank Done** for about 1 second and then return to the **Turbidity – With Blank** menu.



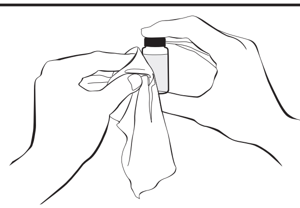
10. Rinse a clean tube (0260), or the same tube, three times with the sample.



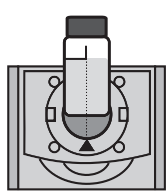
11. Fill the tube to the fill line with the sample. Pour the standard down the inside of the tube to avoid creating bubbles. Cap the tube.



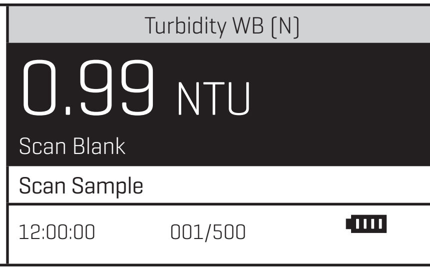
12. Wipe the tube thoroughly with a lint-free cloth.



13. Open the meter lid. Insert the tube into the chamber. Align the index line on the tube with the index arrow on the meter. Close the lid.



14. Press ENTER to select **Scan Sample** and scan the sample. The screen will display **Reading** for about 1 second. The result will appear on the screen. "Overrange" will be displayed if the reading is out of range. Dilute the sample or select a mode that is appropriate for the range of the sample.



NOTE: The meter will remember the last scanned blank reading. It is not necessary to scan a blank each time the test is performed. To use the previous blank reading, instead of scanning a new one, scroll to Scan Sample and proceed. For the most accurate results, the meter should be blanked before each test and the same tube should be used for the blank and the reacted sample.

DILUTION PROCEDURES

If a sample is encountered that is more than 2000 NTU or FNU, a careful dilution with 0 NTU/FNU or very low turbidity water will bring the sample into an acceptable range. However, there is no guarantee that halving the concentration will exactly halve the NTU or FNU value. Particulates often react in an unpredictable manner when diluted.

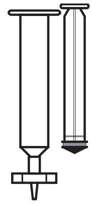
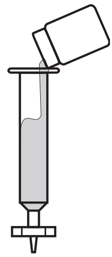
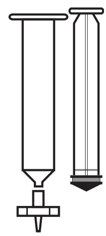
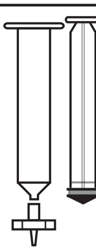
Turbidity-Free Water

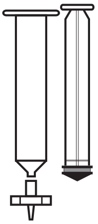
The definition of low turbidity and turbidity-free water has changed as filter technology has changed and nephelometric instruments have become more sensitive. At one time turbidity-free water was defined as water that had passed through a 0.6 micron filter. Now 0.1 micron filters are available and higher purity water is possible. Water that has been passed through a 0.1 micron filter could be considered particle free and therefore turbidity free, 0 NTU water. Turbidity is caused by scattered light. Therefore, low turbidity water is water without any particles that scatter a measurable amount of light. But water that passed through a 0.1 micron filter may still have detectable light scatter with modern instruments. This light scattering can be the result of dissolved molecules or sub-micron sized particles that can not be filtered out of the water. Because there may still be a small amount of scattered light from dissolved molecules, high purity water is often called low turbidity water and assigned a value of 0.01 or 0.02 NTU. However, because this water is used as a baseline to compare to sample water, the difference between the sample and the low turbidity or turbidity-free water will be the same whether it is called 0.00 NTU or 0.02 NTU. For design simplicity the 2020t/i uses the term turbidity-free water and the value of 0.00 NTU.

PREPARATION OF TURBIDITY-FREE WATER

A 0 NTU/FNU Standard (Code 1480) is included with the meter. Accessories are available for preparing turbidity-free water for blanking the meter and dilution of high turbidity samples.

The preparation of turbidity-free water requires careful technique. Introduction of foreign matter will affect the turbidity reading. A filtering device with a special membrane filter is used to prepare turbidity-free water. The filter, filter holder and syringe must be conditioned by forcing at least two syringes full of deionized water through the filtering apparatus to remove foreign matter. The first and second rinses should be discarded. Turbidity-free water as prepared with the following procedure may be stored in the dark at room temperature in a clean glass bottle with a screw cap and used as required. The storage container should be rinsed thoroughly with filtered deionized water before filling. The water should be periodically inspected for foreign matter in bright light.

1. Remove the plunger from the syringe (0943). Attach a filter (2-2097) to the bottom of the syringe.	
2. Pour approximately 50 mL of deionized water into the barrel of the syringe. Insert the plunger. Exert pressure on the plunger to slowly force the water through the filter. Collect water in the clean storage container. Rinse walls of the container then discard this rinse water.	
3. Remove the filter from the syringe. Remove the plunger from the barrel. (This step is required to prevent rupturing the filter by the vacuum that would be created when the plunger is removed.)	
4. Replace the filter and repeat step 2 for a second rinse of the syringe and storage container.	
5. Remove the filter from the syringe. Remove the plunger from the barrel. Replace the filter and fill the syringe with approximately 50 mL of deionized water. Filter the water into the storage container and save this turbidity-free water.	

6. Repeat Step 5 until the desired amount of turbidity-free water has been collected.	

■ TESTING TIPS

1. Samples should be collected in a clean glass or polyethylene container.
2. Samples should be analyzed as soon as possible after collection.
3. Gently mix sample by inverting before taking a reading but avoid introducing air bubbles.
4. For the most precise results, follow the recommended procedure for wiping a filled tube before placing it in the meter chamber. Invert tube very slowly and gently three times to mix the sample. Surround the tube with a clean, lint-free cloth. Press the cloth around the tube. Rotate the tube in the cloth three times to assure that all areas of the tube have been wiped. Place tubes in the chamber with the same orientation each time.
5. Discard tubes that have significant scratches and imperfections in the light pass zones. (Central zone between bottom and fill line).
6. When reading very low turbidity samples, do not use tubes or caps that have been used previously with high turbidity samples.
7. Use the averaging option for low level measurements of turbidity.
8. The meter should be placed on a surface that is free from vibrations. Vibrations can cause high readings.
9. Turbidity readings will be affected by electric fields around motors.
10. Carbon in the sample will absorb light and cause low readings.
11. Excessive color in a sample will absorb light and cause low readings. The user should verify if a certain level of color will cause a significant error at the level of turbidity being tested. Use of the Ratiometric calibration curve is recommended for highly colored samples.
12. Observe shelf life recommendations for turbidity standards.
13. Do not use silicone oil on tubes when testing turbidity with the 2020t/i.
14. When testing at low concentrations use the same tube for the blank and the sample.
15. Always insert tube into the meter chamber with the same amount of pressure and to the same depth.
16. Occasionally clean the chamber with a damp lint-free wipe, followed by a Windex® dampened wipe. A clean chamber and tubes are essential for reliable results.
17. For the greatest accuracy during the calibration procedure, be sure that after the meter is blanked and the blank is scanned as a sample, the reading is 0.00. If not, reblank the meter and scan the blank again until it reads 0.00. When scanning the calibration standards as the sample, scan the calibration standard three times removing the tube from the chamber after each scan. The readings should be

consistent. Use the last consistent reading to calibrate the meter. If the readings are not consistent, avoid using an aberrant reading to calibrate the meter.

18. Calibrate the meter daily.
19. Calibrate the meter with a standard that is closest to the expected range of the sample being tested. For example, if the sample is expected to be less than 1.0 NTU, calibrate with a 1.0 NTU standard and a blank (0 NTU standard). If the sample is expected to be around 2 NTU also calibrate with the 1.0 NTU standard but if the sample is expected to be around 8 NTU calibrate with a 10 NTU standard. If the sample is expected to be over 30 – 40 NTU it is recommended that the meter be calibrated with a 100 NTU standard.
20. To maintain a consistent lamp temperature, do not turn the meter on and off when analyzing samples.

TROUBLESHOOTING GUIDE

■ TROUBLESHOOTING

PROBLEM	REASON	SOLUTION
"Blank?"	Sample is reading lower than the blank.	With samples of very low concentration reblank or record as zero. On samples of higher concentration reblank and read again.
 Flashing	Low battery. Readings are reliable.	Charge battery or use USB wall/computer charger.
"Low Battery"	Battery voltage is very low. Readings are not reliable.	Charge battery or use USB wall/computer charger.
"Shut Down Low Batt" Shut Down	Battery is too low to operate the unit.	Charge battery or use USB wall/computer charger.
"Over range"	Sample is outside of acceptable range.	Dilute sample and test again.
"Error1"	High readings with 90° and 180° detectors.	Dilute sample by at least 50% and retest.
Unusually large negative or positive readings when performing calibration	Incorrect standards used to calibrate meter.	Use fresh 0.0 standard in clean tube. Recalibrate meter.

■ STRAY LIGHT

The accuracy of readings on the 2020t/i should not be affected by stray light. Make sure that the sample compartment lid is always fully closed when taking readings. The backlight will interfere with turbidity readings. The meter will temporarily disable the backlight while turbidity measurements are being taken.

GENERAL OPERATING INFORMATION

OVERVIEW

The 2020t/i is a portable, microprocessor controlled, direct reading nephelometer. Turbidity is measured directly according to EPA Method 180.1 or ISO Method 7027, or is calculated ratiometrically by using a combination of the two measurements. It has a graphical liquid crystal display and six button keypad. These allow the user to select options from the menu driven software, to directly read test results or to review stored results of previous tests in the data logger. The menus can be displayed in seven different languages.

The 2020t/i uses a state of the art, multi-detector optical configuration that assures long term stability of calibrations, high precision and accuracy and low detection limits. All readings are determined by digital signal processing algorithms, minimizing fluctuations in readings and enabling rapid, repeatable measurements. The microprocessor and optics enable a dynamic range and auto-ranging over several ranges. Energy efficient LED light sources are used for ISO turbidity. EPA turbidity uses a tungsten filament light source that meets or exceeds EPA specifications and is designed for a uniform light spot image and stable output.

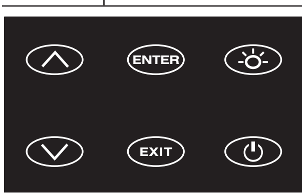
A USB wall adapter, USB computer connection or lithium battery powers the 2020t/i.

GENERAL OPERATING INFORMATION

The operation of the 2020t/i is controlled by the menu driven software and user interface. A menu is a list of choices. This allows a selection of various tasks for the 2020t/i to perform, such as, scan blank and scan sample. The keypad is used to make menu selections that are viewed on the display.

THE KEYPAD

	This button will scroll up through a list of menu selections.
ENTER	The button is used to select choices in a menu viewed in the display.
	This button controls the backlight on the display.
	This button will scroll down through a list of menu selections.
EXIT	This button exits to the previous menu.
	This button turns the meter on or off.

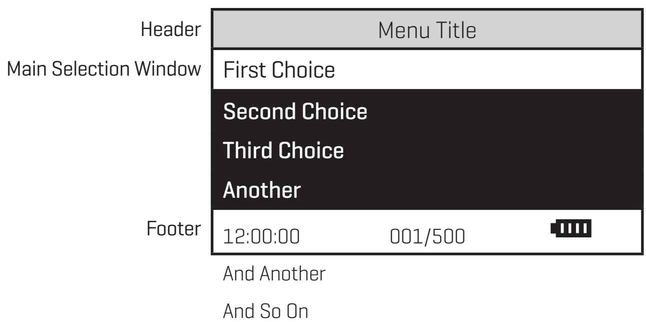


THE DISPLAY & MENUS

The display allows menu selections to be viewed and selected. These selections instruct the 2020t/i to perform specific tasks. The menus are viewed in the display using two general formats that are followed from one menu to the next. Each menu is a list of choices or selections.

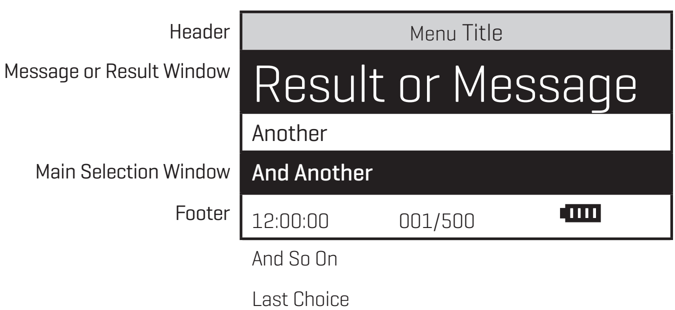
The display has a header line at the top and a footer line at the bottom. The header displays the title of the current menu. The footer line displays the time and the date, the data logger status and the battery status. The menu selection window is in the middle of the display between the header and the footer.

The menu selection window displays information in two general formats. In the first format only menu selections are displayed. Up to 4 lines of menu selections may be displayed. If more selections are available they can be viewed by pressing the arrow buttons to scroll the other menu selections into the menu selection window. Think of the menu selections as a vertical list in the display that moves up or down each time an arrow button is pressed. Some menus in the 2020t/i are looping menus. The top and bottom menu choices are connected in a loop. Scrolling down past the bottom of the menu will lead to the top of the menu. Scrolling up past the top of the menu will lead to the bottom of the menu.



A light colored bar will indicate the menu choice. As the menu is scrolled through, the light colored bar will highlight different menu choices. Pressing the ENTER button will select the menu choice that is indicated by the light colored bar.

In the second format the menu choice window takes advantage of the graphical capabilities of the display. Large format graphic information, such as test results or error messages or the LaMotte logo is displayed. The top two lines of the display are used to display information in a large, easy to read format. The menus work in the same way as previously described but only two lines of the menu are visible at the bottom of the display.



As described previously, the **EXIT** button allows an exit or escape from the current menu and a return to the previous menu. This allows a rapid exit from an inner menu to the main menu by repeatedly pushing the **EXIT** button. Pushing ⏻ at any time will turn the 2020t/i off.

The display may show the following messages:

	Battery Status
↑ ↓	More choices are available and can be viewed by scrolling up and/or down through the display.
Header	Identifies the current menu and information on calibration curves and reagent systems if applicable.
Footer	In the data logging mode the number of the data point is displayed and the total number of data points in the memory will be shown. The footer also shows current time and battery status

NEGATIVE RESULTS

There are always small variations in readings with analytical instruments. Often these variations can be observed by taking multiple readings of the same sample. These normal variations will fall above and below an average reading. Repeated readings on a 0.00 sample might give readings above and below 0.00. Therefore, negative readings are possible and expected on samples with concentrations at or near zero. This does not mean there is a negative concentration in the sample. It means the sample reading was less than the blank reading. Small negative readings can indicate that the sample was at or near the detection limit. A large negative reading, however, is not normal and indicates a problem. Some instruments are designed to display negative readings as zero. In this type of instrument, if the meter displayed zero when the result was actually a large negative number there would be no indication that a problem existed. For this reason, the 2020t/i displays negative numbers for turbidity.

TUBES AND CHAMBERS

The 2020t/i uses a specific tube (Code 0260).

The handling of the tubes is of utmost importance. Tubes must be clean and free from lint, fingerprints, dried spills and significant scratches, especially the central zone between the bottom and the sample line.

Scratches, fingerprints and water droplets on the tube can cause stray light interference leading to inaccurate results when measuring turbidity. Scratches and abrasions will affect the accuracy of the readings. Tubes that have been scratched in the light zone through excessive use should be discarded and replaced with new ones.

Tubes should always be washed on the inside and outside with mild detergent prior to use to remove dirt or fingerprints. The tubes should be allowed to air-dry in an inverted position to prevent dust from entering the tubes. Dry tubes should be stored with the caps on to prevent contamination.

After a tube has been filled and capped, it should be held by the cap and the outside surface should be wiped with a clean, lint-free absorbent cloth until it is dry and smudge-free. Handling the tube only by the cap will avoid problems from fingerprints. Always set the clean tube aside on a clean surface that will not contaminate the tube. It is imperative that the tubes and light chamber be clean and dry. The outside of the tubes should be dried with a clean, lint-free cloth or disposable wipe before they are placed in the meter chamber.

Tubes should be emptied and cleaned as soon as possible after reading a sample to prevent deposition of particulates on the inside of the tubes. When highly accurate results are required, reduce error by designating tubes to be used only for very low turbidity and very high turbidity testing.

Variability in the geometry of the glassware and technique are the predominate cause of variability in results. Slight variations in wall thickness and the diameter of the tubes may lead to slight variations in the test results. To eliminate this error the tubes should be placed in the chamber with the same orientation each time.

Chambers which have been scratched through excessive use should be discarded and replaced with a new one.

MAINTENANCE

■ CLEANING

Clean the exterior housing with a damp, lint-free cloth. Do not allow water to enter the light chamber or any other parts of the meter. To clean the light chamber and optics area, point a can of compressed air into the light chamber and blow the pressurized air into the light chamber. Use a cotton swab dampened with Windex® window cleaner to gently swab the interior of the chamber. Do not use alcohol; it will leave a thin residue over the optics when dry.

■ REPAIRS

Should it be necessary to return the meter for repair or servicing, pack the meter carefully in a suitable container with adequate packing material. A return authorization number must be obtained from LaMotte Company by calling 800-344-3100 (US only) or 410-778-3100, faxing 410-778-6394, or emailing tech@lamotte.com. Often a problem can be resolved over the phone or by email. If a return of the meter is necessary, attach a letter with the return authorization number, meter serial number, a brief description of problem and contact information including phone and FAX numbers to the shipping carton. This information will enable the service department to make the required repairs more efficiently.

■ METER DISPOSAL

Waste Electrical and Electronic Equipment (WEEE)

Natural resources were used in the production of this equipment. This equipment may contain materials that are hazardous to health and the environment. To avoid harm to the environment and natural resources, the use of appropriate take-back systems is recommended. The crossed out wheeled bin symbol on the meter encourages the use of these systems when disposing of this equipment.

Take-back systems will allow the materials to be reused or recycled in a way that will not harm the environment. For more information on approved collection, reuse, and recycling systems contact local or regional waste administration or recycling services.

ÍNDICE

Consulte la **Guía de inicio rápido** para procedimientos de calibración y análisis simplificados.

Consulte la **Guía de análisis** para procedimientos de calibración y análisis detalladas con el fin de mejorar la precisión de las mediciones de turbidez de rango bajo.

Consulte la **Guía de inicio** rápido para procedimientos de calibración y análisis simplificados.

Consulte la **Guía de análisis** para procedimientos de calibración y análisis detalladas con el fin de mejorar la precisión de las mediciones de turbidez de rango bajo.

INFORMACIÓN GENERAL

EMBALAJE Y DEVOLUCIONES

El personal experimentado responsable del embalaje en LaMotte Company se asegura de proteger adecuadamente el producto frente a los riesgos normales que conlleva el transporte de los envíos.

Cuando el producto sale de LaMotte Company, la responsabilidad de una entrega segura está garantizada por la empresa de transportes. Las reclamaciones por daños deben presentarse de inmediato ante la empresa de transportes para recibir una compensación por los productos dañados.

PRECAUCIONES GENERALES

LEA EL MANUAL DE INSTRUCCIONES ANTES DE INTENTAR CONFIGURAR O UTILIZAR EL FOTÓMETRO. No hacerlo puede conllevar lesiones personales o daños al fotómetro. No use ni guarde el fotómetro en un entorno húmedo o corrosivo. Conviene tener cuidado para evitar que el agua de los tubos húmedos entre en la cámara del fotómetro.

NO COLOQUE NUNCA TUBOS HÚMEDOS EN EL FOTÓMETRO.

PRECAUCIONES DE SEGURIDAD

*ADVERTENCIA: los reactivos marcados con un * se consideran riesgos potenciales para la salud. Si quiere ver o imprimir una ficha de datos de seguridad (SDS) de estos reactivos, visite www.lamotte.com.

Busque el código reactivo de cuatro dígitos que aparece en la etiqueta del reactivo, en la lista de contenido o en los procedimientos de análisis. Omita cualquier letra que siga o anteceda al código de cuatro dígitos.

Por ejemplo, si el código es 4450WT-H, busque 4450. Para obtener una copia impresa, contacte con LaMotte por correo electrónico, teléfono o fax.

Puede obtener información para casos de emergencia sobre todos los reactivos de LaMotte en el teléfono: (EEUU, 1-800-255-3924) (Internacional, a cobro revertido, 813-248-0585).

Compruebe que la protección facilitada por este equipo no esté dañada. No instale ni use este equipo de una forma distinta a la indicada en este manual.

LIMITACIÓN DE RESPONSABILIDAD

En ningún caso será LaMotte Company responsable de la pérdida de vidas, propiedades, beneficios u otros daños en que se incurra al utilizar o abusar de sus productos.

ESPECIFICACIONES - 2020t/i

Modo	Nefelométrico	Ratiométrico	Atenuación
Unidad de medida **2020t**	NTU, ASBC, EBC	NTU, NTRU, ASBC, EBC	NTU, AU, ASBC, EBC
Unidad de medida **2020i**	NTU, FNU, ASBC, EBC	NTU, FNRU, ASBC, EBC	NTU, FAU, ASBC, EBC
Rango	0-100 NTU/FNU 0-1,750 ASBC 0-25 EBC	0-1,000 NTRU/FNRU 0-17,500 ASBC 0-250 EBC	0-2,000 AU/FAU 0-70,000 ASBC 0-1,000 EBC
Resolución	0–10.99 NTU/FNU: 0.01 NTU/FNU, 11.0–100.0 NTU/FNU: 0.1 NTU/FNU	0–10.99 NTRU/FNRU: 0.01 NTRU/FNRU, 11.0–109.9 NTRU/FNRU: 0.1 NTRU/FNRU, 110–1000 NTRU/FNRU: 1 NTRU/FNRU	0–2000 AU/FAU: 1 AU/FAU
Precisión	0-2.5 NTU/FNU: ±0.05 NTU/FNU, 2.5-100 NTU/FNU: ±2%	0-2.5 NTRU/FNRU: ±0.05 NTRU/FNRU, 2.5-100 NTRU/FNRU: ±2%, 100-1000 NTRU/FNRU: ±3%.	0-2000 AU/FAU: ±10 AU/FAU or 6% el que sea mayor
Límite de detección	0,05 NTU/FNU	0,05 NTRU/FNRU	10 AU/FAU
Reproducibilidad	0,02 NTU/FNU o 1 %	0,02 NTRU/FNRU o 1 %	1%
Selección de rango	Automática		
Fuente de luz	2020t Lámpara de tungsteno 2300 °K ±50 °K, 2020i: LED IR 860 nm ±10 nm, ancho de banda espectral con 50 nm		
Detector:	2020t Fotodiodo, centrado a 90° y 180°, nivel máximo 400-600 nm 2020t/i: Fotodiodo, centrado a 90° y 180°		
Tiempo de respuesta:	<2 segundos		
Promediador de señal	Sí		
Cámara de muestra:	Acepta tubos de ensayo de fondo plano y 25 mm de diámetro		
Muestra:	10 ml en tubo tapado		
Pantalla:	Pantalla gráfica de cristal líquido con retroiluminación		
Software:	Auto Apagado: 5, 10, 30 min, calibración desactivada: Campo ajustable, en blanco y 1 punto Registro de datos: 500 puntos		
Idiomas:	inglés, español, francés, portugués, italiano, chino y japonés (kana).		
Temperatura:	Funcionamiento: 0-50 °C; almacenamiento: -40-60 °C		
Rango de humedad durante el funcionamiento	0-90 % HR, sin condensación		
Auto Apagado:	5, 10, 30 min, desactivado		
Fuente de alimentación:	Adaptador de pared USB, conexión al ordenador por USB o batería recargable interna de litio-ión		

Batería	Duración de la carga: Aproximadamente 380 pruebas con la retroiluminación activada y hasta 1000 pruebas con la retroiluminación apagada. (Promediador de señal desactivado). Vida de la batería: Unas 500 cargas.
Clasificaciones eléctricas:	voltaje clasificado (5 V), potencia de corriente de entrada (1,0A) en puerto miniUSB.
Registro de Datos:	500 resultados de pruebas almacenados
Impermeable:	IP67 con conector de puerto USB en su sitio.
Dimensiones:	(An x L x Al) 8,84 × 19,05 × 2,5 cm, 3,5 x 7,5 x 2,2 pulgadas
Certificaciones:	CE Mark / Safety: Low Voltage Directive (2006/95/EC) IEC 61010-1:2001, EN 601010-1:2001, 2nd edition EU / EMC: EMC Directive (2004/108/EC) EN 61326-1:2006, EN 61000-4-2:1995 including A1:1998 and A2:2001, EN 61000-4-3:2002, EN 61000-4-4:2004, EN 61000-4-5:1995 including A1:2001, EN 61000-4-6:1996 and A1:2001, EN 61000-4-11:2004, EN 55011:2007, IEC 61000-3-2:2005, EN 61000-3-2:2006, IEC 61000-3-3:1994, EN 61000-3-3:1995 including A1:2001 and A2:2005 US / EMC: CFR 47, Part 15 Subpart B:2007 CAN / EMC: ICES-003, Issue 4, February 2004 AU/NZ / EMC: AU/NZ: CISPR 11:2004
Peso:	362 g, 13 oz (solo el fotómetro)
Interfaz USB:	Mini B

DEFINICIONES ESTADÍSTICAS Y TÉCNICAS RELACIONADAS CON LAS ESPECIFICACIONES DE PRODUCTO

Límite de detección de método (MDL) : «El límite de detección del método (MDL) se define como la concentración mínima de una sustancia que puede medirse y notificarse con una fiabilidad del 99 % de que la concentración de analito es superior a cero y se determina a partir del análisis de una muestra en una matriz concreta que contiene el analito».[1] Tenga en cuenta que, tal y como declaró el Dr. William Horwitz una vez, «En casi todos los casos en los que se trata un límite de detección o de determinación, el objetivo principal de determinar dicho límite es mantenerse alejado de él».[2]

Precisión : la precisión es la proximidad de una medición al valor aceptado o verdadero.[3] La precisión puede expresarse como un rango, en torno al valor verdadero, en el que se produce una medición (es decir, ±0,5 ppm). También puede expresarse como el porcentaje de recuperación de una cantidad conocida de analito en una determinación del analito (es decir, 103,5 %).

Resolución : la resolución es la diferencia discernible más pequeña entre dos mediciones cualesquiera que se puedan hacer.[4] En el caso de los fotómetros, esta suele ser la cantidad de decimales que se muestran (es decir, 0,01). Tenga en cuenta que la resolución cambia con la concentración o el rango. En algunos casos la resolución puede ser menor que el intervalo más pequeño, si es posible hacer una lectura que se sitúe entre las marcas de calibración. Una pequeña advertencia: esa resolución tiene muy poca relación con la exactitud o la precisión. La resolución siempre será menor que la exactitud o precisión, pero no es una medida estadística de lo bien que funciona un método de análisis. ¡La resolución puede ser muy, muy buena y la exactitud y precisión pueden ser muy malas! Esta no es una medida útil del rendimiento de un método de prueba.

Repetitividad : la repetitividad es la precisión dentro de la serie.[5] Una serie es un único conjunto de datos, desde la puesta en marcha hasta la limpieza. Generalmente, le ejecución de una serie se realiza en un día. Sin embargo, para las calibraciones de fotómetros, una sola calibración se considera una sola serie o conjunto de datos, aunque pueda tardar 2 o 3 días.

Reproducibilidad: la reproducibilidad es la precisión entre series.[6]

Límite de detección (DL) : el límite de detección (DL) para 2020t/i se define como el valor o la concentración mínimos que pueden ser determinados por el fotómetro, que es mayor que cero, independientemente de la matriz, el cristal y otras fuentes de error en el manejo de muestras. Es el límite de detección para el sistema óptico del fotómetro.

[1] CFR 40, parte 136, anexo B
[2] Statistics in Analytical Chemistry: Part 7 – A review, D. Coleman y L Vanatta, American Laboratory, sept. 2003, P. 31.
[3] Skoog, D.A., West, D. M., Fundamental of Analytical Chemistry, 2nd ed., Holt Rinehart and Winston, Inc, 1969, p. 26.
[4] Statistics in Analytical Chemistry: Part 7 – A review, D. Coleman y L Vanatta, American Laboratory, sept. 2003, P. 34.
[5] Jeffery G. H., Basset J., Mendham J., Denney R. C., Vogel's Textbook of Quantitative Chemical Analysis, 5th ed., Longman Scientific & Technical, 1989, p. 130.
[6] Jeffery G. H., Basset J., Mendham J., Denney R. C., Vogel's Textbook of Quantitative Chemical Analysis, 5th ed., Longman Scientific & Technical, 1989, p. 130

CONTENIDO Y ACCESORIOS

	Kit 2020t Versión EPA Código 1974-T	**Kit 2020i** Versión ISO Código 1974-I
Índice	**Código**	**Código**
2020t/i Turbidímetro		
Estándar 0 NTU, 60 ml	1480	1480
Estándar 1 NTU, 60 ml	1441	
Estándar 10 NTU/FNU, 60 ml	1442	1447
Estándar 100 FNU, 60 ml		1444
Botella de muestra de agua, 60 ml	0688	0688
Tubos de ensayo, con tapones	0260 (6)	0260 (6)
Cable, USB	1720	1720
Adaptador de pared USB	1721	1721
Manual 2020t/i	1974-MN	1974-MN
Guía de inicio rápido 2020t/i	1974-QG	1974-QG
Guía de análisis 2020t/i	1974-TG	1974-TG

Accesorios	
Código	**Descripción**
0260-6	Tubos de ensayo, con tapones
1446	Estándar 1 FNU, 60 ml (ISO)
1443	Estándar 100 NTU, 60 ml (EPA)
6195-H	Solución estándar de formacina, 4000 NTU, 60 ml
3-0038	Cámara de repuesto
0943	Jeringa, 60 mL, el plastico
2-2097	Filtros, 0,1 micras, paquete de 50
5-0132	Cargador para coche

CONFORMIDAD EPA

El fotómetro 2020t cumple o supera las especificaciones de diseño de la EPA para los programas de control de turbidez NPDWR y NPDES según lo especificado por el método 180.1 de la USEPA.

CONFORMIDAD ISO

Este fotómetro 2020i cumple con los criterios de diseño de métodos cuantitativos de la turbidez utilizando tubidímetros ópticos, según se contempla en la ISO 7027.

CONFORMIDAD CE

Este dispositivo cumple lo dispuesto en la Parte 15 de las normas FCC. El funcionamiento está sujeto a las dos condiciones siguientes: (1) este dispositivo no puede causar interferencias graves; y (2) este dispositivo debe aceptar cualquier interferencia recibida, incluyendo interferencia que pueda ocasionar un funcionamiento no deseado.

Nota: Este equipo ha sido analizado y se confirma que cumple los límites de dispositivo digital de Clase A, conforme a la Parte 15 de las normas FCC. Estos límites están diseñados para proporcionar una protección razonable contra interferencias graves cuando el equipo está funcionando en un entorno comercial. Este equipo genera, usa y puede emitir energía de radiofrecuencia y, en caso de no estar instalado o de no usarse conforme al manual de instrucciones, puede ocasionar graves interferencias en las radiocomunicaciones. Es probable que el funcionamiento de este equipo en un área residencial cause interferencias perjudiciales, en cuyo caso el usuario deberá corregir la interferencia por su propia cuenta.

CONFORMIDAD IP67

El 2020t/i cumple la norma IP67 para la protección frente a polvo e inmersión solo cuando el conector de puerto USB está en su sitio. La documentación está disponible en www. lamotte.com.

GARANTÍA

LaMotte Company garantiza que este instrumento está libre de defectos en las piezas y la calidad durante dos años desde la fecha del envío. Si fuese necesario devolver el instrumento para su mantenimiento durante el periodo de garantía o después, póngase en contacto con el departamento de Servicio Técnico en el 1-800-344-3100 para obtener un número de autorización de devolución o visite www.lamotte.com para consultar la sección de resolución de incidencias. Al remitente le corresponde asumir los costes de envío, flete, seguro y embalaje seguro para evitar daños durante el transporte. Esta garantía no se aplica a los defectos resultantes de acciones del usuario como el uso incorrecto, el cableado incorrecto, el manejo sin respetar las especificaciones, el mantenimiento o la reparación inadecuados, o la modificación no autorizada. LaMotte Company niega específicamente cualquier garantía, comerciabilidad o idoneidad implícitas para un fin concreto y no será responsable por cualquier daño directo, indirecto, incidental o consecutivo. La responsabilidad total de LaMotte Company se limita a reparar o cambiar el producto. La garantía estipulada anteriormente está completa y no existe ninguna otra garantía, ni escrita ni oral, expresa o implícita.

■ REGISTRE SU FOTÓMETRO

Para inscribir su medidor en el departamento de Mantenimiento de LaMotte, visite www.lamotte.com y elija SUPPORT en la barra de navegación superior.

CONEXIÓN AL ORDENADOR

■ SALIDA

USB

■ CONEXIÓN AL ORDENADOR

USB tipo A, USB mini B, Código de pedido del cable 1720.

■ FUNCIONAMIENTO BATERÍA/CORRIENTE ALTERNA

El 2020t/i puede utilizarse con batería, a través de un adaptador USB de pared o a través de una conexión USB al ordenador. Si utiliza el fotómetro como unidad de sobremesa, use el adaptador de pared, si es posible, para prolongar la vida de la batería. El fotómetro permanecerá encendido mientras esté usando el adaptador USB.

Para cargar la batería con el adaptador de pared, conecte el extremo más estrecho del cable USB (conector USB mini B) al fotómetro y el extremo más grande al cable USB (conector USB tipo A) al adaptador de pared. Conecte el adaptador de pared a una toma de corriente. Introduzca de nuevo el conector de puerto USB tras la carga.

Para cargar la batería desde un ordenador, conecte el extremo más estrecho del cable USB (conector USB mini B) al fotómetro y el extremo más grande del cable USB (conector USB tipo A) al puerto USB del ordenador. Introduzca de nuevo el conector de puerto USB tras la carga.

El icono de la batería no mostrará ninguna barra de estado y parpadeará cuando la unidad se encienda por primera vez. A continuación el indicador mostrará el estado de la batería con 0, 1, 2, 3 o 4 barras.

Cargar por completa una batería baja tarda 5 horas. El icono de la batería parpadeará cuando la batería esté cargándose. El icono de la batería mostrará cuatro barras y dejará de parpadear cuando esté completamente cargada. El circuito de carga cambiará automáticamente a carga de flotación cuando la batería esté completamente cargada. El cargador puede seguir conectado. Algunos ordenadores NO suministran corriente a sus puertos USB durante el modo standby. El adaptador de pared cargará la unidad continuamente.

El icono de la batería no mostrará ninguna barra y parpadeará continuamente si la batería está agotándose, pero la unidad seguirá funcionando con normalidad. El mensaje de «Batería baja» en la barra de estado de la pantalla reemplazará la hora cuando el voltaje de la batería sea demasiado bajo para funcionar correctamente y la precisión pueda verse mermada. El mensaje de «Apagado por batería baja» aparecerá en pantalla durante unos segundos antes de que se desconecte la unidad cuando el voltaje de la batería sea demasiado bajo para funcionar.

Para prolongar la vida de la batería:

- Desconecte la unidad mediante el interruptor cuando no esté tomando medidas o use la opción de ahorro energético para que la unidad se apague automáticamente transcurridos 5 minutos.
- Guarde la unidad en un lugar fresco y seco.
- Cargue la batería completamente antes de almacenar la unidad durante periodos de tiempo prolongados.
- Limite el uso de la retroiluminación, La unidad consume 3 veces más potencia de lo normal con la retroiluminación activada. Fije la opción de tiempo de retroiluminación a 10 segundos o seleccione "Control por botón" y mantenga la retroiluminación desactivada.

Cambio de batería : La batería de litio-ión usada en esta unidad debería durar muchos años con un uso normal. Cuando deje de conectar la unidad el tiempo suficiente para cumplir los requisitos de análisis, será necesario reemplazarla. Las baterías de litio-ión que se cargan y se almacenan correctamente no suelen reducir su capacidad; solo tienen una menor capacidad tras cientos de ciclos de carga. Esta unidad utiliza una batería especial que solo está disponible en LaMotte Company. El cambio de batería debe realizarse en un centro de reparación autorizado de LaMotte. El usuario no debe abrir la carcasa impermeable del fotómetro. Contacte con LaMotte Company por teléfono (1-800-344-3100) o correo electrónico (tech@lamotte.com) para solicitar un número de autorización de devolución.

TURBIDEZ

¿QUÉ ES LA TURBIDEZ?

La turbidez es una propiedad óptica que resulta cuando la luz pasa a través de una muestra líquida y se dispersa por la materia de partículas. La dispersión de la luz provoca un cambio en la dirección de la luz que pasa a través del líquido. Si la turbidez es baja, las partículas pueden ser invisibles a simple vista y gran parte de la luz continuará en la dirección original. A medida que la cantidad de partículas aumenta en las muestras con mayor turbidez, la luz incide sobre las partículas en solución y se dispersa hacia atrás, hacia los lados y hacia delante. La luz dispersada por las partículas permite que las partículas de la solución sean «visibles» o se detecten de la misma manera que la luz solar permite que las partículas de polvo en el aire se vean. A altas concentraciones, la turbidez se percibe como nubosidad, neblina o ausencia de claridad. La turbidez no es específica de los tipos de partículas en la muestra. Las partículas pueden estar suspendidas o ser coloidales, y pueden tener orígenes inorgánicos, orgánicos o biológicos.

En el agua potable, la turbidez puede indicar un problema de tratamiento o condiciones de señal con un mayor riesgo de enfermedades gastrointestinales. Debido a que patógenos como el *criptosporidio* y la *giardia* causan cantidades mensurables de turbidez, el control de la turbidez puede ser la clave para asegurar una adecuada filtración del agua. En 1998, la EPA publicó la norma IESWTR (norma de tratamiento de agua de superficie mejorada provisional) que autoriza la turbidez en los efluentes de filtración combinada a mostrar valores iguales o inferiores a 0,3 NTU. Al hacerlo, la EPA esperaba obtener una eliminación de 2 registros (99 %) del *criptosporidio*. Actualmente se está considerando la posibilidad de reducirla a 0,1 NTU. La tendencia ha sido verificar la calibración de los turbidímetros en línea utilizados para controlar el agua potable con unidades de campo portátiles. El diseño óptico y el bajo límite de detección del 2020t/i permiten lecturas muy precisas para dichas calibraciones. El agua potable turbia no siempre es perjudicial para la salud humana, pero ofrece una apariencia desagradable.

La turbidez en las aguas ambientales reduce la cantidad de luz solar beneficiosa que llega a la vegetación acuática sumergida, eleva la temperatura de las aguas superficiales, entierra los huevos y las criaturas que habitan en el fondo, y puede transportar sedimentos y pesticidas a través del sistema de agua.

¿CÓMO SE MIDE LA TURBIDEZ?

La turbidez se mide detectando y cuantificando la dispersión de la luz en una solución. La cantidad de luz que se dispersa está influenciada por las propiedades de las partículas relativas a color, forma, tamaño y reflectividad. La turbidez puede medirse de varias maneras, incluyendo métodos visuales y métodos instrumentales. Los métodos visuales son más adecuados para muestras con alta turbidez. Los métodos instrumentales pueden utilizarse para muestras con turbidez a todos los niveles.

Algunos ejemplos de métodos visuales son el método del disco de Secchi y el método de la vela de Jackson. El método del disco de Secchi se utiliza a menudo en aguas naturales. Un disco de Secchi con cuadrantes blancos y negros se introduce en el agua hasta que ya no puede verse. Luego se eleva hasta que se puede ver de nuevo. La media de estas dos mediciones se conoce como «profundidad de Secchi». El método de la vela de Jackson utiliza un largo tubo calibrado de vidrio colocado sobre una vela estándar. Se añade o se quita agua del tubo hasta que la llama de la vela se vuelve borrosa. La altura del agua en el tubo se mide con una escala calibrada y convertida a unidades de turbidez Jackson (JTU). El nivel más bajo de turbidez que puede determinarse con precisión con este método es de aproximadamente 25 JTU.

Los métodos instrumentales para medir la turbidez implican una combinación de ángulos de detección y fuentes de luz para optimizar la precisión en varias muestras y cumplir los requisitos normativos. Los turbidímetros 2020t y 2020i ofrecen la opción de tres curvas de calibración para medir la turbidez basada en las características de la muestra.

En el modo nefelométrico, que es el modo predeterminado, el detector que se encuentra a 90° de la fuente de luz mide la luz dispersa de un haz de luz que pasa a través de una muestra. En el 2020t, esta configuración y la lámpara de tungsteno, con una temperatura de color de 2.200-3.000 °K, cumplen los requisitos del método 180.1 de la EPA. El 2020i, que tiene una fuente de luz LED IR a 860 nm, utiliza el detector de 90° para cumplir los requisitos de la norma ISO 2027. El modo nefelométrico se utiliza mejor para cumplir los requisitos normativos de las muestras, como el agua potable, que se sitúan en el rango de 0,00 a 40,00 Unidades de Turbidez Nefelométrica (NTU) para 2020t o de 0,00 a 10,00 Unidades de Turbidez Nefelométrica de formacina (FNU) para 2020i. Una opción de promediador de señal mejora la estabilidad de las lecturas en muestras de baja turbidez.

El modo ratiométrico se utiliza normalmente para aguas naturales y aguas pluviales, u otras muestras en el rango de 0 - 1000 NTU/FNU, para minimizar la interferencia del color en la muestra. El modo ratiométrico toma lecturas tanto del detector de 90° como del detector de 180°. Los resultados se indican como Unidades del ratio de turbidez nefelométrica (NTRU, 2020t) o Unidades del ratio de formacina nefelométrica (FNRU, 2020i).

En el modo de atenuación, el detector se encuentra a 180° de la fuente de luz. Mide la atenuación del haz de luz debido a la absorción y dispersión. Este modo se utiliza mejor para medir muestras con altos niveles de turbidez en el rango de 40 - 4000 unidades de atenuación (AU, 2020t) o unidades de atenuación de formacina (FAU, 2020i).

UNIDADES DE TURBIDEZ

Tradicionalmente, los turbidímetros diseñados para uso en Estados Unidos se fabricaban según las especificaciones del método 180.1 de la EPA. Este método definió la NTU, unidad de turbidez nefelométrica, como una unidad que mide la turbidez en el rango de 0 - 40 NTU mediante un nefelómetro. Según la EPA, un nefelómetro era un turbidímetro que mide la turbidez con un detector de 90°. Si una muestra tenía una turbidez superior a 40 NTU, era necesaria una disolución para llevar la muestra al rango de 0 a 40 NTU. Hoy en día, muchos turbidímetros tienen detectores adicionales que aumentan el rango de medición de la turbidez, eliminan interferencias y, por lo general, mejoran el rendimiento. Actualmente, muchos turbidímetros son capaces de medir por encima de 40 NTU utilizando detectores que no sean de 90°. Aunque pueden utilizar un detector de 180°, que no cumple con la definición de nefelómetro, los resultados a menudo se indican como NTU.

Dado que la posición del detector y de la fuente de luz es información importante a incluir cuando se arrojan y comparan los resultados de turbidez, recientemente ha habido un esfuerzo por parte de la ASTM para usar unidades de turbidez que incluyan esta información. Para los fotómetros que cumplen con la EPA, las mediciones realizadas con un detector de 90° y una fuente de luz blanca incandescente se indican como Unidades de Turbidez Nefelométrica (NTU). Cuando se realiza una medición de atenuación con un detector de 180°, utilizando la misma fuente de luz, los resultados se indican como Unidades de Atenuación (UA). Si se utiliza un ratio de las mediciones de ambos detectores para calcular la turbidez, los resultados se presentan en Unidades del ratio de turbidez nefelométrica (NTRU).

El método ISO 7027, que especifica una fuente de luz de 860 nm, arroja resultados en cuatro unidades de turbidez. Cuando se utiliza el detector de 90°, los resultados se presentan como Unidades de formacina nefelométrica (FNU). Con una medición de atenuación realizada con un detector de 180°, los resultados se presentan como Unidades de atenuación de formacina (FAU). Y los resultados que son una relación de medidas desde los dos ángulos se presentan en Unidades del ratio de formacina nefelométrica (FNRU). También es posible presentar las lecturas de cada uno de los tres modos ISO en Unidades de turbidez nefelométrica (NTU).

Debe tenerse en cuenta que todas las unidades son numéricamente equivalentes si los fotómetros están calibrados con formacina. Las unidades diferencian qué detector y fuente de luz se utilizaron para realizar la medición. Por ejemplo, 1 NTU = 1 AU = 1 NTRU = 1 FNU =1 FAU = 1 FNRU.

Cada modo de calibración de turbidez tiene una unidad predeterminada:

Modo nefelométrico: NTU (2020t) o FNU (2020i)

Modo radiométrico: NTRU (2020t) o FNRU (2020i)

Modo de atenuación: AU (2020t) o FAU (2020i)

El fotómetro le permitirá al usuario elegir la presentación de resultados en cualquiera de las otras unidades de calibración disponibles (NTU, FNU, AU, FAU, NTRU o FNRU) que no sean la unidad predeterminada. También permite a la industria cervecera verificar el agua de proceso en el modo nefelométrico y elegir que los resultados se presenten en las unidades de la Sociedad Americana de Químicos de la Cerveza (American Society of Brewing Chemists, ASBC) o de la Convención Europea de Cerveceros (European Brewery Convention, EBC).

Acrónimos	Definiciones	Notas	Método normativo
NTU	Unidades de turbidez nefelométrica	Luz blanca incandescente entre 400 y 600 nm, detección de 90°, 2020t	EPA 180.1
FNU	Unidades de formacina nefelométrica	LED IR (normalmente) 860 nm, ancho de banda inferior a 60 nm, detección 90°, 2020i	ISO 7027
AU	Unidades de atenuación	Luz blanca incandescente entre 400 y 600 nm, detección de 180°, 2020t	No procede
FAU	Unidades de atenuación de formacina	LED IR (normalmente) 860 nm, ancho de banda inferior a 60 nm, detección 180°, 2020i	ISO 7027
NTRU	Unidades del ratio de turbidez nefelométrica	Luz blanca incandescente entre 400 y 600 nm, detección de 90° y 180°, 2020t	EPA 180.1
FNRU	Unidades del ratio de formacina nefelométrica	LED IR (normalmente) 860 nm, ancho de banda inferior a 60 nm, detección 90° y 180°, 2020i	No procede
ASBC	American Society of Brewing Chemists (Sociedad Americana de Químicos de la Cerveza)	2020t/i	No procede
EBC	Convención europea de cerveceros	2020t/i	No procede

Para obtener más información, consulte la Guía de la norma ASTM 07726-4 sobre el uso de diversas tecnologías de turbidímetros para la medición de la turbidez en el agua.

TOMA DE MUESTRAS DE AGUA PARA ANALIZAR LA TURBIDEZ

Para las muestras de turbidez pueden utilizarse recipientes limpios de plástico o vidrio. Lo ideal sería que las muestras se analizaran poco después de la recogida y a la misma temperatura que cuando se recogieron.

TÉCNICAS DE DISOLUCIÓN DE MUESTRAS

Si el resultado de la prueba está fuera del rango del fotómetro, como indica un mensaje en pantalla de rango sobrepasado, la muestra debe diluirse y volverse a analizar. La siguiente tabla ofrece una guía de consulta rápida para realizar disoluciones en varias proporciones.

Cantidad de muestra	Agua desionizada para que el volumen final sea de 10 mL	Factor de multiplicación
10 mL	0 mL	1
5 mL	5 mL	2
2,5 mL	7,5 mL	4
1 mL	9 mL	10
0,5 mL	9,5 mL	20

Todas las disoluciones se basan en un volumen final de 10 mL, de modo que varias disoluciones requerirán menos cantidad de muestra de agua. Las pipetas graduadas se usan para todas las disoluciones. Si el cristal volumétrico no está disponible, puede realizar las disoluciones con el tubo del colorímetro. Llene el tubo hasta la línea de 10 mL con la muestra y traspáselo a otro recipiente. Añada volúmenes de 10 mL de agua desionizada al recipiente y mezcle. Traspase 10 mL de la muestra diluida al tubo del colorímetro y siga el procedimiento de análisis. Repita los procedimientos de disolución y análisis hasta que el resultado se encuentre dentro del rango de calibración. Multiplique el resultado del análisis por el factor de disolución. Por ejemplo, si se diluyen 10 mL de agua de muestra con tres volúmenes de 10 mL de agua desionizada, el factor de disolución es cuatro. El resultado de la prueba de muestra diluida debe multiplicarse por cuatro.

OPCIONES Y CONFIGURACIÓN

CONFIGURACIÓN DE FÁBRICA POR DEFECTO

La configuración que tiene opciones de usuario se ha ajustado de fábrica a la configuración por defecto.

La configuración de fábrica por defecto es la siguiente:

Curva de calibración de turbidez	Nefelométrico (N)
Unidades de turbidez	Por defecto
Medición de turbidez	Turbidez - Sin blanco (NB)
Promediano	Desactivado
Formato de fecha	DD-MM-AAAA
Ahorro de energía	5 minutos
Retroiluminación	10 segundos
Idioma	Inglés

OPCIONES DE TURBIDEZ

Hay tres curvas de calibración disponibles: nefelométrica, ratiométrica y de atenuación. Para el 2020t, la nefelométrica es la curva de calibración por defecto y las unidades disponibles son NTU, NTRU, ASBC y EBC. Para el 2020i, la nefelométrica es la curva de calibración por defecto y las unidades disponibles son FNU, NTU, FNRU, ASBC y EBC.

El 2020t en modo nefelométrico con las unidades NTU por defecto se debe utilizar para analizar el agua potable pública para el cumplimiento de la norma 180.1 de la EPA.

Una vez seleccionadas la curva de calibración y las unidades de turbidez, estas permanecerán seleccionadas hasta que se cambien la curva de calibración y las unidades de turbidez mediante los siguientes procedimientos.

SELECCIÓN DE UNA CURVA DE CALIBRACIÓN DE TURBIDEZ

Hay tres curvas de calibración disponibles: nefelométrica, ratiométrica y de atenuación. La curva de calibración por defecto es la nefelométrica. Debería elegirse la curva de calibración que se ajuste al tipo de muestra que se está analizando.

Modo nefelométrico:	**Detector de 90°**	**Rango 0 – 100 NTU/FNU, para muestras de agua potable**
Modo radiométrico:	**Detectores 90° y 180°**	**Rango 0 – 1000 NTU/NTRU/FNRU, para muestras de agua potable y agua natural, muestras de agua pluvial y muestras coloreadas**
Modo de atenuación:	**Detector de 180°**	**Rango 0 – 2000 NTU/AU/FAU, para muestras con alta turbidez**

Por lo general los métodos ratiométricos reducen las interferencias de color.

El 2020t en modo nefelométrico con las unidades NTU por defecto se debe utilizar para analizar el agua potable pública para el cumplimiento de la norma 180.1 de la EPA.

El modo nefelométrico se usará en el ejemplo. Para cambiar la curva de calibración:

1. Mantenga pulsado brevemente para encender el fotómetro. La pantalla con el logotipo de LaMotte aparecerá durante aprox. 3 segundos y se mostrará el **Menú Principal**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
2. Pulse para desplazarse por **Opciones**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
3. Pulse ENTER para seleccionar **Opciones**.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500

4. Pulse ENTER para seleccionar **Opciones de turbidez**.	Opciones de turbidez Calibración turbidez Unidades de turbidez 12:00:00 001/500
5. Pulse ENTER para seleccionar **Calibración turbidez**.	Calibración turbidez Nefelométrica NTU Nadiometrica NTRU Atenuación AU 12:00:00 001/500
6. Desplácese hasta la opción de calibración deseada.	Calibración turbidez Nefelométrica NTU Nadiometrica NTRU Atenuación AU 12:00:00 001/500

NOTA: los estándares Stablcal® por debajo de 50 NTU no deben usarse para calibra el 2020t/i. El diluyente tiene un índice de refracción diferente al de los estándares tradicionales de formacina y afectará los resultados.

7. Pulse ENTER para guardar la selección. En pantalla aparecerá **Almacenando....** durante aproximadamente 1 segundo y regresará al menú **Opciones**. Pulse EXIT para regresar a un menú anterior.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500

SELECCIÓN DE UNIDADES DE TURBIDEZ

Los resultados para cada curva de calibración se presentarán en las unidades por defecto para esa curva de calibración, salvo que se seleccionen unidades diferentes. La unidad por defecto se muestra después del nombre de la curva de calibración. Las unidades por defecto son:

	Curva de calibración	**Unidad por defecto**
2020t	Nefelométrica	NTU (Unidades de turbidez nefelométrica)
	Ratiométrica	NTRU (Unidades del ratio de turbidez nefelométrica)
	De atenuación	AU (Unidades de atenuación)

2020i	Nefelométrica Ratiométrica De atenuación	FNU (Unidades de formacina nefelométrica) FNRU (Unidades del ratio de formacina nefelométrica) FAU (Unidades de atenuación de formacina)

Es posible seleccionar que los resultados se presenten en una unidad alternativa en lugar de en la unidad predeterminada para cada modo. Cuando se desean unidades American Society of Brewing Chemists (Sociedad Americana de Químicos de la Cerveza) y EBC (Convención europea de cerveceros) se debe utilizar la curva de calibración nefelométrica.

Para el 2020t, las unidades disponibles son: NTU, NTRU, AU, ASBC, EBC

Para el 2020i, las unidades disponibles son: FNU, NTU, FNRU, FAU, ASBC, EBC

NTRU, AU, FNU, FNRU y FAU equivalen numéricamente a NTU. Las unidades diferencian qué detector y fuente de luz se utilizaron para realizar la medición. Consulte la página 56 para la definición de las unidades de turbidez..

1. Mantenga pulsado brevemente ⏻ para encender el fotómetro. La pantalla con el logotipo de LaMotte aparecerá durante aprox. 3 segundos y se mostrará el **Menú Principal**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
2. Pulse ∨ para desplazarse por **Opciones**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
3. Pulse ENTER para seleccionar **Opciones**.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500

4. Pulse ENTER para seleccionar **Opciones de turbidez**.	Opciones de turbidez Calibración de turbidez Unidades de turbidez 12:00:00 001/500
5. Pulse para desplazarse por las **Unidades de turbidez**.	Opciones de turbidez Calibración turbidez Unidades de turbidez 12:00:00 001/500
6. Pulse ENTER para seleccionar **Unidades de turbidez**.	Unidades Turbidez Defecto NTU ASBC EBC 12:00:00 001/500
7. Pulse o para desplazarse por las unidades deseadas.	Unidades Turbidez Defecto NTU ASBC EBC 12:00:00 001/500
8. Pulse ENTER para guardar la selección. En pantalla aparecerá **Almacendando**.... durante aproximadamente 1 segundo y regresará al menú **Opciones**. Pulse EXIT para regresar a un menú anterior.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500

PROMEDIANO

La opción de romedio permite al usuario promediar múltiples lecturas. Esta opción mejora la precisión de las muestras cuya lectura podría tener tendencia a derivar con el tiempo. Al elegir las opciones de dos, cinco o diez mediciones, se muestra la media final. Esta opción está desactivada por defecto. Para cambiar la configuración:

1. Mantenga pulsado brevemente para encender el fotómetro. La pantalla con el logotipo de LaMotte aparecerá durante aprox. 3 segundos y se mostrará el **Menú Principal**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
2. Pulse para desplazarse por **Opciones**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
3. Pulse ENTER para seleccionar **Opciones**.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500
4. Pulse para desplazarse por **Promediano**.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500
5. Pulse ENTER para seleccionar **Promediano**.	Menú Promediano Inhabilitado 2 Medidas 5 Medidas 10 Medidas 12:00:00 001/500

6. Pulse o para desplazarse por la opción deseada.	Menú Promediano Inhabilitado 2 Medidas 5 Medidas 10 Medidas 12:00:00 001/500
7. Pulse ENTER para guardar la selección. En pantalla aparecerá **Almacenando....** durante aproximadamente 1 segundo y regresará al menú **Opciones**. Pulse EXIT para regresar a un menú anterior.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500

NOTA: cuando la opción de Promediano está activada, se necesitará más tiempo para mostrar una lectura y se consumirá más energía.

AJUSTAR RELOJ

1. Mantenga pulsado brevemente para encender el fotómetro. La pantalla con el logotipo de LaMotte aparecerá durante aprox. 3 segundos y se mostrará el **Menú Principal**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
2. Pulse para desplazarse por **Opciones**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
3. Pulse ENTER para seleccionar **Opciones**. Pulse para desplazarse por **Ajustar reloj**.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500

4. Pulse ENTER para seleccionar Ajustar reloj. La fecha se muestra como día-mes-año. La hora se muestra como horas:minutos:segundos AM/PM. Pulse ∧ o ∨ para seleccionar el carácter apropiado y pulse ENTER para seleccionar. El cursor se moverá al siguiente carácter. Configure todos los caracteres de la misma manera. Se trata de un menú de desplazamiento.	Establecer la hora fecha: 07-09-2018 tiempo: 02:09:08 PM 12:00:00 001/500
5. Pulse ENTER para seleccionar el último carácter. Se guardarán la hora y la fecha, y la pantalla volverá al **Menú Opciones**.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500

AJUSTE DE AHORRO ENERGÉTICO

La función Auto Apagado para ahorrar energía desconectará el fotómetro cuando el botón no se haya presionado durante un determinado plazo de tiempo. La configuración por defecto es de 5 minutos. Para cambiar la configuración:

1. Mantenga pulsado brevemente ⏻ para encender el fotómetro. La pantalla con el logotipo de LaMotte aparecerá durante aprox. 3 segundos y se mostrará el **Menú Principal**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
2. Pulse ∨ para desplazarse por **Opciones**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500

3. Pulse ENTER para seleccionar **Opciones**.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500
4. Pulse ▼ para desplazarse por **Config. ahorro energ**.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500
5. Pulse ENTER para seleccionar **Ahorro energético**.	Auto Apagado Inhabilitar 5 Minutos 15 Minutos 30 Minutos 12:00:00 001/500
6. Pulse ▲ o ▼ para desplazarse a la configuración deseada.	Auto Apagado Inhabilitar 5 Minutos 15 Minutos 30 Minutos 12:00:00 001/500
7. Pulse ENTER para guardar la selección. En pantalla aparecerá **Almacenando**.... durante aproximadamente 1 segundo y regresará al **Menú Opciones**.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500

AJUSTE DEL TIEMPO DE RETROILUMINACIÓN

La retroiluminación ilumina la pantalla para mejorar la visualización. Si está seleccionado el Control por botón, el botón de retroiluminacón del teclado actuará como interruptor on/off y la retroiluminación permanecerá encendida o apagada cuando se esté utilizando el fotómetro. Cuando uno de los otros ajustes (10, 20 o 30 segundos) esté seleccionado, la pantalla se iluminará durante el tiempo especificado después de apretar cualquier botón. Como medida de precaución, la retroiluminación no se iluminará durante las mediciones de turbidez para evitar la interferencia en la dispersión de luz.

NOTA: la función de retroiluminación usa una cantidad considerable de energía. Cuanto más tiempo esté activada la retroiluminación, con más frecuencia habrá que cargar la batería si el adaptador USB/de pared no está en uso.

1. Mantenga pulsado brevemente para encender el fotómetro. La pantalla con el logotipo de LaMotte aparecerá durante aprox. 3 segundos y se mostrará el **Menú Principal**..	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
2. Pulse para desplazarse por **Opciones**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
3. Pulse ENTER para seleccionar **Opciones**.	Menú Opciones Promediano Ajustar reloj Config. ahorro energ. Config.tpo.luz fondo 12:00:00 001/500
4. Pulse para desplazarse por **Config. tpo. luz fondo**.	Menú Opciones Promediano Ajustar reloj Config. ahorro energ. Config. tpo. luz fondo 12:00:00 001/500

5. Pulse ENTER para seleccionar **Config. tpo. luz fondo**.	Tiempo de retroiluminación Botón de Control 10 Segundos 20 Segundos 30 Segundos 12:00:00 001/500
6. Pulse o para desplazarse a la configuración deseada.	Tiempo de retroiluminación Botón de Control 10 Segundos 20 Segundos 30 Segundos 12:00:00 001/500
7. Pulse ENTER para guardar la selección. En pantalla aparecerá **Almacenando....** durante aproximadamente 1 segundo y regresará al **Menú Opciones**.	Menú Opciones Promediano Ajustar reloj Config. ahorro energ. Config. tpo. luz fondo 12:00:00 001/500

SELECCIONE UN IDIOMA

El 2020t/i está disponible en siete idiomas: inglés, español, francés, portugués, italiano, chino y japonés (kana).

1. Mantenga pulsado brevemente para encender el fotómetro. La pantalla con el logotipo de LaMotte aparecerá durante aprox. 3 segundos y se mostrará el **Menú Principal**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
2. Pulse para desplazarse por **Opciones**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500

3. Pulse ENTER para seleccionar **Opciones**.	Menú Opciones Opciones de turbidez Promediano Ajustar reloj Config. ahorro energ. 12:00:00 001/500
4. Pulse para desplazarse por **Seleccionar Idioma**.	Menú Opciones Ajustar reloj Config. ahorro energ. Ajuste el tiempo de retroiluminación Seleccionar Idioma 12:00:00 001/500
5. Pulse ENTER para desplazarse por **Seleccionar Idioma**.	Seleccionar Idioma Inglés Español Francés Portugués 12:00:00 001/500
6. Pulse o para desplazarse a el idioma deseado.	Seleccionar Idioma Inglés Español Francés Portugués 12:00:00 001/500
7. Pulse ENTER para seleccionar el idioma deseado. En pantalla aparecerá momentáneamente **Almacenando**.... durante aproximadamente 1 segundo y regresará al **menú Opciones**.	Menú Opciones Ajustar reloj Config. ahorro energ. Ajuste el tiempo de retroiluminación Seleccionar Idioma 12:00:00 001/500

NOTA: si el fotómetro cambia accidentalmente a otro idioma, use el procedimiento anterior para resetear el fotómetro al idioma deseado. Por ejemplo, para resetear el fotómetro a inglés:

1. Encienda el fotómetro.
2. Pulse dos veces la flecha hacia abajo. Pulse ENTER.
3. Pulse seis veces la flecha hacia abajo. Pulse ENTER.
4. Pulse ENTER.

■ ENLACE AL PC

Ejecutar enlace al PC se utiliza para fabricar el fotómetro. Este menú no se usa para el operador sobre el terreno.

REGISTRO DE DATOS

El ajuste predeterminado del registro de datos está activado. El fotómetro registrará los últimos 500 puntos de datos. El contador en la parte inferior central de la pantalla mostrará el número de puntos de datos que se han registrado. La pantalla mostrará 500+ cuando el registro de datos haya superado los 500 puntos y los puntos se datos se sobrescribirán.

1. Mantenga pulsado brevemente para encender el fotómetro. La pantalla con el logotipo de LaMotte aparecerá durante aprox. 3 segundos y se mostrará el **Menú Principal**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
2. Pulse para desplazarse por el **Registro de Datos**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
3. Pulse ENTER para seleccionar el **Registro de Datos**.	Registrando Mostrar pruebas reg. Habilitas registras Deshabilitas registras Borrar registras 12:00:00 001/500

4. Pulse ENTER para visualizar el último punto de datos y la hora en que se registró.	Registro número 2 Turbidez - WB (N) 655 AU 12:26:58 PM 08-03-2018 12:00:00 001/500
5. Pulse o para desplazarse por los puntos de datos del registro.	Registro número 2 Turbidez - WB (R) 95.4 NTU 12:26:44 PM 08-03-2018 12:00:00 001/500
6. Pulse EXIT para regresar al menú Registro. Pulse o para desplazarse para desactivar las opciones de registro o borrar el registro. Pulse ENTER para seleccionar la opción. En pantalla aparecerá **Almacenando**.... durante aproximadamente 1 segundo y regresará al **menú Registrando**.	Registrando Mostrar pruebas reg. Habilitas registras Deshabilitas registras Borrar registras 12:00:00 001/500

CALIBRACIÓN

Estándares de turbidez

Utilice únicamente los estándares AMCO o de formacina con el 2020t/i. Los estándares StablCal® por debajo de 50 NTU no deben usarse para calibrar el 2020t/i. El diluyente usado en los estándares StablCal® tiene un índice de refracción diferente al de los estándares tradicionales de formacina y afectará los resultados. La concentración del estándar de calibración debería ser similar a la concentración esperada de las muestras que se van a analizar. El estándar nunca debe volver a verterse desde el tubo a la botella. Los estándares no tendrán el mismo valor de turbidez en los tres modos.

En LaMotte Company están disponibles los siguientes estándares:

Modo Unidades	**Nefelométrico (N)**	**Nefelométrico (N)**	**Ratiométrico (R)**	**Ratiométrico (R)**
Fotómetro	**2020t**	**2020i**	**2020t**	**2020i**
Código 1480	0 NTU	0 FNU	0 NTRU	0 FNRU
Código 1441	1 NTU	-	1 NTRU	-
Código 1446	-	1 FNU	-	1 FNRU
Código 1442	10 NTU	-	10 NTRU	
Código 1447	-	10 FNU	-	10 FNRU
Código 1444	-	100 FNU	-	100 FNRU

Los estándares pueden variar ligeramente de lote a lote para el modo ratiométrico. Los valores estándar para el modo nefelométrico y el modo ratiométrico se encuentran en la etiqueta estándar de la botella. **Utilice el valor de la etiqueta de la botella estándar de turbidez como el valor objetivo al calibrar el fotómetro en el modo nefelométrico y en el modo ratiométrico.** Los estándares para la calibración en el modo de atenuación deben prepararse a partir de formacina.

Tubos

Utilice tubos de turbidez (0260) que estén libres de arañazos e imperfecciones en la zona de luz entre el fondo del tubo y la línea de llenado. Deseche los tubos que presenten arañazos. Al leer muestras de muy baja turbidez, no utilice tubos o tapones que hayan sido utilizados previamente con muestras de alta turbidez. Consulte la página 53 para obtener más información.

Procedimiento de calibración de la turbidez

La curva de calibración por defecto es la nefelométrica, como se indica en el apartado (N) de la barra de Menú. Las unidades por defecto son NTU (2020t) y FNU (2020i). Otras opciones de curva de calibración son la ratiométrica y la de atenuación. La curva de calibración ratiométrica se indica con (R) y la curva de calibración de atenuación con (A). Se debe realizar una calibración de usuario para cada modo con estándares que sean apropiados para el fotómetro y el rango.

Para obtener los resultados más precisos posibles, se debe realizar una calibración del usuario en el rango más pequeño posible. **Utilice un estándar de calibración que, junto con el blanco, abarque el rango de las muestras que se analizarán.** Por ejemplo, si se espera que las muestras que se van a analizar estén por debajo de 1 NTU, se obtendrán resultados más precisos mediante la calibración con un blanco y un estándar de 1 NTU en lugar de un blanco y un estándar de 10 NTU.

El número de rangos de medición para cada modo varía.

Modo	Nefelométrico (N)	Ratiométrico (R)	De atenuación (A)
Rangos	0-11 NTU/FNU 10-110 NTU/FNU	0-11 NTRU/FNRU 10-110 NTRU/FNRU 100-510 NTRU/FNRU 500-1000 NTRU/FNRU	0-1010 AU/FAU 1000-2000 AU/FAU

Cada rango puede calibrarse con un punto por rango más un blanco. Los nuevos puntos de calibración reemplazarán a los puntos de calibración antiguos de forma independiente para cada rango. Si se recalibra un rango, el fotómetro conservará los datos de calibración antiguos para los otros rangos. Se recomienda calibrar el fotómetro para cada rango que se vaya a utilizar. El valor de los estándares elegidos para la calibración no debe situarse en los extremos de los rangos. El fotómetro es de rango automático y seleccionará automáticamente el rango apropiado para la muestra que se está analizando.

Se recomienda calibrar el fotómetro diariamente.

En los ejemplos siguientes se utilizará el 2020t en el modo nefelométrico con estándares NTU.

1. Mantenga pulsado brevemente ⏻ para encender el fotómetro. La pantalla con el logotipo de LaMotte aparecerá durante aprox. 3 segundos y se mostrará el **Menú Principal**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
2. Pulse ENTER para seleccionar **Medir**.	Menú Medir (N) Turbidez sin blanco Turbidez con blanco 12:00:00 001/500
3. Pulse ∨ para desplazarse por **Turbidez con blanco**.	Menú Medir (N) Turbidez sin blanco Turbidez con blanco 12:00:00 001/500

4. Pulse ENTER para seleccionar **Turbidez con blanco**.

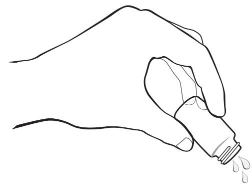
Turbidez WB (N)

Escaneo del blanco

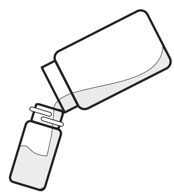
Escaneo de la muestra

12:00:00 001/500

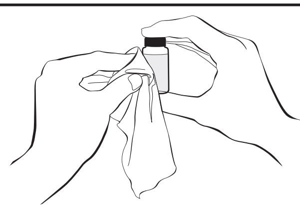
5. Enjuague un tubo limpio (0260) tres veces con la muestra de blanco. Si se espera que la lectura de las muestras sea inferior a 1 NTU, debe realizarse una medición de blanco del fotómetro con un estándar primario de 0 NTU o prepararse con agua sin turbidez (<0,1 NTU). Para obtener los resultados más precisos, use el mismo tubo para la muestra de blanco y la muestra.



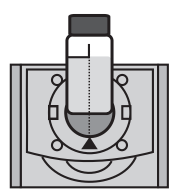
6. Llene el tubo hasta la línea de llenado con la muestra de blanco. Vierta la muestra de blanco por la pared interior del tubo para evitar la formación de burbujas. Cierre el tubo.



7. Limpie bien el tubo con un paño sin pelusas.



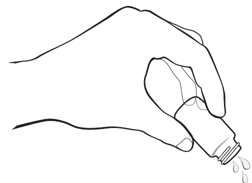
8. Abra la tapa del fotómetro. Inserte el tubo en la cámara. Alinee la línea del índice del tubo con la flecha del índice del fotómetro. Cierre la tapa.



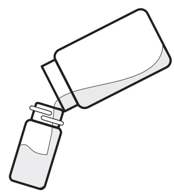
9. Pulse ENTER para seleccionar Analizar el blanco y analice la muestra de blanco. En pantalla aparecerá Análisis en **blanco terminado....** durante aproximadamente 1 segundo y a continuación regresará al menú de **Turbidez con blanco**.

Turbidez WB (N)
Escaneo del blanco
Escaneo de la muestra
12:00:00 001/500

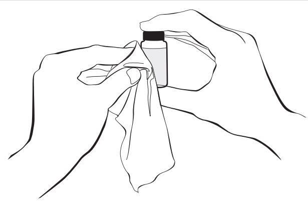
10. Enjuague un tubo limpio (0260), o el mismo tubo, tres veces con la muestra estándar de turbidez.



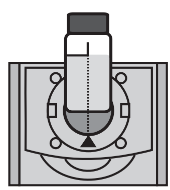
11. Llene el tubo hasta la línea de llenado con la muestra estándar de turbidez. Vierta la muestra estándar por la pared interior del tubo para evitar la formación de burbujas. Cierre el tubo.



12. Limpie bien el tubo con un paño sin pelusas.



13. Abra la tapa del fotómetro. Inserte el tubo en la cámara. Alinee la línea del índice del tubo con la flecha del índice del fotómetro. Cierre la tapa.



14. Pulse ENTER para seleccionar **Escaneo de la muestra** y analice la muestra estándar. La pantalla mostrará **Leyendo** durante aproximadamente 1 segundo. El resultado aparecerá en pantalla.

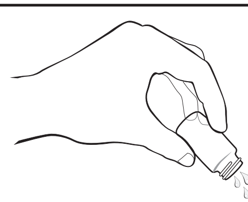
Turbidez WB (N)
0.99 NTU
Escaneo del blanco
Escaneo de la muestra
12:00:00 001/500

15. Pulse ▼ para desplazarse a **Calibración**.	Turbidez WB [N] 0.99 NTU Escaneo de la muestra Calibración 12:00:00 001/500
16. Pulse ENTER para seleccionar **Calibración**. Una fuente inversa [fondo claro con caracteres negros] aparecerá para indicar que se ha ajustado la lectura.	Turbidez WB [N] 0.99 NTU Escaneo de la muestra Calibración 12:00:00 001/500
17. Pulse ▲ o ▼ para desplazarse por la concentración del estándar, 1,00 en este ejemplo. **Utilice el valor de la etiqueta de la botella estándar de turbidez como valor objetivo.** Nota: El ajuste permitido es de ±25 %. Si se alcanza el límite de ajuste permitido, aparecerá «superación del margen».	Turbidez WB [N] 1.00 NTU Escaneo de la muestra Calibración 12:00:00 001/500
18. Pulse ENTER para seleccionar **Calibración**. Se ofrecerán dos opciones de menú, **Config. calibración** y **Configuracion fábrica**.	Calibración [N] 1.00 NTU Config. calibración Configuración fábrica 12:00:00 001/500
19. Pulse ENTER para seleccionar **Config. calibración** y guarde la calibración. Pulse ▲ o ▼ para desplazarse y seleccione **Configuracion fábrica** para volver a la calibración de fábrica. El fotómetro mostrará momentáneamente **Almacenando**... y regresará al menú de **Turbidez sin blanco** de blanco. Ahora se ha guardado la calibración y el fotómetro puede usarse para analizar.	Turbidez WB Escaneo del blanco Escaneo de la muestra 12:00:00 001/500

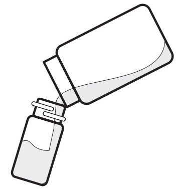
NOTA: para obtener la máxima precisión posible durante el procedimiento de calibración, asegúrese de que después de que el fotómetro esté en blanco y la muestra de blanco se haya analizado como muestra, la lectura sea 0,00. Si no fuera así, vuelva a introducir en el fotómetro una muestra de blanco y realice de nuevo el análisis hasta que el resultado se a 0,00. Cuando analice los estándares de calibración como la muestra, analice la muestra estándar de calibración tres veces retirando el tubo de la cámara después de cada análisis y vuelva a insertar el tubo en la cámara con la misma orientación. Las lecturas deberían ser consistentes. Use la última lectura consistente para calibrar el fotómetro. Si las lecturas no son consistentes, evite usar una lectura anormal para calibrar el fotómetro.

■ ANÁLISIS SIN PROCEDIMIENTO EN BLANCO

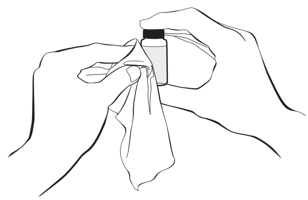
Para obtener los resultados más precisos posibles, el fotómetro debe estar en blanco antes de analizar una muestra. El paso de poner en blanco el fotómetro no es tan importante para muestras por encima de 10 NTU. El fotómetro siempre debe estar en blanco antes de leer muestras por debajo de 10 NTU.

1. Mantenga pulsado brevemente para encender el fotómetro. La pantalla con el logotipo de LaMotte aparecerá durante aprox. 3 segundos y se mostrará el **Menú Principal**.	Menú Principal Medir Registro de Datos Opciones 12:00:00 001/500
2. Pulse ENTER para seleccionar **Medir**.	Menú Medir (N) Turbidez sin blanco Turbidez con blanco 12:00:00 001/500
3. Pulse ENTER para seleccionar **Turbidez sin blanco**.	Turbidez NB (N) Turbidez sin blanco Turbidez con blanco 12:00:00 001/500
4. Enjuague un tubo limpio (0260) tres veces con la muestra.	

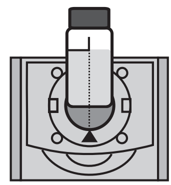
5. Llene el tubo hasta la línea de llenado con la muestra. Vierta la muestra por la pared interior del tubo para evitar la formación de burbujas. Cierre el tubo.



6. Limpie bien el tubo con un paño sin pelusas.



7. Abra la tapa del fotómetro. Inserte el tubo en la cámara. Alinee la línea del índice del tubo con la flecha del índice del fotómetro. Cierre la tapa.



8. Pulse ENTER para seleccionar **Analizar muestra** y analice la muestra. La pantalla mostrará **Leyendo** durante aproximadamente 1 segundo. El resultado aparecerá en pantalla.
Se mostrará “Sobre rango” si la lectura está fuera de rango. Diluya la muestra o seleccione un modo que sea apropiado para el rango de la muestra.

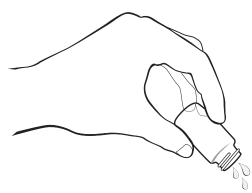
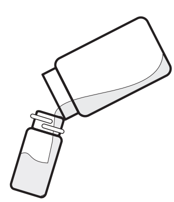
Turbidez NB (N)
10.22 NTU
Escaneo del blanco
Escaneo de la muestra
12:00:00 001/500

ANÁLISIS CON PROCEDIMIENTO EN BLANCO

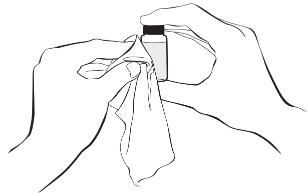
Para obtener los resultados más precisos posibles, el fotómetro debe estar en blanco antes de analizar una muestra. El paso de poner en blanco el fotómetro no es tan importante para muestras por encima de 10 NTU. El fotómetro siempre debe estar en blanco antes de leer muestras por debajo de 10 NTU.

1. Mantenga pulsado brevemente para encender el fotómetro. La pantalla con el logotipo de LaMotte aparecerá durante aprox. 3 segundos y se mostrará el **Menú Principal**.

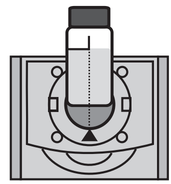
Menú Principal
Medir
Registro de Datos
Opciones
12:00:00 001/500

2. Pulse **ENTER** para seleccionar **Medir**.	Menú Medir (N) Turbidez sin blanco Turbidez con blanco 12:00:00 001/500
3. Pulse para desplazarse por **Turbidez con blanco**.	Menú Medir (N) Turbidez sin blanco Turbidez con blanco
4. Pulse **ENTER** para seleccionar **Turbidez con blanco**.	Turbidez WB (N) Escaneo del blanco Escaneo de la muestra 12:00:00 001/500
5. Enjuague un tubo limpio (0260) tres veces con la blanco. Si se espera que la lectura de las muestras sea inferior a 1 NTU, debe realizarse una medición en blanco del fotómetro con un estándar primario de 0 NTU o prepararse con agua sin turbidez (<0,1 NTU). Para obtener los resultados más precisos, use el mismo tubo para el blanco y la muestra.	
6. Llene el tubo hasta la línea de llenado con el blanco. Viértalo por la pared interior del tubo para evitar la formación de burbujas. Cierre el tubo.	

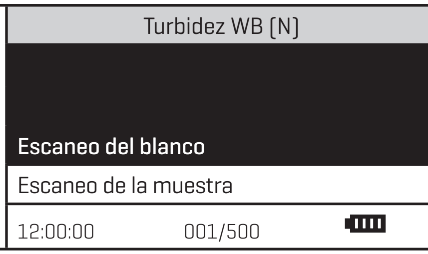
7. Limpie bien el tubo con un paño sin pelusas.



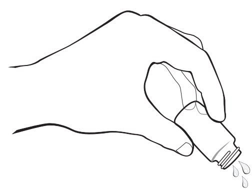
8. Abra la tapa del fotómetro. Inserte el tubo en la cámara. Alinee la línea del índice del tubo con la flecha del índice del fotómetro. Cierre la tapa.



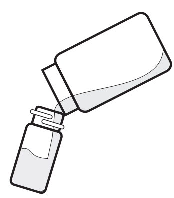
9. Pulse ENTER para seleccionar **Escaneo del blanco** y analice el blanco. En pantalla aparecerá **blanco terminado**.... durante aproximadamente 1 segundo y a continuación regresará a **Turbidez con blanco**.



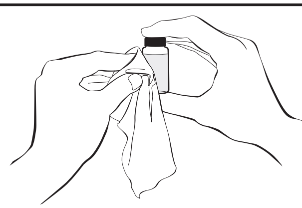
10. Enjuague un tubo limpio (0260), o el mismo tubo, tres veces con la muestra.



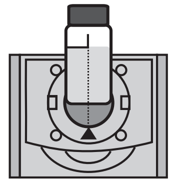
11. Llene el tubo hasta la línea de llenado con la muestra. Vierta la muestra estándar por la pared interior del tubo para evitar la formación de burbujas. Cierre el tubo.



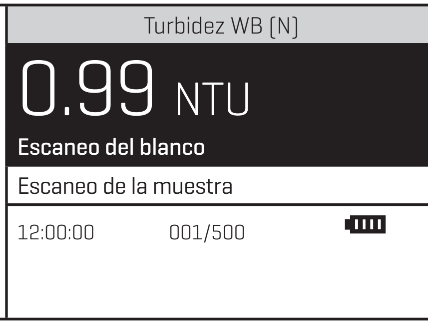
12. Limpie bien el tubo con un paño sin pelusas.



13. Abra la tapa del fotómetro. Inserte el tubo en la cámara. Alinee la línea del índice del tubo con la flecha del índice del fotómetro. Cierre la tapa.



14. Pulse ENTER para seleccionar **Escaneo de la muestra** y analice la muestra. La pantalla mostrará **Leyendo** durante aproximadamente 1 segundo. El resultado aparecerá en pantalla.
Se mostrará “Sobre rango” si la lectura está fuera de rango. Diluya la muestra o seleccione un modo que sea apropiado para el rango de la muestra.



NOTA: El fotómetro recordará la última lectura de blanco analizada. No es necesario analizar el blanco cada vez que se realiza el análisis. Para usar la lectura anterior en blanco, en lugar de analizar una nueva, vaya a Analizar muestra y proceda. Para obtener resultados lo más precisos posibles, el fotómetro debe estar en blanco antes de cada prueba y debe usarse el mismo tubo para el blanco y para la muestra de reactivo.

PROCEDIMIENTO DE DISOLUCIÓN

Si se encuentra una muestra que es superior a 2000 NTU o FNU, una disolución cuidada con 0 NTU/FNU o agua de muy baja turbidez situará la muestra en un rango aceptable. Sin embargo, no hay garantía de que la reducción a la mitad de la concentración reduzca exactamente a la mitad el valor de NTU o FNU. Las partículas a menudo reaccionan de manera impredecible cuando se diluyen.

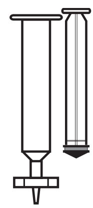
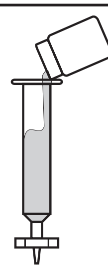
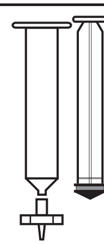
Agua sin turbidez

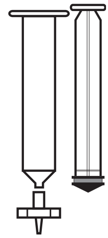
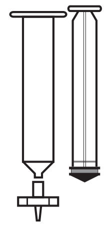
La definición de baja turbidez y agua sin turbidez ha cambiado a medida que se ha ido desarrollando la tecnología de filtración y los instrumentos nefelométricos se han vuelto más sensibles. Hubo una época en la que el agua sin turbidez se definía como el agua que había pasado por un filtro de 0,6 micras. Ahora hay disponibles filtros de 0,1 micras y es posible obtener agua de mayor pureza. El agua que ha pasado a través de un filtro de 0.1 micras puede considerarse libre de partículas y, por lo tanto, sin turbidez, agua con 0 NTU. La turbidez se ocasiona por la luz dispersa. Por lo tanto, el agua de baja turbidez es agua sin partículas que dispersan una cantidad mensurable de luz. Pero el agua que pasó a través de un filtro de 0,1 micras aún puede tener una dispersión de luz detectable con los instrumentos modernos. Esta dispersión de la luz puede ser el resultado de moléculas disueltas o partículas de tamaño submicra que no pueden ser filtradas fuera del agua. Debido a que todavía puede haber una pequeña cantidad de luz dispersa de moléculas disueltas, el agua de alta pureza a menudo se denomina agua de baja turbidez y se le asigna un valor de 0,01 o 0,02 NTU. Sin embargo, debido a que esta agua se utiliza como línea de base para compararla con el agua de la muestra, la diferencia entre la muestra y el agua de baja turbidez o sin turbidez será la misma, ya sea que se llame 0,00 NTU o 0,02 NTU. Para simplificar el diseño, el 2020t/i utiliza el término agua sin turbidez y el valor de 0,00 NTU.

PREPARACIÓN DE AGUA SIN TURBIDEZ

El fotómetro incluye un estándar 0 NTU/FNU (Código 1480). Accesorios están disponibles para la preparación de agua sin turbidez para poner en blanco el fotómetro y la disolución de muestras de alta turbidez.

La preparación de agua sin turbidez requiere una técnica cuidada. La introducción de materia extraña afectará la lectura de turbidez. Un dispositivo de filtración con un filtro de membrana especial se usa para preparar agua sin turbidez. El filtro, el soporte del filtro y la jeringa deben acondicionarse forzando al menos dos jeringas llenas de agua desionizada a través del aparato filtrante para eliminar la materia extraña. El primer y segundo enjuagues deben desecharse. El agua sin turbidez preparada con el siguiente procedimiento puede almacenarse en la oscuridad a temperatura ambiente en una botella de vidrio limpia con tapón de rosca y utilizarse según sea necesario. El recipiente de almacenamiento debe enjuagarse bien con agua desionizada filtrada antes de llenarlo. El agua debe ser inspeccionada periódicamente en busca de materia extraña en entornos muy luminosos.

1. Retire el émbolo de la jeringa (0943). Coloque el filtro en la parte inferior de la jeringa.	
2. Vierta aproximadamente 50 ml de agua desionizada en el tambor de la jeringa. Inserte el émbolo. Ejerza presión sobre el émbolo para forzar lentamente el agua a través del filtro. Recoger el agua en el recipiente de almacenamiento limpio. Enjuague las paredes del recipiente y luego deseche el agua de enjuague.	
3. Retire el filtro de la jeringa. Retire el émbolo del tambor (Este paso es necesario para evitar la ruptura del filtro por el vacío que se crearía cuando se retira el émbolo).	
4. Reemplace el filtro y repita el paso 2 para un segundo enjuague de la jeringa y el recipiente de almacenamiento.	

5.	Retire el filtro de la jeringa. Retire el émbolo del tambor Reemplace el filtro y llene la jeringa con aproximadamente 50 ml de agua desionizada. Filtre el agua en el recipiente de almacenamiento y guarde el agua sin turbidez.	
6.	Repita el paso 5 hasta que se haya recogido la cantidad deseada de agua sin turbidez.	

CONSEJOS DE ANÁLISIS

- Las muestras deben recogerse en un recipiente limpio de vidrio o polietileno.
- Las muestras deben analizarse tan pronto como sea posible después de la recogida.
- Mezcle suavemente la muestra invirtiéndola antes de tomar una lectura, pero evite que se formen burbujas de aire.
- Para obtener resultados más precisos, siga el procedimiento recomendado para limpiar un tubo lleno antes de colocarlo en la cámara del fotómetro. Invierta el tubo muy lenta y suavemente tres veces para mezclar la muestra. Envuelva el tubo con un paño limpio y sin pelusas. Presione el paño alrededor del tubo. Gire tres veces el tubo con el paño para asegurarse de que todas las áreas del tubo se han limpiado. Coloque los tubos en la cámara con la misma orientación cada vez.
- Deseche los tubos que tengan arañazos e imperfecciones significativas en las zonas de paso de luz (zona central entre la línea de fondo y la línea de relleno).
- Al leer muestras de muy baja turbidez, no utilice tubos o tapones que hayan sido utilizados previamente con muestras de alta turbidez.
- Utilice la opción de promediano para mediciones de bajo nivel de turbidez.
- El fotómetro debe colocarse sobre una superficie libre de vibraciones. Las vibraciones pueden causar lecturas altas.
- Las lecturas de turbidez se verán afectadas por los campos eléctricos alrededor de los motores.
- El carbón en la muestra absorberá la luz y arrojará lecturas bajas.
- El exceso de color en una muestra absorberá la luz y causará lecturas bajas. El usuario debe verificar si un cierto nivel de color causará un error significativo en el nivel de turbidez que se está analizando. Se recomienda el uso de la curva de calibración ratiométrica para muestras muy coloreadas.
- Observe las recomendaciones de vida útil para los estándares de turbidez.
- No utilice aceite de silicona en los tubos cuando analice la turbidez con el 2020t/i.

- Cuando se realizan análisis a bajas concentraciones, utilice el mismo tubo para el blanco y para la muestra.
- Inserte siempre el tubo en la cámara del fotómetro con la misma presión y a la misma profundidad.
- Ocasionalmente limpie la cámara con un paño húmedo sin pelusas y a continuación con un paño húmedo Windex®. Una cámara y tubos limpios son esenciales para obtener resultados fiables.
- para obtener la máxima precisión posible durante el procedimiento de calibración, asegúrese de que después de que el fotómetro esté en blanco y la muestra de blanco se haya analizado como muestra, la lectura sea 0,00. Si no fuera así, vuelva a introducir en el fotómetro una muestra de blanco y realice de nuevo el análisis hasta que el resultado se a 0,00. Cuando analice los estándares de calibración como la muestra, analice la muestra estándar de calibración tres veces retirando el tubo de la cámara después de cada análisis. Las lecturas deberían ser consistentes. Use la última lectura consistente para calibrar el fotómetro. Si las lecturas no son consistentes, evite usar una lectura anormal para calibrar el fotómetro.
- Calibre el fotómetro diariamente.
- Calibre el fotómetro con un estándar que esté lo más cerca posible del rango esperado de la muestra que se está analizando. Por ejemplo, si se espera que la muestra sea inferior a 1,0 NTU, calibre con un estándar de 1,0 NTU y una muestra de blanco (estándar de 0 NTU). Si se espera que la muestra esté alrededor de 2 NTU, calibre también con el estándar de 1,0 NTU, pero si se espera que la muestra esté alrededor de 8 NTU, calibre con un estándar de 10 NTU. Si se espera que la muestra sea superior a 30 - 40 NTU, se recomienda calibrar el fotómetro con un estándar de 100 NTU.
- Para mantener una temperatura constante de la lámpara, no encienda ni apague el fotómetro cuando analice las muestras.

GUÍA DE RESOLUCIÓN DE INCIDENCIAS

RESOLUCIÓN DE INCIDENCIAS

PROBLEMA	CAUSA	SOLUCIÓN
¿«En blanco»?	La muestra arroja lecturas por debajo del blanco.	Con muestras de muy baja concentración, vuelva a realizar un análisis en blanco o regístrelas como cero. En muestras de mayor concentración, vuelva a poner en blanco y realice de nuevo la lectura.
 Parpadeante	Batería baja. Las lecturas son fiables.	Cargue la batería o use un adaptador de pared/ ordenador USB.
“Batería baja”	Voltaje de batería muy bajo. Las lecturas no son fiables.	Cargue la batería o use un adaptador de pared/ ordenador USB.
Apagado “Apagado batería baja”	La batería es demasiado baja como para utilizar la unidad.	Cargue la batería o use un adaptador de pared/ ordenador USB.
“Fuera de rango”	La muestra está fuera del rango aceptable.	Disuelva la muestra y realice el análisis de nuevo.
«Error1»	Lecturas altas con detectores de 90° y 180°.	Diluya la muestra en al menos un 50 % y vuelva a realizar la prueba.
Muchas lecturas negativas o positivas poco habituales al realizar la calibración.	Se han usado estándares incorrectos para calibrar el fotómetro.	Use un estándar 0.0 reciente en un tubo limpio. Recalibre el fotómetro.

DISPERSIÓN DE LUZ

La precisión de las lecturas en el 2020t/i no debe verse afectada por la dispersión de luz. Asegúrese de que la tapa del compartimento de la muestra está siempre cerrada cuando realice las lecturas. La retroiluminación interferirá con las lecturas de turbidez. El fotómetro desactivará temporalmente la retroiluminación mientras se realizan mediciones de turbidez.

INFORMACIÓN GENERAL DE FUNCIONAMIENTO

RESUMEN

El 2020t/i es un nefelómetro portátil, controlado por microprocesador y de lectura directa. La turbidez se mide directamente según el método 180.1 de la EPA o el método 7027 de la ISO, o se calcula ratiométricamente utilizando una combinación de las dos mediciones. Cuenta con una pantalla gráfica de cristal líquido y un teclado con 6 botones. Esto permite al usuario seleccionar opciones desde el software controlado por el menú, leer directamente resultados de análisis o revisar resultados almacenados de pruebas anteriores en el registro de datos. Los menús pueden mostrarse en siete idiomas diferentes.

El 2020t/i utiliza una configuración óptica multidetector de última generación que asegura la estabilidad a largo plazo de las calibraciones, alta precisión y exactitud, y bajos límites de detección. Todas las lecturas se determinan mediante algoritmos de procesamiento de señales digitales, minimizando las fluctuaciones en las lecturas y permitiendo mediciones rápidas y repetibles. El microprocesador y la óptica permiten un rango dinámico y un rango automático en varios rangos. Las fuentes de luz LED de bajo consumo se utilizan para la turbidez ISO. La turbidez de EPA utiliza una fuente de luz con filamento de tungsteno que cumple o excede las especificaciones de la EPA y está diseñada para una imagen de punto de luz uniforme y una salida estable.

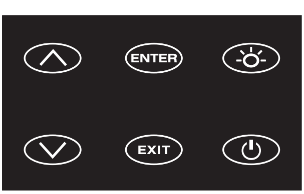
El 2020t/i funciona a través de un adaptador de pared USB, la conexión al ordenador por USB o con una batería de litio.

INFORMACIÓN GENERAL DE FUNCIONAMIENTO

El 2020t/i funciona mediante un software controlado por menú y una interfaz de usuario. Un menú es una lista de opciones. Esto permite seleccionar varias tareas para que las realice el 2020t/i, como Analizar blanco y analizar una muestra. El teclado se usa para realizar las selecciones de menú que se van a mostrar en pantalla.

EL TECLADO

	Este botón se desplazará hacia arriba por la lista de opciones del menú.
	El botón se usa para seleccionar las opciones del menú que se muestra en pantalla.
	Este botón controla la retroiluminación en la pantalla.
	Este botón se desplazará hacia abajo por la lista de opciones del menú.
	Este botón regresa al menú anterior.
	Este botón enciende o apaga el fotómetro.

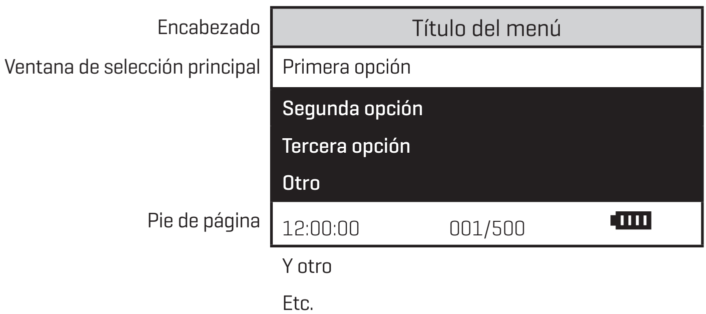


LA PANTALLA Y LOS MENÚS

La pantalla permite visualizar y seleccionar opciones de menú. Estas opciones ordenan al 2020t/i realizar tareas concretas. Los menús se muestran en pantalla usando dos formatos generales que pasan de un menú al siguiente. Cada menú es una lista de opciones.

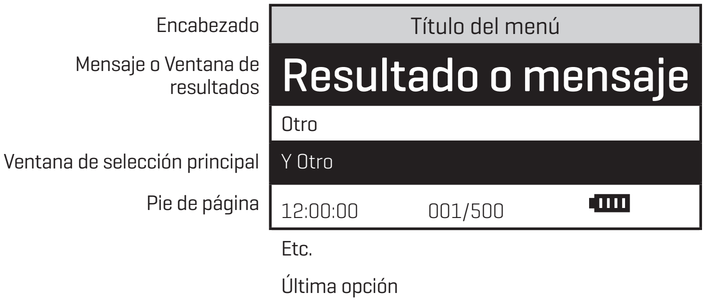
En la pantalla aparece un encabezado en la parte superior y un pie de página en la parte inferior. El encabezado muestra el título del menú actual. El pie de página muestra la hora y la fecha, el estado del registro de datos y el estado de la batería. La ventana de selección de menú se encuentra en el centro de la pantalla, entre el encabezado y el pie.

En la ventana de selección de menú aparece información en dos formatos generales. En el primer formato solo se muestran las opciones de menú. Pueden mostrarse hasta 4 líneas de opciones de menú. Si hay más opciones disponibles pueden visualizarse pulsando los botones de las flechas para desplazarse a otras opciones de menú en la ventana de selección de menú. Piense en las opciones de menú como una lista vertical en la pantalla que se mueve hacia arriba o hacia abajo cada vez que presiona una tecla con una flecha Algunos menús del 2020t/i son menús iterativos. Las opciones de menú superiores e inferiores están conectadas en un ciclo. Desplazarse hacia abajo pasando la parte inferior del menú conducirá a la parte superior del menú. Desplazarse hacia arriba pasando la parte superior del menú conducirá a la parte inferior del menú.



Una barra de color claro indicará la opción del menú. A medida que se desplaza por el menú, la barra de color claro resaltará diferentes opciones de menú. Al pulsar la tecla ENTER seleccione la opción del menú que se indica en la barra de color claro.

En el segundo formato, la ventana de opción de menú se beneficia de la capacidad gráfica de la pantalla. Se muestra información gráfica de gran formato, como resultados de pruebas o mensajes de error o el logotipo de LaMotte. Las dos líneas superiores de la pantalla se usan para mostrar información en un formato grande y fácil de leer. Los menús funcionan de la misma forma que se ha descrito anteriormente, pero solo se visualizan dos líneas del menú en la parte inferior de la pantalla.



Tal y como se ha detallado anteriormente, la tecla EXIT permite salir del menú actual y regresar al menú anterior. Esto facilita una salida más rápida desde un menú interno al Menú Principal pulsando reiteradamente el botón EXIT. Al pulsar en cualquier momento se apagará el 2020t/i.

La pantalla muestra los siguientes mensajes:

	Estado de la batería
↑ ↓	Hay más opciones disponibles que pueden visualizarse al desplazarse hacia arriba o hacia abajo por la pantalla.
Encabezado	Identifica el menú actual y la información en curvas de calibración y sistemas de reactivos, en su caso.
Pie de página	En el modo de registro de datos se muestra el número de puntos de datos y aparecerá el número total de puntos de datos en la memoria. El pie de página muestra también la hora actual y el estado de la batería.

■ RESULTADOS NEGATIVOS

Siempre hay pequeñas variaciones en las lecturas con instrumentos analíticos. A menudo estas variaciones pueden observarse tomando múltiples lecturas de la misma muestra. Estas variaciones normales caerán por encima y por debajo de una lectura promediano. Las lecturas repetidas en una muestra de 0,00 pueden dar lecturas por encima y por debajo de 0,00. Por lo tanto, las lecturas negativas son posibles y esperadas en muestras con concentraciones a o cerca de cero. Esto no significa que haya una concentración negativa en la muestra. Significa que la lectura de la muestra fue inferior que la lectura en blanco. Pequeñas lecturas negativas pueden indicar que la muestra se encontraba en el límite de detección o cerca de él. Una gran lectura negativa, sin embargo, no es normal e indica un problema. Algunos instrumentos están diseñados para mostrar las lecturas negativas como cero. En este tipo de instrumento, si el fotómetro mostrara cero cuando el resultado era en realidad un gran número negativo, no habría indicación de que existe un problema. Por esta razón, el 2020t/i muestra números negativos de turbidez.

■ TUBOS Y CÁMARAS

El 2020t/i utiliza un tubo especial (Código 0260).

La manipulación de los tubos es de suma importancia. Los tubos deben estar limpios y libres de pelusas, huellas, salpicaduras secas y arañazos significativos, especialmente la zona central entre la parte inferior y la línea de muestra.

Arañazos, huellas y gotas de agua en el tubo pueden provocar interferencias en la dispersión de luz y arrojar resultados imprecisos. Las rayadas y abrasiones afectarán la precisión de las lecturas. Los tubos que presentan rayaduras en la zona de luz por el uso excesivo deberían desecharse y sustituirse por otros nuevos.

Lave siempre los tubos por dentro y por fuera con detergente suave antes de usarlos para eliminar la suciedad y las huellas. Deje que se sequen al aire libre en una posición invertida para evitar que entre polvo en los tubos. Almacene los tubos secos con los tapones para evitar contaminación.

Después de haber llenado y tapado un tubo, sujételo por el tapón y limpie la superficie exterior con un paño absorbente limpio y libre de pelusas hasta que esté seco y sin manchas. Manipular el tubo solo por el tapón evitará problemas de huellas. Deje siempre el tubo limpio apartado sobre una superficie limpia que no contamine el tubo. Es imprescindible que los tubos y la cámara de luz estén limpios y secos. Limpie la parte exterior de los tubos con un paño limpio y sin pelusas o una bayeta desechable antes de colocarlos en la cámara del fotómetro.

Vacíe y limpie los tubos en cuanto haya terminado de leer la muestra para evitar la deposición de partículas en el interior de los tubos. Cuando se requieran resultados de alta precisión, reduzca el error designando tubos que se usarán solo para análisis de muy baja turbidez y muy alta turbidez.

La variabilidad en la geometría del cristal y la técnica es la causa principal de variabilidad en los resultados. Ligeras variaciones en el grosor de la pared y el diámetro de los tubos pueden conducir a pequeñas variaciones en los resultados del análisis. Para evitar este error, coloque siempre los tubos en la cámara con la misma orientación.

Deseche las cámaras que presentan arañazos por el uso excesivo y sustitúyalas por otras nuevas.

MANTENIMIENTO

LIMPIEZA

Limpie la carcasa exterior con un paño húmedo sin pelusas. Evite que entre agua en la cámara de luz o en cualquier otra pieza del fotómetro. Para limpiar la cámara de luz y el área de la óptica, apunte con un bote de aire comprimido a la cámara de luz y aplique el aire presurizado a esta zona. Utilice un bastoncillo humedecido en limpiador de ventanas Windex® para frotar suavemente el interior de la cámara. No utilice alcohol; dejará un leve residuo en las lentes al secarse.

REPARACIONES

Si fuese necesario devolver el fotómetro para que lo reparen o lo pongan a punto, empaquete el fotómetro con cuidado en un envase apropiado y con material de embalaje adecuado. Debe obtener un número de autorización de devolución de LaMotte Company llamando al 800- -344-3100 (solo EE. UU.) o al 410-778-3100, fax 410-778-6394, o escribiendo a tech@lamotte.com. A menudo el problema se puede resolver por teléfono o correo electrónico. En caso de que sea necesaria la devolución, incluya en el paquete una carta con el número de autorización de la devolución, el número de serie del fotómetro, una breve descripción del problema y la información de contacto (incluidos los números de teléfono y fax. Esta información permitirá que el departamento de mantenimiento realice las reparaciones necesarias con mayor eficacia.

■ ELIMINACIÓN DEL FOTÓMETRO

Residuos de aparatos eléctricos y electrónicos (RAAE)

Se han utilizado recursos naturales para fabricar este equipo y puede que contenga materiales peligrosos para la salud y el medio ambiente. Para evitar perjudicar al medio ambiente y a los recursos naturales, se recomienda utilizar los sistemas de recuperación adecuados. El símbolo del contenedor tachado en el fotómetro invita a usar estos sistemas a la hora de deshacerse de este equipo.

Los sistemas de recuperación permitirán reutilizar o reciclar los materiales de forma que no perjudiquen al medio ambiente. Para obtener más información sobre los sistemas aprobados de recogida, reutilización y reciclaje, póngase en contacto con la administración de residuos local o regional o con los servicios de reciclaje.

CONTENU

ÉTALONNAGE ET ANALYSE

GUIDE DE DÉPANNAGE

INFORMATIONS GÉNÉRALES SUR LE FONCTIONNEMENT

ENTRETIEN

Reportez-vous au **Guide de démarrage rapide** pour obtenir les procédures simplifiées d'étalonnage et d'analyse.

Reportez-vous au **Guide d'analyse** pour obtenir les procédures détaillées d'étalonnage et d'analyse afin d'améliorer la précision des mesures de turbidité plage basse.

Reportez-vous au **Guide de démarrage rapide** pour obtenir les procédures simplifiées d'étalonnage et d'analyse.

Reportez-vous au **Guide d'analyse** pour obtenir les procédures détaillées d'étalonnage et d'analyse afin d'améliorer la précision des mesures de turbidité plage basse.

INFORMATIONS GÉNÉRALES

EMBALLAGE ET LIVRAISON

Le personnel de LaMotte Company possède une grande expérience en emballage et garantit une protection adéquate contre les dangers usuels du transport de marchandise.

Une fois que le produit a quitté l'entreprise LaMotte, l'entreprise de transport assume l'entière responsabilité de la livraison en toute sécurité. Les réclamations pour endommagement doivent être directement déposées auprès de l'entreprise de transport afin de recevoir une compensation pour les biens endommagés.

PRÉCAUTIONS GÉNÉRALES

CONSULTEZ LE MODE D'EMPLOI AVANT TOUTE TENTATIVE DE CONFIGURATION OU D'UTILISATION DE L'INSTRUMENT. Dans le cas contraire, vous risqueriez de vous blesser ou d'endommager le turbidimètre. L'instrument ne doit pas être utilisé ou stocké dans un environnement humide ou corrosif. Veillez à ne pas laisser d'eau provenant des éprouvettes humides pénétrer dans la chambre du turbidimètre.

N'INSÉREZ JAMAIS D'ÉPROUVETTE HUMIDE DANS LE TURBIDIMÈTRE.

MESURES DE SÉCURITÉ

*AVERTISSEMENT : Les réactifs signalés par une astérisque * sont considérés comme représentant des dangers potentiels pour la santé. Pour afficher ou imprimer les fiches de données de sécurité (SDS) de ces réactifs, accédez à www.lamotte.com.

Cherchez le code à quatre chiffres du réactif indiqué sur l'étiquette du réactif, dans la liste du contenu ou dans les procédures d'analyse. Ignorez toute lettre précédant ou suivant le code à quatre chiffres.

Par exemple, si le code est 4450WT-H, tenez compte uniquement de 4450. Pour obtenir une version imprimée, contactez LaMotte par courriel, téléphone ou fax.

En cas d'urgence, des informations pour tous les réactifs LaMotte sont disponibles auprès de Chem-Tel : (US 1-800-255-3924) (appel international, en PCV, 813-248-0585).

Assurez-vous que la protection de l'équipement n'est pas compromise. N'installez et n'utilisez jamais l'équipement d'une façon qui ne soit pas indiquée dans le manuel.

LIMITES DE RESPONSABILITÉ

En aucun cas, LaMotte Company ne saurait être tenue pour responsable en cas de décès, de perte de propriété, de perte de profits ou de tout autre dommage engendré par l'utilisation ou l'utilisation impropre de ses produits.

SPÉCIFICATIONS - 2020t/i

Mode	Néphélométrique	Ratiométrique	Atténuation
Unité de mesure 2020t	NTU, ASBC, EBC	NTU, NTRU, ASBC, EBC	NTU, AU, ASBC, EBC
Unité de mesure 2020i	NTU, FNU, ASBC, EBC	NTU, FNRU, ASBC, EBC	NTU, FAU, ASBC, EBC
Plage	0-100 NTU/FNU 0-1,750 ASBC 0-25 EBC	0-1,000 NTRU/FNRU 0-17,500 ASBC 0-250 EBC	0-2,000 AU/FAU 0-70,000 ASBC 0-1,000 EBC
Résolution	0–10.99 NTU/FNU: 0.01 NTU/FNU, 11.0–100.0 NTU/FNU: 0.1 NTU/FNU	0–10.99 NTRU/FNRU: 0.01 NTRU/FNRU, 11.0–109.9 NTRU/FNRU: 0.1 NTRU/FNRU, 110–1000 NTRU/FNRU: 1 NTRU/FNRU	0–2000 AU/FAU: 1 AU/FAU
Précision	0-2.5 NTU/FNU: ±0.05 NTU/FNU, 2.5-100 NTU/FNU: ±2%	0-2.5 NTRU/FNRU: ±0.05 NTRU/FNRU, 2.5-100 NTRU/FNRU: ±2%, 100-1000 NTRU/FNRU: ±3%.	0-2000 AU/FAU: ±10 AU/FAU or 6% selon le plus élevé
Limite de détection	0.05 NTU/FNU	0.05 NTRU/FNRU	10 AU/FAU
Reproductibilité	0.02 NTU/FNU ou 1 %	0.02 NTRU/FNRU ou 1 %	1 %
Sélection de plage	Automatique		
Source de lumière	2020t : lampe au tungstène 2300 °K ±50 °K, 2020i : LED IR 860 nm ±10 nm, bande passante spectrale de 50 nm		
Détecteur	2020t : photodiode, centrée à 90° et 180°, pic maximal 400-600 nm; 2020t/i : photodiode, centrée à 90° et 180°		
Temps de réponse :	<2 secondes		
Moyenne de signaux :	Oui		
Chambre d'échantillon :	Accepte les éprouvettes 25 mm à fond plat		
Échantillon :	10 mL en éprouvette fermée		
Écran :	Écran graphique à cristaux liquides avec rétroéclairage		
Logiciel :	Arrêt automatique : 5, 10, 30 min, désactivé; Étalonnage : champ ajustable, blanc et 1 point; Enregistrement de données : 500 points		
Langues :	anglais, espagnol, français, portugais, italien, chinois, japonais (kana)		
Température :	De fonctionnement : 0–50 °C ; de stockage : -40–60 °C		
Plage d'humidité pour le fonctionnement :	0–90 % HR, sans condensation		
Arrêt automatique :	5, 10, 30 min, désactivé		

Source d'alimentation :	Adaptateur secteur USB, connexion ordinateur USB ou batterie lithium-ion rechargeable
Batterie :	Durée de la charge : environ 380 analyses avec rétroéclairage et 1000 analyses sans rétroéclairage. (Moyenne de signaux désactivée.) Durée de vie de la batterie : environ 500 charges.
Indications électriques :	Tension nominale (5 V), courant d'entrée nominal (1.0 A) au niveau du port d'entrée mini-USB
Enregistreur de données :	500 résultats d'analyse stockés
Étanchéité :	IP67 avec le capuchon du port USB en place.
Dimensions :	(L x l x H) 8.84 x 19.05 x 6.35 cm ; 3.5 x 7.5 x 2.2 pouces
Certifications :	CE Mark — Safety: Low Voltage Directive (2006/95/EC) IEC 61010-1:2001, EN 601010-1:2001, 2nd edition EU — EMC: EMC Directive (2004/108/EC) EN 61326-1:2006, EN 61000-4-2:1995 including A1:1998 and A2:2001, EN 61000-4-3:2002, EN 61000-4-4:2004, EN 61000-4-5:1995 including A1:2001, EN 61000-4-6:1996 and A1:2001, EN 61000-4-11:2004, EN 55011:2007, IEC 61000-3-2:2005, EN 61000-3-2:2006, IEC 61000-3-3:1994, EN 61000-3-3:1995 including A1:2001 and A2:2005 US — EMC — CFR 47, Part 15 Subpart B:2007 CAN — EMC — ICES-003, Issue 4, February 2004 AU/NZ — EMC — AU/NZ: CISPR 11:2004
Poids :	362 g, 13 oz (instrument uniquement)
Interface USB :	mini B

■ DÉFINITIONS STATISTIQUES ET TECHNIQUES EN RELATION AVEC LES SPÉCIFICATIONS DU PRODUIT

Limite de détection de la méthode : « La limite de détection de la méthode est définie comme la concentration minimale d'une substance pouvant être mesurée et dont on puisse dire avec une confiance de 99 % que la concentration en analyte est supérieure à zéro et déterminée à partir de l'analyse d'un échantillon dans une matrice donnée contenant l'analyte. »[1] « Comme l'a déclaré le Dr. William Horwitz, "Dans presque tous les cas, lorsque l'on a affaire à une limite de détection ou à une limite de détermination, le but principal de la détermination de cette limite consiste à s'en tenir à l'écart." »[2]

Précision : La précision est la proximité d'une mesure à la valeur acceptée ou vraie.[3] La précision peut être exprimée en tant que plage autour de la valeur vraie dans laquelle s'effectue une mesure (par ex., ±0.5 ppm). On peut aussi l'exprimer en tant que pourcentage de recouvrement d'une quantité connue d'analyte dans une détermination de l'analyte (par ex., 103.5 %).

Résolution : La résolution est la plus petite différence discernable entre deux mesures.[4] Pour les instruments de mesure, cela correspond habituellement au nombre de décimales affichées (par ex., 0.01). La résolution change fortement en fonction de la concentration ou de la plage. Dans certains cas, la résolution peut être inférieure au plus petit intervalle s'il est possible d'effectuer une mesure dont le résultat se situe entre les repères d'étalonnage. Attention, la résolution n'a que peu de lien avec la précision. La résolution est toujours inférieure à la précision, mais ce n'est pas une mesure statistique du bon fonctionnement d'une méthode d'analyse. La résolution peut être extrêmement bonne et la précision extrêmement mauvaise ! Il ne s'agit pas d'une mesure utile de la performance d'une méthode d'analyse.

Répétabilité : La répétabilité est la précision au sein d'une même série.[5] Une série est un même ensemble de données, de la configuration au nettoyage final. En général, une série s'effectue en un jour. Toutefois, pour les étalonnages d'instrument de mesure, chaque étalonnage est considéré comme une série, ou ensemble de données, unique même s'il nécessite 2 ou 3 jours.

Reproductibilité : La reproductibilité est la précision entre les séries.[6]

Limite de détection : La limite de détection de l'appareil 2020t/i est définie comme la valeur ou la concentration minimale que l'appareil de mesure peut déterminer et qui est supérieure à zéro, indépendante de la matrice, de la verrerie et des autres sources d'erreur provenant de la manipulation. Il s'agit de la limite de détection du système optique de l'instrument de mesure.

[1] CFR 40, part 136, appendix B.
[2] Statistics in Analytical Chemistry: Part 7 – A Review, D. Coleman and L Vanatta, American Laboratory, Sept 2003, P. 31.
[3] Skoog, D.A., West, D. M., Fundamental of Analytical Chemistry, 2nd ed., Holt Rinehart and Winston, Inc, 1969, p. 26.
[4] Statistics in Analytical Chemistry: Part 7 – A Review, D. Coleman and L Vanatta, American Laboratory, Sept 2003, P. 34.
[5] Jeffery G. H., Basset J., Mendham J., Denney R. C., Vogel's Textbook of Quantitative Chemical Analysis, 5th ed., Longman Scientific & Technical, 1989, p. 130.
[6] Jeffery G. H., Basset J., Mendham J., Denney R. C., Vogel's Textbook of Quantitative Chemical Analysis, 5th ed., Longman Scientific & Technical, 1989, p. 130.

CONTENU ET ACCESSOIRES

	Kit 2020t Version EPA/Code 1974-T	**Kit 2020i** Version ISO/Code 1974-I
Contenu	**Code**	**Code**
Turbidimètre 2020t/i		
Étalon 0 NTU, 60 mL	1480	1480
Étalon 1 NTU, 60 mL	1441	
Étalon 10 NTU/FNU, 60 mL	1442	1447
Étalon 100 FNU, 60 mL		1444
Flacon d'échantillon d'eau, 60 mL	0688	0688
Éprouvettes, avec bouchons	0260 (6)	0260 (6)
Câble, USB	1720	1720
Adaptateur secteur USB	1721	1721
Mode d'emploi du turbidimètre 2020t/i	1974-MN	1974-MN
Guide de démarrage rapide du turbidimètre 2020t/i	1974-QG-FR	1974-QG-FR
Guide d'analyse du turbidimètre 2020t/i	1974-TG-FR	1974-TG-FR

Accessories	
Code	**Description**
0260-6	Éprouvettes, avec bouchons
1446	Étalon 1 FNU, 60 mL (ISO)
1443	Étalon 100 NTU, 60 mL (EPA)
6195-H	Solution d'étalon à la formazine, 4000 NTU, 60 mL
3-0038	Chambre de rechange
0943	Seringue, 60 ml, en plastique
2-2097	Filtres 0.1 micron, paquet de 50
5-0132	Chargeur de voiture

■ CONFORMITÉ EPA

Le turbidimètre 2020t est conforme ou supérieur aux spécifications de conception EPA pour les programmes de contrôle de turbidité NPDWR et NPDES comme spécifié par la méthode USEPA 180.1.

■ CONFORMITÉ ISO

Le turbidimètre 2020t est conforme ou supérieur aux critères de conception ISO pour les méthodes quantitatives de turbidité utilisant des turbidimètres optiques comme spécifié par la norme ISO 7027.

■ CONFORMITÉ CE

Cet appareil est conforme à la Partie 15 des réglementations de la FCC. Son fonctionnement est soumis aux deux conditions suivantes : (1) cet appareil ne peut provoquer aucune interférence nuisible et (2) cet appareil doit accepter toute autre interférence reçue, y compris les interférences pouvant entraîner un fonctionnement non désiré.

Remarque : Ce matériel a été testé et déclaré conforme aux limites applicables aux appareils numériques de classe A, conformément à la Partie 15 des réglementations de la FCC. Ces limites ont pour objectif de fournir une protection raisonnable contre les interférences nuisibles quand l'appareil est utilisé dans un environnement commercial. Cet appareil génère, utilise et émet de l'énergie d'ondes radio et peut, en cas d'installation ou d'utilisation non conforme au mode d'emploi, engendrer des interférences nuisibles au niveau des communications radio. L'utilisation de cet appareil dans une zone résidentielle peut entraîner des interférences nuisibles, lesquelles devront être corrigées aux frais de l'utilisateur.

■ CONFORMITÉ IP67

Le turbidimètre 2020t/i est conforme aux normes IP67 relatives à la protection contre la poussière et l'immersion uniquement lorsque le capuchon du port USB est en place. Documentation disponible sur www.lamotte.com.

■ GARANTIE

LaMotte Company garantit que cet instrument est exempt de défauts matériaux et de fabrication pendant 2 ans à partir de la date d'expédition. S'il s'avérait nécessaire de renvoyer l'instrument au service technique pendant ou au-delà de la période de garantie, contactez notre service technique au 1-800-344-3100 afin d'obtenir un numéro d'autorisation de retour ou accédez au site Web www.lamotte.com pour obtenir de l'aide relative au dépannage. L'expéditeur est responsable des frais d'envoi, du transport, de l'assurance et de l'emballage adéquat du produit afin que ce dernier soit protégé contre les dommages qui pourraient survenir durant le transport. La garantie ne s'applique pas aux défauts résultant de l'action de l'utilisateur, telle qu'une utilisation impropre, un branchement incorrect, un fonctionnement hors spécifications, un entretien ou une réparation inappropriés, ou une modification non autorisée. LaMotte Company décline expressément toute garantie implicite de qualité marchande ou de convenance à une fin particulière et ne pourra en aucun cas être tenue pour responsable de tout dommage consécutif, accessoire, indirect ou direct. La responsabilité totale de LaMotte Company est limitée à la réparation et au remplacement du produit. La garantie énoncée ci-avant est inclusive et aucune autre garantie, écrite ou orale, n'est expresse ou implicite.

■ ENREGISTREMENT DE VOTRE TURBIDIMÈTRE

Pour enregistrer votre turbidimètre auprès du service technique LaMotte accédez à www.lamotte.com et cliquez sur SUPPORT dans la barre de navigation.

CONNEXION À UN ORDINATEUR

■ SORTIE

USB

■ CONNEXION À UN ORDINATEUR

USB type A, USB mini B, câble code 1720.

FONCTIONNEMENT SUR BATTERIE/SECTEUR

Le turbidimètre 2020t/i peut fonctionner sur batterie ou sur secteur avec l'adaptateur secteur USB ou via la connexion USB à un ordinateur. Si vous vous servez du turbidimètre en tant qu'appareil principal, utilisez l'adaptateur secteur si possible afin de prolonger la durée de vie de la batterie. Le turbidimètre reste allumé lorsque l'adaptateur USB est employé.

Pour recharger la batterie lithium-ion via l'adaptateur secteur, branchez l'embout le plus petit du câble USB (prise USB mini B) sur le turbidimètre et l'embout le plus grand du câble USB (prise USB type A) sur l'adaptateur secteur. Branchez l'adaptateur secteur sur une prise secteur. Remettez le capuchon du port USB après avoir chargé la batterie.

Pour recharger la batterie à partir d'un ordinateur, branchez l'embout le plus petit du câble USB (prise USB mini B) sur le turbidimètre et l'embout le plus grand du câble USB (prise USB type A) sur l'un des ports USB de l'ordinateur. Remettez le capuchon du port USB après avoir chargé la batterie.

L'icône de la batterie n'affiche d'abord aucune barre et clignote lorsque l'appareil se met en marche. Puis il indique le statut de la batterie en affichant 0, 1, 2, 3 ou 4 barres.

La recharge complète d'une batterie faible dure 5 heures. L'icône de la batterie clignote lorsque la batterie est en chargement. L'icône de la batterie affiche quatre barres et cesse de clignoter lorsque la batterie est entièrement chargée. Le circuit de charge passe automatiquement à une charge flottante lorsque la batterie est entièrement chargée. Le chargeur peut rester branché. Certains ordinateurs n'alimentent PAS les ports USB lorsqu'ils sont en veille. L'adaptateur secteur charge l'appareil en continu.

L'icône de la batterie n'affiche aucune barre et clignote de façon continue si la batterie est faible, mais l'appareil continue de fonctionner normalement. Un message « Batterie faible » au niveau de la barre de statut sur l'écran remplace le temps de batterie restante lorsque la tension de la batterie est trop faible pour un fonctionnement correct et que la précision risque d'être altérée. Un message « Arrêt batt. faible » apparaît sur l'écran quelques secondes avant l'extinction de l'appareil lorsque la batterie est trop faible pour faire fonctionner ce dernier.

Pour prolonger la durée de vie de la batterie :

- Éteignez l'appareil avec le bouton d'alimentation lorsque vous n'effectuez aucune mesure ou utilisez l'option d'**économie d'énergie** afin que l'appareil s'éteigne automatiquement après 5 minutes d'inactivité.
- Stockez l'appareil dans un lieu sec et frais.
- Chargez complètement la batterie avant de stocker l'appareil pour une longue période.
- Évitez d'utiliser le rétroéclairage. L'appareil consomme trois fois plus d'énergie lorsque le rétroéclairage est activé. Configurez l'option de **durée de rétroéclairage** sur 10 secondes ou sélectionnez « Bouton de commande » et désactivez le rétroéclairage.

Remplacement de la batterie : La batterie lithium-ion utilisée dans cet appareil dure de nombreuses années si vous en faites un usage correct. Lorsque la batterie ne parvient plus à alimenter l'appareil assez longtemps pour satisfaire aux exigences d'analyse, remplacez-la. Les batteries lithium-ion chargées et stockées correctement ne perdent pas toute leur capacité, mais seulement une partie au bout de plusieurs centaines de cycles de chargement. Cet appareil emploie un assemblage de batteries personnalisé, uniquement disponible chez LaMotte. Le remplacement de la batterie doit être effectué dans une installation de réparation autorisée par LaMotte. Le logement résistant à l'eau de ce turbidimètre ne doit pas être ouvert par l'utilisateur. Contactez l'entreprise LaMotte par téléphone (1-800-344-3100) ou par courriel (tech@lamotte.com) pour obtenir un numéro d'autorisation de retour.

TURBIDITÉ

■ QU'EST-CE QUE LA TURBIDITÉ ?

La turbidité est une propriété optique qui survient lorsque la lumière traversant un liquide est dispersée par les particules de matière. La dispersion de la lumière est provoquée par le changement de direction de la lumière lorsque cette dernière traverse le liquide. Si la turbidité est faible, les particules peuvent être invisibles à l'œil nu et la plupart de la lumière continuera sa trajectoire initiale. La quantité de particules est plus importante dans les échantillons présentant une turbidité plus élevée ; la lumière est alors réfléchie par les particules présentes dans la solution et dispersée selon plusieurs angles. La lumière diffusée par les particules permet de « voir » ou de détecter les particules dans la solution, de même que les rayons du soleil permettent de voir les particules de poussière présentes dans l'air. Lorsque que le taux de turbidité est élevé, cette dernière est visible sous forme de trouble, de voile ou d'absence de limpidité. La turbidité n'est pas spécifique des types de particule contenus dans l'échantillon. Les particules peuvent être en suspension ou colloïdes, et peuvent être minérales, organiques ou biologiques.

Dans l'eau de boisson, la turbidité peut indiquer un problème de traitement ou signaler des conditions de risque accru de maladies gastro-intestinales. Les agents pathogènes tels que *Cryptosporidium* et *Giardia* provoquent des taux de turbidité considérables, il est donc extrêmement important de surveiller la turbidité afin d'assurer une filtration adéquate de l'eau. En 1998, l'EPA a publié la règlementation IESWTR (interim enhanced surface water treatment rule) autorisant dans les effluents de filtration combinée une turbidité inférieure ou égale à 0.3 NTU. Ainsi, l'EPA souhaitait parvenir à éliminer le *Cryptosporidium* à 2 log (99 %). La réduction de cette limite à 0.1 NTU est actuellement en cours de discussion.

La tendance a été marquée par la vérification de l'étalonnage des turbidimètres en ligne utilisés pour contrôler l'eau de boisson avec des appareils de terrain portables. La conception optique et la limite de détection basse du 2020t/i permettent des mesures très précises pour de tels étalonnages. L'eau de boisson trouble n'est pas toujours nocive pour la santé humaine, mais elle présente une apparence peu engageante.

La turbidité dans les eaux environnementales réduit la quantité des rayons du soleil nécessaire à la végétation aquatique, augmente la température de l'eau de surface, ensevelit les œufs et les organismes benthiques et peut introduire des sédiments et des pesticides dans le réseau d'eau.

■ COMMENT LA TURBIDITÉ EST-ELLE MESURÉE ?

On mesure la turbidité en détectant et en quantifiant la diffusion de la lumière dans une solution. La quantité de lumière diffusée dépend des propriétés des particules (couleur, taille, forme et réflectivité). De nombreuses méthodes permettent de mesurer la turbidité, y compris des méthodes visuelles et instrumentales. Les méthodes visuelles conviennent mieux aux échantillons présentant une forte turbidité, tandis que les méthodes instrumentales peuvent être utilisées avec des échantillons présentant une turbidité faible ou forte.

La méthode du disque de Secchi et la méthode de la chandelle de Jackson sont deux exemples de méthodes visuelles. La méthode du disque de Secchi est souvent utilisée pour les eaux naturelles : on abaisse un disque de Secchi noir et blanc dans l'eau jusqu'à ce qu'il disparaisse, puis on le remonte jusqu'à ce qu'il réapparaisse. La moyenne de ces deux mesures est connue sous le nom de « profondeur de Secchi ». La méthode de la chandelle de Jackson emploie un long tube de verre placé au-dessus d'une bougie normée. On ajoute de l'eau dans le tube ou on en enlève jusqu'à ce que la flamme se trouble. La profondeur de l'eau dans le tube est mesurée à l'aide d'une échelle calibrée et reportée en unités de turbidité de Jackson (JTU). La plus faible turbidité mesurable via cette méthode est d'environ 25 JTU.

Les méthodes instrumentales mesurent la turbidité en alliant angles de détection et sources de lumière afin d'optimiser la précision des différents échantillons et de satisfaire aux exigences réglementaires. Les turbidimètres 2020t et 2020i offrent la possibilité de choisir entre trois courbes d'étalonnage pour mesurer la turbidité, en fonction des caractéristiques de l'échantillon.

En mode néphélométrique, mode par défaut, le détecteur situé à 90° de la source de lumière mesure la lumière diffusée à partir d'un faisceau traversant l'échantillon. Dans le cas du turbidimètre 2020t, cette configuration et la lampe au tungstène, présentant une température de couleur de 2200–3000 °K, sont conformes aux exigences de la méthode EPA 180.1. Le turbidimètre 2020i est équipé d'une source de lumière LED IR de 860 nm et utilise le détecteur à 90° afin de répondre aux exigences de la norme ISO 2027. Le mode néphélométrique est le plus adapté pour répondre aux exigences réglementaires pour les échantillons, tels que l'eau de boisson, qui se trouvent dans une plage allant de 0.00 à 40.00 NTU (Nephelometric Turbidity Units) pour le turbidimètre 2020t et de 0.00 à 10.00 (Formazin Nephelometric Units) pour le turbidimètre 2020i. Une option de moyenne des signaux améliore la stabilité des résultats pour les échantillons présentant une faible turbidité.

Le mode ratiométrique est généralement utilisé pour les eaux naturelles et les eaux de pluie, ou tout autre échantillon se trouvant dans la plage 0 – 1000 NTU/FNU, car il permet de réduire les interférences de couleur dans l'échantillon. Le mode ratiométrique utilise à la fois les mesures du détecteur à 90° et celles du détecteur à 180°. Les résultats sont exprimés en NTRU (Nephelometric Turbidity Ratio Units) pour le 2020t et en FNRU (Formazin Nephelometric Ratio Units) pour le 2020i.

En mode d'atténuation, le détecteur est situé à 180° de la source de lumière. Il mesure l'atténuation du faisceau lumineux résultant de l'absorption et de la diffusion. Ce mode est particulièrement approprié pour mesurer des échantillons présentant des taux de turbidité élevés, se situant dans une plage allant de 40 à 4000 AU (Attenuation Units) pour le 2020t ou FAU (Formazin Attenuation Units) pour le 2020i.

■ UNITÉS DE TURBIDITÉ

Traditionnellement, les turbidimètres conçus pour les États-Unis répondaient aux exigences de la méthode EPA 180.31. Cette méthode définissait le NTU (nephelometric turbidity unit) comme unité de mesure de la turbidité comprise dans une plage allant de 0 à 40 NTU à l'aide d'un néphélomètre. Selon l'EPA, un néphélomètre était un turbidimètre mesurant la turbidité avec un détecteur à 90°. Si un échantillon présentait une turbidité supérieure à 40 NTU, une dilution était nécessaire afin que l'échantillon se trouve dans la plage 0 – 40 NTU. De nos jours, de nombreux turbidimètres sont équipés de détecteurs supplémentaires qui augmentent la plage de mesure de la turbidité, éliminent les interférences et améliorent de façon générale la performance. Actuellement, de nombreux turbidimètres sont capables de mesurer au-delà de 40 NTU à l'aide de détecteurs autres qu'un détecteur à 90°. Même s'ils utilisent un détecteur à 180°, qui ne répond pas à la définition d'un néphélomètre, les résultats sont généralement exprimés en NTU.

La position du détecteur et la source de lumière représentent des informations importantes à inclure lors de la mesure et de la comparaison des résultats de turbidité, c'est pourquoi l'ASTM s'efforce depuis peu d'utiliser des unités de turbidité qui incluent ces informations. Dans le cas des instruments de mesure conformes aux exigences EPA, les mesures réalisées à l'aide d'un détecteur à 90° et d'une source de lumière blanche à incandescence sont exprimées en NTU (Nephelometric Turbidity Units). Lorsqu'une mesure d'atténuation est effectuée avec un détecteur à 180°, à l'aide de la même source de lumière, les résultats sont exprimés en AU (Attenuation Units). Si un ratio des mesures des deux détecteurs est utilisé pour calculer la turbidité, les résultats sont exprimés en NTRU (Nephelometric Turbidity Ratio Units).

La méthode ISO 7027 spécifie une source de lumière de 860 nm et exprime les résultats dans quatre unités de turbidité. Lorsque le détecteur à 90° est utilisé, les résultats sont exprimés en FNU (Formazin Nephelometric Units). Dans le cas d'une mesure d'atténuation réalisée à l'aide du détecteur à 180°, les résultats sont exprimés en FAU (Formazin Attenuation Units). Enfin, les résultats qui sont le ratio des mesures réalisées à partir des deux angles sont exprimés en FNRU (Formazin Nephelometric Ratio Units). Il est également possible d'exprimer les mesures effectuées à l'aide de chacun des trois modes ISO en NTU (Nephelometric Turbidity Units).

Toutes les unités sont numériquement équivalentes si les instruments de mesure sont étalonnés à la formazine. Les unités indiquent quel détecteur et quelle source de lumière ont été utilisés pour réaliser la mesure. Par exemple, 1 NTU = 1 AU = 1 NTRU = 1 FNU = 1 FAU = 1 FNRU.

Chaque mode d'étalonnage de la turbidité a une unité par défaut :

Mode néphélométrique : NTU (2020t) ou FNU (2020i)

Mode ratiométrique : NTRU (2020t) ou FNRU (2020i)

Mode d'atténuation : AU (2020t) ou FAU (2020i)

L'instrument de mesure permet à l'utilisateur de choisir une autre unité que celle par défaut parmi toutes les unités d'étalonnage disponibles (NTU, FNU, AU, FAU, NTRU ou FNRU). Il permet également à l'industrie brassicole de contrôler l'eau de traitement en mode néphélométrique et de choisir d'exprimer le résultat en unités ASBC (American Society of Brewing Chemists) ou EBC (European Brewery Convention).

Acronymes	Définitions	Remarques	Méthode réglementaire
NTU	Nephelometric Turbidity Units (unité de turbidité néphélométrique)	Lumière blanche à incandescence entre 400 et 600 nm, détection à 90°, 2020t	EPA 180.1
FNU	Formazin Nephelometric Units (unité néphélométrique formazine)	LED IR (généralement) 860 nm, bande passante inférieure à 60 nm, détection à 90°, 2020i	ISO 7027
AU	Attenuation Units (unité d'atténuation)	Lumière blanche à incandescence entre 400 et 600 nm, détection à 180°, 2020t	Not applicable
FAU	Formazin Attenuation Units (unité d'atténuation formazine)	LED IR (généralement) 860 nm, bande passante inférieure à 60 nm, détection à 180°, 2020i	ISO 7027
NTRU	Nephelometric Turbidity Ratio Units (unité de ratio de turbidité néphélométrique)	Lumière blanche à incandescence entre 400 et 600 nm, détection à 90° et à 180°, 2020t	EPA 180.1
FNRU	Formazin Nephelometric Ratio Units (unité de ratio néphélométrique formazine)	LED IR (généralement) 860 nm, bande passante inférieure à 60 nm, détection à 90° et à 180°, 2020i	Not applicable
ASBC	American Society of Brewing Chemists (unité américaine utilisée en brasserie)	2020t/i	Not applicable
EBC	European Brewery Convention (unité européenne utilisée en brasserie)	2020t/i	Not applicable

Pour obtenir davantage d'informations, consultez le guide de la norme ASTM 07726-4 relatif à l'utilisation des diverses technologies de turbidimètre pour mesurer la turbidité de l'eau.

■ PRÉLÈVEMENT D'ÉCHANTILLONS D'EAU POUR MESURES DE TURBIDITÉ

Vous pouvez utiliser des récipients propres, en verre ou en plastique, pour recueillir les échantillons de turbidité. Dans l'idéal, analysez les échantillons immédiatement après leur prélèvement et à la même température.

■ TECHNIQUES DE DILUTION D'ÉCHANTILLON

Si un résultat d'analyse se trouve en dehors de la plage du turbidimètre, un message à l'écran vous l'indique. Vous devez alors diluer l'échantillon et l'analyser à nouveau. Le tableau suivant vous donne de rapides indications de référence pour les dilutions en diverses proportions.

Quantité d'échantillon	Eau désionisée à rajouter pour un volume final de 10 mL	Facteur multiplicatif
10 mL	0 mL	1
5 mL	5 mL	2
2.5 mL	7.5 mL	4
1 mL	9 mL	10
0.5 mL	9.5 mL	20

Toutes les dilutions sont basées sur un volume final de 10 mL, de sorte que plusieurs dilutions ne nécessiteront que de faibles volumes d'échantillon d'eau. Il est recommandé d'utiliser des pipettes graduées pour toutes les dilutions. Si vous ne disposez pas de verrerie volumétrique, vous pouvez réaliser les dilutions avec l'éprouvette du colorimètre. Remplissez l'éprouvette jusqu'à la ligne des 10 mL avec l'échantillon, puis transférez-le dans un autre récipient. Ajoutez 10 mL d'eau désionisée dans le récipient et mélangez. Transférez 10 mL de l'échantillon dilué dans l'éprouvette du colorimètre et suivez la procédure d'analyse. Répétez les procédures de dilution et d'analyse jusqu'à ce que le résultat soit compris dans la plage d'étalonnage. Multipliez le résultat de l'analyse par le facteur de dilution. Par exemple, si 10 mL de l'échantillon d'eau ont été dilués par trois volumes d'eau désionisée de 10 mL, le facteur de dilution sera de quatre. Le résultat de l'analyse de l'échantillon dilué devra être multiplié par quatre.

OPTION ET CONFIGURATION

■ RÉGLAGES D'USINE PAR DÉFAUT

Les paramètres proposant des options à l'utilisateur ont été réglés en usine sur des valeurs par défaut.

Les réglages d'usine par défaut sont les suivants :

Courbe d'étalonnage de la turbidité	Néphélométrique (N)
Unités de turbidité	Par défaut
Mesure de la turbidité	Turbidité sans blanc
Moyenne	Désactivé
Format de date	MM-JJ-AAAA
Économie d'énergie	5 minutes
Rétroéclairage	10 secondes
Langues	Anglais

■ OPTIONS DE TURBIDITÉ

Trois courbes d'étalonnage sont disponibles : Néphélométrique, Ratiométrique et Atténuation. Pour l'appareil 2020t, la courbe néphélométrique est la courbe d'étalonnage par défaut et les unités disponibles sont NTU, NTRU, ASBC et EBC. Pour l'appareil 2020i, la courbe néphélométrique est la courbe d'étalonnage par défaut et les unités disponibles sont FNU, NTU, FNRU, ASBC et EBC.

Utilisez l'appareil 2020t en mode néphélométrique avec l'unité par défaut NTU pour analyser l'eau de boisson de réseau public conformément à la règlementation EPA 180.1.

Une fois que vous avez sélectionné une courbe d'étalonnage et une unité de turbidité, ces dernières restent sélectionnées jusqu'à ce que vous les modifiiez en suivant les procédures ci-dessous.

■ SÉLECTION D'UNE COURBE D'ÉTALONNAGE DE LA TURBIDITÉ

Trois courbes d'étalonnage sont disponibles : Néphélométrique, Ratiométrique et Atténuation. La courbe d'étalonnage par défaut est Néphélométrique. Choisissez la courbe d'étalonnage en fonction du type d'échantillon que vous analysez.

Mode néphélométrique :	**Détecteur à 90°**	**Plage 0 – 100 NTU/FNU, pour les échantillons d'eau de boisson**
Mode ratiométrique :	**Détecteurs à 90° et à 180°**	**Plage 0 – 1000 NTU/NTRU/FNRU, pour les échantillons d'eau de boisson, d'eau naturelle, d'eau de pluie et les échantillons colorés**
Mode d'atténuation :	**Détecteur à 180°**	**Plage 0 – 2000 NTU/AU/FAU, pour les échantillons d'eau présentant une turbidité élevée**

Les méthodes ratiométriques réduisent généralement l'interférence de couleur.

Utilisez l'appareil 2020t en mode néphélométrique avec l'unité par défaut NTU pour analyser l'eau de boisson de réseau public conformément à la règlementation EPA 180.1.

L'exemple utilise le mode néphélométrique. Pour modifier la courbe d'étalonnage, procédez comme suit :

1. Appuyez sur et maintenez le bouton brièvement enfoncé pour allumer le turbidimètre. Un écran apparaît et affiche le logo de LaMotte pendant 3 secondes environ, puis le **Menu principal.**	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
2. Appuyez sur pour atteindre **Options**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500

3. Appuyez sur ENTER pour sélectionner **Options**.	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500
4. Appuyez sur ENTER pour sélectionner **Options turbidité**.	Options turbidité Étalonnage turbidité Unités de turbidité 12:00:00 001/500
5. Appuyez sur ENTER pour sélectionner **Étalonnage turbidité**.	Étalonnage turbid. Néphélométrique NTU Ratiométrique NTRU Atténuation AU 12:00:00 001/500
6. Faites défiler jusqu'à l'option d'étalonnage désirée.	Étalonnage turbid. Néphélométrique NTU Ratiométrique NTRU Atténuation AU 12:00:00 001/500

REMARQUE : N'utilisez pas les étalons Stablcal® inférieurs à 50 NTU pour étalonner le 2020t/i. Le diluant a un indice de réfraction différent des étalons traditionnels à la formazine, ce qui fausse les résultats.

7. Appuyez sur ENTER pour enregistrer la sélection. L'écran affiche **Mémorise...** pendant 1 seconde environ, puis revient au **Menu Options**. Appuyez sur EXIT pour revenir au menu précédent.	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500

SÉLECTION DES UNITÉS DE TURBIDITÉ

Les résultats de chaque courbe d'étalonnage seront exprimés dans l'unité par défaut pour la courbe d'étalonnage donnée sauf si vous sélectionnez une unité différente. L'unité par défaut est affichée après le nom de la courbe d'étalonnage. Les unités par défaut sont les suivantes :

	Courbe d'étalonnage	Unité par défaut
2020t	Néphélométrique	NTU (Nephelometric Turbidity Units)
	Ratiométrique	NTRU (Nephelometric Turbidity Ratio Units)
	Atténuation	AU (Attenuation Units)
2020i	Néphélométrique	FNU (Formazin Nephelometric Units)
	Ratiométrique	FNRU (Formazin Nephelometric Ratio Units)
	Atténuation	FAU (Formazin Attenuation Units)

Pour chaque mode, il est possible de choisir une autre unité que celle par défaut pour exprimer les résultats. Si vous choisissez les unités ASBC (American Society of Brewing Chemists) et EBC (European Brewery Convention), utilisez la courbe d'étalonnage néphélométrique.

Pour l'appareil 2020t, les unités disponibles sont les suivantes : NTU, NTRU, AU, ASBC, EBC

Pour l'appareil 2020i, les unités disponibles sont les suivantes : FNU, NTU, FNRU, FAU, ASBC, EBC

Les unités NTRU, AU, FNU, FNRU et FAU sont numériquement équivalentes à l'unité NTU. Les unités indiquent quel détecteur et quelle source de lumière ont été utilisés pour réaliser la mesure. Consultez les définitions de chaque unité de turbidité à la page 102.

1. Appuyez sur et maintenez le bouton brièvement enfoncé pour allumer le turbidimètre. Un écran apparaît et affiche le logo de LaMotte pendant 3 secondes environ, puis le **Menu principal**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
2. Appuyez sur pour atteindre **Options**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500

3. Appuyez sur ENTER pour sélectionner **Options**.	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500
4. Appuyez sur ENTER pour sélectionner **Options turbidité**.	Options turbidité Étalonnage de la turbidité Unités de turbidité 12:00:00 001/500
5. Appuyez sur ▼ pour atteindre **Unités turbidité.**	Options turbidité Étalonnage de turbidité Unités turbidité 12:00:00 001/500
6. Appuyez sur ENTER pour sélectionner **Unités turbidité**.	Unités turbidité Défaut NTU ASBC EBC 12:00:00 001/500
7. Appuyez sur ▲ ou ▼ pour atteindre l'unité désirée.	Unités turbidité Défaut NTU ASBC EBC 12:00:00 001/500

8. Appuyez sur ENTER pour enregistrer la sélection. L'écran affiche **Mémorise...** pendant 1 seconde environ, puis revient au **Menu Options**. Appuyez sur EXIT pour revenir au menu précédent.	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500

MOYENNE

L'option Moyenne permet à l'utilisateur d'établir la moyenne de plusieurs résultats. Cette option améliore la précision des échantillons dont les résultats peuvent avoir tendance à dériver avec le temps. Si vous choisissez l'option de deux, cinq ou dix mesures, la moyenne finale s'affiche. Par défaut, l'option est désactivée. Pour modifier ce paramètre, procédez comme suit :

1. Appuyez sur et maintenez le bouton brièvement enfoncé pour allumer le turbidimètre. Un écran apparaît et affiche le logo de LaMotte pendant 3 secondes environ, puis le **Menu principal**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
2. Appuyez sur pour atteindre **Options**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
3. Appuyez sur ENTER pour sélectionner **Options**	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500

4.	Appuyez sur pour **Calcul de moyenne**.	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500
5.	Appuyez sur ENTER pour sélectionner Calcul de moyenne.	Calcul de moyenne Désactivé 2 mesures 5 mesures 10 mesures 12:00:00 001/500
6.	Appuyez sur ou pour atteindre l'option désirée.	Calcul de moyenne Désactivé 2 mesures 5 mesures 10 mesures 12:00:00 001/500
7.	Appuyez sur ENTER pour enregistrer la sélection. L'écran affiche **Mémorise...** pendant 1 seconde environ, puis revient au **Menu Options**. Appuyez sur EXIT pour revenir au menu précédent.	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500

REMARQUE : Lorsque l'option Moyenne est activée, le délai d'affichage du résultat est plus long et l'appareil consomme davantage d'énergie.

RÉGLAGE HORLOGE

1. Appuyez sur et maintenez le bouton brièvement enfoncé pour allumer le turbidimètre. Un écran apparaît et affiche le logo de LaMotte pendant 3 secondes environ, puis le **Menu principal**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
2. Appuyez sur pour atteindre **Options**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
3. Appuyez sur ENTER pour sélectionner **Options**. Appuyez sur pour atteindre **Réglage horloge.**	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500
4. Appuyez sur ENTER pour sélectionner **Réglage horloge**. La date est affichée au format mois-jour-année. L'heure est affichée au format heures:minutes:secondes AM/PM. Appuyez sur ou pour atteindre le chiffre approprié, puis appuyez sur ENTER pour le sélectionner. Le curseur passe au chiffre suivant. Réglez chaque chiffre de la même manière. Il s'agit d'un menu déroulant.	Réglage hueure date : <u>07</u>-09-2018 temps : 02:09:08 PM 12:00:00 001/500
5. Appuyez sur ENTER pour sélectionner le dernier chiffre. L'heure et la date sont enregistrées et l'écran revient au **Menu Options**.	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500

■ RÉGLAGE ÉNERGIE

La fonction d'économie d'énergie d'arrêt automatique éteint l'instrument au bout d'un certain délai si vous n'appuyez sur aucun bouton. Par défaut, le délai est réglé sur 5 minutes. Pour modifier ce paramètre, procédez comme suit :

1. Appuyez sur et maintenez le bouton brièvement enfoncé pour allumer le turbidimètre. Un écran apparaît et affiche le logo de LaMotte pendant 3 secondes environ, puis le **Menu principal**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
2. Appuyez sur pour atteindre **Options**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
3. Appuyez sur ENTER pour sélectionner **Options**.	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500
4. Appuyez sur pour atteindre **Réglage énergie**.	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500
5. Appuyez sur ENTER pour sélectionner **Économie d'énergie**.	Auto-Extinction Désactiver 5 Minutes 15 Minutes 30 Minutes 12:00:00 001/500

6. Press or to scroll to desired setting. Appuyez sur ou pour atteindre l'option désirée.	Auto-Extinction Desactiver 5 Minutes 15 Minutes 30 Minutes 12:00:00 001/500
7. Appuyez sur ENTER pour enregistrer la sélection. L'écran affiche **Mémorise...** pendant 1 seconde environ, puis revient au **Menu Options.**	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500

■ RÉGLAGE DE LA DURÉE DU RÉTROÉCLAIRAGE

Le rétroéclairage éclaire l'écran pour en augmenter la visibilité. Si Bouton de commande est sélectionné, le bouton du rétroéclairage sur le clavier fonctionne comme un bouton marche/arrêt et le rétroéclairage reste activé ou désactivé lorsque l'appareil est utilisé. Lorsque l'une des autres options (10, 20 ou 30 secondes) est sélectionnée, l'écran reste éclairé pendant le délai indiqué, décompté à partir du moment où vous avez appuyé sur une touche pour la dernière fois. Par mesure de précaution, le rétroéclairage est désactivé pendant la mesure de la turbidité pour éviter toute interférence de lumière parasite.

REMARQUE : La fonction de rétroéclairage consomme beaucoup d'énergie. Plus le rétroéclairage fonctionne, plus vous devrez recharger la batterie si vous ne vous servez pas du chargeur secteur/USB.

1. Appuyez sur et maintenez le bouton brièvement enfoncé pour allumer le turbidimètre. Un écran apparaît et affiche le logo de LaMotte pendant 3 secondes environ, puis le **Menu principal**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
2. Appuyez sur pour atteindre **Options**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500

3. Appuyez sur ENTER pour sélectionner **Options.**	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500
4. Appuyez sur pour atteindre **Régl. Rétroéclair**.	Menu Options Calcul de moyenne Réglage horloge Réglage énergie Régl. Rétroéclair. 12:00:00 001/500
5. Appuyez sur ENTER pour sélectionner **Régl. Rétroéclair**.	Temps Rétroécl. Bouton contrôle 10 secondes 20 secondes 30 secondes 12:00:00 001/500
6. Appuyez sur ou pour atteindre l'option désirée.	Temps Rétroécl. Bouton contrôle 10 secondes 20 secondes 30 secondes 12:00:00 001/500
7. Appuyez sur ENTER pour enregistrer la sélection. L'écran affiche **Mémorise...** pendant 1 seconde environ, puis revient au **Menu Options**.	Menu Options Calcul de moyenne Réglage horloge Réglage énergie Régl. Rétroéclair. 12:00:00 001/500

SÉLECTION DE LA LANGUE

Sept langues sont disponibles pour le 2020t/i : anglais, espagnol, français, portugais, italien, chinois et japonais (kana).

1. Appuyez sur ⏻ et maintenez le bouton brièvement enfoncé pour allumer le turbidimètre. Un écran apparaît et affiche le logo de LaMotte pendant 3 secondes environ, puis le **Menu principal**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
2. Appuyez sur ∨ pour atteindre **Options**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
3. Appuyez sur ENTER pour sélectionner **Options**.	Menu Options Options turbidité Calcul de moyenne Réglage horloge Réglage énergie 12:00:00 001/500
4. Appuyez sur ∨ pour atteindre **Choix Langue.**	Menu Options Réglage horloge Réglage énergie Régl. Rétroéclair. Choix Langue 12:00:00 001/500
5. Appuyez sur ENTER pour sélectionner **Choix Langue.**	Choix Langue Anglais Espagnol Français Portugais 12:00:00 001/500

6. Appuyez sur ou pour atteindre la langue désirée.	Choix Langue Anglais Espagnol Français Portugais 12:00:00 001/500
7. Appuyez sur ENTER pour sélectionner la langue désirée. L'écran affiche momentanément **Mémorise...** , pendant 1 seconde environ, puis revient au menu Options.	Menu Options Réglage horloge Réglage énergie Régl. Rétroéclair. Choix Langue 12:00:00 001/500

REMARQUE : Si vous sélectionnez par mégarde une autre langue, suivez la procédure ci-dessus pour la modifier. Par exemple, pour régler la langue du turbidimètre sur Anglais, procédez comme suit :

1. Allumez le turbidimètre.
2. Appuyez sur la flèche du bas deux fois. Appuyez sur ENTER.
3. Appuyez sur la flèche du bas six fois. Appuyez sur ENTER.
4. Appuyez sur ENTER.

LIAISON PC

La fonction Liaison PC est utilisée pour la fabrication de l'instrument de mesure. Ce menu n'est pas destiné à être utilisé par l'opérateur sur le terrain.

ENREGISTREMENT DES DONNÉES

Par défaut, l'Enregist. est activé. L'appareil enregistre les 500 derniers points de données. Le nombre au bas et au centre de l'écran indique le nombre de points de données enregistrés. L'écran affiche 500+ lorsque les données enregistrées dépassent les 500 points et que les points de données sont écrasés.

1. Appuyez sur et maintenez le bouton brièvement enfoncé pour allumer le turbidimètre. Un écran apparaît et affiche le logo de LaMotte pendant 3 secondes environ, puis le **Menu principal**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500

2. Appuyez sur ▼ pour atteindre **Enregist. des données**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
3. Appuyez sur ENTER pour sélectionner **Enregist. des données**.	Connexion Afficher est enreg. Permettre enr enregistr. Désactiver enregistr. Effacer enregistr. 12:00:00 001/500
4. Appuyez sur ENTER pour afficher le dernier point de données et l'heure à laquelle il a été enregistré.	Num. d'entregistr. 2 Turbidité - WB (N) 655 AU 12:26:58 PM 08-03-2018 12:00:00 001/500
5. Appuyez sur ▲ ou ▼ pour parcourir les points de données dans le journal.	Num. d'entregistr. 1 Turbidité - WB (R) 95.4 NTU 12:26:44 PM 08-03-2018 12:00:00 001/500
6. Appuyez sur EXIT pour revenir au menu Enregistrement. Appuyez sur ▲ ou ▼ pour parcourir les options d'enregistrement et les désactiver ou effacer le journal. Appuyez sur ENTER pour sélectionner l'option. L'écran affiche **Mémorise...** pendant 1 seconde environ, puis revient au **menu Connexion**.	Enregistrement Afficher est en reg. Permettre enr egistr. Désactiver en registr. Effacer en registr. 12:00:00 001/500

■ ÉTALONNAGE

Étalons de turbidité

Utilisez uniquement les étalons AMCO ou à la formazine avec le 2020t/i. N'utilisez pas les étalons StablCal® inférieurs à 50 NTU pour étalonner le 2020t/i. Le diluant utilisé dans les étalons StablCal® a un indice de réfraction différent des étalons traditionnels à la formazine et fausse les résultats. La concentration de la solution d'étalon doit être similaire à la concentration attendue des échantillons à analyser. Ne reversez jamais la solution d'étalon de l'éprouvette au flacon. Les solutions d'étalon n'ont pas la même valeur de turbidité dans les trois modes.

Les étalons suivants sont disponibles chez LaMotte :

Mode Unités	**Néphélométrique (N)**	**Néphélométrique (N)**	**Ratiométrique (R)**	**Ratiométrique (R)**
Instrument	**2020t**	**2020i**	**2020t**	**2020i**
Code 1480	0 NTU	0 FNU	0 NTRU	0 FNRU
Code 1441	1 NTU	-	1 NTRU	-
Code 1446	-	1 FNU	-	1 FNRU
Code 1442	10 NTU	-	10 NTRU	
Code 1447	-	10 FNU	-	10 FNRU
Code 1444	-	100 FNU	-	100 FNRU

Les étalons peuvent varier légèrement d'un lot à l'autre en mode ratiométrique. Les valeurs d'étalon pour le mode néphélométrique et le mode ratiométrique sont indiquées sur l'étiquette du flacon de la solution d'étalon. Utilisez la valeur indiquée sur l'étiquette du flacon de l'étalon de turbidité comme valeur cible lorsque vous étalonnez le turbidimètre en mode néphélométrique et en mode ratiométrique. Les étalons en mode d'atténuation doivent être à la formazine.

Éprouvettes

Utilisez des éprouvettes de turbidité (0260) qui ne présentent aucune rayure ni imperfection dans la zone de lumière, du bas de l'éprouvette jusqu'à la ligne de remplissage. Jetez toute éprouvette présentant des rayures. Lors de la mesure d'échantillons affichant une turbidité très faible, n'utilisez pas les éprouvettes ni les bouchons précédemment utilisés pour des échantillons dont la turbidité était élevée. Reportez-vous à la page 78 pour obtenir davantage d'informations.

Procédure d'étalonnage de la turbidité

La courbe d'étalonnage par défaut est néphélométrique comme l'indique le (N) dans la barre de menu. Les unités par défaut sont NTU (2020t) et FNU (2020i). Les autres options de courbe d'étalonnage sont les suivantes : ratiométrique et atténuation. La courbe d'étalonnage ratiométrique est indiquée par (R) et la courbe d'étalonnage d'atténuation est indiquée par (A). L'utilisateur doit effectuer un étalonnage pour chaque mode avec les étalons adaptés à l'instrument et à la plage.

Pour obtenir des résultats plus précis, l'utilisateur doit effectuer l'étalonnage sur la plus petite plage possible. Utilisez une solution d'étalon qui, avec le blanc, comprend la plage des échantillons à analyser. Par exemple, si les échantillons à analyser sont censés donner des résultats inférieurs à 1 NTU, les résultats seront plus précis si vous réalisez l'étalonnage avec un blanc et un étalon 1 NTU plutôt qu'avec un blanc et un étalon 10 NTU.

Le nombre de plages de mesure varie pour chaque mode.

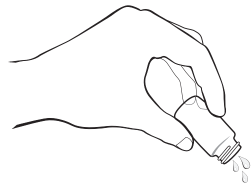
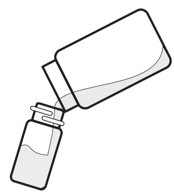
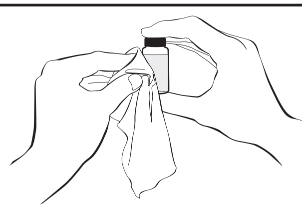
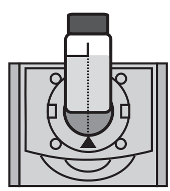
Mode	Néphélométrique (N)	Ratiométrique (R)	Atténuation (A)
Plages	0-11 NTU/FNU 10-110 NTU/FNU	0-11 NTRU/FNRU 10-110 NTRU/FNRU 100-510 NTRU/FNRU 500-1000 NTRU/FNRU	0-1010 AU/FAU 1000-2000 AU/FAU

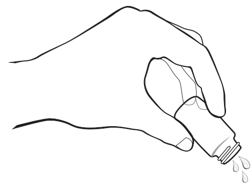
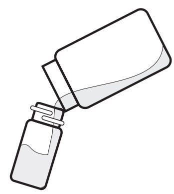
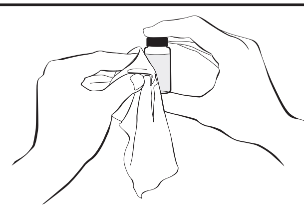
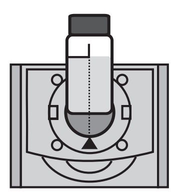
Vous pouvez étalonner chaque plage avec un point par plage plus un blanc. Les nouveaux points d'étalonnage remplaceront les anciens de façon indépendante pour chaque plage. Si l'une des plages est à nouveau étalonnée, le turbidimètre conservera les anciennes données d'étalonnage pour les autres plages. Il est recommandé d'étalonner le turbidimètre pour chaque plage utilisée. La valeur des étalons choisis ne doit pas se situer aux extrémités des plages. L'appareil sélectionne automatiquement la plage appropriée à l'échantillon analysé.

Il est recommandé d'étalonner le turbidimètre tous les jours.

Dans les exemples suivants, le turbidimètre utilisé est le 2020t en mode néphélométrique avec des étalons NTU.

1. Appuyez sur ⏻ et maintenez le bouton brièvement enfoncé pour allumer le turbidimètre. Un écran apparaît et affiche le logo de LaMotte pendant 3 secondes environ, puis le **Menu principal**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
2. Appuyez sur ENTER pour sélectionner **Mesurer**.	Menu Mesurer (N) Turbidité - Sans blanc Turbidité - Avec blanc 12:00:00 001/500
3. Appuyez sur ∨ pour atteindre **Turbidité - Avec blanc**.	Menu Mesurer (N) Turbidité - Sans blanc Turbidité - Avec blanc 12:00:00 001/500

4. Appuyez sur **ENTER** pour sélectionner **Turbidité – Avec blanc**.	Turbidité WB (N) Scanner un blanc **Scanner échantillon** 12:00:00 001/500
5. Rincez trois fois une éprouvette (0260) propre avec le blanc. Si les échantillons sont censés donner des résultats inférieurs à 1 NTU, le turbidimètre doit être remis à zéro avec un étalon primaire 0 NTU ou une eau sans turbidité (<0.1 NTU) préparée. Pour obtenir des résultats plus précis, utilisez la même éprouvette pour le blanc et l'échantillon.	
6. Remplissez l'éprouvette jusqu'à la ligne de remplissage avec le blanc. Versez le blanc le long de la paroi interne de l'éprouvette pour éviter de créer des bulles. Fermez l'éprouvette.	
7. Essuyez minutieusement l'éprouvette avec une lingette non pelucheuse.	
8. Ouvrez le couvercle du turbidimètre. Insérez l'éprouvette dans la chambre. Faites correspondre la ligne repère sur l'éprouvette avec la flèche repère sur le turbidimètre. Fermez le couvercle.	

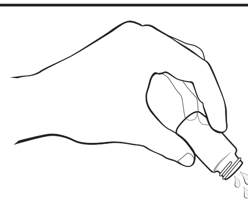
9. Appuyez sur **ENTER** pour sélectionner **Scanner un blanc** et analysez le blanc. L'écran affiche **Blanc Fait** pendant 1 seconde environ, puis revient au menu **Turbidité – Avec blanc**.	Turbidité WB (N) Scanner un blanc Scanner échantillon 12:00:00 001/500
10. Rincez trois fois une éprouvette (0260) propre, ou la même éprouvette, avec la solution d'étalon.	
11. Remplissez l'éprouvette jusqu'à la ligne de remplissage avec la solution d'étalon. Versez la solution d'étalon le long de la paroi interne de l'éprouvette pour éviter de créer des bulles. Fermez l'éprouvette.	
12. Essuyez minutieusement l'éprouvette avec une lingette non pelucheuse.	
13. Ouvrez le couvercle du turbidimètre. Insérez l'éprouvette dans la chambre. Faites correspondre la ligne repère sur l'éprouvette avec la flèche repère sur le turbidimètre. Fermez le couvercle.	
14. Appuyez sur **ENTER** pour sélectionner **Scanner un blanc** et analysez l'étalon. L'écran affiche **Lecture** pendant 1 seconde environ. Le résultat s'affiche à l'écran.	Turbidité WB (N) 0.99 NTU Scanner un blanc Scanner échantillon 12:00:00 001/500

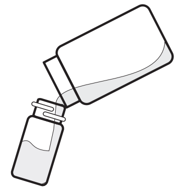
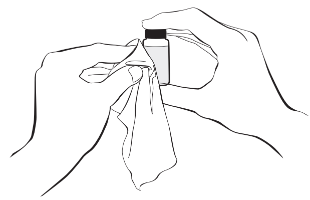
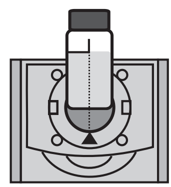
15. Appuyez sur ▼ pour atteindre **Calibrage**.	Turbidité WB [N] 0.99 NTU Scanner échantillon Calibrage 12:00:00 001/500
16. Appuyez sur ENTER pour sélectionner **Calibrage**. Une police inversée (caractères sombres sur fond clair) s'affiche pour indiquer que la mesure peut être ajustée.	Turbidité WB [N] 0.99 NTU Scanner échantillon Calibrage 12:00:00 001/500
17. Appuyez sur ▲ ou ▼ pour atteindre la concentration de l'étalon, 1.00 dans l'exemple. **Utilisez la valeur indiquée sur l'étiquette du flacon de l'étalon de turbidité comme valeur cible.** Remarque : l'ajustement autorisé est de ±25 %. Si la limite de l'ajustement autorisé est atteinte, « Hors plage » s'affiche.	Turbidité WB [N] 1.00 NTU Scanner échantillon Calibrage 12:00:00 001/500
18. Appuyez sur ENTER pour sélectionner **Calibrage**. Deux options de menu s'affichent : Définir l'étalonnage et Réglage d'usine	Menu Étalonner [N] 1.00 NTU Calibrage Réglage Usine 12:00:00 001/500
19. Appuyez sur ENTER pour sélectionner **Calibrage** et sauvegarder l'étalonnage. Appuyez sur ▲ ou ▼ pour atteindre et sélectionner Réglage d'usine pour restaurer **Réglage Usine**. Le turbidimètre affiche momentanément **Mémorise...** , puis revient au menu **Turbidité - Sans blanc**. L'étalonnage est à présent sauvegardé et vous pouvez utiliser le turbidimètre pour effectuer des analyses.	Turbidité WB [N] Scanner un blanc Scanner échantillon 12:00:00 001/500

REMARQUE : Pour garantir une précision maximale pendant la procédure d'étalonnage, analysez le blanc en tant qu'échantillon après avoir remis à zéro le turbidimètre et assurez-vous que le résultat est 0.00. Si ce n'est pas le cas, effectuez à nouveau la remise à zéro du turbidimètre, jusqu'à ce que le résultat soit 0.00. Lorsque vous analysez l'étalon en tant qu'échantillon, analysez-le trois fois en enlevant l'éprouvette de la chambre entre chaque analyse, puis en la réinsérant dans la même position. Les résultats doivent être cohérents. Utilisez le dernier résultat cohérent pour étalonner le turbidimètre. Si les mesures ne sont pas cohérentes, évitez d'utiliser une mesure anormale pour étalonner le turbidimètre.

■ ANALYSE SANS PROCÉDURE DE REMISE À ZÉRO DU BLANC

Pour obtenir des résultats aussi précis possibles, le turbidimètre doit être remis à zéro avant d'effectuer toute mesure d'échantillon. L'étape de remise à zéro est un peu moins essentielle pour les échantillons supérieurs à 10 NTU, mais pour les échantillons inférieurs à 10 NTU, le turbidimètre doit toujours être remis à zéro.

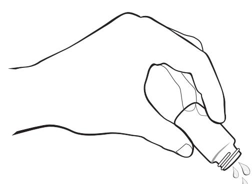
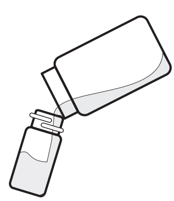
1. Appuyez sur et maintenez le bouton brièvement enfoncé pour allumer le turbidimètre. Un écran apparaît et affiche le logo de LaMotte pendant 3 secondes environ, puis le **Menu principal**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500
2. Appuyez sur ENTER pour sélectionner **Mesurer**.	Menu Mesurer (N) Turbidité - Sans blanc Turbidité - Avec blanc 12:00:00 001/500
3. Appuyez sur ENTER pour sélectionner **Turbidité - Sans blanc**.	Turbidité NB (N) Scanner un blanc Scanner échantillon 12:00:00 001/500
4. Rincez trois fois une éprouvette (0260) propre avec l'échantillon.	

5. Remplissez l'éprouvette jusqu'à la ligne de remplissage avec l'échantillon. Versez l'échantillon le long de la paroi interne de l'éprouvette pour éviter de créer des bulles. Fermez l'éprouvette.	
6. Essuyez minutieusement l'éprouvette avec une lingette non pelucheuse.	
7. Ouvrez le couvercle du turbidimètre. Insérez l'éprouvette dans la chambre. Faites correspondre la ligne repère sur l'éprouvette avec la flèche repère sur le turbidimètre. Fermez le couvercle.	
8. Appuyez sur ENTER pour sélectionner **Scanner échantillon** et analysez l'échantillon. L'écran affiche **Lecture** en cours pendant 1 seconde environ. Le résultat s'affiche à l'écran. "Hors limites" sera affiché si la lecture est hors limites. Diluez l'échantillon ou sélectionnez un mode adapté à la plage de l'échantillon.	Turbidité NB (N) 10.22 NTU Scanner un blanc Scanner échantillon 12:00:00 001/500

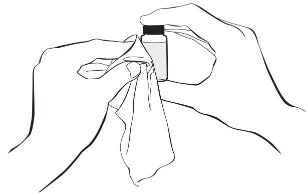
ANALYSE AVEC PROCÉDURE DE REMISE À ZÉRO DU BLANC

Pour obtenir des résultats aussi précis possibles, le turbidimètre doit être remis à zéro avant d'effectuer toute mesure d'échantillon. L'étape de remise à zéro est un peu moins essentielle pour les échantillons supérieurs à 10 NTU, mais pour les échantillons inférieurs à 10 NTU, le turbidimètre doit toujours être remis à zéro.

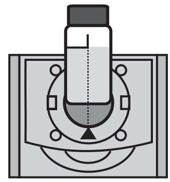
1. Appuyez sur et maintenez le bouton brièvement enfoncé pour allumer le turbidimètre. Un écran apparaît et affiche le logo de LaMotte pendant 3 secondes environ, puis le **Menu principal**.	Menu principal Mesurer Enregist. des données Options 12:00:00 001/500

2. Appuyez sur ENTER pour sélectionner **Mesurer**.	Menu Mesurer (N) Turbidité - Sans blanc Turbidité - Avec blanc 12:00:00 001/500
3. Appuyez sur pour atteindre **Turbidité - Avec blanc**.	Menu Mesurer (N) Turbidité - Sans blanc Turbidité - Avec blanc
4. Appuyez sur ENTER pour sélectionner **Turbidité - Avec blanc**.	Turbidité WB (N) Scanner un blanc Scanner échantillon 12:00:00 001/500
5. Rincez trois fois une éprouvette (0260) propre avec le blanc. Si les échantillons sont censés donner des résultats inférieurs à 1 NTU, le turbidimètre doit être remis à zéro avec un étalon primaire 0 NTU ou une eau sans turbidité (<0.1 NTU) préparée. Pour obtenir des résultats plus précis, utilisez la même éprouvette pour le blanc et l'échantillon.	
6. Remplissez l'éprouvette jusqu'à la ligne de remplissage avec le blanc. Versez le blanc le long de la paroi interne de l'éprouvette pour éviter de créer des bulles. Fermez l'éprouvette.	

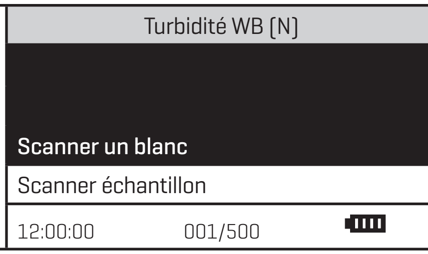
7. Essuyez minutieusement l'éprouvette avec une lingette non pelucheuse.



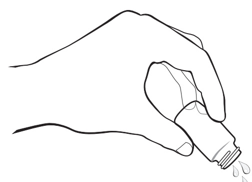
8. Ouvrez le couvercle du turbidimètre. Insérez l'éprouvette dans la chambre. Faites correspondre la ligne repère sur l'éprouvette avec la flèche repère sur le turbidimètre. Fermez le couvercle.



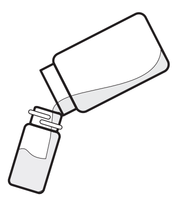
9. Appuyez sur ENTER pour sélectionner **Scanner un blanc** et analysez le blanc. L'écran affiche **Blanc Fait** pendant 1 seconde environ, puis revient au menu **Turbidité - Avec blanc**.



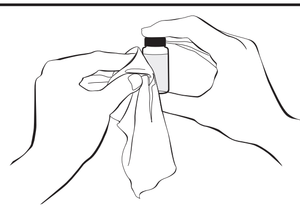
10. Rincez trois fois une éprouvette (0260) propre, ou la même éprouvette, avec l'échantillon.



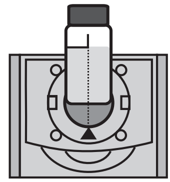
11. Remplissez l'éprouvette jusqu'à la ligne de remplissage avec l'échantillon. Versez la solution d'étalon le long de la paroi interne de l'éprouvette pour éviter de créer des bulles. Fermez l'éprouvette.



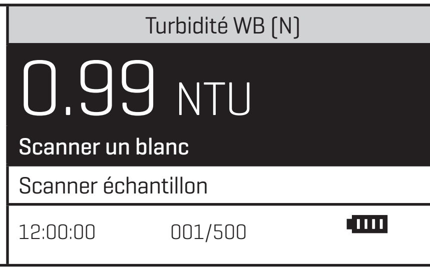
12. Essuyez minutieusement l'éprouvette avec une lingette non pelucheuse.



13. Ouvrez le couvercle du turbidimètre. Insérez l'éprouvette dans la chambre. Faites correspondre la ligne repère sur l'éprouvette avec la flèche repère sur le turbidimètre. Fermez le couvercle.



14. Appuyez sur **ENTER** pour sélectionner **Scanner échantillon** et analysez l'échantillon. L'écran affiche **Lecture** pendant 1 seconde environ. Le résultat s'affiche à l'écran. “Hors limites” sera affiché si la lecture est hors limites. Diluez l'échantillon ou sélectionnez un mode adapté à la plage de l'échantillon.



REMARQUE : Le turbidimètre se souvient de la dernière mesure d'analyse du blanc. Il n'est pas nécessaire d'analyser le blanc à chaque analyse. Pour utiliser la précédente mesure du blanc, au lieu d'analyser un nouveau blanc, sélectionnez Analyser l'échantillon et poursuivez. Pour obtenir des résultats précis, le turbidimètre doit être remis à zéro avant chaque analyse et la même éprouvette doit être utilisée pour le blanc et l'échantillon analysé.

PROCÉDURES DE DILUTION

Si un échantillon est supérieur à 2000 NTU ou FNU, diluez-le minutieusement avec la solution 0 NTU/FNU ou une eau de turbidité très faible pour que l'échantillon se situe dans une plage acceptable. Toutefois, il n'est pas garanti que diviser la concentration par deux donne une valeur NTU ou FNU divisée par deux. Les particules réagissent souvent de façon imprévisible lorsqu'elles sont diluées.

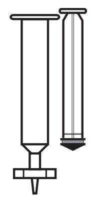
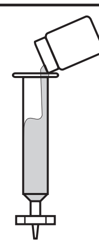
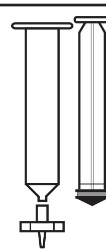
Eau sans turbidité

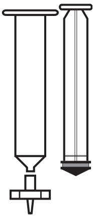
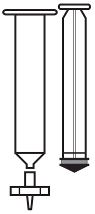
La définition d'une eau de faible turbidité ou sans turbidité a évolué avec le développement de la technologie de filtration et les instruments néphélométriques ont gagné en précision. Auparavant, une eau sans turbidité était définie comme une eau passant à travers un filtre de 0,6 micron. De nos jours, des filtres de 0,1 micron sont disponibles permettant d'obtenir une eau plus pure. L'eau passée à travers un filtre de 0,1 micron peut être considérée comme exempte de particules et donc sans turbidité, soit une eau de 0 NTU. La turbidité est provoquée par la diffusion de la lumière. Par conséquent, une eau de faible turbidité est une eau sans aucune particule diffusant une quantité de lumière mesurable. Toutefois, il est possible qu'une eau passant à travers un filtre de 0,1 micron comprenne encore une diffusion lumineuse mesurable avec des instruments modernes. Cette diffusion lumineuse peut être le résultat de molécules dissoutes ou de particules d'une taille inférieure au micron qu'il est impossible d'éliminer avec un filtre. Puisque l'eau peut encore contenir une faible quantité de lumière diffusée par des molécules dissoutes, on appelle généralement l'eau de grande pureté « eau de faible turbidité » et on lui affecte une valeur de 0.01 ou 0.02 NTU. Toutefois, cette eau étant utilisée comme base de comparaison pour les échantillons d'eau, la différence entre l'échantillon et l'eau de faible turbidité ou sans turbidité sera la même, qu'elle soit d'une valeur de 0.00 ou de 0.02 NTU. Pour une question de simplicité, le 2020t/i utilise le terme « eau sans turbidité » et la valeur 0.00 NTU.

PRÉPARATION D'EAU SANS TURBIDITÉ

Un étalon 0 NTU/FNU (code 1480) est inclus avec le turbidimètre. Les accessoires sont disponibles la préparation d'eau sans turbidité pour la remise à zéro du turbidimètre et la dilution des échantillons affichant une turbidité élevée.

La préparation d'eau sans turbidité requiert une technique minutieuse. L'introduction de matières étrangères fausse la mesure de la turbidité. Un appareil de filtration doté d'une membrane de filtration spéciale est utilisé pour préparer l'eau sans turbidité. Le filtre, son support et la seringue doivent être conditionnés en introduisant le contenu d'au moins deux seringues d'eau désionisée dans le système de filtration pour éliminer toute matière étrangère. L'eau du premier et du second rinçage doit être jetée. L'eau sans turbidité préparée à l'aide de la procédure suivante peut être stockée dans l'obscurité, à température ambiante, dans un flacon en verre fermé par un bouchon à vis et utilisée selon les besoins. Rincez minutieusement le récipient de stockage avec l'eau désionisée filtrée avant de le remplir. Inspectez régulièrement l'eau à la lumière pour vérifier qu'elle ne contienne aucune matière étrangère.

1. Enlevez le piston de la seringue (0943). Fixez le filtre au bout de la seringue.	
2. Versez approximativement 50 mL d'eau désionisée dans le corps de la seringue. Replacez le piston. Exercez une pression sur le piston pour faire passer lentement l'eau à travers le filtre. Récupérez l'eau dans un récipient de stockage propre. Rincez les parois du récipient, puis jetez l'eau de rinçage.	
3. Enlevez le filtre de la seringue. Enlevez le piston du corps de la seringue. (Cette étape est obligatoire, car elle permet d'éviter de rompre le filtre par le vide créé lorsque le piston est enlevé.)	
4. Replacez le filtre et effectuez à nouveau l'étape 2 pour réaliser un second rinçage de la seringue et du récipient de stockage.	

5. Enlevez le filtre de la seringue. Enlevez le piston du corps de la seringue. Replacez le filtre et remplissez la seringue avec environ 50 mL d'eau désionisée. Filtrez l'eau et récupérez-la dans le récipient de stockage, puis conservez cette eau sans turbidité.	
6. Effectuez à nouveau l'étape 5 jusqu'à obtenir la quantité désirée d'eau sans turbidité.	

■ ASTUCES D'ANALYSE

1. Prélevez les échantillons dans un récipient propre en verre ou en polyéthylène.
2. Analysez les échantillons aussi rapidement que possible après leur prélèvement.
3. Mélangez délicatement l'échantillon en renversant le récipient avant d'effectuer toute mesure, tout en faisant attention à ne pas introduire de bulles d'air.
4. Pour des résultats plus précis, suivez la procédure recommandée pour essuyer l'éprouvette remplie avant de la placer dans la chambre du turbidimètre. Renversez lentement et délicatement l'éprouvette, trois fois, pour mélanger l'échantillon. Entourez l'éprouvette d'une lingette propre et non pelucheuse. Maintenez la lingette bien serrée autour de l'éprouvette. Faites tourner l'éprouvette trois fois dans la lingette pour vous assurer que toutes les zones de l'éprouvette ont bien été essuyées. Placez les éprouvettes dans la chambre dans la même position à chaque fois.
5. Jetez les éprouvettes qui présentent d'importantes rayures et imperfections au niveau de la zone où passe la lumière. (Zone centrale entre le bas de l'éprouvette et la ligne de remplissage.)
6. Lors de la mesure d'échantillons affichant une turbidité très faible, n'utilisez pas les éprouvettes ni les bouchons précédemment utilisés pour des échantillons dont la turbidité était élevée.
7. Utilisez l'option Moyenne pour mesurer des taux de turbidité faibles.
8. Placez le turbidimètre sur une surface exempte de toute vibration. Les vibrations peuvent augmenter les valeurs des résultats.
9. Les champs électriques autour des moteurs faussent les résultats de mesure de turbidité.
10. La présence de carbone dans l'échantillon absorbe la lumière et réduit les valeurs des résultats.
11. Une couleur excessive dans l'échantillon absorbe la lumière et réduit les valeurs des résultats. L'utilisateur doit vérifier si le niveau de couleur risque de provoquer une erreur considérable au niveau de la turbidité analysée. Il est recommandé d'utiliser la courbe d'étalonnage ratiométrique pour les échantillons très colorés.

12. Respectez les recommandations de durée de vie des étalons de turbidité.
13. N'utilisez pas d'huile de silicone sur les éprouvettes lorsque vous analysez la turbidité avec l'appareil 2020t/i.
14. Lorsque vous analysez des échantillons présentant une faible concentration, utilisez la même éprouvette pour le blanc et l'échantillon.
15. Insérez toujours l'éprouvette dans la chambre du turbidimètre en exerçant la même pression et à la même profondeur.
16. Nettoyez régulièrement la chambre avec une lingette non pelucheuse humide, puis avec la lingette humide Windex®. Il est essentiel d'utiliser des éprouvettes et une chambre propres pour obtenir des résultats fiables.
17. Pour garantir une précision maximale pendant la procédure d'étalonnage, analysez le blanc en tant qu'échantillon après avoir remis à zéro le turbidimètre et assurez-vous que le résultat est 0.00. Si ce n'est pas le cas, effectuez à nouveau la remise à zéro du turbidimètre, jusqu'à ce que le résultat soit 0.00. Lorsque vous analysez l'étalon en tant qu'échantillon, analysez-le trois fois en enlevant l'éprouvette de la chambre entre chaque analyse. Les résultats doivent être cohérents. Utilisez le dernier résultat cohérent pour étalonner le turbidimètre. Si les mesures ne sont pas cohérentes, évitez d'utiliser une mesure anormale pour étalonner le turbidimètre.
18. Étalonnez le turbidimètre tous les jours.
19. Étalonnez le turbidimètre avec un étalon qui soit le plus proche possible de la plage attendue pour l'échantillon analysé. Par exemple, si l'échantillon est censé donner une valeur inférieure à 1.0 NTU, étalonnez le turbidimètre avec un étalon 1.0 NTU et un blanc (étalon 0 NTU). Si l'échantillon est censé donner un résultat aux alentours de 2 NTU, étalonnez le turbidimètre également avec l'étalon 1.0 NTU, mais si la valeur de résultat attendue est d'environ 8 NTU, réalisez l'étalonnage avec un étalon 10 NTU. Si la valeur attendue du résultat pour l'échantillon est supérieure à 30 – 40 NTU, il est recommandé d'étalonner le turbidimètre avec un étalon 100 NTU.
20. Pour maintenir la température de la lampe constante, n'éteignez pas le turbidimètre lorsque vous analysez des échantillons.

GUIDE DE DÉPANNAGE

■ DÉPANNAGE

PROBLÈME	RAISON	SOLUTION
« Blanc ? »	L'échantillon donne un résultat inférieur au blanc.	Pour des échantillons dont la concentration est très faible, effectuez à nouveau la remise à zéro ou enregistrez le résultat en tant que zéro. Pour des échantillons dont la concentration est plus élevée, effectuez à nouveau la remise à zéro puis l'analyse.
L'affichage clignote	Batterie faible. Les mesures sont fiables.	Rechargez la batterie ou utilisez le chargeur ordinateur/secteur USB.
« Batterie faible »	La tension de la batterie est très faible. Les mesures ne sont pas fiables.	Rechargez la batterie ou utilisez le chargeur ordinateur/secteur USB.

Arrêt « Arrêt batt. faible »	La batterie est trop faible pour pouvoir faire fonctionner l'appareil.	Rechargez la batterie ou utilisez le chargeur ordinateur/secteur USB.
« Hors plage »	L'échantillon se trouve en dehors de la plage acceptable.	Diluez l'échantillon, puis effectuez à nouveau l'analyse.
« Error1 »	Mesures élevées avec détecteurs à 90° et 180°.	Diluez l'échantillon d'au moins 50 %, puis effectuez à nouveau l'analyse.
Mesures positives ou négatives importantes inhabituelles lors de l'étalonnage	Les étalons utilisés pour étalonner le turbidimètre ne sont pas les bons.	Utilisez une solution d'étalon 0.0 fraîche dans une éprouvette propre. Étalonnez à nouveau le turbidimètre.

■ LUMIÈRE PARASITE

La précision des mesures du 2020t/i ne doit pas être faussée par une lumière parasite. Assurez-vous que le couvercle du compartiment d'échantillon est toujours bien fermé lorsque vous réalisez une analyse. Le rétroéclairage interfère avec les mesures de turbidité. Le turbidimètre désactive temporairement le rétroéclairage lors de la mesure de la turbidité.

INFORMATIONS GÉNÉRALES SUR LE FONCTIONNEMENT

■ PRÉSENTATION GÉNÉRALE

L'appareil 2020t/i est un néphélomètre portable, commandé par microprocesseur, à lecture directe. La turbidité est mesurée directement conformément à la méthode EPA 180.1 ou à la méthode ISO 7027 ou bien calculée de façon ratiométrique à l'aide d'une combinaison de deux mesures. L'appareil est équipé d'un écran graphique à cristaux liquides et d'un clavier à six touches, grâce auxquels l'utilisateur peut sélectionner les options dans les menus du logiciel, afficher directement les résultats d'analyse ou réviser d'anciens résultats stockés dans l'enregistreur de données. Les menus peuvent être affichés en sept langues différentes.

L'appareil 2020t/i utilise une configuration optique à plusieurs détecteurs à la pointe de la technologie qui assure une stabilité à long terme des étalonnages, une grande précision, ainsi que des limites de détection basses. Toutes les mesures sont déterminées par des algorithmes de traitement numérique de signal, ce qui réduit les fluctuations dans les résultats et permet des mesures rapides et répétables. Le microprocesseur et les lentilles optiques permettent une plage dynamique et une définition automatique de la plage. Des sources de lumière LED de grande efficacité énergétique sont utilisées pour la turbidité ISO. La turbidité EPA utilise une source de lumière à filament de tungstène qui est conforme ou supérieure aux exigences EPA et conçue pour donner une image ponctuelle uniforme et un rendement en sortie stable.

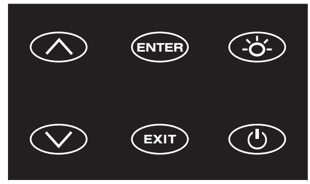
Le 2020t/i fonctionne sur secteur avec un adaptateur USB, sur ordinateur via une connexion USB ou sur batterie lithium.

■ INFORMATIONS GÉNÉRALES SUR LE FONCTIONNEMENT

L'utilisation du 2020t/i se fait au moyen des menus du logiciel et de l'interface utilisateur. Un menu est une liste de choix, permettant de sélectionner différentes tâches que l'appareil 2020t/i doit exécuter, telles que l'analyse du blanc ou l'analyse d'un échantillon. Le clavier sert à sélectionner les options du menu qui sont affichées à l'écran.

CLAVIER

	Ce bouton permet de parcourir vers le haut les options du menu.
ENTER	Ce bouton sert à sélectionner les choix dans le menu affiché à l'écran.
	Ce bouton permet de contrôler le rétroéclairage de l'écran.
	Ce bouton permet de parcourir vers le bas les options du menu.
EXIT	Ce bouton permet de revenir au menu précédent.
	Ce bouton permet d'allumer et d'éteindre le turbidimètre.

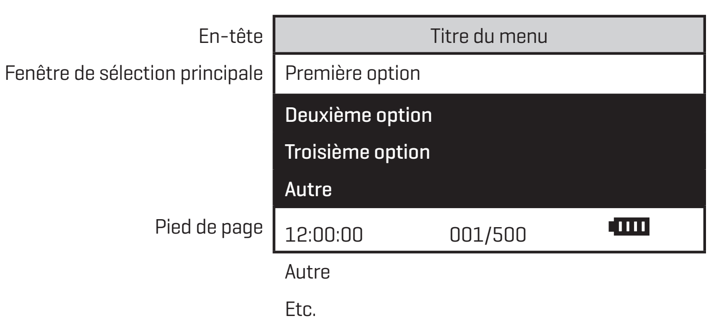


ÉCRAN ET MENUS

L'écran permet d'afficher et de sélectionner les options de menu. Ces options permettent d'indiquer à l'appareil 2020t/i d'exécuter des tâches spécifiques. Les menus sont présentés à l'écran sous deux formats généraux utilisés d'un menu à l'autre. Chaque menu est une liste de choix ou d'options.

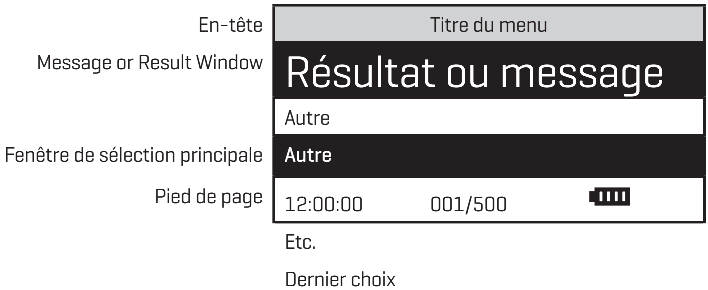
L'écran présente une ligne d'en-tête en haut et une ligne de bas de page en bas. L'en-tête affiche le titre du menu en cours. La ligne de bas de page affiche l'heure et la date, le statut de l'enregistreur de données et le statut de la batterie. La fenêtre de sélection du menu se trouve au milieu de l'écran, entre l'en-tête et le bas de page.

La fenêtre de sélection du menu présente des informations sous deux formats généraux. Le premier format affiche uniquement les options de menu. Jusqu'à quatre lignes d'options de menu peuvent être affichées. Si davantage d'options sont disponibles, vous pouvez les afficher et les parcourir dans la fenêtre de sélection du menu en appuyant sur les flèches ou . Imaginez que les options de menu représentent une liste verticale affichée à l'écran qui monte et descend à chaque fois que vous appuyez sur l'une des flèches ou . Certains menus du 2020t/i sont des menus en boucle. La première et la dernière option du menu sont reliées dans une boucle. Si vous faites défiler vers le bas la dernière option du menu, vous vous retrouvez à la première option. Si vous faites défiler vers le haut la première option du menu, vous vous retrouvez à la dernière option.



Une barre à fond clair indique l'option du menu. Lorsque vous parcourez les options du menu, la barre à fond clair met en surbrillance les différents choix du menu. Si vous appuyez sur le bouton ENTER, vous sélectionnez le choix du menu indiqué par la barre à fond clair.

Le deuxième format de la fenêtre des options de menu met à profit les capacités graphiques de l'écran. L'écran présente sous un grand format certaines informations, telles que les résultats d'analyse, les messages d'erreur ou le logo Lamotte. Les deux premières lignes de l'écran sont utilisées pour présenter des informations sous un grand format, facilement lisible. Les menus fonctionnent de la même manière que décrit précédemment, mais seules deux lignes du menu sont visibles au bas de l'écran.



Comme décrit précédemment, le bouton EXIT permet de quitter ou de fermer le menu en cours et de revenir vers le précédent menu. Il est ainsi possible de quitter rapidement un sous-menu pour revenir au Menu principal en appuyant plusieurs fois sur le bouton EXIT. En appuyant sur ce bouton à tout moment, l'appareil 2020t/i s'éteint.

L'écran peut afficher les messages suivants :

	Statut de la batterie
↑↓	Différents choix sont disponibles et peuvent être affichés en faisant défiler l'écran vers le bas ou vers le haut.
En-tête	Indique le menu en cours et les informations concernant les courbes d'étalonnage et les systèmes de réactifs, le cas échéant.
Pied de page	Lorsque le mode d'Enregist. est activé, le nombre de points de données est affiché et le nombre total de points de données en mémoire est indiqué. Le bas de page contient également l'heure et le statut de la batterie.

RÉSULTATS NÉGATIFS

Il existe toujours de légères variations dans les mesures effectuées par des instruments analytiques. Ces variations sont souvent observées lorsqu'un même échantillon est analysé plusieurs fois. Ces variations habituelles se trouvent au-dessus et en dessous d'une mesure moyenne. Une analyse réalisée plusieurs fois sur un même échantillon 0.00 peut donner des résultats supérieurs et inférieurs à 0.00. Par conséquent, il est possible et normal d'obtenir des mesures négatives pour des échantillons dont les concentrations sont proches de zéro. Cela ne signifie pas que la concentration d'un échantillon est négative, mais tout simplement que la mesure est inférieure à la mesure du blanc. Des mesures de faibles valeurs négatives peuvent indiquer que l'échantillon est proche de la limite de détection. Toutefois, une mesure négative importante n'est pas normale et indique un problème. Certains instruments sont conçus pour afficher zéro à la place des mesures négatives. Sur ce type d'instrument, si l'écran affiche zéro alors que le résultat était un nombre négatif important, le problème est occulté. C'est pourquoi, le 2020t/i affiche les nombres négatifs pour la turbidité.

■ ÉPROUVETTES ET CHAMBRES

Le 2020t/i utilise une éprouvette spécifique (code 0260).

La façon de manipuler les éprouvettes est extrêmement importante. Les éprouvettes doivent être propres et exemptes de peluches, d'empreintes de doigts, d'éclaboussures séchées et de rayures excessives, particulièrement au niveau de la zone centrale qui se trouve entre le bas de l'éprouvette et la ligne de remplissage.

Les rayures, taches de doigts et éclaboussures sur les éprouvettes peuvent provoquer une interférence de lumière parasite et donc des résultats imprécis lors de la mesure de la turbidité. Les rayures et abrasions réduisent la précision des résultats. Jetez et remplacez toute éprouvette rayée au niveau de la zone de lumière pour cause d'usage excessif.

Lavez toujours les éprouvettes à l'intérieur et à l'extérieur à l'aide d'un produit nettoyant doux avant toute utilisation afin d'éliminer la saleté et les taches de doigts. Faites sécher les éprouvettes à l'envers afin d'éviter que toute poussière puisse y entrer. Stockez les éprouvettes sèches avec leur bouchon afin d'éviter toute contamination.

Après avoir rempli et fermé une éprouvette, tenez-la par le bouchon et essuyez-en la surface externe avec une lingette absorbante propre et non pelucheuse jusqu'à ce qu'elle soit sèche et exempte de traces. Manipulez l'éprouvette uniquement par le bouchon afin d'éviter toute trace de doigts. Posez toujours l'éprouvette propre sur une surface propre pour ne pas la contaminer. Il est impératif que les éprouvettes et la chambre lumineuse soit propres et sèches. Séchez l'extérieur des éprouvettes à l'aide d'une lingette non pelucheuse propre ou d'une lingette jetable avant de les placer dans la chambre du turbidimètre.

Videz et nettoyez les éprouvettes aussi rapidement que possible une fois l'analyse de l'échantillon réalisée afin d'éviter que des particules ne s'y déposent. Lorsque vous avez besoin de résultats très précis, vous pouvez réduire le risque d'erreur en désignant des éprouvettes à utiliser uniquement pour les échantillons présentant une turbidité très faible et d'autres à utiliser uniquement pour les échantillons présentant une turbidité très élevée.

La variation de la géométrie de la verrerie et de la technique représente la principale cause de variation des résultats. De légères variations d'épaisseur et de diamètre des éprouvettes peuvent entraîner de légères variations dans les résultats d'analyse. Afin d'éliminer cette erreur, placez les éprouvettes dans la chambre toujours dans la même position.

Jetez et remplacez toute chambre rayée pour cause d'usage excessif.

ENTRETIEN

■ NETTOYAGE

Nettoyez l'extérieur du logement avec une lingette non pelucheuse humide. Ne laissez pas d'eau pénétrer dans la chambre lumineuse ni aucune autre partie du turbidimètre. Pour nettoyer la chambre lumineuse et la zone des lentilles optiques, dirigez une bombe à air comprimé vers la chambre lumineuse et ventilez-y l'air comprimé. Servez-vous d'un coton-tige imbibé de produit à vitre Windex® pour nettoyer délicatement l'intérieur de la chambre. N'utilisez pas d'alcool, car une fois sec, ce dernier laisse un fin résidu sur les lentilles.

■ RÉPARATIONS

Si vous devez renvoyer le turbidimètre pour réparation ou révision, emballez-le avec précaution dans un contenant approprié dont le matériau est adapté. Vous devez obtenir un numéro d'autorisation de retour auprès de LaMotte Company en appelant le 800--344-3100 (États-Unis uniquement) ou le 410-778-3100, par fax au 410-778-6394, ou en envoyant un courriel à tech@lamotte.com. Généralement, les problèmes peuvent être résolus par téléphone ou par courriel. S'il est nécessaire de renvoyer le turbidimètre, joignez-y une lettre contenant le numéro d'autorisation de retour, le numéro de série du turbidimètre, une brève description du problème et vos coordonnées, y compris vos numéros de téléphone et de fax. Ces informations permettront au service technique d'effectuer les réparations nécessaires plus efficacement.

■ ÉLIMINATION DU TURBIDIMÈTRE

Déchets d'équipements électriques et électroniques (DEEE)

Des ressources naturelles ont été utilisées pour la production de cet équipement. Cet équipement peut contenir des matériaux dangereux pour la santé et l'environnement. Pour éviter de nuire à l'environnement et aux ressources naturelles, il est recommandé d'employer les systèmes de reprise appropriés. Le symbole de poubelle sur roues barrée d'une croix apposé sur le turbidimètre encourage à utiliser ces systèmes lors de l'élimination de cet équipement.

Les systèmes de reprise permettent aux matériaux d'être réutilisés ou recyclés d'une manière qui ne soit pas nocive à l'environnement. Pour obtenir davantage d'informations sur les systèmes de collecte, de réutilisation et de recyclage approuvés, contactez les autorités locales ou régionales responsables des déchets ou les services de recyclage.

802 Washington Ave · Chestertown · Maryland · 21620 · USA
410-778-3100 · 800-344-3100
www.lamotte.com

1974-MN · 01.04.19

MiniRAE 2000

Portable Handheld VOC Monitor

The rugged MiniRAE 2000 is the smallest pumped handheld volatile organic compound (VOC) monitor on the market. Its Photoionization Detector's (PID) extended range of 0 to 10,000 ppm makes it an ideal instrument for applications from environmental site surveying to HazMat/ Homeland Security.

AutoRAE Compatible

Wireless

Key Features

- **Proven PID technology** The patented sensor provides a 3-second response up to 10,000 ppm and sets a new standard for resistance to moisture and dirt.
- **Wireless communication enabled and certified**
- **Self-cleaning lamp and sensor** The patented self-cleaning lamp and sensor minimize the need for maintenance and calibration.
- **The MiniRAE 2000 lamp and sensor can be taken apart in seconds for easy maintenance without tools!**
- **Measure more chemicals than with any other PID.** With over 100 Correction Factors built into the MiniRAE 2000 memory and the largest printed list of Correction Factors in the world (300+), RAE Systems offers the ability to accurately measure more ionizable chemicals than any other PID. When a gas is selected from the MiniRAE 2000's library, the alarm points are automatically loaded into the meter.
- **User friendly** screens make it easy to use for simple applications and flexible enough for sophisticated operations.
- **Drop-in battery** When work schedules require putting in more than the 10 hours supplied by the standard NiMH battery, the drop-in alkaline pack supplied with every MiniRAE 2000 lets you finish the job.
- **Rugged Rubber Boot** The standard rubber boot helps assure that the MiniRAE 2000 survives the bumps and knocks of tough field use.
- **Strong, built-in sample pump** draws up to 100 feet (30 m) horizontally or vertically.
- **Tough, flexible inlet probe**
- **Large keys** operable with 3 layers of gloves.
- **Easy-to-read display** with backlight.
- **Stores up to 267 hours of data** at one-minute intervals for downloading to PC.
- **3-year 10.6 eV lamp warranty**

Applications

HazMat/Homeland Security

- Initial PPE (personal protective equipment) assessment
- Leak detection
- Safety perimeter establishment and maintenance
- Spill delineation
- Decontamination
- Remediation

Industrial Hygiene/Safety

- Confined Space Entry (CSE)
- Indoor Air Quality (IAQ)
- Worker exposure studies

Environmental

- Soil and water headspace analysis
- Leaking underground storage tanks
- Perimeter fenceline monitoring
- Fugitive emissions (EPA Method 21)
- Vapor recovery breakthrough
- Landfill monitoring

ver12_04.07

MiniRAE 2000

Specifications*

Detector Specifications

Size	8.2" L x 3.0" W x 2.0" H (21.8 x 7.62 x 5.0 cm)
Weight	20 oz with battery pack (553 g) w/o rubber boot
Sensor	Photoionization sensor with standard 10.6 eV or optional 9.8 eV or 11.7 eV UV lamp
Battery	• Rechargeable, external, field-replaceable Nickel-Metal-Hydride (NiMH) battery pack • Alkaline battery holder (for 4 AA batteries)
Operating Period	10 hours continuous operation
Display	Large LCD, backlight activated manually, by alarms or by darkness
Keypad	1 operation and 2 programming keys
Direct Readout	• VOCs as ppm by volume • High and low values • STEL and TWA (in hygiene mode) • Battery and shut down voltage
Alarms	90 dB buzzer and flashing red LED to indicate exceeded preset limits: • High: 3 beeps and flashes per second • Low: 2 beeps and flashes per second • STEL and TWA: 1 beep and flash per second • Alarms automatic reset or latching with manual override • Optional plug-in pen size vibration alarm • User adjustable alarm limits
Calibration	Two-point field calibration of zero and standard reference gas. Calibration memory of 8 calibration gases, alarm limits, span values and calibration date
Datalogging	267 hours (at one-minute intervals) with date/time. Header information includes monitor serial number, user ID, site ID, date and time
Sampling Pump	• Internal, integrated flow rate of 400 cc/min • Sample from 100' (30 m) horizontally or vertically
Low Flow Alarm	Auto shut-off pump at low flow condition
Communication	Download data and upload instrument set-up from PC through RS-232 link to serial port. Wireless communication enabled and certified (requires RAELink2 and ProRAE Remote to use)
Temperature	14° F to 104° F (-10° C to 40° C)
Humidity	0% to 95% relative humidity (non-condensing)
EM/RFI	Highly resistant to EMI /RFI. Compliant with EMC Directive 89/336/EEC
IP-rating	IP-55: protected against dust, protected against low-pressure jets of water from all directions
Hazardous Area Approval	• **US and Canada:** UL and cUL, Classified for use in Class I, Division 1, Groups A, B, C and D hazardous locations • **Europe:** ATEX II IG EEx ia IIC T4
Attachment	Durable bright yellow rubber boot w/belt clip & wrist strap
Warranty	Lifetime on non-consumable components (per RAE Systems Standard Warranty), 3 years for 10.6.V PID lamp, 1 year for pump and battery

* Specifications are subject to change
** Performance based on isobutylene calibration

Default Sensor Settings**

Gas Monitor (ppm)	Range (ppm)	Resolution Time (T90)	Response
VOCs	0 to 99.9 ppm	0.1 ppm	< 3 sec
	100 to 10,000 ppm	1 ppm	< 3 sec

MiniRAE 2000 and Accessories

Monitor only includes:

- RAE Systems UV lamp: 10.6 eV, 9.8 eV or 11.7 eV as specified
- ProRAE Suite software package for Windows® 98, NT, 2000 and XP
- Computer interface cable
- 5-inch Flex-I-Probe
- External filter
- Rubber boot with belt clip
- Alkaline battery adapter
- Tool kit
- Lamp cleaning kit
- Nickel-Metal-Hydride (NiMH) battery
- 120/230 V AC/DC wall adapter (if specified)
- Operation and maintenance manual

Monitor with accessories kit adds:

- Hard transport case with pre-cut foam padding
- 5 porous metal filters and O-rings
- Organic vapor zeroing adapter
- Gas outlet port and tubing

Optional calibration kit adds:

- 10 ppm isobutylene calibration gas, 34L
- Calibration regulator and flow controller

Optional Guaranteed Cost of Ownership Program:

- 4-year repair and replacement guarantee
- Annual maintenance service

DISTRIBUTED BY:

ver12_04.07

RAE Systems Inc.
3775 North First Street
San Jose, CA 95134 USA
raesales@raesystems.com

USA/Canada 1-877-723-2878
Europe/Russia +45 8652 5155
Middle East/Australia 971 50 429 1385
China 8610 58858788
Asia +852 2669 0828

MiniRAE 3000
User's Guide

Rev. A
April 2007
P/N 059-4020-000

Contents

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 removing the instrument cover. Disconnect the battery before removing sensor module for service. Never operate the instrument when the cover is removed. Remove instrument cover and sensor module only in an area known to be non-hazardous.

The instrument is classified as to intrinsic safety for use in Class I, Division 1, groups A, B, C, D, or non-hazardous locations only.

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.

WARNINGS

STATIC HAZARD: Clean only with 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 and 059-3052-000. 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.

AVERTISSEMENT

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. 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.

Standard Contents

Instrument
Calibration Kit
Charging Cradle
AC/DC Adapter
Alkaline Battery Adapter
Data Cable
CD-ROM With User's Guide, Quick Start Guide, and related materials

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 11.7 eV gas-discharge lamp. Features are:

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) 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

- 500,000-point datalogging storage capacity (>11 months) for data download to PC

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.

Physical Description

The main components of the portable VOC monitoring instrument include:

- Three keys for user to interact 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

Specifications

Size:	9.25" L x 3.6" W x 2.9" H
Weight:	28 oz with battery pack
Detector:	Photoionization sensor with 9.8, 10.6, or 11.7 eV UV lamp
Battery:	A 4.2V/3300mAH 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:	Up to16 hours continuous operation
Display:	Large dot matrix screen with backlight

Measurement range & resolution

Lamp	Range	Resolution
10.6 eV	0.1 ppm to 15,000 ppm	0.1 ppm
9.8 eV	0.1 ppm to 5,000 ppm	100 ppb
11.7 eV	0.1 ppm to 2,000 ppm	100 ppb

Response time (T_{90}): 2 seconds

Accuracy (Isobutylene):	10 to 2000 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
Calibration Reference:	Store up to 8 sets of calibration data, alarm limits and span values
Inlet Probe:	Flexible 5" tubing
Radio module:	Bluetooth (2.4GHz), RF module (433MHz, 868MHz , 915MHz, or 2.4GHz)
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, Group A, B, C, D
	Europe: ATEX (II 1G EEx ia IIC T4)
	IECEx (Ex ia IIC T4)
EM Interference:	Highly resistant to EMI/RFI. Compliant with EMC R&TTE (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:	800,000 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.
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	Polycarbonate, splashproof and dustproof
rubber boot):	Battery can be changed without removing rubber boot.

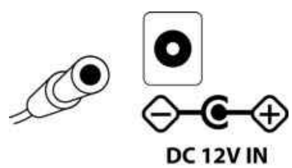
Charging The Battery

Always fully charge the battery before using the instrument. The instrument's Li-ion 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 charging cradle, 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 cradle.



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 glow

The instrument begins charging automatically. The "Primary" LED in the cradle 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..."

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. The cradle's 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 set into the cradle properly. If you still receive the message, check the Troubleshooting section of this guide.

Note: If the instrument or battery has been in the cradle 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 between the instrument (or battery) are meeting the cradle. If the message is still shown, consult your distributor or RAE Systems Technical Services.

Charging A Spare Rechargeable Battery

A rechargeable Li-ion battery can be charged when it is not inside the monitor. The charging cradle 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.

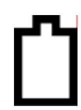
Note: If you need to replace the Li-ion battery pack, replacements are available from RAE Systems. The part number is 059-3051-000.

Note: An Alkaline Battery Adapter (part number 059-3052-000), which uses four AA alkaline batteries (Duracell MN1500 or Energizer E91), 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.

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.

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 RAE Systems service technician. It is not user-replaceable.

Data Protection While Power Is Off

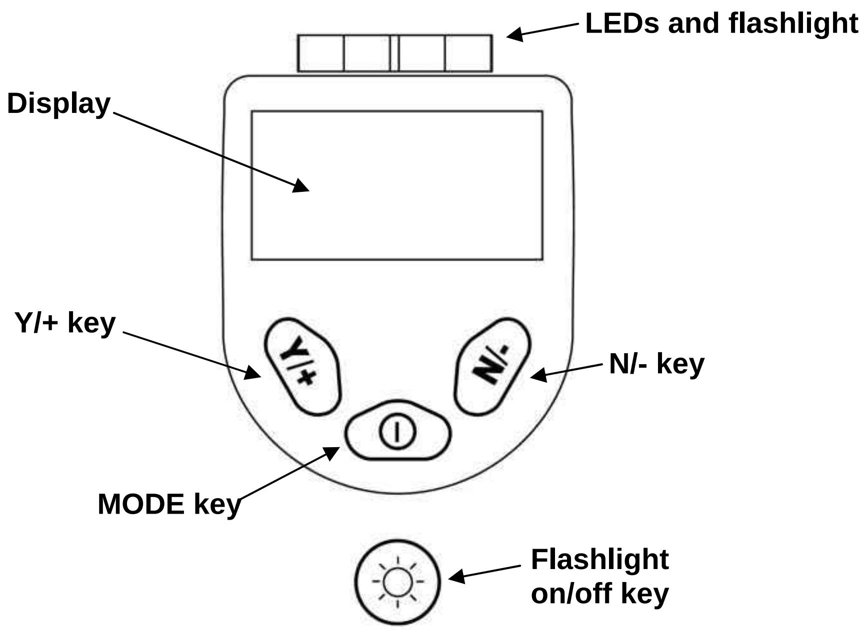
When the instrument is turned off, all the current real-time data including last measured values are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost.

User Interface

The instrument's user interface consists of the display, LEDs, an alarm transducer, and four keys. The keys are:

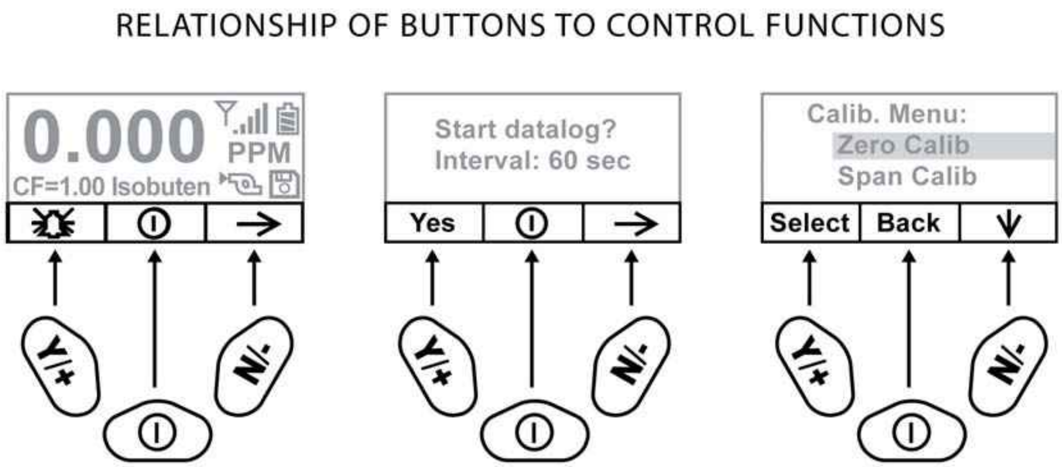
Y/+
MODE
N/-
Flashlight on/off

The LCD display provides visual feedback that includes the reading, time, battery condition, and other functions.



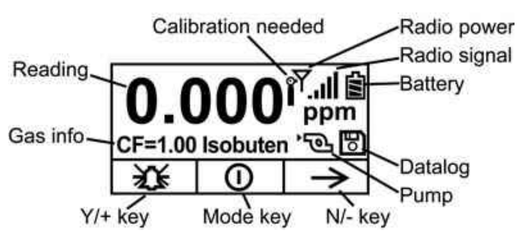
In addition to their labeled functions, the keys labeled Y/+, MODE, and N/- act as "soft keys" that control different parameters and make different selections within the instrument's menus. From menu to menu, each key controls a different parameter or makes a different selection.

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:



Display

The display shows the following information:



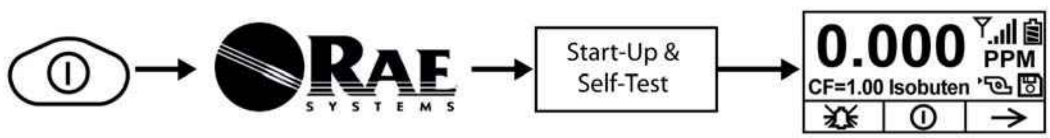
Graph	Graphic representation of concentration plotted over time
Gas info	Tells the Correction Factor and type of calibration gas
Reading	Concentration of gas as measured by the instrument
Calibration needed	Indicates that calibration should be performed
Radio power	Indicates whether radio connection is on or off
Radio signal	Indicates signal strength in 5-bar bargraph
Battery	Indicates battery 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

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.

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 RAE Systems logo should appear first. (If the logo does not appear, there is likely a problem and you should contact your distributor or 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.

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.

Operating The Built-In Flashlight

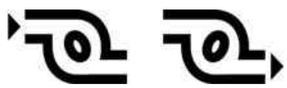
The instrument has a built-in flashlight that helps you point the probe in dark places. Press the flashlight key to turn it on. Press it again to turn it off.

Note: Using the flashlight for extended periods shortens the battery’s operating time before it needs recharging.

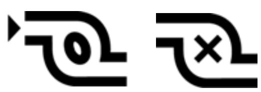
Pump Status

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.

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.

Operating Modes

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 using the instrument’s navigation. In other cases, you must use ProRAE Studio software.

The default setting for your instrument is:

User Mode: Basic
Operation Mode: Hygiene

This is outlined in detail on page 56.

The other options, covered later in this guide, are:

User Mode: Advanced (page 59)
Operation Mode: Search (page 61)

User Mode: Advanced (page 59)
Operation Mode: Hygiene (page 59)

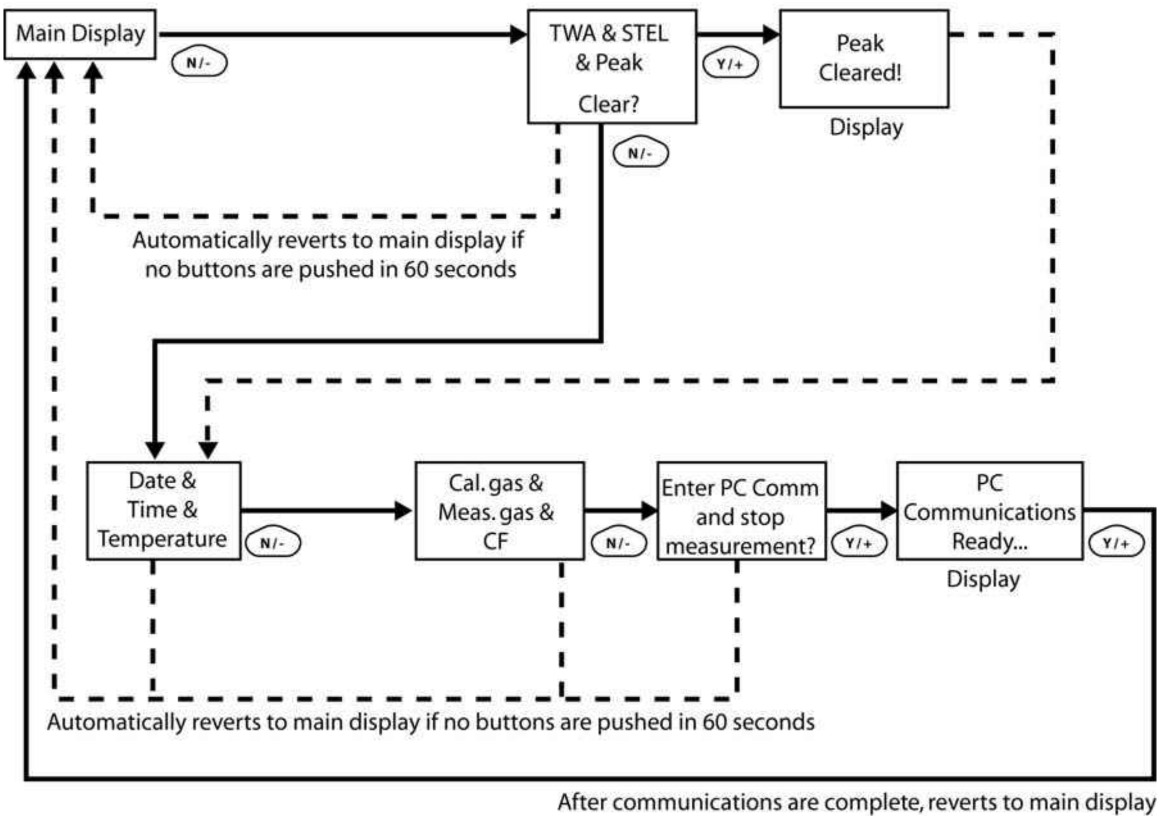
Using ProRAE Studio allows access to other options. In addition, Diagnostic Mode (page 62) is available for service technicians.

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.

After the instrument is turned on, it runs through the start-up menu. Then the message "**Please apply zero gas…**" is displayed.

At this point, you can perform a zero air (fresh air) calibration. If the ambient air is clean, you can use that. Otherwise, use a cylinder of zero air. Refer to Zero Calibration on page 28 for a more detailed description of zero calibration.

Start zero calibration by pressing Start. You see the message "Zeroing…" followed by a 30-second countdown.

Note: You can press [MODE] to quit, bypassing the zero air calibration.

When zero calibration is complete, you see the message:

Zeroing is done!

Reading = 0.00 ppm

The instrument is now sampling and collecting data.

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.

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.

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

* 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.

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 3000	100	ppm	50	100	10	25

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.

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 200' (61 m) away horizontally, or 90' (27.5 m) vertically, at about 3' (0.9 m) per second flow speed.

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.

Backlight

The LCD display is equipped with an LED backlight to assist in reading the display under poor lighting conditions.

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 at a later time to a PC.

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.

Datalogging sample

After an event is recorded, the unit records a shorter form of the data. When transferred to a PC running ProRAE Studio, this data is arranged with a sample number, time, date, gas concentration, and other related information.

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 48 for details).
Snapshot	Datalogs only during snapshot (single-event capture, initiated by pressing [MODE]) sampling. See page 49 for details.

Note: You can only choose one datalog type to be active at a time.

Accessories

The following accessories are included with the instrument:

- An AC Adapter (Battery Charger)
- Alkaline battery adapter
- External Filter
- Organic Vapor Zeroing kit

Hard-case kits also include these accessories:

- Calibration adapter
- Calibration regulator and Flow controller

Standard Kit & Accessories

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.

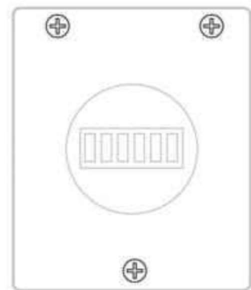
A completely discharged instrument can be charged to full capacity within 8 hours. Batteries drain slowly even if an instrument is off. Therefore, if the instrument has been in storage or has not been charged for several days or longer, check the charge before using it.

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.

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 or Energizer E91) 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.

External Filter

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.

Optional Accessories

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.

Calibration Regulator

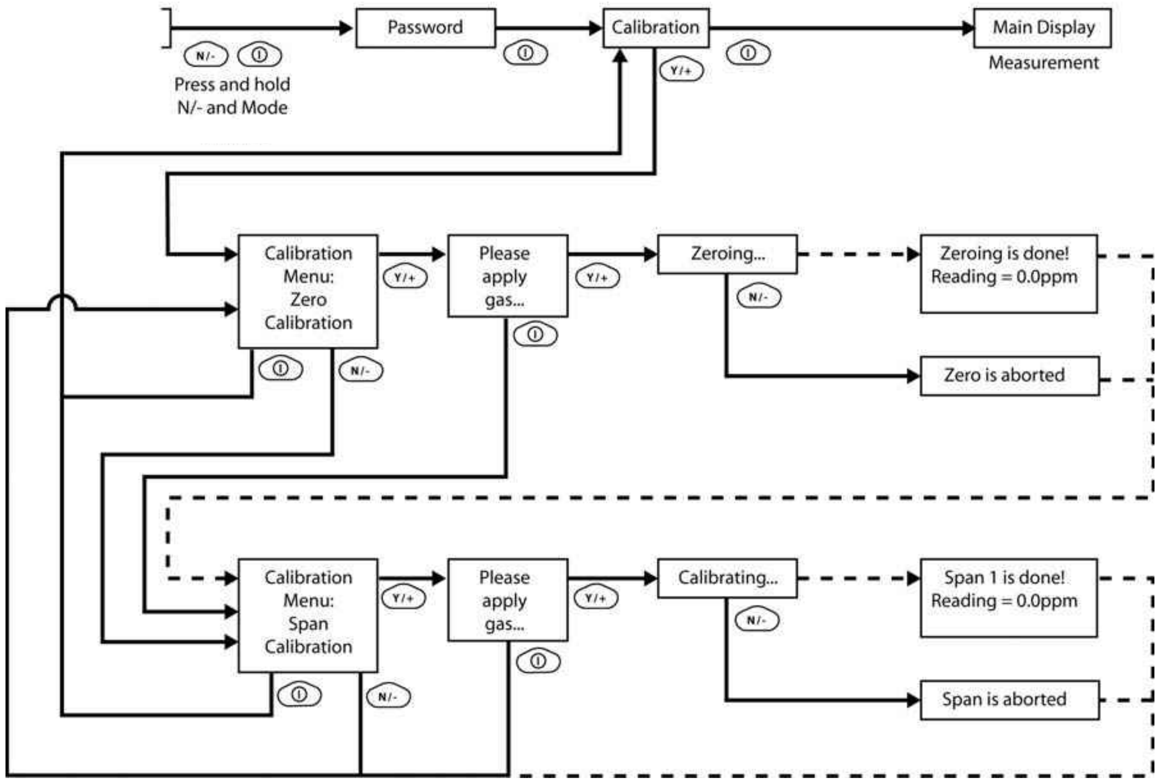
The Calibration Regulator is used in the calibration process. It regulates the gas flow rate from the Span gas cylinder into the gas inlet of the instrument during calibration process. The maximum flow rate allowed by the flow controller is about 0.5L/min (500 cc per min.). Alternatively, a demand-flow regulator or a Tedlar gas bag may be used to match the pump flow precisely.

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.

Standard Two-Point Calibration (Zero & Span)

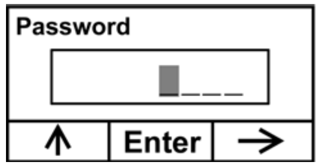
The following diagram shows the instrument's calibrations in Basic/Hygiene mode.



Note: Dashed line indicates automatic progression.

Entering Calibration

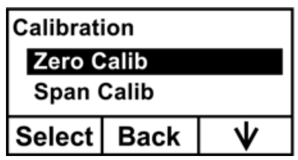
1. Press and hold [MODE] and [N/-] until you see the Password screen.



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.

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...		
Start	**Quit**	

1. Turn on your 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 30-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!
Reading = 0.000 ppm

The instrument will then show the Calibration menu on its display, with Span Calib hightlighted.

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...

Start	**Quit**	

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 = 100. 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.

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…

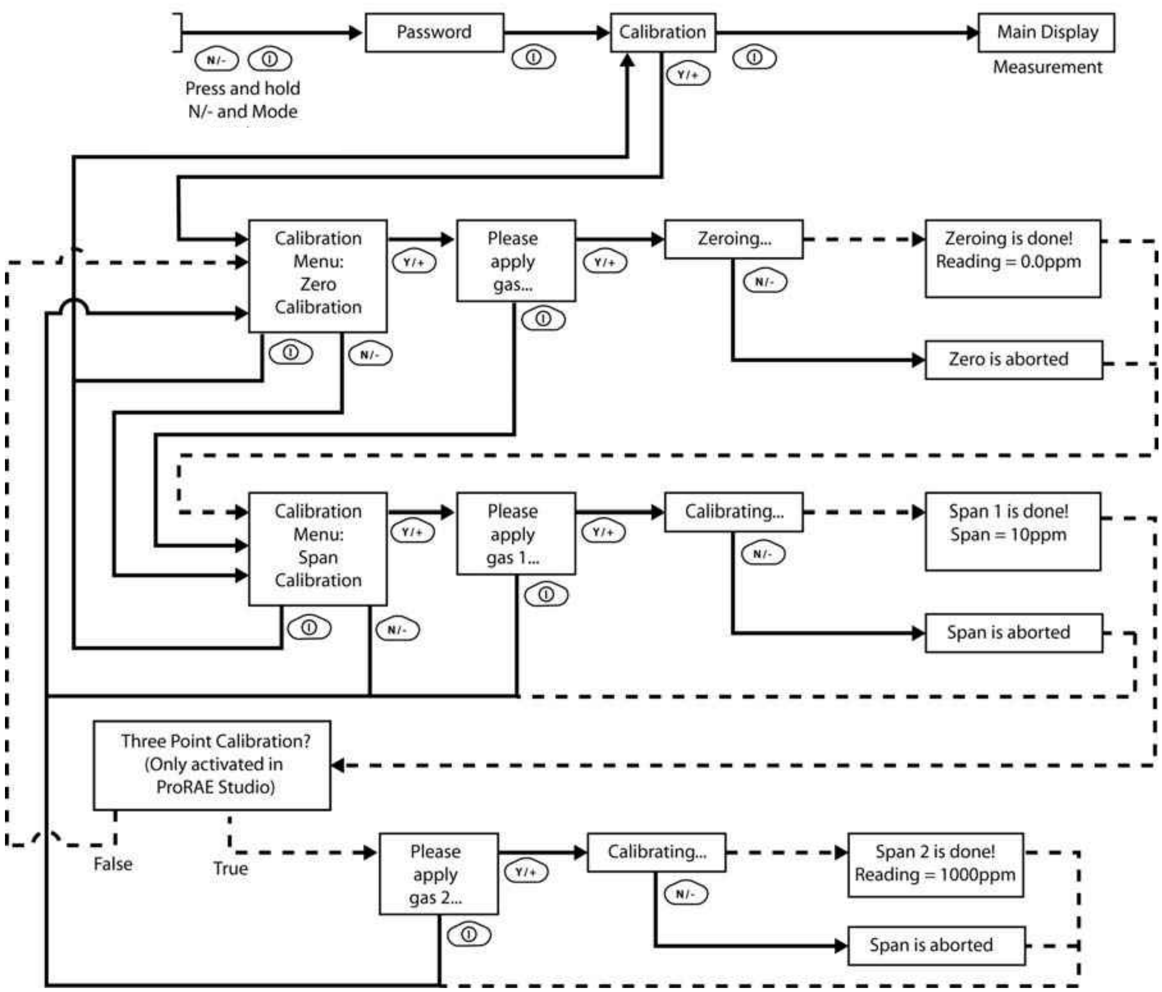
The instrument updates its settings and then returns to the main display. It begins or resumes monitoring.

Three-Point Calibration

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 software and a PC, as well as a higher concentration of calibration gas.

Note: Once the third calibration is set, you do not need to use ProRAE Studio to allow future 3-point calibrations. Also, you can only disable 3-point calibration capability by using ProRAE Studio 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: Dashed line indicates automatic progression.

Span 2 Calibration

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...

4. Turn on your span calibration gas.
5. 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.

6. 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.

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…

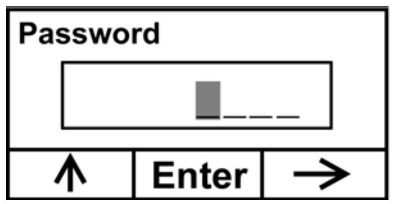
The instrument updates its settings and then returns to the main display. It begins or resumes monitoring.

Programming Mode

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.

Entering Programming Mode

1. Press and hold [MODE] and [N/-] until you see the Password screen.



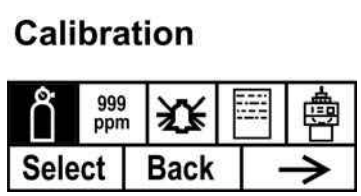
2. Input the 4-digit password:

- 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.

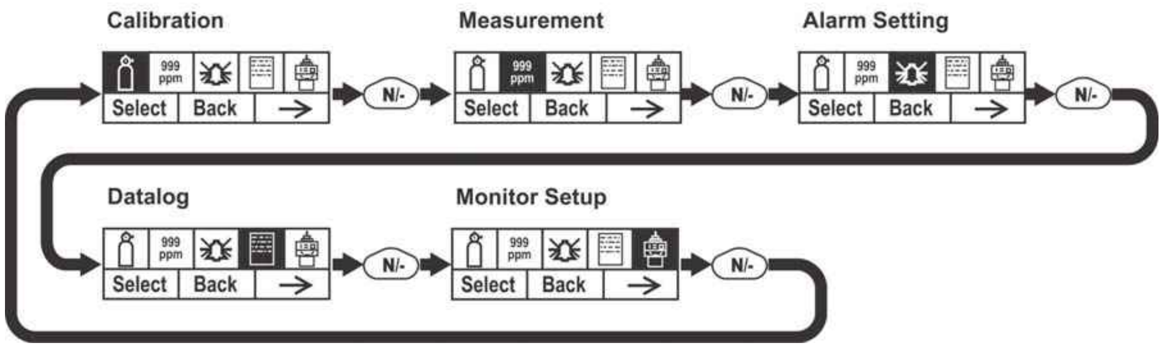
Note: The default password is 0000.

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 software. Follow the instructions in ProRAE Studio 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:

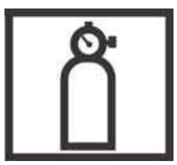
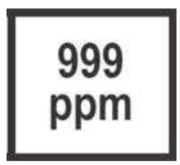
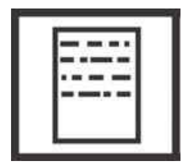
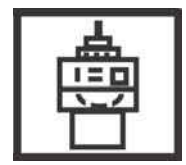


Note: When you reach Monitor Setup and press [N/-], the menu cycles back to Calibration.

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.

This table shows the menus and sub-menus:

	 			
Calibration	**Measurement**	**Alarm Setting**	**Datalog**	**Monitor Setup**
Zero Calibration	Meas. Gas	High Alarm	Clear Datalog	Op Mode
Span Calibration	Meas. Unit	Low Alarm	Interval	Site ID
		STEL Alarm	Data Selection	User ID
		TWA Alarm	Datalog Type	User Mode
		Alarm Type		Date
		Buzzer & Light		Time
				Pump Duty Cycle
				Pump Speed
				Temperature Unit
				Language
				Radio Power
				Real Time Protocol
				Power On Zero
				Unit ID
				LCD Contrast

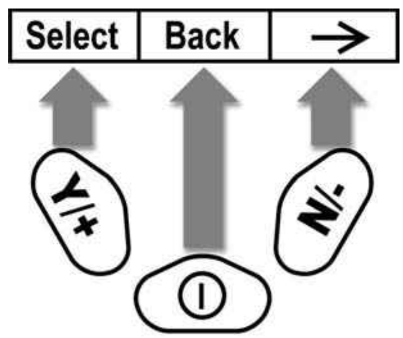
Once you enter Programming Mode, the LCD displays the first menu, Calibration. Each subsequent menu is accessed by pressing [N/-] repeatedly until the desired menu is displayed. To enter a sub-menu of a menu, press [Y/+].

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.

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:



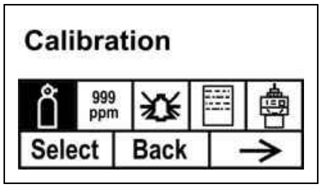
Note: Pressing [MODE] in the Programming Mode's top level causes the instrument to exit Programming Mode and return to monitoring.

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/-]:	Decrease alphanumerical value for data entry or deny (no) for a question

Calibration

Two types of calibration are available: Zero (fresh air) and Span.



Select Zero or Span Calibration by pressing [N/+]. Once your choice is highlighted, press [Y/+].

Zero Calibration

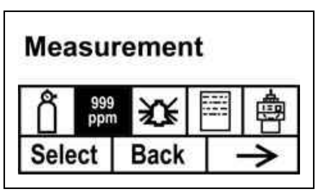
The procedure for performing a zero calibration is covered on page 27.

Span Calibration

The procedure for performing a basic span calibration is covered on page 27.

Measurement

The sub-menus for Measurement are Measurement Gas and Measurement Unit.



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 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, 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.

Leave the sub-menu and return to the Programming Mode menus by pressing [MODE].

Meas. Unit

Standard available measurement units include:

Abbreviation	**Unit**	**MiniRAE 3000**
ppm	parts per million	Yes
ppb	parts per billion	
mg/m3	milligrams per cubic meter	Yes
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/-].

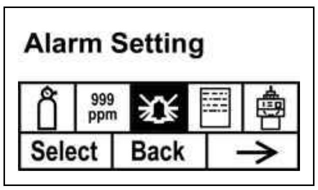
Leave the sub-menu and return to the Programming Mode menus by pressing [MODE].

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 21.

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 ppb (parts per billion), or mg/m3 (milligrams per cubic meter), depending on your setting.



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.

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.

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 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.

STEL Alarm

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 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.

TWA Alarm

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 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.

Alarm Type

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.

1. 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.

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

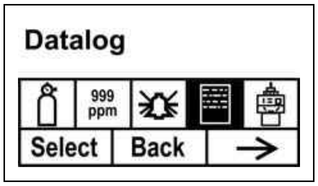
2. Press [N/-] to step from one option to the next.
3. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates your selection).
4. When you have completed your selections, press [MODE].

   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.

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.



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.

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.

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 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.

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 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 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.

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 page 48 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 have the opportunity to register the new settings or to change your mind and revert to your previous settings.

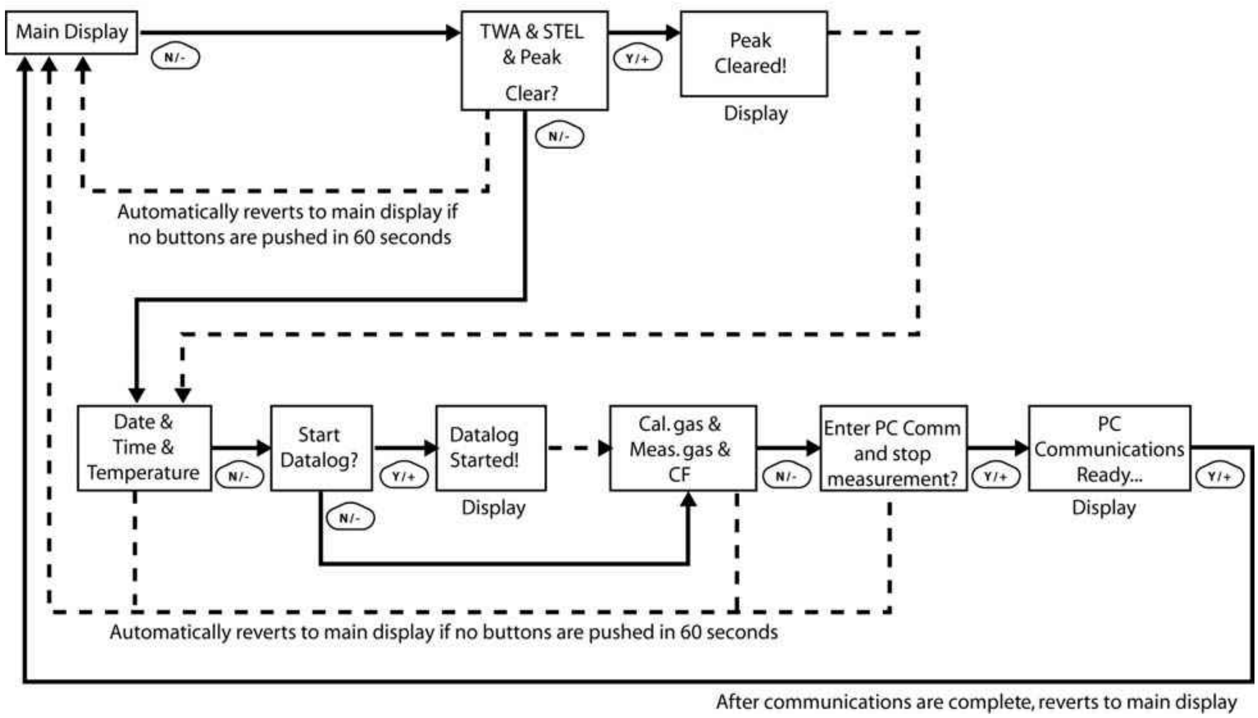
- Press [Y/+] to save the changes.

Press [N/-] to undo the changes and revert to the previous settings.

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.



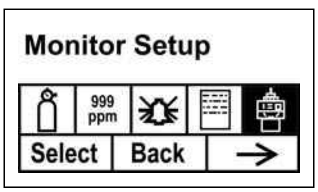
Snapshot Datalog

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, the data snapshots are uniquely identified by time and other parameters.

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.



Op Mode

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).

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), 10 numerals (0 to 9) and symbols (- / .). **Note:** The last four digits must be numerals.
3. Press [N/-] to advance to the next digit. The next digit to the right flashes.

   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.

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.

   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.

User Mode

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.

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.

   Repeat this process until all six digits of the new date are entered.

Press [MODE] to exit.

- Press [Y/+] to save the new date.
- Press [N/-] to undo the change and move to the next sub-menu.

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.

   Repeat this process until all six digits of the new time are entered.

Press [MODE] to exit.

- Press [Y/+] to save the new date.
- Press [N/-] to undo the change and move to the next sub-menu.

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), and the period is 10 seconds. Therefore, a duty cycle of 60% means that the pump is on for 6 seconds and off for four seconds. 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 2ppm threshold and is re-enabled when the reading falls below 90% of the threshold (1.8 ppm).

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.

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.

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.

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.

Radio Power

The radio connection can be turned on or 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.

Real Time Protocol

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.
P2M (wireless)	Point to multipoint, wireless. Data is transferred wirelessly and can be received by multiple 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.

Power On Zero

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.

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.

Repeat this process until all three digits of the Unit ID are entered.

3. 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.

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.

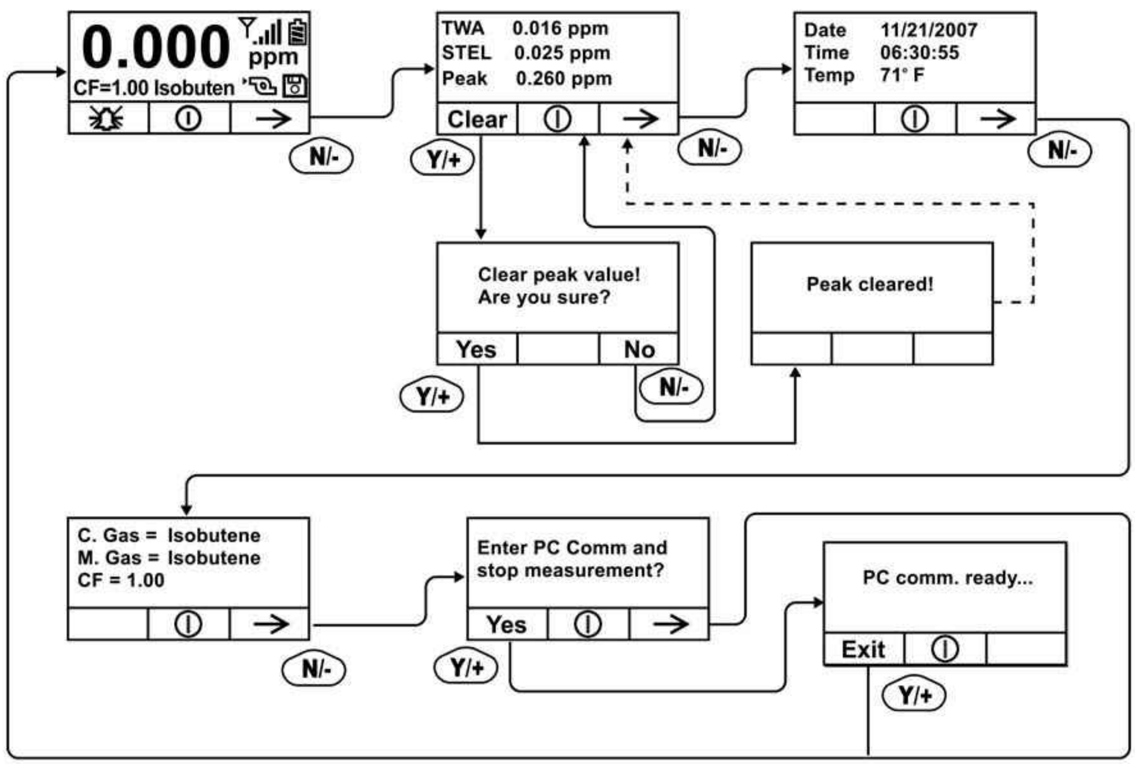
Hygiene Mode

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.

Basic User Level & Hygiene Mode

The default setting is navigated in the following way:



Note: Dashed line indicates automatic change to another screen.

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.

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."

Press [Y/+] to select.

You will see:

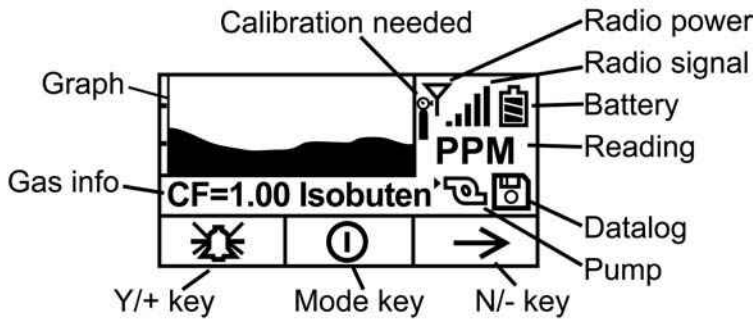
Hygiene
Search

The current mode is indicated by a dark circle within the circle in front of either Hygiene or Search.

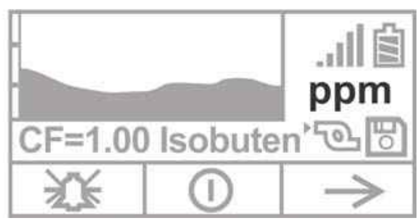
1. Select Hygiene or Search by pressing [N/-].
2. Press [Y/+] to place the instrument into the selected mode.
3. Press [MODE] when you want to register your selection to place the instrument in the selected mode.
4. Press [Y/+] to commit the change and exit to the Monitor Setup screen, or press [N/-] to Undo (exit to the Monitor Setup screen without changing the Mode).

Optional Graphic Screen In Search Mode

Using ProRAE Studio, you can set your instrument to show a graphic display instead of a numeric display of ongoing data. Consult your ProRAE Studio disc for information.



During sampling, the display's readings are shown numerically, plus the graph tracks the highest readings over time. The numeric reading alternates between the value and the measurement units, as well:



Advanced User Level (Hygiene Mode Or Search Mode)

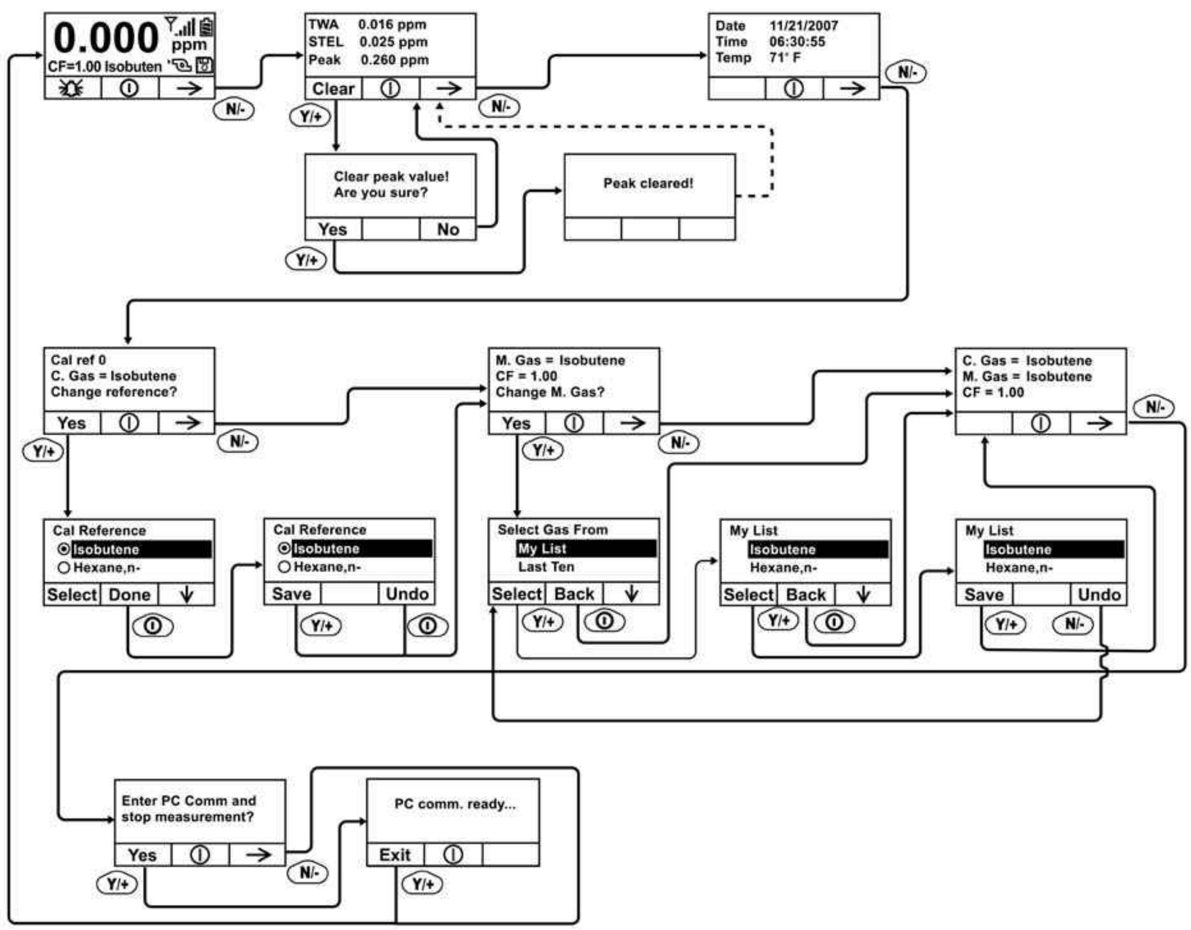
The User Mode called Advanced User Level allows a greater number of parameters to be changed than Basic User Level. It can be used with either of the Operation Modes, Hygiene Mode or Search Mode.

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.

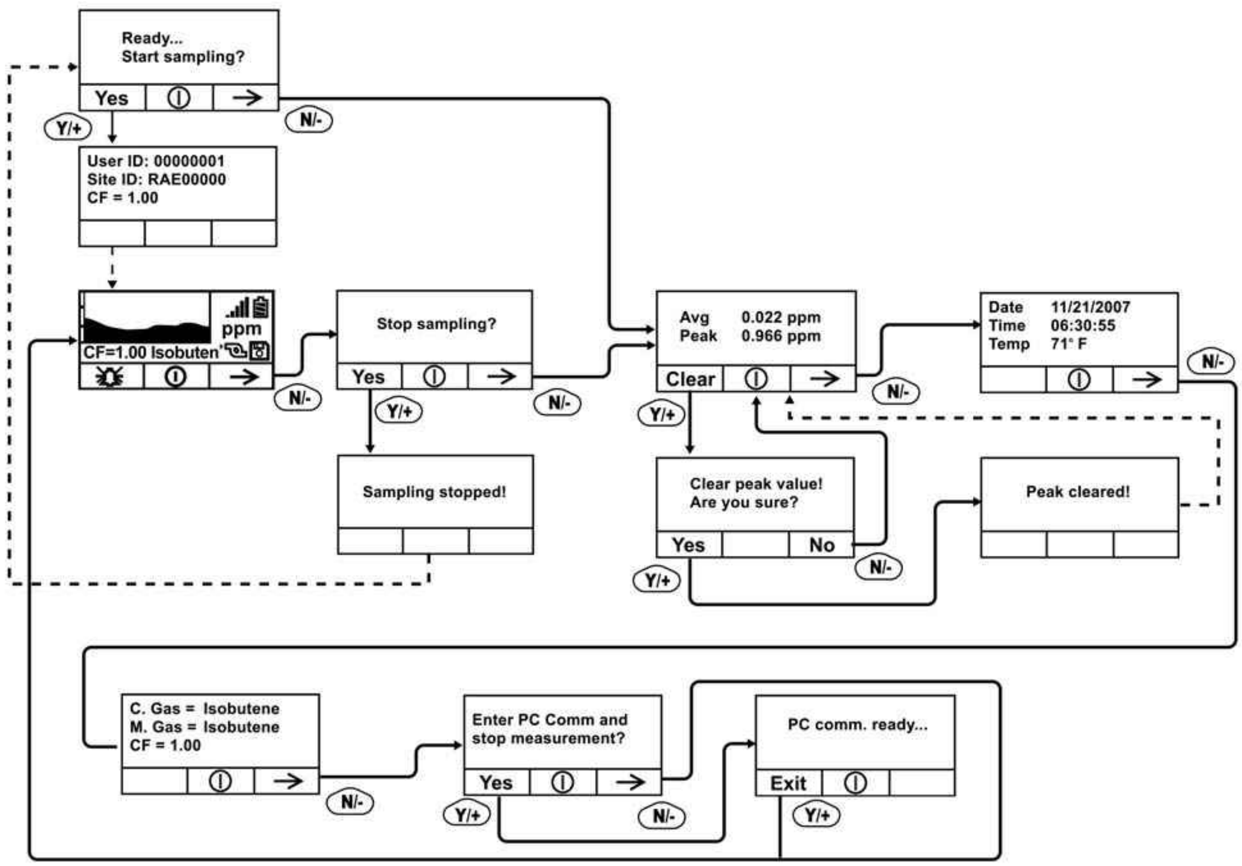


Note: Dashed line indicates automatic change to another screen.

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).

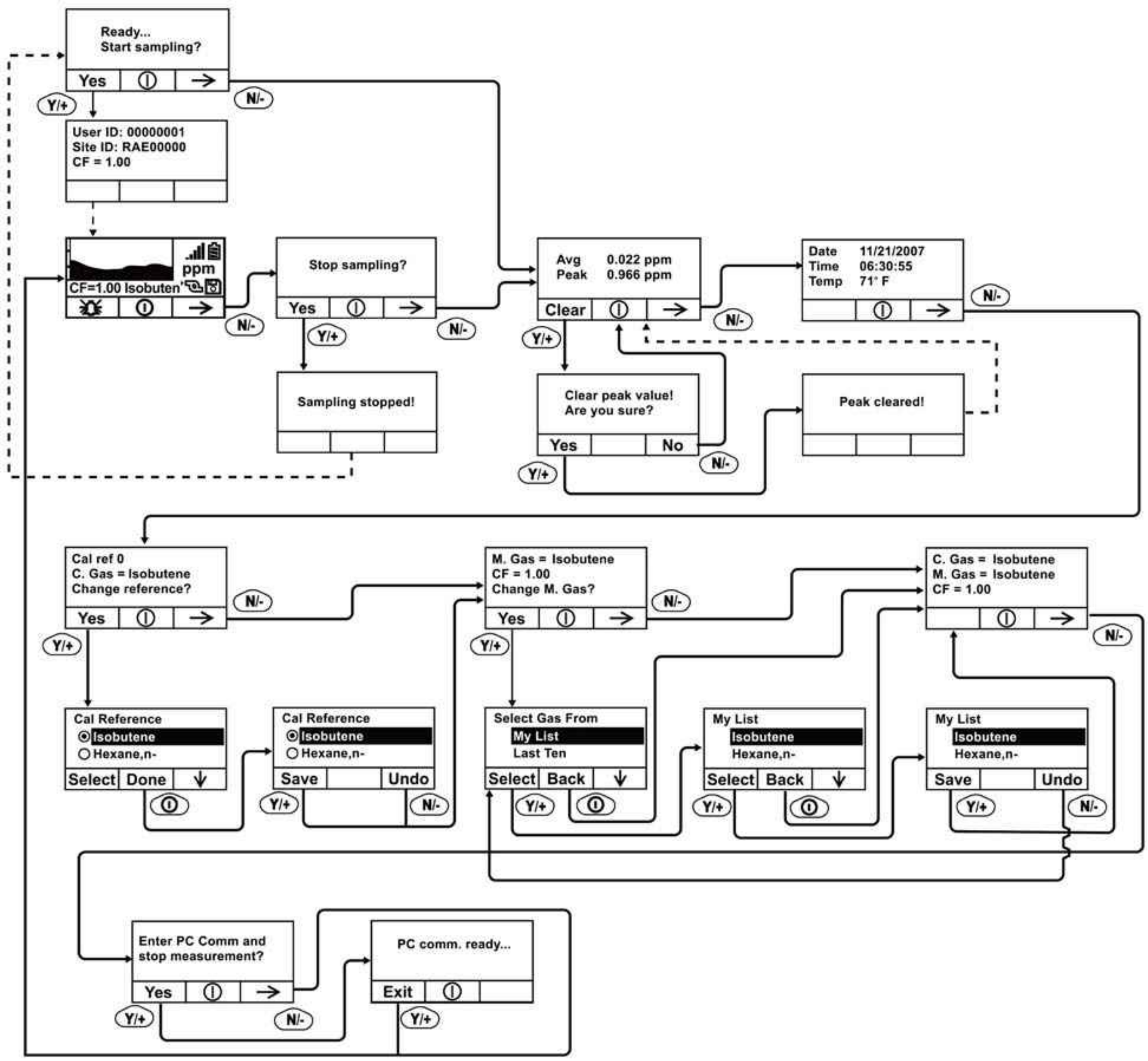
When the instrument is in Search Mode, it only samples when you activate sampling. When you see the display that says, "Ready…Start sampling?" press [Y/+] to start. The pump turns on and the instrument begins collecting data. To stop sampling, press [N/-] while the main display is showing. You will see 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 change to another screen.

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 on page 39 for more details.



Note: Dashed line indicates automatic change to another screen.

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.

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].

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:

Pump High

In Diagnostic Mode, press the [MODE] key until "Pump High" is displayed. The pump shows the maximum, minimum, and stall values for the pump at its high speed.

Block the gas inlet and watch the pump current reading (labeled "I") increase. Write down the blocked reading. If the pump current reading does not increase significantly (for example, more than 10 counts), then there may be a leak in the gas inlet or the pump is weak or defective.

Use the [Y/+] or [N/-] key to increase or decrease the stall value until it is the average of the maximum block count and the maximum idle count.

Press the [MODE] key to exit this display.

Pump Low

In Diagnostic Mode, press the [MODE] key until "Pump Low" is displayed. The pump shows the maximum, minimum, and stall values for the pump at its low speed.

Block the gas inlet and watch the pump current reading (labeled "I") increase. Write down the blocked reading. If the pump current reading does not increase significantly (for example, more than 10 counts), then there may be a leak in the gas inlet or the pump is weak or defective.

Use the [Y/+] or [N/-] key to increase or decrease the stall value until it is the average of the maximum block count and the maximum idle count.

Press the [MODE] key to exit this display.

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."

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).

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 on your PC.
4. From ProRAE Studio, 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.

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 on your PC.
4. From ProRAE Studio, select "Operation" and select Setup Connection.
5. Select the COM port to establish a communication link between the PC and the instrument.
6. Select Operation → Download Firmware.

Once communication is established, follow the instructions that accompany ProRAE Studio and the firmware to upload the new firmware to your instrument.

Note: Check for the latest updates to ProRAE Studio at www.raesystems.com.

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.

Battery Charging & Replacement

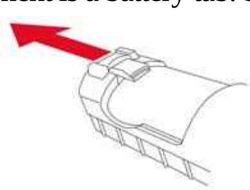
When the display shows a flashing empty battery icon, the battery requires recharging. It is recommended to recharge the instrument upon returning from fieldwork. A fully charged battery runs a instrument for 16 hours continuously. The charging time is less than 8 hours for a fully discharged battery. The battery may be replaced in the field (in areas known to be non-hazardous), if required.

WARNING!

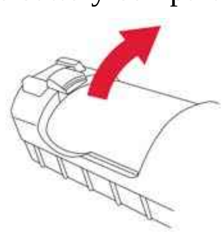
To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in areas known to be non-hazardous.

Replacing 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.

5. Slide the capture tab back up to its locked position.

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.

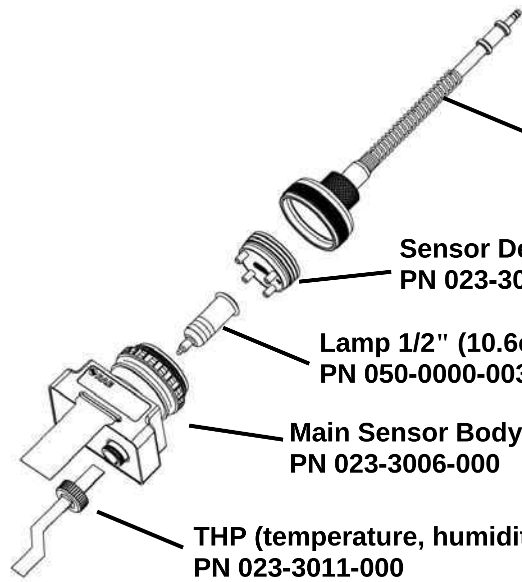
WARNING!

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.

PID Sensor & Lamp Cleaning/Replacement

The sensor module is made of several components and is attached to the lamp-housing unit as shown below.



Sensor Components

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.

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.

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.

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.

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 charging cradle to make sure they are clean. If they are not, wipe them with a soft, dry cloth. Never use solvents or cleaners.

Ordering Replacement Parts

If you need replacement parts, contact your local RAE Systems distributor. A list is available online:

http://www.raesystems.com

In the U.S., you can order sensors, replacement batteries, and other accessories online at:

http://istore.raesystems.com/

Special Servicing Note

If the instrument needs to be serviced, contact either:

1. The RAE Systems distributor from whom the instrument was purchased; they will return the instrument on your behalf.

   or

2. The RAE Systems 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.

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:** **Solutions:**	Pump diaphragm damaged or has debris. Flow path leaks. 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:** **Solutions:**	Lamp drive circuit. Weak or defective PID lamp, defective. Turn the unit off and back on. Replace UV lamp

Technical Support

To contact RAE Systems Technical Support Team:

Monday through Friday, 7:00AM to 5:00PM Pacific (US) Time
Phone (toll-free): +1 888-723-4800
Phone: +1 408-952-8461
Email: tech@raesystems.com

Life-critical after-hours support is available:

+1 408-952-8200 select option 8

RAE Systems Contacts

RAE Systems
World Headquarters
3775 N. First St.
San Jose, CA 95134-1708 USA
Phone: +1 408.952.8200
Fax: +1 408.952.8480

E-mail: customerserv@raesystems.com
Web Site: www.raesystems.com

RAE Systems Technical Support
Monday through Friday, 7:00AM to 5:00PM Pacific Time
Phone: +1.408.952.8461
Email: tech@raesystems.com

Life-critical after-hours support is available
+1.408.952.8200 select option 9

RAE Systems Europe ApS
Ørestads Boulevards 69
2300 Copenhagen S
Denmark
Phone: +45 86525155
Fax: +45 86525177
orders@raeeurope.com
sales@raeeurope.com
service@raesystems.com
Web: www.raesystems.dk

RAE Systems UK Ltd
D5 Culham Innovation Centre
Culham Science Centre
Abingdon, Oxon OX14 3DB
United Kingdom
Phone: +44 1865408368
Fax: +44 1235531119
Mobile: +44 7841362693
Email: raeuk@raeeurope.com

RAE Systems France
336, rue de la fée des eaux
69390 Vernaison
France
Phone: +33 4 78 46 16 65
Fax: +33 4 78 46 25 98
Email: info-france@raeeurope.com
Web: www.raesystems.fr

RAE BeNeLux BV
Rijndal 20
2904 DC Capelle a/d IJssel
Phone: +31 10 4426149
Fax: +31 10 4426148
Email: info@rae.nl
Web: www.rae.nl

RAE Systems Spain, s.l.
Av. Remolar, 31
08820 El Prat de Llobregat
Spain
Phone: +34 933 788 352
Fax: +34 933 788 353
Mobile: +34 687 491 106
Email: mdelgado@raespain.com
Web: www.raespain.com

RAE Systems Middle East
Mobile: +45 2674 9791
or +97 50 429 1385
Email: mjorgensen@raesystems.com

RAE Systems (Hong Kong) Ltd.
Room 8, 6/F, Hong Leong Plaza
33 Lok Yip Road
Fanling, N.T, Hong Kong
Phone: +852.2669.0828
Fax: +852.2669.0803
Email: hksales@raesystems.com

RAE Systems Japan
403 Plaza Ochanomizu Bldg. 2-1
Surugadai Kanda Chiyoda-Ku
Tokyo, Japan
Phone: 81-3-5283-3268
Fax: 81-3-5283-3275
Email: jpsales@raesystems.com

RAE Systems Korea
#1010, DaeMyungAnsVill First,
Sang-Dong 412-2, Wonmi-Gu, Bucheon,
Kyungki-Do, Korea
Phone: 82-32-328-7123
Fax: 82-32-328-7127
Email: krsales@raesystems.com

Appendix A: Regulatory Information

059-4020-000-APNDX Rev A.

Intrinsic Safety:	US and Canada: Class I, Division 1, Group A, B, C, D
	Europe: ATEX (II 1G EEx ia IIC T4)
	IECEx (Ex ia IIC T4)
Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)

Basic Operation

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.

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.

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.

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
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	100	ppm	50	100	10	25

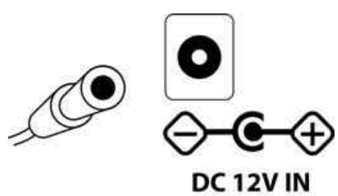
Charging The Battery

Always fully charge the battery before using the instrument. The instrument's Li-ion 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 charging cradle, 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 cradle.



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 (part number 059-3051-000) 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 or Energizer E91), 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.

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.

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 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.

Replacing the Rechargeable Li-Ion Battery

Caution: Turn off the instrument before removing or replacing the battery.

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 or Energizer E91).

Do not mix old and new batteries or batteries from different manufacturers.

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

RAE Systems
World Headquarters
3775 N. First St.
San Jose, CA 95134-1708 USA
Phone: 408.952.8200
Fax: 408.952.8480

E-mail: customerserv@raesystems.com
Web Site: www.raesystems.com

Rev. A
April 2007
P/N 059-4020-000

MiniRAE 2000

Portable VOC Monitor
PGM-7600

OPERATION AND MAINTENANCE MANUAL

(Document No.: 011-4001-000)
Revision E, May 2005

RAE SYSTEMS

ISO 9001 CERTIFIED

ATTENTION!

For European Applications

A. CE 0575 Ex II 1G/2G
DEMKO 03 ATEX 0204759X
Eex ia IIC T4

B. Recharge batteries only in non-hazardous locations.

C. Do not connect external cable to serial interface jack in hazardous locations.

D. Use RAE Systems Adapter P/N 500-0072 for connection to communication port and charging jack only in a non-hazardous area.

Table of Contents

WARNING

- Do NOT proceed before reading -

This manual must be carefully read by all individuals who have or will have the responsibility for 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.

CAUTION!!

To reduce the risk of electric shock, turn off power before removing the monitor cover. Disconnect the battery before removing sensor module for service. Never operate the monitor while the cover is removed. Remove monitor cover and sensor module only in an area known to be non-hazardous.

The model PGM-7600 equipment is classified as to intrinsic safety for use in class I, division 1, groups A, B, C, D, or non-hazardous locations only.

Special Notes

-1-

When the MiniRAE 2000 Monitor is taken out from 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 monitor. After running for several minutes, the residual vapor in the detector chamber will be cleared and the reading should return to zero.

-2-

The battery of the MiniRAE 2000 monitor will discharge slowly even if it is turned off. If the monitor has not been charged for 5-7 days, the battery voltage will be low. Therefore, it is a good practice to always charge the monitor before using it. It is also recommended to fully charge the monitor FOR AT LEAST 10 HOURS before first use. See Section 7 for more information on battery charging and replacement.

WARNINGS

STATIC HAZARD: Clean only with 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 nos. 012-3050, 012-3051 or 012-3052. 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.

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 MiniRAE 2000 should be checked by exposing it to a known concentration calibration gas before each day's use.

AVERTISSEMENTS

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 012-3050, 012-3051 au 012-3052. 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.

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 MiniRAE 2000 doit être verifier en exposant l’instrument a une concentration de gaz connue par une procédure diétalonnage avant chaque utilisation journalière.

1. GENERAL INFORMATION

MiniRAE 2000 Portable VOC Monitor (Model PGM 7600) is a compact monitor designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It monitors Volatile Organic Compounds (VOC) using a Photo-Ionization Detector (PID) with a 9.8 eV, 10.6 eV, or 11.7 eV gas discharge lamp. Features are:

- **Lightweight and Compact**
  -Compact, light weight (19 oz.) and rugged design
  -Built-in sample draw pump

- **Dependable and Accurate**
  - Up to 10 hours of continuous monitoring with rechargeable battery pack
  - Designed to continuously monitor VOC vapor at ppm 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**
  -15,000 point datalogging storage capacity for data download to PC

MiniRAE 2000 consists of a PID with associated microcomputer and electronic circuit. The unit is housed in a rugged ABS + PC case with a backlit 1 line by 8 character dot matrix LCD and 3 keys to provide easy user interface.

1.1 General Specifications

Table 1.1

Portable VOC Monitor Specification			
Size:	8.2"L x 3.0"W x 2.0"H		
Weight:	19.5 oz with battery pack		
Detector:	Photo-ionization sensor with 9.8, 10.6, or 11.7 eV UV lamp		
Battery:	A 4.8V /1250 mAH Rechargeable Nickel Metal Hydride battery pack (snap in, field replaceable)		
Battery Charging:	10 hours charge through built-in charger		
Operating Hours:	Up to10 hours continuous operation		
Display:	1 line by 8 characters 5x7 dot matrix LCD (0.4" character height) with LED back light automatically in dim light		
Range, Resolution & Response time (t_{90}):			
Isobutylene (calibration gas)			
	0-99 ppm	0.1 ppm	2 sec
	100-1,999 ppm	1.0 ppm	2 sec
	2000-10,000 ppm	1.0 ppm	2 sec
Measurement Accuracy (Isobutylene):			
	0 – 2000 ppm: ± 2 ppm or 10% of reading.		
	> 2000 ppm: ± 20% of reading		
PID Detector:	Easy access to lamp and sensor for cleaning and replacement		
Correction Factors:	Built-in 102 VOC gases		
Calibration:	Two-point field calibration of zero and standard reference gas		
Calibration Memory:			
	Store up to 8 separate calibration, alarm limits and span value		
Inlet Probe:	Flexible 5" tubing		
Keypad:	1 operation key and 2 programming keys		

Direct Readout:	Instantaneous, average, STEL and peak value, battery voltage and elapsed time
Intrinsic Safety:	UL & cUL Class 1, Division I, Group A,B,C,D, Temperature Code T3C (US & Canada); CE 0575 Ex II 1G DEMKO 02 ATEX 0204759 Eex ia IIC T4 (Europe)
EM Interference:	No effect when exposed to 0.43 W/cm^2 RF interference (5 watt transmitter at 12 inches)
Alarm Setting:	Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode:	Survey or Hygiene mode
Alarm:	90 dB buzzer and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure.
External Alarm:	Optional plug-in pen-size vibration alarm or remote alarm
Alarm Mode:	Latching or automatic reset
Real-time Clock:	Automatic date and time stamps on data logged information
Datalogging:	15,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC through RS-232 port
Sampling Pump:	Internally integrated. Flow rate: 450-550 cc/min.
Temperature:	0º to 45ºC (32º to 113ºF)
Humidity:	0 % to 95 % relative humidity (non-condensing)
Housing:	ABS + PC, conductive coating, splash and dust proof, will withstand 1 meter drop test with rubber boot
Attachment:	Wrist strap, rubber boot and belt clip

2. OPERATION OF MINIRAE 2000

The MiniRAE 2000 Portable VOC Monitor is a compact Monitor 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 MiniRAE 2000 is preset with default alarm limits and the sensor is pre-calibrated with standard calibration gas. However, the user should test the instrument and verify the calibration before the first use. After the monitor is fully charged and calibrated, it is ready for immediate operation.

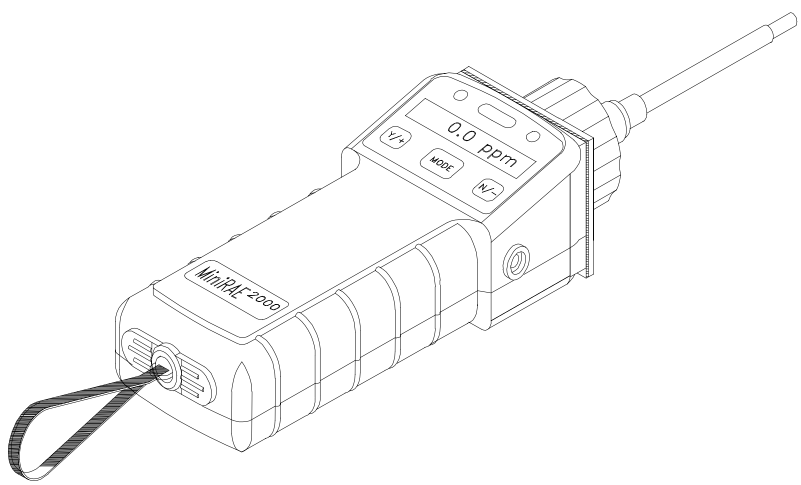


Figure 2-1 MiniRAE 2000

2.1 Physical Description

The main components of the MiniRAE 2000 Portable VOC monitor include:

- Three keys for user to interact with the monitor: 1 operation key and 2 programming keys for normal operation or programming of the monitor
- LCD display with back light for direct readout and calculated measurements
- Buzzer and red LED's for alarm signaling whenever the exposures exceed preset limits
- Wrist strap
- Charge contact for plugging directly to the charging station
- Gas entry and exit ports
- Serial communication port for PC interface
- External alarm and analog output port
- Protective rubber cover

2.2 Keys and Display

Figure 2.2 shows the LCD display and the keypad on the front panel of the monitor. The function of the 3 keys during normal operation are summarized below:

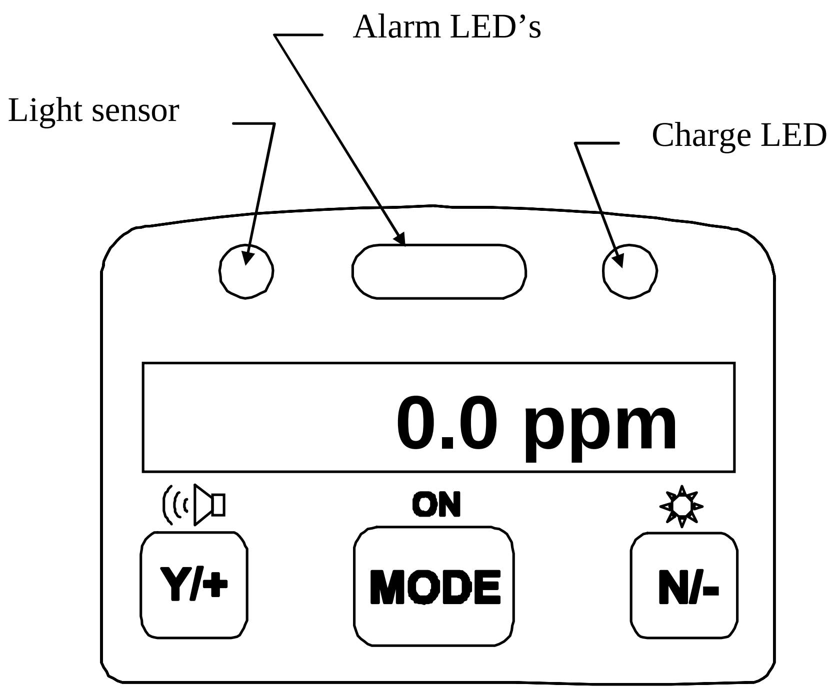


Figure 2-2 LCD Display and Keypad

Key Function in Normal Operation

[MODE] -Turn on/off the power* and step through menu items
[N/-] -Toggle on/off the back light, negative acknowledge, decrease value
[Y/+] -Start measurement, positive acknowledge, increase value value

* Pressing and holding **[MODE]** key for 5 seconds turns off the power to the monitor. Monitor will beep once per second and display countdown timer during power-down sequence. Press **[MODE]** key momentarily to step through menu items. To save time, press any key during message scrolling to skip to the end of the message.

2.3 Power On/Off

To turn on the MiniRAE 2000 portable VOC monitor, press **[MODE]** key for one second and release. The audio buzzer will beep once and the air pump will turn on. The display will show "ON!.." and then "Ver n.nn" to indicate the unit's current firmware version number. Next displayed are the serial number, the model number, Operating mode, current date and time, unit internal temperature, gas selected, high low, STEL, TWA/AVG alarm limits, battery voltage, and shut off voltage. Also displayed are internal mode settings such as User mode, Alarm mode, datalog time remaining and log periods in the respective order.

To turn off the MiniRAE 2000 portable VOC monitor, press and hold the **[MODE]** key for 5 seconds. The monitor will beep once per second during the power-down sequence with a count down timer showing the number of remaining seconds. The message "Off!.." flashes on the LCD display and the display will go blank indicating that the monitor is turned off.

Data protection during power off

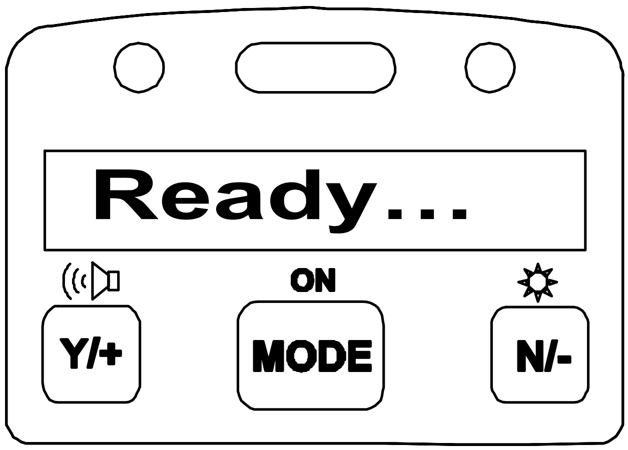
When the monitor is turned off, all the current real time data including last measured value are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost. While the power is off, the real time clock will continue to operate until the battery is completely drained (usually in 4-5 days without any charging). If the battery is completely drained or is disconnected from the monitor for more than 30 minutes, the real time clock will be lost. In this case, the user needs to enter the real time clock information again, as described in Section 4, or send the PC clock during configuration through the PC communication.

2.4 Operation

The **MiniRAE 2000** VOC monitor has two operation modes: **Survey** and **Hygiene** mode. The **Survey mode** allows the user to manually start and stop the monitoring/measuring operation and display certain exposure values. In the **Hygiene mode,** the monitor runs continuously after the monitor is turned on. Refer to Section 4.7.1 for switching between the two modes.

2.4.1 Survey Mode

After the monitor is turned on, it runs through the start up menu. Then the message “**Ready...**” is displayed (see figure below).



At this point, the user has two options:

1. Step through the Main Menu.
2. Take a measurement.

Press the **[MODE]** button to step through the Main Menu. Press the **[Y/+]** button to proceed to take a measurement.

The Main Menu

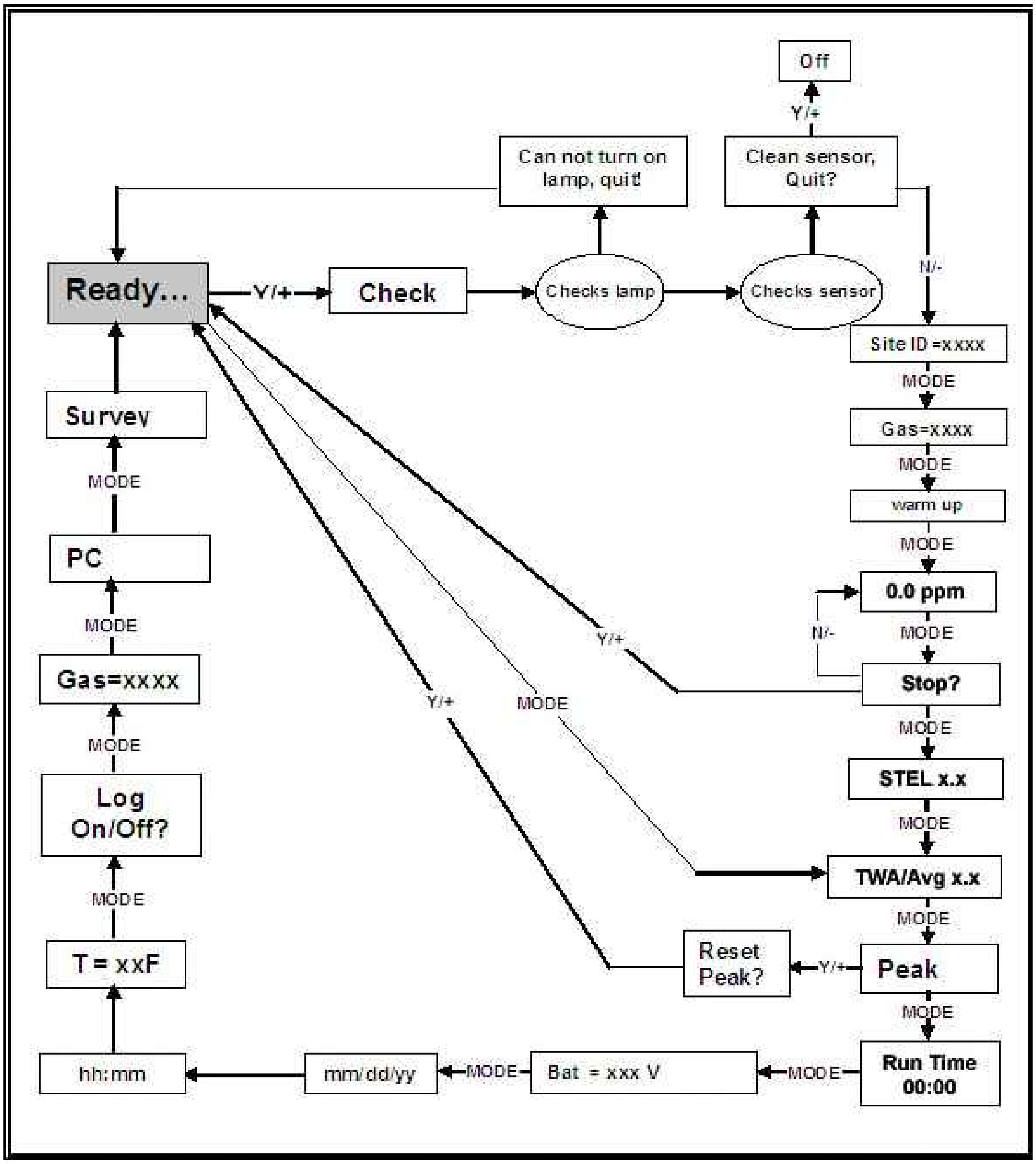
Press the **[MODE]** button to enter the Main Menu. Press the **[Y/+], [MODE]** or **[N/-]** as indicated in the flow chart below to step through the Main Menu. The PID sensor and pump are turned off during this time.

The Main Menu functions are:

- **Ready…**
- **Check**
- **Site ID = xxxx**
- **Gas = xxxx**
- **Warm up**
- **X.x ppm**
- **Stop?**
- **TWA/Avg x.x ppm**
- **STEL x.x ppm**
- **Peak x.x ppm**
- **Run time hh:mm**
- **Bat = X.XV**
- **Mm/dd/yy**
- **hh:mm**
- **T = xxxF [date, time and temperature (°C or °F)]**
- **Log On/Off?**
- **PC Comm?**
- **Survey**

These functions are arranged in a “round robin” order. To select a specific function, press the button as shown below until the desired function appears.

Main Menu



The Main Menu Functions

- **Ready…:** Indicates that the monitor is ready to take a measurement or to step through the Main Menu. Press the **[Y/+]** button to advance to taking a measurement (read "Taking a Measurement" on Page 2-12 for details).

  Note: The **Ready…** screen is skipped if the menu is cycled through while a measurement is running.

- **Check…:** This message displays while the system is checking the lamp and the sensor. If the lamp test succeeds, the system will progress to checking the sensor. If the lamp test does not succeed, the display will read **Can not turn on lamp, quit!**

  - **Can not turn on lamp, quit!:** This message displays when the lamp does not turn on. The system will automatically return to **Ready…** allowing the user to test the lamp again. If the lamp fails a second time, turn the monitor off and refer to Section 7.2 "**PID Sensor & Lamp Cleaning / Replacement**".

  - **Clean Sensor, Quit?:** This message displays when the sensor requires cleaning. Press the **[Y/+]** button to turn the monitor off and clean the sensor. Press the **[N/-]** button and the system will progress to the **Site ID = xx**

- **Site ID = xxxx:** This display shows the Site ID and indicates that the monitor is about to start taking measurements (read "Taking a Measurement" for details)

  Note: This display appears only after a measurement has been started. It does not appear when the user is cyling through the Main Menu and the monitor is idling.

- **Gas = xxxx:** This display identifies the gas to be measured and indicates that the monitor is about to take a measurement (read "Taking a Measurement" for details)

Note: This display appears only after a measurement has been started. It does not appear when the user is cyling through the Main Menu and the monitor is idling.

- **x.x ppm:** (read "Taking a Measurement" for details)

  Note: This display appears only after a measurement has been started. It does not appear when the user is cyling through the Main Menu and the monitor is idling.

- **TWA/Avg:** Displays (in ppm) the Time Weighted Average (TWA) or the Average since the start of the measurement. The average is recalculated every minute.

- **STEL:** Displays the Short Term Exposure Limit.

- **PEAK:** Displays (in ppm) the highest instantaneous reading since the start of the measurement. If **[Y/+]** is pressed while the peak reading is displayed, the unit will ask **Reset Peak?**. If **[Y/+]** is pressed again, the peak value will be cleared and the display will return to the **Ready…** message or instantaneous reading. The peak reading is automatically reset when a new measurement is started by pressing **[Y/+]** from the **Ready…** screen.

- **Run time hh:mm:** The duration of the current measurement period.

- **Bat = X.XV:** The current battery voltage.

  Note: A fully charged battery pack should show 4.8 volts or higher. When the battery voltage falls below 4.4 volts, a flashing **"Bat"** will appear as a warning message. At that point, you have 20-30 minutes of run time remaining. When the battery voltage falls below 4.2 volts the monitor turns off automatically.

- **Mm/dd/yy:** The current date.

- **hh:mm:** The current time (24-hour format)

- **T = xxxF:** The internal unit temperature in degrees Fahrenheit. (see Section 4.7.13 to change temperature units)
- **Log on/Off?:** Allows the user to start datalogging of the current measurement. A superscript "L" flashes in the ppm measurement display when datalogging is on. This screen is not shown when datalogging is disabled or when the monitor is not operating in manual start/stop mode.
- **PC Comm?:** This function enables the user to upload data from the MiniRAE 2000 to a Personal Computer (PC) or send/receive configuration information between a PC and the MiniRAE 2000. Press **[MODE]** to return to **Ready…** .

  To communicate with a PC, connect the monitor to the serial port of a PC and start the MiniRAE 2000 application software. Press the **[Y/+]** button and the LCD displays **"pause monitor, ok?"** Press the **[Y/+]** button one more time, and the display shows **"Comm..."** The monitor is now ready to receive commands from the PC.
- **Survey:** This function displays the Current Operating Mode (**Survey** or **Hygiene**).

<u>Taking a Measurement</u>

There are two ways to start a measurement.

1. Operating in Hygiene mode.
2. Manually start and stop measurement in Survey mode.

To start a measurement in Hygiene mode, please refer to Section 4.7.1, "**Change Operation Mode**". To start a measurement in Survey Mode, the MiniRAE 2000 monitor must first be in the "Ready…" mode. This is the mode to which the monitor normally powers up.

Measurement phases

1. Ready
2. Start measurement
3. Measurement display and datalogging
4. Stop measurement

Ready

The display reads **Ready…** indicating the unit is ready to start a measurement.

Start Measurement

Press the **[Y/+]** button to start the check cycle (see above), and then the measurement cycle.

After completing the **Check** cycle, the display will show the **Site ID** and then the **Gas** selected for measurement. The pump will start and the reading will be displayed. The **Peak** and **Average** values will be automatically reset to zero.

Measurement Display and Datalog

Instantaneous readings of the gas concentration in parts per million (ppm) are updated every second. A flashing superscript **L** is displayed when datalogging is on. Datalog information is saved only after one full datalog period is completed.

Stop Measurement

Press the **[MODE]** button and the display shows Stop? Press **[N/-]** to continue measurement and **[Y/+]** to stop the measurement and datalog event. The pump stops automatically when measurement is stopped. Peak and average values for the current measurement can be read in idle mode until a new measurement is started.

Automatic Increment of Site ID

Every time a measurement is taken, the site ID will be incremented by one automatically in Survey mode.

Variable Alarm Signal

In Survey Mode, if the measurement exceeds the low alarm limit, the buzzer and flashing alarm are activated and will beep/flash once per second. The alarms will increase in frequency as the gas concentration approaches the high alarm limit reaching 8 times per second when the high alarm has been exceeded.

Press **[Y/+]** key to clear if latching alarm.

2.4.2 Hygiene Mode

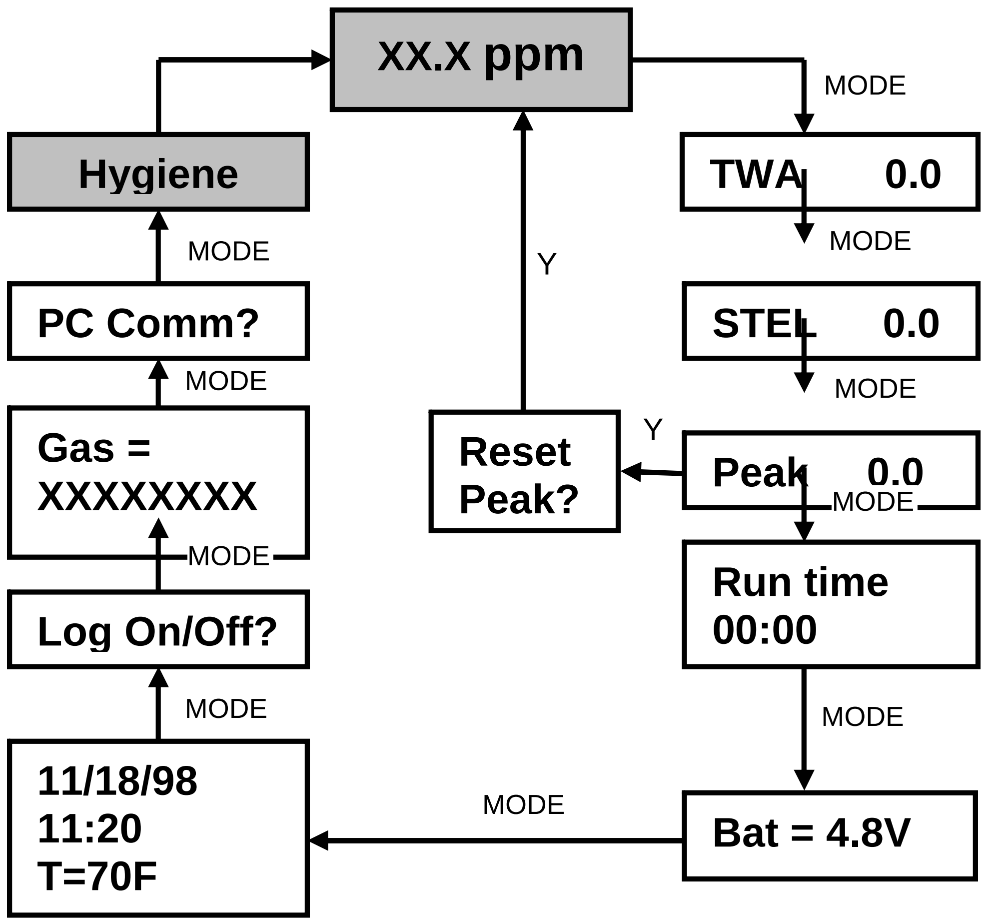
In Hygiene Mode, the unit will continuously taking measurements, once the power is turned on. After the initial start-up sequence displaying the current monitor settings, the LCD displays the instantaneous readings.

The Hygiene operation menu displays include:

- **Real time readings in ppm**
- **Current TWA/Avg, STEL and Peak values (see Section 4.6.6)**
- **Run time**
- **Current battery voltage**
- **Date, time and temperature**
- **Log on/off?**
- **Gas name**
- **PC communication?**
- **Hygiene**

Detailed description of most of these displays are the same as Section 2.4.1.

HYGIENE MODE MAIN MENU



To choose a specific display, press the **[MODE]** key one or more times until the desired display appears, or the **[Y/+]** key where indicated with a Y.

Note: To get back to instantaneous reading from any of the above display, press **[MODE]** key repeatedly until the "XX.X ppm" display appears.

2.5 Alarm Signals

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 the user of the alarm condition.

In addition, the MiniRAE 2000 will alarm if one of the following conditions occurs: battery voltage falls below a pre-set voltage level (4.4 V), failure of UV lamp, pump stall, or when the datalog memory is full. When the low battery alarm occurs, there will be approximately 20-30 minutes of operating time remaining. When the battery voltage falls below 4.2 V, the monitor will turn off automatically.

Alarm Signal Summary:

Condition	**Alarm Signal**
Gas exceeds “High Alarm” limit	3 beeps/flashes per second
Gas exceeds “Low Alarm” limit	2 beeps/flashes per second
Gas exceeds “TWA” limit	1 Beeps/flashes per seconds
Gas exceeds “STEL” limit	1 Beeps/flashes per seconds
Pump failure	3 beeps/flashes per second plus “Pump” message on LCD
PID lamp failure	3 beeps/flashes per second plus “Lamp” message on LCD
Low battery	1 flash per second, 1 beep per minute plus “Bat” message on LCD
Memory full	1 flash per second plus “Mem” message on LCD

Alarm Signal Testing:

Under normal non-alarm conditions, it is possible to test the MiniRAE 2000 LED and buzzer in Special Diagnostic Mode (see Section 8 for details).

2.6 Preset Alarm Limits and Calibration

The MiniRAE 2000 portable VOC monitor is factory calibrated with standard calibration gas, and is programmed with default alarm limits. There are 102 gas settings stored in the library. Some examples of calibration and alarm limits are shown below. Refer to Section 4 on programming procedures for selecting a different gas, perform a calibration or set new alarm limits.

Factory Calibration and Preset Alarm Limits

Cal Gas	Cal Span	unit	Low	High	TWA	STEL
Isobutylene	100	ppm	50	100	100	250
Hexane, n-	100	ppm	500	750	500	750
Xylene, m-	100	ppm	100	150	100	150
Benzene	5	ppm	2	5	5	2
Styrene	50	ppm	20	40	20	40
Toluene	100	ppm	50	100	50	100
Vinyl Chloride	10	ppm	5	10	5	10
Custom	100	ppm	50	100	50	100

2.7 Integrated Sampling Pump

The MiniRAE 2000 portable VOC monitor includes an integrated sampling pump. This is a diaphragm type pump that provides a 500-600 cc per minute flow rate. Connecting a Teflon or metal tubing with 1/8 inch inside diameter to the gas inlet port of the MiniRAE 2000, this pump can pull in air samples from 200 feet away horizontally, or 90 feet vertically, at about 3 feet per second flow speed.

The pump turns on when a measurement is started, and turns off when the sample is manually stopped in Survey mode or when the unit is turned off from Hygiene Mode.

If liquid or other objects are pulled into the inlet port filter, the monitor will detect the obstruction and shut down the pump immediately. The alarm will be activated and a flashing error message "Pump" will be also displayed on the LCD display.

The user should acknowledge the pump shut off condition by clearing the obstruction and pressing the **[Y/+]** key to re-start the pump.

The pump stall threshold is set in the special Diagnostic Mode (Section 8).

2.8 Back Light

The LCD display is equipped with an LED back light to assist in reading the display under poor lighting conditions. Pressing and holding the **[N/-]** key for one second in normal operation can turn on the backlight. The backlight can be turned off by pressing **[N/-]** a second time. If the **[N/-]** key is not pressed, the back light will be turned off automatically after a pre-programmed time-out period to save power.

In addition, the ambient light is sensed and the back light will be turned on automatically if the ambient light is below a threshold level. The back light is turned off automatically when the ambient light exceeds the threshold level.

See Section 8 for instructions on how to set the light threshold level.

Note: The LED backlight consumes about 20-30% of the total average current, when the instrument is idle or not taking a measurement.

2.9 Datalogging

During datalogging, the MiniRAE 2000 Portable VOC monitor flashes a superscript “L”, on the display to indicate that datalogging is enabled. The monitor stores the time stamp, sample number, and measured gas concentration at the end of every sample period (when data logging is enabled). In addition, the following information are 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 at a later time to a PC.

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 monitor is turned on, or a configuration parameter is changed, or datalogging is interrupted (e.g. Communication with PC during Hygiene mode). Information, such as start time, user ID, site ID, gas name, serial number, last calibration date, and alarm limits will be recorded.

Datalogging sample

After an event is recorded, the unit records a shorter form of the data. This data contains: the sample number, time (hour/minute) and gas concentration.

3. OPERATION OF ACCESSORIES

The accessories for the MiniRAE 2000 include:

- An AC Adapter (Battery Charger)
- Alkaline battery holder
- Water Trap Filter

Optional Accessories:

- Dilution Fitting
- Calibration adapter
- Calibration regulator and Flow controller
- Organic Vapor Zeroing kit

3.1 Standard Kit and Accessories

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.

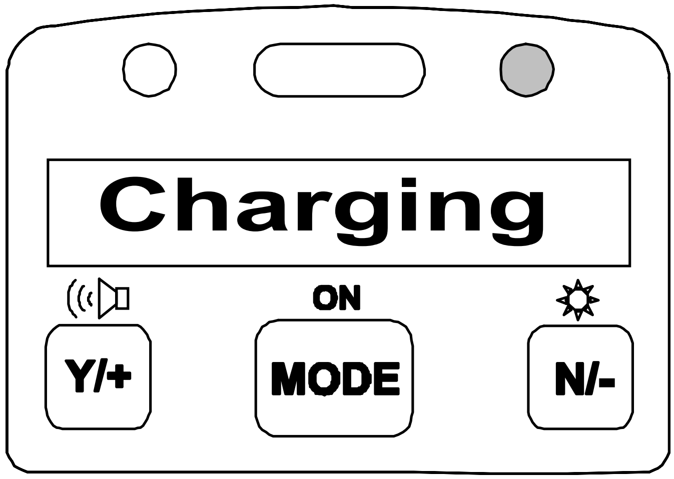
Ne charger les batteries que dans emplacements designés non-dangereuses.

A battery charging circuit is built into the MiniRAE 2000 monitor. It only needs a regular AC to 12 V DC adapter (wall mount transformer) to charge the monitor.

To charge the battery inside the MiniRAE 2000 monitor:

1. Power off the Monitor.
2. Connect the AC adapter (or the optional automotive charging adapter) to the DC jack on the MiniRAE 2000 monitor. If the unit was off, it will automatically turn on.
3. The first message displayed will be “Deep discharge?” The unit will ask this question for three times. If the user wants to discharge the battery pack, affirm this query with the **[Y/+]** key, otherwise the unit will move on to the charge mode directly.

4. While charging, the display message will alternate between "Charging" and "Bat=x.xV" (x.x is the present battery voltage). The LED should be red in color when charging.



5. When the battery is fully charged, the LED will change from red to green and the message "Fully charged" will appear on the display. After the battery is fully charged, the unit will enter the "trickle charge" mode. In which, the red LED will turn on for several seconds every minute, to maintain the full charge.

A completely discharged MiniRAE 2000 monitor will be charged to full capacity within 10 hours. The battery will be drained slowly even if the monitor is turned off. If the monitor has not been charged for 7-10 days, the battery voltage will be low.

The factory-supplied battery is designed to last for 10 hours of normal operation (no alarm, no back light condition), for a new battery under the best condition. As the battery becomes older or is subject to adverse conditions (such as cold ambient temperature), the battery capacity will be reduced significantly.

2) Alkaline Battery Holder

An alkaline battery holder is supplied with each MiniRAE 2000. It accepts four AA size alkaline batteries and can be used in place of the Ni-MH or Ni-Cd battery pack to provide approximately 12-14 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the Ni-Cd or Ni-MH battery pack.

To install the adapter, remove the cover of the battery compartment. Remove the Ni-Cd or Ni-MH battery pack from the battery compartment and replace with the alkaline battery adapter. Replace the battery compartment cover.

The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the monitor.

Note**:** The AA Alkaline battery adapter supplied by RAE Systems Inc. is intrinsically safe!

3) Water Trap Filter

The water trap filter is made of PTFE (Teflon®) membrane with a 0.45 micron pore size to prevent water from being sucked into the sensor manifold, which would cause extensive damage to the monitor. It will also remove any dust and other particles from entering the monitor and prolong the operating life of the sensor. To install the water trap, simply insert it to the front of the inlet tube of the MiniRAE 2000 monitor.

3.2 Optional Accessories

1) Dilution Fitting

The user may wish to install a dilution fitting on the inlet to dilute the gas samples. One application for a dilution fitting is to measure organic gas when the concentration exceeds the upper limit of the sensor range.

Make sure to set the dilution ratio in the programming mode (see Section 4.7.9) so that the correct gas reading will be displayed when the dilution fitting is used.

WARNING: To use a dilution fitting, the user must have the monitor located in a clean atmosphere outside the confined space and use a remote access probe or Tygon tubing to measure the gas concentration inside the confined space.

2) Calibration Adapter

The calibration adapter for the MiniRAE 2000 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 MiniRAE 2000 and the tubing to the gas regulator on the gas bottle.

3) Calibration Regulator and Flow Controller

The Calibration Regulator and Flow controller is used in the calibration process. It regulates the gas flow rate from the Span gas cylinder into the gas inlet of the MiniRAE 2000 monitor 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.

4) Organic Vapor Zeroing kit (Charcoal filter)

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 MiniRAE 2000.

4. PROGRAMMING OF MINIRAE 2000

The MiniRAE 2000 Monitor is built with a microcomputer to provide programming flexibility. Authorized users can re-calibrate the monitor, change the alarm limits, change site ID, user ID, lamp type, and real time clock, etc.

Programming is menu-driven to provide intuitive end-user operation. The display shows the menu options and the key pad used for menu selection and data entry.

4.1 Programming Mode

The programming mode allows the users to change the setups in the monitor, calibrate the monitor, modify the sensor configuration and enter user information, etc. The programming mode has four menu items. Each menu item includes several sub-menus to perform additional programming functions. Appendix A shows a more detailed menu tree structure.

Programming Menu

Calibrate/Select Gas?

Change Alarm Limits?

Change Datalog?

Change Monitor Setup?

Once inside the programming mode, the LCD will display the first menu. Each subsequent menu item can be viewed by pressing the **[N/-]** repeatedly until the desired menu is displayed. To enter the sub-menu of a particular menu, press **[Y/+]** key, the sub-menu will be displayed.

Return to Operation mode: To exit the programming mode and return to operation, press the **[MODE]** key once at any of the programming menu displays.

4.2 Keys for Programming Mode

The three keys perform a different set of functions during the programming mode as summarized below.

Key	Function in Programming Mode
[MODE]:	Exit menu when pressed momentarily or exit data entry mode when pressed and held for 1 second
[Y/+]:	Increase alphanumerical value for data entry or confirm (yes) for a question
[N/-]:	Decrease alphanumerical value for data entry or deny (no) for a question

4.3 Entering into Programming Mode

1. Turn on the MiniRAE 2000 monitor and wait for the **“Ready..”** message or the instantaneous reading display **“0.0 ppm”** message displayed.
2. Press and hold down both **[N/-]** and **[MODE]** keys for three seconds to enter programming mode. This delay is to prevent the user from entering programming mode by accident.
3. The first menu item “Calibrate/select Gas?” will be displayed.
4. Release both **[MODE]** and **[N/-]** keys simultaneously to start the programming mode
5. Press **[N/-]** key to scroll to the next menu item of the programming menu. Press **[Y/+]** key to select the displayed menu item.

The following Sections 4.4 - 4.7 describe the details of each menu options.

4.4 Calibrate and Select Gas

WARNINGS

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 the first time.

For maximum safety, the accuracy of the MiniRAE 2000 should be checked by exposing it to known concentration calibration gas before each day's use.

In the first menu of the programming mode, the user can perform functions such as calibration of the MiniRAE 2000 Monitor, select default cal memories, and modify cal memories (see Table 4.4).

Table 4.4

Calibrate/Select Gas Sub-Menu
Fresh Air Cal?
Span Cal?
Select Cal Memory?
Change Span Value?
Modify Cal Memory?
Change Correction Factor?

Calibrating the MiniRAE 2000 monitor is a two-point process using "fresh air " and the standard reference gas (also known as span gas). First a "Fresh air" calibration, which contains no detectable VOC (0.0 ppm), is used to set the zero point for the sensor. Then a standard reference gas that contains a known concentration of a given gas is used to set the second point of reference.

Note: The span value must be set prior to calibrating for fresh air or span.

The user can store calibrations for up to 8 different measurement gases. The default gas selections are as follows:

Cal Memory #0……Isobutylene

Cal Memory #1……Hexane

Cal Memory #2……Xylene

Cal Memory #3……Benzene

Cal Memory #4……Styrene

Cal Memory #5……Toluene

Cal Memory #6……Vinyl Chloride

Cal Memory #7……Custom?

Memory #0 functions differently than the other 7 memories. For Memory #0, isobutylene is always the calibration gas. When the gas is changed in Memory #0 to one of 100 other preprogrammed chemicals or to a user-defined custom gas, a correction factor is applied to all the readings. During calibration, the unit requests isobutylene gas and displays the isobutylene concentration immediately following calibration, but when the unit is returned to the normal reading mode, it displays the selected gas and applies the correction factor.

The other 7 cal memories require the same calibration gas as the measurement gas. These memories may also be modified to a preprogrammed chemical or to a user-defined custom gas. In the gas library, only the gases that can be detected by the installed UV lamp will actually be displayed. Note that although the correction factor for the new gas will be displayed and can be modified, this factor is not applied when Memories #1-7 are used. Therefore the factor will not affect the readings in these memories.

Once each of the memories has been calibrated, the user can switch between the calibrated gases by changing the cal memory without the need to recalibrate. Or the user can switch the measurement gas in Memory #0 and the appropriate correction factor will automatically be applied without the need to recalibrate. If the gas is changed in Memories #1-7, it is necessary to recalibrate.

To change a default gas from the list above to a library or custom gas, first go to Select Cal Memory (Section 4.4.3) and then proceed to Modify Cal Memory (Section 4.4.5) to enter the desired gas. If the desired compound does not appear in the preprogrammed library, the user can use the Custom_VOC entry in the library, or the name and correction factor of any of the existing compounds can be changed as described in Section 4.4.5. A list of some 300 correction factors is given in Technical Note 106, available at the website www.raesystems.com.

4.4.1 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 MiniRAE 2000 to a "fresh" air source such as from a cylinder or Tedlar bag (option accessory). The "fresh" air is clean dry air without any organic impurities. If such an air cylinder is not available, any clean ambient air without detectable contaminant or a charcoal filter can be used.

1. The first sub-menu shows: "Fresh air Cal?"
2. Make sure that the MiniRAE 2000 is connected to one of the "fresh" air sources described above.
3. Press the **[Y/+]** key, the display shows "zero in progress" followed by "wait.." and a countdown timer.

After about 15 seconds pause, the display will show the message "update data…zeroed… reading = X.X ppm…" Press any key or wait about 20 seconds, the monitor will return back to "Fresh air Calibration?" submenu.

4.4.2 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 MiniRAE 2000 Monitor, 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.

Before executing a span calibration, make sure the span value has been set correctly (see next sub-menu).

1. Make sure the monitor is connected to one of the span gas sources described above.
2. Press the **[Y/+]** key at the “Span Cal?” to start the calibration. The display shows the gas name and the span value of the corresponding gas.
3. The display shows “Apply gas now!” Turn on the valve of the span gas supply.

4. Display shows “wait.... 30” with a count down timer showing the number of remaining seconds while the monitor performs the calibration.

5. To abort the calibration, press any key during the count down. The display shows “Aborted!” and return to “Span Cal?” sub-menu.

6. When the count down timer reaches 0, the display shows the calibrated value.

   Note: The reading should be very close to the span gas value.

7. During calibration, the monitor waits for an increased signal before starting the countdown timer. If a minimal response is not obtained after 35 seconds, the monitor displays “No Gas!” Check the span gas valve is on and for lamp or sensor failure before trying again.

8. The calibration can be started manually by pressing any key while the “Apply gas now!” is displayed.

9. After a span calibration is completed, the display will show the message “Update Data Span Cal Done! Turn Off Gas.”

10. Turn off the flow of gas. Disconnect the calibration adapter or Tedlar bag from the MiniRAE 2000 Monitor.

11. Press any key and it returns back to “Span Gas Cal?”

4.4.3 Select Cal Memory

This function allows the user to select one of eight different memories for gas calibration and measurement. For Memories #1-7, the calibration and measurement gas is the same and no correction factor is applied. For Memory #0, the calibration gas is always isobutylene and the measurement gas may be different, in which case the correction factor for that gas is automatically applied. The default gas selections are listed in Section 4.4

1. "Select Cal Memory?" is the third sub-menu item in the Calibration sub-menu. Pressing the **[Y/+]** key, the display will show "Gas =" gas name followed by "Mem # x?"
2. Press **[N/-]** to scroll through all the memory numbers and the gas selections respectively. Press **[Y/+]** to accept the displayed Cal Memory number.
3. After the **[Y/+]** key is pressed, the display shows "Save?" Press **[Y/+]** key to save and proceed. Press **[N/-]** to discard the entry and advance to the next sub-menu.
4. If the gas in a newly selected Cal Memory number is not calibrated, the display shows "CF= x.xx". A correction factor with the value "x.xx" will be applied.
5. If the gas of a newly selected cal memory number has been calibrated previously, the display shows "Last calibrated xx/xx/xx".

4.4.4 Change Span Value

This function allows the user to change the span values of the calibration gases.

1. “Change Span Value?” is the fourth sub-menu item in the Calibration sub-menu
2. Press **[Y/+]**, display shows the gas name and the span value. A cursor will blink at the first digit of the Span value. To modify the span gas value, go to Step 3. Otherwise, press and hold the **[MODE]** key for 1 second to accept the previously stored span gas value and move to the next sub-menu.
3. Starting from the left-most digit of the span gas value, use the **[Y/+]** or **[N/-]** key to change the digit value and press **[MODE]** key momentarily to advance to next digit. Repeat this process until all digits are entered. Press and hold the **[MODE]** for 1 second to exit.
4. The display shows “Save?” To accept the new value, press the **[Y/+]** key. Press the **[N/-]** key or the **[MODE]** key to discard the change and move to the next sub-menu.

4.4.5 Modify Cal Memory

If the current cal memory number selected is not memory 0, users will be prompted whether to modify the settings of the selected cal memory. Press **[Y/+]** to modify the cal memory and **[N/-]** to go to the next sub-menu.

Once **[Y/+]** is pressed the LCD display will show the current memory number, current Gas selected and prompt user for acceptance of current gas selected.

1. Press **[N/-]** to modify the gas selection if desired. Or press **[Y/+]** key to skip the change of gas selection, and proceed to the next sub-menu.
2. After pressing **[N/-]**, display shows “Copy gas from library?” Press **[Y/+]** to accept or **[N/-]** for the next sub-menu, “Enter Custom gas?”
3. In the “Copy gas from library” submenu, use **[Y/+]** and **[N/-]** keys to scroll through the selections in the library. Press **[MODE]** key momentarily to select the gas. The display shows ”Save?” Press **[Y/+]** to save or **[N/-]** to discard the changes and proceed to next sub-menu.
4. In the Custom gas sub-menu, the user can enter the gas name. Press the **[Y/+]** or **[N/-]** key to cycle through all 26 letters and 10 numerals. Press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all digits (up to 8 digits) of the custom gas name is entered.

Press and hold the **[MODE]** key for 1 second to exit the name entry mode. The display will show “Save?“ Press **[Y/+]** to save the entry, or **[N/-]** to discard the changes.

4.4.6 Change Correction Factor

This function allows the user to change the Correction Factor of the standard calibration gas (only for Cal Memory #0).

1. "Change Correction Factor?" is the sixth sub-menu in the Calibration sub-menu.
2. Press **[Y/+]** key. Display shows the gas name, then the correction factor.

   A cursor blinks at the left-most digit of the correction factor. If user wants to modify the correction factor, go to Step 3. Otherwise, press and hold the **[MODE]** key for 1 second to accept the previously stored correction factor value and return to the first sub-menu of the calibrate/select gas menu.
3. Starting from the left-most digit of the correction factor, use **[Y/+]** or **[N/-]** key to change the digit value and press **[MODE]** key momentarily to advance to the next digit, the cursor will move to the next digit to the right. Repeat this process until all digits are entered. Press and hold the **[MODE]** for 1 second to exit.
4. The display shows "Save?" To confirm the new value, press **[Y/+]** to accept the change. Press **[N/-]** or **[MODE]** to discard the change and return to the first sub-menu, Calibrate and Select Gas.

4.5 Change Alarm Limits

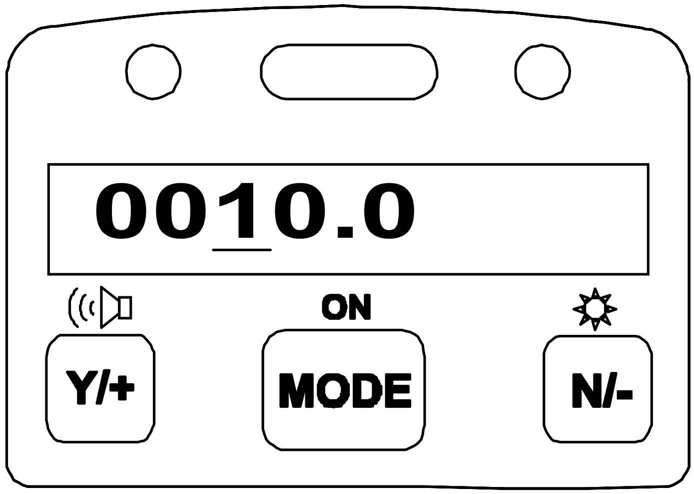
In this menu, the user can change the high and low alarm limits, the STEL limit and the TWA limit (see Table 4.5 below). Press the **[Y/+]** key and the display shows the current gas selected followed by the first sub-menu item below.

Table 4.5

Alarm Limit Sub-Menu
Change High Alarm limit?
Change Low Alarm limit?
Change STEL limit?
Change TWA limit?

1. Scroll through the Alarm Limit sub-menu using the **[N/-]** key until the display shows the desired limit to be changed, e.g.,”High limit?”, “STEL limit?”, etc.

2. Press the **[Y/+]** key to select the desired limit and the display shows a flashing cursor on the left-most digit of the previously stored alarm limit.



3. To modify this limit value, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to its right. Repeat this process until the new limit value is entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.

4. If there is any change to the existing value, the display shows "Save?" Press **[Y/+]** to accept the new value and move to the next sub-menu. Press **[N/-]** to discard the changes and move to the next sub-menu.

4.5.1 Change Low Alarm Limit

The second sub-menu item in the Alarm Limit sub-menu allows the user to change the Low Alarm limit. The LCD displays "Low limit?" To change Low Alarm limit, press **[Y/+]** key, or Press **[N/-]** key advance to next sub-menu in Table 4.5.

1. Press **[Y/+]** and the display will show a flashing cursor on the left-most digit of the previously stored Low alarm limit.
2. To modify this limit value, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to its right. Repeat this process until the new limit values is entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
3. If there is any change to the existing value, the display shows "Save?" Press **[Y/+]** to accept the new value and move to the next sub-menu. Press **[N/-]** to discard the changes and move to the next sub-menu.

4.5.2 Change STEL Limit

This sub-menu item allows the user to change the STEL limit. The display shows “STEL limit?”

1. Press the **[Y/+]** key and the display will show a flashing cursor on the left-most digit of the previously stored STEL limit.
2. To modify this limit value, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new limit values is entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
3. If there is any change to the existing value, the display shows “Save?” Press **[Y/+]** to accept the new value and move to the next sub-menu. Press **[N/-]** to discard the changes and move to the next sub-menu.

4.5.3 Change TWA Limit

This sub-menu item allows the user to change the TWA limit. The LCD displays “TWA limit?”

1. Press **[Y/+]** and the display will show a flashing cursor on the left-most digit of the previously stored TWA limit.
2. To modify this limit value, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new limit values is entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
3. If there is any change to the existing value, the display shows “Save?” Press **[Y/+]** to accept the new value and move to the next sub-menu. Press **[N/-]** to discard the changes and move to the next sub-menu.

4.6 Change Datalog

The MiniRAE 2000 monitor 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.

Datalog Sub-Menu

Reset Peak/Minimum?

Clear Data?

Change Data Period?

Change Average Type?

4.6.1 Reset Peak

This function will reset the peak and minimum stored in the data memory. Note: this function will not clear the STEL or TWA data.

1. “Reset Peak?” is the first sub-menu item in the Datalog sub-menu (Table 4.6).
2. Press the **[Y/+]** key to reset the Peak/Minimum Values. The display shows “Are You Sure?”
3. Pressing the **[Y/+]** key again will reset the values. The display shows “Peak/Minimum Cleared” and moves to the next submenu.
4. Press the **[N/-]** or **[MODE]** key to exit without resetting the values and move to the next sub-menu.

4.6.2 Clear Data

This function will erase all data stored in the non-volatile datalog memory. Note: This function does not change STEL, TWA, Peak, Minimum and run time values, which are stored in the regular data memory.

1. “Clear Data?” is the third sub-menu item in the Datalog sub-menu.
2. Press the **[Y/+]** key to clear the datalog memory. The display shows “Are you sure?”
3. Press the **[Y/+]** key again to confirm erasure of all the datalog memory.
4. Press the **[N/-]** or **[MODE]** key to exit without clearing the datalog memory and move to the next datalog sub-menu.

4.6.3 Change Data Period

The datalog period can be programmed from 1 to 3,600 seconds (1 hour).

1. "Change Data Period?" is the fifth sub-menu item in the Datalog sub-menu.
2. Press the **[Y/+]** key and the display shows "Datalog Period = XXXX" with the left-most digit flashing, where "XXXX" is the previously stored data log period.
4. To modify this period, starting from the left-most digit, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 4 digits of the new period are entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
5. If there is any change to the existing value, the display will show "Save?" Press **[Y/+]** to accept the new value or **[N/-]** to discard the changes and move to the next sub-menu.

4.6.4 Change Average Type

The user can select either an 8-hour Time Weighted Average (TWA) or a running Average. The running average is simply the average of all instantaneous (1-second) readings since the measurement was started. This average may increase or decrease with time depending on the readings. The TWA is a cumulative value used to estimate the fraction of the 8-hour limit to which the user has been exposed since the start of the measurement. This value can only increase or remain constant, never decrease. Refer to Technical Note 119 for more information on how TWA is calculated.

1. "Change Average Type?" is the sixth sub-menu in the Datalog sub-menu.
2. Press the **[Y/+]** key to enter the function.
3. The display will show "Running Average?" or " Time Weighted Average?" depending on the current average type.
4. Press **[N/-]** key to toggle between the average types. Press **[Y/+]** key to select the displayed average type.
5. If there is any change to the existing setting, the display shows "Save?" Press **[Y/+]** to save the change. Press **[N/-]** or **[MODE]** to discard the change and return to the first sub-menu.

4.7 Change Monitor Setup

Several monitor specific variables can be changed in this menu. The following is a list of configuration data that can be modified by the user.

Monitor Setup Sub-Menu	**Diagnostic Mode**
Change Operation Mode?	“
Change Site ID?	Change Unit ID?
Change User ID?	Change Host ID?
Change Alarm Mode?	“
Change User Mode?	“
Change Date?	“
Change Time?	“
Change Lamp?	“
Change Pump Duty Cycle?	“
Change Unit?	“
Change Dilution Ratio?	“
Change Output?	“
Change DAC Range?	“
Set Temperature Unit?	“

4.7.1 Change Operation Mode

MiniRAE 2000 supports two operation modes: Survey and Hygiene mode.

Survey mode: Manual start/stop of measurements and display of certain exposure values.

Hygiene mode: Automatic measurements, running and datalogging continuously and calculates additional exposure values.

1. “Change Op Mode?” is the first sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the **[Y/+]** key and the display shows the current user mode: “Op Mode = *current mode*?”
3. Press the **[Y/+]** key to accept the currently displayed operation (Op) mode. Press **[N/-]** to toggle to the other operation mode. Press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.
4. When changing Op mode from Hygiene to Survey, the display shows the additional message “Warning! Exit Hygiene?” to prevent accidental exit from Hygiene mode. Press the **[Y/+]** key to acknowledge.
5. If there is any change to the existing setting, the display will show “Save?” Press the **[Y/+]** key to accept or the **[N/-]** key to discard and move to the next sub-menu.

Note: If a new Op Mode is saved, the display shows “Op Mode changed!!” when exiting the programming mode.

4.7.2 Change Site ID

The user can enter an 8-digit alphanumeric site ID in the programming mode. This site ID will be included in the datalog report.

1. "Change Site ID?" is the second sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the **[Y/+]** key and the display shows the current site ID: "Site ID = xxxxxxx" with the left most digit flashing.
3. Press the **[Y/+]** or **[N/-]** key to cycle through all 26 letters and 10 numerals. Press **[MODE]** momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 8 digits of the new site ID are entered.
4. Press and hold the **[MODE]** key for 1 second to exit the data entry mode.
5. If there is any change to the existing site ID, the display shows "Save?" Press the **[Y/+]** key to accept the new site ID. Press the **[N/-]** key to discard the change and move to the next sub-menu.

4.7.3 Change User ID

The user can enter an 8-digit alphanumeric user ID in the programming mode. This user ID will be included in the datalog report.

1. "Change User ID?" is the third sub-menu item the Monitor Setup menu.
2. Press the **[Y/+]** key and the display shows the current user ID: "User ID = xxxxxxxx" with the left most digit flashing.
3. Press the **[Y/+]** or **[N/-]** key to cycle through all 26 letters and 10 numerals. Press **[MODE]** momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 8 digits of the new user ID are entered.
4. Press and hold the **[MODE]** key for 1 second to exit the data entry mode.
5. If there is any change to the existing user ID, the display shows "Save?" Press the **[Y/+]** key to accept the new user ID. Or press the **[N/-]** key to discard the changes and move to the next sub-menu.

4.7.4 Change Alarm Mode?

There are two different alarm modes: **Latched** and **Automatic Reset** (Auto Reset) in the MiniRAE 2000 that can be selected from the programming menu.

1. "Change Alarm Mode?" is the fourth sub-menu item in the Monitor Setup menu.
2. Press the **[Y/+]** key; the display shows the current alarm mode.
3. Press the **[Y/+]** key to accept the currently displayed alarm mode. Press **[N/-]** key to toggle to the other alarm mode. Press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing setting, the display will show "Save?" Press **[Y/+]** to save the change. Press **[N/-]** or **[MODE]** to discard the change and move to the next sub-menu.

4.7.5 Change User Mode

There are two different user modes: **Display** and **Program** that can be selected from the programming menu.

1. "Change User Mode?" is the fifth sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the **[Y/+]** key; the display shows the current user mode selected.
3. Press the **[Y/+]** key to accept the currently displayed user mode. Press **[N/-]** key to toggle to the alternate user modes. Press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing selection, the display shows messages "Program change" and "Are you sure?" Press **[Y/+]** to confirm the change or press **[N/-]** or **[MODE]** to discard the changes and move to the next sub-menu.

CAUTION: If the user mode is changed to **Display** mode, the user can no longer enter the programming mode. Therefore, the user can not change the user mode back to **Program** mode in normal mode.

To restore the user mode back to **Program** mode, turn the unit off and back on in Diagnostic Mode. Next enter Program mode by holding the **[MODE] and [N/-]** keys for three seconds. Enter the password at the prompt (the default is 0000). Once program mode is entered, go to the "Change Monitor Setup" / "Change User Mode" and change the mode back to **Program.**

An alternative way to change Display mode back to Program mode is through the PC and the ProRAE-Suite software.

4.7.6 Change Date

The MiniRAE 2000 monitor is equipped with a real time clock (RTC). The user can enter the correct date and time (see 4.7.7) for the real time clock.

1. "Change Date?" is the sixth sub-menu item in the Monitor Setup menu.
2. Press **[Y/+]** and the display shows the current date "mm / dd / yy" with the left most digit of the date flashing.
5. To modify this value, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new date and time values are entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows "Save?" Press **[Y/+]** to confirm the new value or press **[N/-]** or **[MODE]** to discard the changes and move to the next sub-menu.

4.7.7 Change Time

To change the time in the RTC of the MiniRAE 2000:

1. "Change Time?" is the seventh sub-menu item in the Monitor Setup menu.
2. Press **[Y/+]** and the display shows the current time in the 24-hour format "hh : mm" with the left most digit of the time flashing.
3. To modify this value, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new date and time values are entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows "Save?" Press **[Y/+]** to confirm the new value or press **[N/-]** or **[MODE]** to discard the changes and move to the next sub-menu.

4.7.8 Change Lamp

There are three UV lamps with different photon energies available for the PID sensor: **9.8 eV, 10.6 eV** and **11.7 eV**. The user can select any one of the lamps from the programming mode.

1. “Change Lamp Type?” is the eighth sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the **[Y/+]** key; the display shows the current PID lamp selection.
3. Press the **[Y/+]** key to accept the currently displayed lamp. Press **[N/-]** key to scroll through the sub-menu for other lamp selections. Press **[MODE]** to exit this sub-menu and return to the next sub-menu in Table 4.7.
4. If there is any change to the existing selection, the display will show “Save?” Press **[Y/+]** to save the new selection or press **[N/-]** or **[MODE]** to discard the change and return to the next sub-menu in Table 4.7.

4.7.9 Change Unit

User can change the display and datalog unit from parts per million (ppm) to milli-gram per cubic meter (mg/m^3).

1. "Change Unit?" is the ninth sub-menu item in the Monitor Setup sub-menu.
2. Press the **[Y/+]** key, the display should show the current unit "Display Unit = ppm?" or "Display Unit = mg?"
3. Press **[Y/+]** key to accept the currently displayed unit. Press **[N/-]** key to toggle to the other unit. Press **[MODE]** key to exit this sub-menu.
4. If there is any change to the existing selection, press **[Y/+]** to confirm the new selection or press **[N/-]** or **[MODE]** to discard the changes and move to the next sub-menu.

Caution:

1. **The correction factor in the gas library is calculated based on "ppm" unit. If "mg" unit is selected, the built-in correction factor library is not valid.**
2. **No automatic conversion between "ppm" and "mg/m^3" reading is performed by the monitor.**
3. **When the unit name is changed from "ppm" to "mg", the unit must be recalibrated with the span gas concentration entered in mg/m^3. The converse rule applies when the unit is changed from "mg" to "ppm".**

4.7.10 Change Dilution Ratio

If a dilution system is used upstream of the MiniRAE 2000 inlet port, the user can enter the dilution ratio (from 1 to 10) to compensate the readings. The unit will then display the actual concentration of the gas before dilution. The dilution ratio should be 1 in normal operation where no dilution gas is applied to the sample gas. Dilution improves accuracy and linearity when the concentrations are above a few thousand ppm.

1. "Change Dilution Ratio?" is the tenth sub-menu item in the Monitor Setup menu.
2. Press the **[Y/+]** key; the display shows the current dilution ratio: "Dilution Ratio = xx" with the left most digit flashing.
3. Press the **[Y/+]** or **[N/-]** key to increase or decrease the value of the digit. Press **[MODE]** momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until both digits of the new dilution ratio are entered.
4. Press and hold the **[MODE]** key for 1 second to exit the data entry mode and move to the next sub-menu.
5. If there is any change to the existing dilution ratio, the display shows "Save?" Press **[Y/+]** to confirm the new value or press **[N/-]** or **[MODE]** to discard the changes and move to the next sub-menu.

4.7.11 Change Output?

There are two different external output options: DAC (Analog output) and Alarm in the MiniRAE 2000 that can be selected from the programming menu. The alarm output can be used to connect to the optional vibration alarm (vibrator) only. The analog output, which is proportional to the gas concentration, can be connected a chart recorder or can be queried by a computer to download data in real time (see Technical Note 141).

1. "Change External Output?" is the eleventh sub-menu item in the Monitor Setup menu.
2. Press the **[Y/+]** key and the display shows the current output option selection: "Output = DAC?"
3. Press the **[Y/+]** key to accept the currently displayed output option. Press **[N/-]** to change to the other external option: "Output = Alarm?" Press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing selection the display will show "Save?" Then, press **[Y/+]** to save the change, press **[N/-]** to go back to Step 2, or press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.

4.7.12 Change DAC Range?

There are four different DAC (Digital-to-Analog Conversion) range values available in the **MiniRAE 2000: 20, 200, 2000** and **10K ppm**. The maximum 2.5V DC analog signal output from the unit will represent the range value chosen. (See for analog signal output connection.)

1. "Change DAC Range?" is the twelfth sub-menu item in the Monitor Setup menu.
2. Press the **[Y/+]** key, the display shows the current DAC Range value: "DAC Range = 2000 ppm?"
3. Press the **[Y/+]** key to accept the currently displayed value. Press **[N/-]** to scroll through the sub-menu for other range values. Press **[MODE]** to exit this sub-menu and return to the first sub-menu in Table 4.7.
4. If there is any change to the existing selection, press the **[Y/+]** key and the display will show "Save?" Press the **[Y/+]** key to save the change or press the **[N/-]** key to discard and return to the first sub-menu in Table 4.7.

4.7.13 Set Temperature Unit?

The temperature display can be switched between Fahrenheit and Celsius units.

1. “Set Temperature Unit?” is the thirteenth sub-menu item in the Monitor Setup menu.
2. Press the **[Y/+]** key, and the display shows the current setting: “Temperature Unit = Fahrenheit?”
3. Press the **[Y/+]** key to accept the currently displayed value. Press **[N/-]** to select the sub-menu “Temperature Unit = Celsius?” Press **[MODE]** to exit this sub-menu and return to the first sub-menu in Table 4.7.
4. If there is any change to the existing selection, press the **[Y/+]** key and the display will show “Save?” Press the **[Y/+]** key to save the change and return to the first sub-menu in Table 4.7 or press the **[N/-]** key to discard and return to Step 3..

4.8 Exit Programming Mode

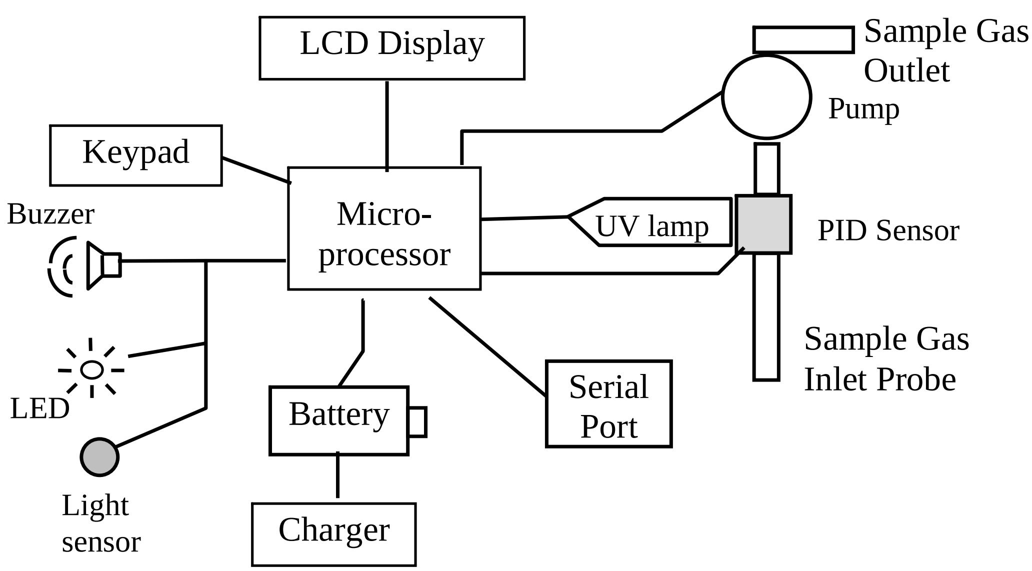
1. To exit programming mode from the first tier menu level, press the **[MODE]** key once.
2. To exit programming mode from 2nd tier sub-menu, press the **[MODE]** key twice.
3. To return to programming mode, press and hold down both the **[MODE]** and **[N/-]** keys for 3 seconds.

5. THEORY OF OPERATION

The MiniRAE 2000 monitor uses a newly developed electrodeless discharge UV lamp as the high-energy photon source for the PID. As organic vapors pass by the lamp, they are photo-ionized and the ejected electrons are detected as a current. The PID sensor with a standard 10.6 eV lamp detects a broad range of organic vapors. A lamp with high photon energy (e.g. 11.7 eV) will measure the more kinds of compounds, whereas low photon energies (e.g. 9.8 eV) are selective for easily ionizable compounds such as aromatics. In principle, any compound with an ionization energy lower than that of the lamp photons can be measured.

The PID sensor for the MiniRAE 2000 monitor is constructed as a small cavity in front of the UV lamp. A diaphragm pump draws the gas sample into the sensor and then pumps it out through the side of the instrument.

Figure 5-1   MiniRAE 2000 Block Diagram



A single chip microcomputer is used to control the operation of the alarm buzzer, LED, pump and light sensor. It measures the sensor readings and calculates the gas concentrations based on calibration to known standard gases. The data are stored in non-volatile memory so that they can be sent to a PC for record keeping. RS-232 transceivers provide a serial interface between the monitor and the serial port of a PC. An LCD display consisting of a single row of eight alpha/numeric characters is used to display the readings. The user interacts with the monitor through three keys on the front panel keypad.

A rechargeable NiMH, NiCd battery, or an alkaline battery pack powers the monitor.

6. MAINTENANCE

The major maintenance items of the MiniRAE 2000 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 monitor 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 monitor. Severe damage to the printed circuit board or battery may occur if the battery pack is not disconnected before servicing the unit.

6.1 Battery Charging and Replacement

When the display shows a flashing message "Bat", the battery requires recharging (see Section 3.1 for Battery charging). It is recommended to recharge the MiniRAE 2000 monitor upon returning from fieldwork. A fully charged battery runs a MiniRAE 2000 monitor for 10 hours continuously. The charging time is less than 10 hours for a fully discharged battery. The built-in charging circuit is controlled by the micro-controller to prevent over-charging. The battery may be replaced in the field (in area 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 area known to be non-hazardous.

Replacing Battery Pack

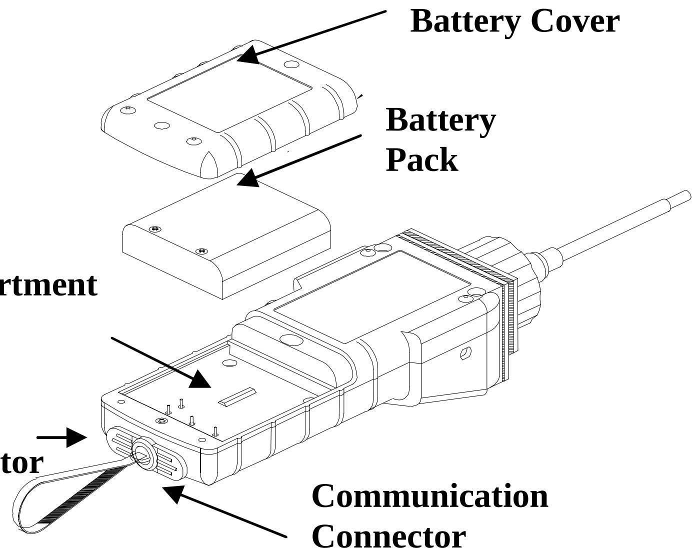


Figure 6-1 Battery Replacement

1.

Turn off the power of the MiniRAE 2000.

2. Unscrew the two battery compartment screws, located on the bottom of the monitor, and remove the cover.
3. Remove the battery pack from the battery compartment.
4. Replace a fully charged spare battery pack inside the battery compartment. Make sure the battery pack is oriented properly inside the compartment
5. Close the battery cover and tighten the two screws.

Replacing Alkaline Battery Adapter

1. Insert four fresh AA size alkaline batteries into the alkaline battery holder. Make sure that the polarity of the batteries is correct.
2. Follow the same procedure as described above to replace the battery holder.

Note: The internal charging circuit is designed to prevent charging to alkaline batteries.

6.2 PID Sensor & Lamp Cleaning/Replacement

The sensor module is made of several components and is attached to the lamp-housing unit as shown in Figure 7-2.

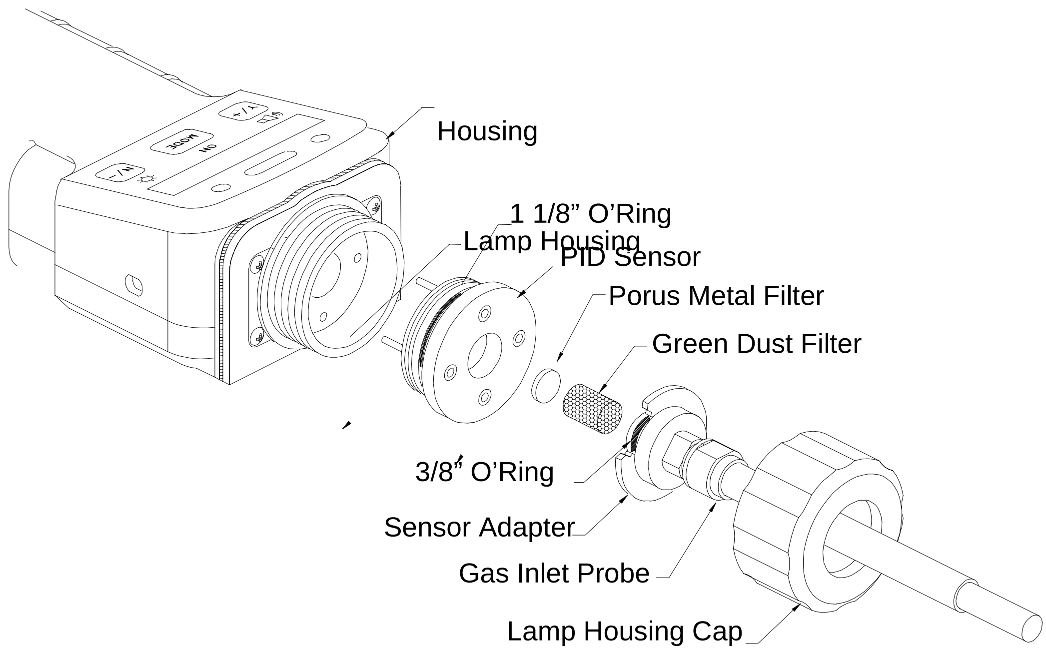


Figure 7-2 Sensor Components

Note: Normally the cleaning procedure is not needed. Clean the PID sensor module, the lamp and the lamp housing only when one of the following 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 water trap filter will help prevent contamination and accidentally drawing liquid into 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 straight out to avoid bending the electrical pins on the sensor (see Figure 7-2). A slight, gentle rocking motion helps release the sensor.

To clean 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.

To clean lamp housing or change the lamp:

To clean lamp housing or change the lamp:

If the lamp does not turn on, the monitor 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.
5. If the lamp type has been changed, adjust the lamp type setting in the programming mode (Section 4.7.8).

6.3 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.

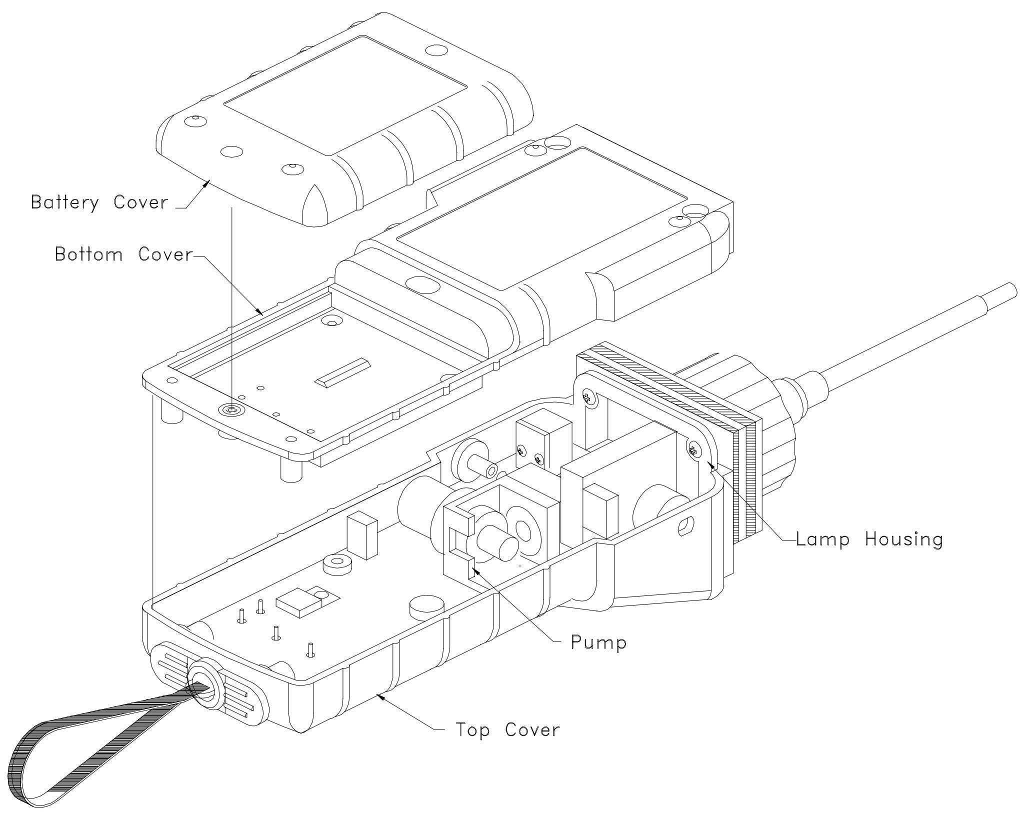


Figure 7-3 Sampling Pump

Pump Replacement

1. Turn off the MiniRAE 2000 power.
2. Open the battery cover, remove the battery pack**,** and carefully unscrew the six screws to open the bottom cover.
3. Unplug the pump from the PCB. Unscrew the two screws that hold the pump assembly to the PCB. Disconnect the Tygon tubing that connects the pump to the gas inlet port and gas outlet port.
4. Insert a new pump assembly. Connect the Tygon tubing to the gas inlet port. Plug the pump connector back into the PCB and screw down the pump assembly to the board.
5. Replace the bottom cover and tighten the six screws. Re-connect the battery pack. Replace the battery pack and its cover.

6.4 Turning on the UV Lamp

The UV lamp is made of a glass envelope and a UV window (salt crystal) on one end of the envelope. The inside of the lamp is filled with low pressure gases. To turn on the lamp, a high voltage electric field is applied from the outside of the glass envelope. The molecules inside the lamp are ionized and produce a glow discharge that generates the UV light. The MiniRAE 2000 has a built-in sensing mechanism to monitor the status of the UV lamp and display a "Lamp" error message if it is not on.

If the UV lamp has not been used for a long period of time (> 1 month) or is cold, it may become slightly harder to turn on. If such a condition occurs, the "Lamp" message will appear in the monitor display during the power on sequence. This phenomenon is more significant in 0.25" UV lamps used in ToxiRAE and MultiRAE Plus products, because of the relatively small lamp size. To solve this problem, simply turn on and off the monitor a few times and the lamp should turn on. After the UV lamp is turned on for the first time, it should be easier to turn on the UV lamp next time.

It is possible that the UV lamp is actually on when the lamp error message appears. This is because when the lamp becomes old, the internal threshold level to detect lamp failure may have shifted and cause a false alarm. To eliminate such possibility, simply check to see the UV lamp is actually on. This can be done easily by removing the sensor cap and observing the glow light of the UV lamp in a dark place. The user can also feed the monitor with calibration gas and observe if the sensor reading changes. If the reading changes significantly with the gas, the UV lamp is actually on.

A possible failure mechanism for the UV lamp is a leak developed along the seal of the glass envelope. When such condition occurs, the lamp will become very hard or impossible to turn on and will need to be replaced.

7. TROUBLESHOOTING

To aid the user in diagnosing the monitor, a special diagnostic mode can be used displays critical, low level parameters. Section 7.1 describes the operation of the diagnostic mode. Section 7.2 summarizes the frequently encountered problems and suggested solutions. By turning on the MiniRAE 2000 monitor in diagnostic mode and by using the troubleshooting table in Section 7.2, the user can usually correct the problem without having to return the monitor for repair.

WARNING

This function should be used by qualified personnel only! The diagnostic mode allows the user to set several low-level parameters that are very critical to the operation of the monitor. Extra care should be taken when setting these parameters. If the user is not familiar with the function of these parameters and sets them incorrectly, it may cause the monitor to shut down or malfunction.

7.1 Troubleshooting Table

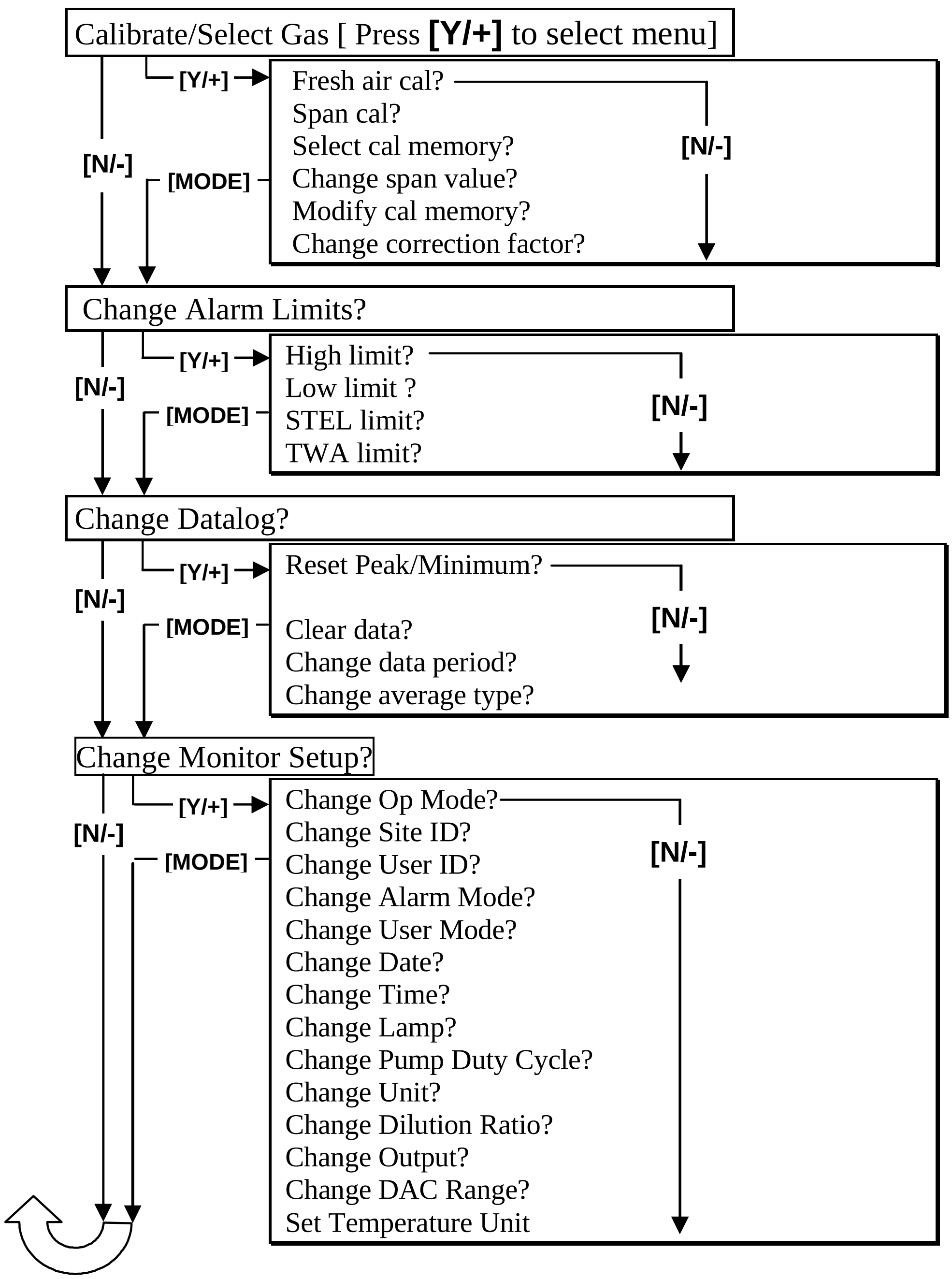
Problem	**Possible Reasons & Solutions**
Cannot turn on power after charging the battery	**Reasons:** Discharged battery. Defective battery. Microcomputer hang-up. **Solutions:** Charge or replace battery. Disconnect, then connect battery to reset computer.
No LCD back light	**Reasons:** Trigger level too low, the current mode is not user mode, and the mode does not support automatic turn on back light. **Solutions:** Adjust trigger level. Verify the back light can be turned on in user mode. Call authorized service center.
Lost password	**Solutions:** Call Technical Support at +1.408 .752 .0723 or +1. 888 .723 .4800
Reading abnormally High	**Reasons:** Dirty sensor module. Dirty water trap filter. Excessive moisture and water condensation. **Solutions:** Clean sensor module and lamp housing. Replace water trap filter. Blow dry the sensor module.
Buzzer Inoperative	**Reasons:** Bad buzzer. **Solutions:** 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. Replace pump or diaphragm.
"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
Full scale measurement in humid environment	**Reasons:**	Dirty or wet sensor.
	Solutions:	Clean and dry sensor and lamp housing. Adjust sensor fingers to ensure not touching Teflon. Use water trap filter.
Reading abnormally low	**Reasons:**	Incorrect calibration. Low sensitivity to the specific gas. Weak or dirty lamp. Air leakage.
	Solutions:	Calibrate the monitor. Replace sensor. Clean or replace lamp. Check air leakage.

APPENDIX A. QUICK REFERENCE GUIDE

Press [N/-] and [MODE], simultaneously, for 3 seconds, to enter Programming Mode. Press [MODE] to return to Survey Mode.

PROGRAMMING MODE



RAE Systems, Inc. Contact Information

Main Office:	3775 N. First St. San Jose, CA 95134-1708 USA
Telephone:	408-952-8200
Fax:	408-952-8480
Instrument Sales:	877-723-2878
Email:	RaeSales@raesystems.com
Website:	www.raesystems.com
Technical Service:	888-723-4800 Tech@raesystems.com

Special Note

If the monitor needs to be serviced, contact either:

1. The RAE Systems distributor from whom the monitor was purchased; they will return the monitor on your behalf.
2. The RAE Systems Technical Service Department. Before returning the monitor 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 monitor is returned for service or upgrade. Packages without RMA Numbers will be refused at the factory.

MICRO PURGE® basics

QED

MODEL MP10

CONTROLLER

PATENT PENDING

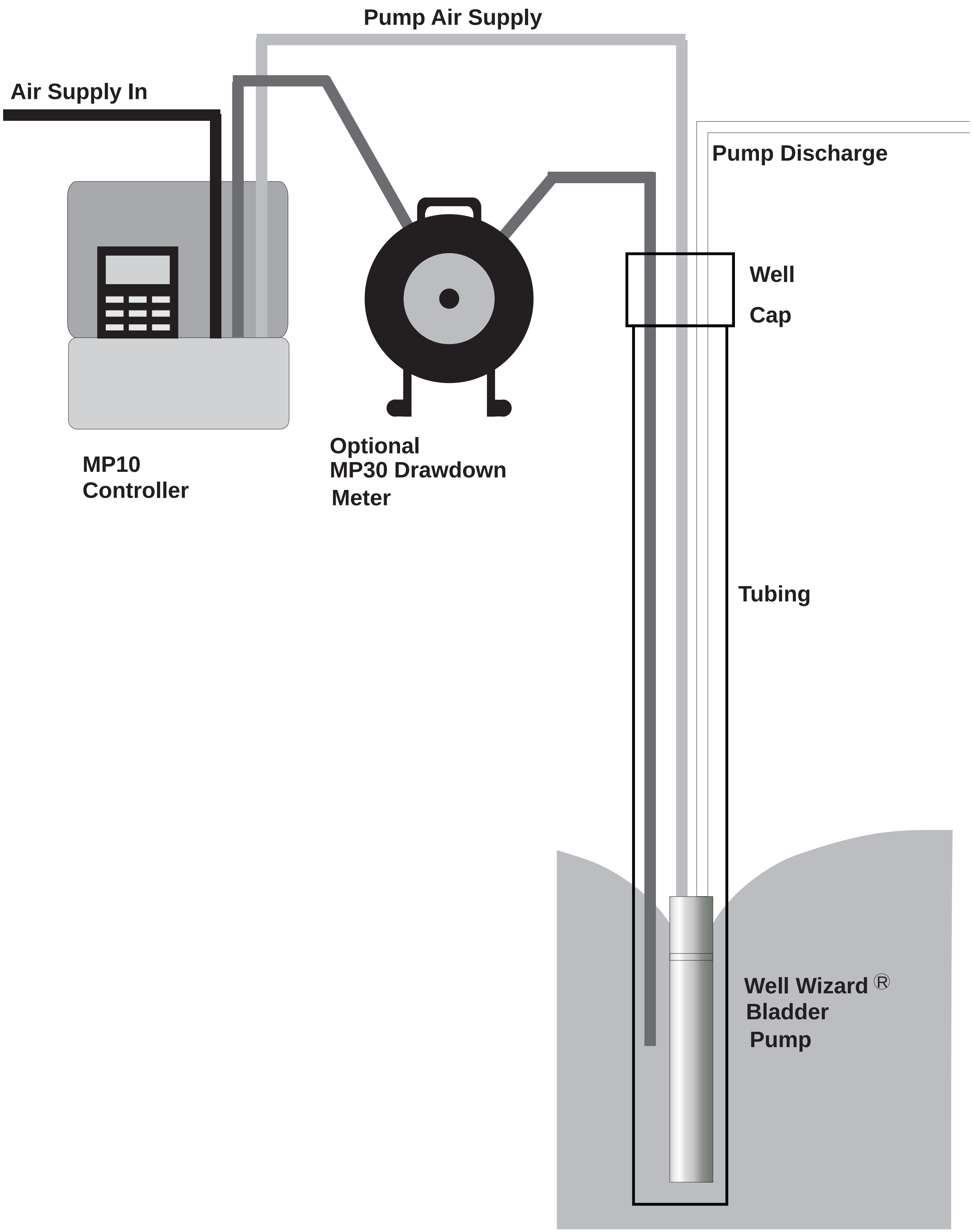
Instruction Manual

Part No. 95177 11-20-14

QED Environmental Systems

P.O. Box 3726 Ann Arbor, MI 48106-3726 USA
1-800-624-2026 Fax (734) 995-1170
info@qedenv.com www.qedenv.com

MP10 Basic Setup



Topic	Page

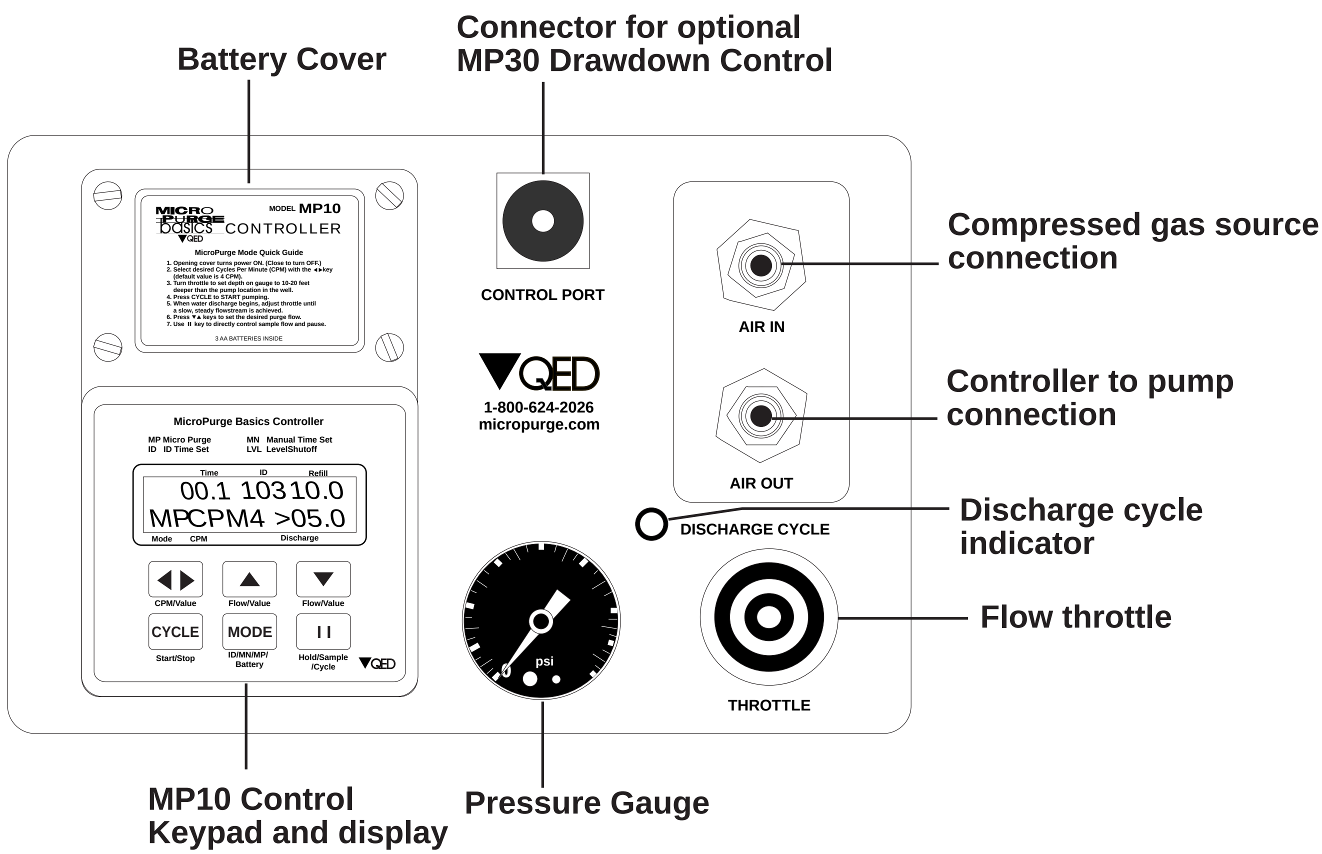
Safety warnings

Compressed air - Use caution when working with compressed air or gas. Compressed gas cylinders are under extreme pressure and can cause unrestrained hoses to whip about dangerously. Do not over pressurize your controller. Failure to operate the controller within the pressure limits could result in failure. Read all operating instructions before operating the MP10 controller.

Warning - Do not disassemble the pneumatic pump while it is connected to a compressed gas source. Dangerous pressures could cause injury.

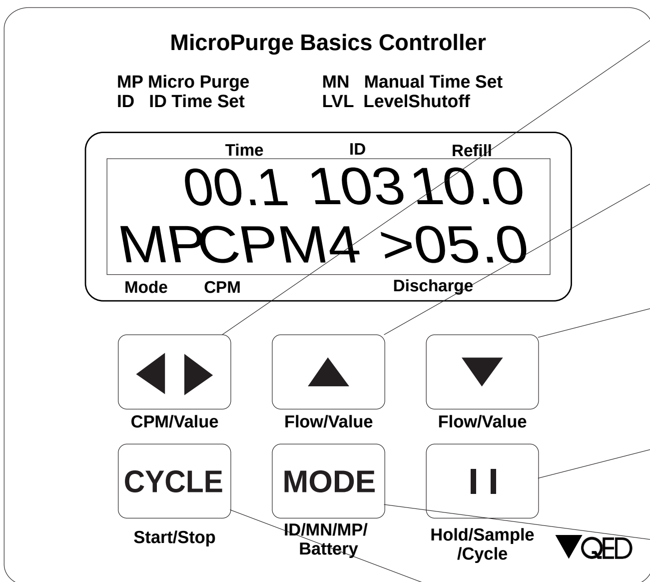
Diagrams and Conventions used in the Text

MP10 Panel Layout:



Diagrams and Conventions used in the Text (cont.)

MP10 Control Keys:

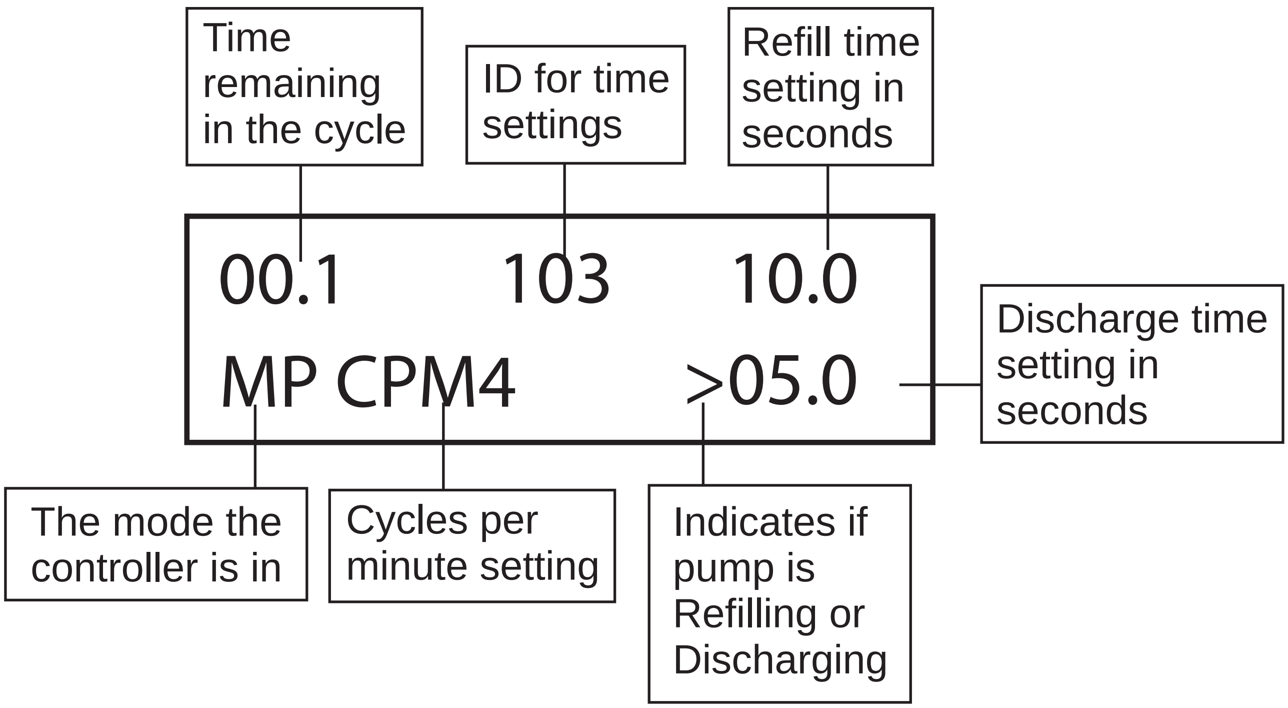


In MP Mode	In Other Modes
Cycle Per Minute key - Changes cycle per minute	Scrolls cursor
Faster key - Speeds up flow	Changes a value at the cursor location
Slower key - Slows down flow	Changes a value at the cursor location
Pause key - Pauses flow for sampling	
Mode key -Selects the operation mode. Also battery check	
Cycle key -Selects Start and Stop of pump cycling	

◀ ▶	CPM Button (also scroll for item selects)	CYCLE	CYCLE Button
▲	UP Button, faster pumping (also increase item)	MODE	MODE Button (also battery check)
▼	DOWN Button, slower pumping (also decrease item)	I I	PAUSE Button (also manual sample)

Diagrams and Conventions used in the Text (cont.)

MP10 Display:



Abbreviations:

CPM	Cycles Per Minute
MP	MicroPurge Mode
ID	ID Time Set Mode
HELD	Held In A Cycle
MN	Manual Time Set Mode
BAT	Battery
LVL	Level Pause
>	Indicates Refill Or Discharge Cycle

Introduction / Quick start

Introduction: The MP10 Micro Purge Basics Controller is used to operate QED Well Wizard™ bladder sampling pumps to purge and sample ground water. The MP10 has specific design features to make MicroPurge ™ sampling easier. These features include:

- **MicroPurge Mode Operation** Simple Increase / Decrease keys allow you to easily set the flow rate you need for each well.
- **ID Time Set Mode Operation** Quickly recalls pre-determined settings for each well by specifying a 3-digit ID.
- **Level Delay Interface** The controller plugs into the optional MP30 MicroPurge Drawdown / Water Level Meter to provide direct feedback of well drawdown and to pause pump operation until the level recovers.

The optional MP30 MicroPurge Drawdown / Water Level Meter plugs into the MP10 to provide water level feedback. The MP30 uses a standard conductivity probe to detect the ground water surface and a marked tape allowing the user to measure the depth. When the meter is set in MicroPurge mode, the probe is lowered a specific distance below the static water level and fixed in this position. During well sampling if the water level drops below the user-set probe position, the MP10 is paused which prevents further drawdown by the pump. Once the level recovers the MP10 begins pump operation again, starting in the pump refill cycle. Use of the MP10 with the MP30 is detailed later in this manual.

Insert Batteries: Remove the battery cover on the top of the MP10. Insert 3, AA alkaline batteries into the battery holder and carefully replace the holder in the carrier. Replace the battery cover and tighten the 4 screws. Batteries should last for about 6-8 weeks of typical full-time field use. If the MP10 will be stored longer than about 3 months, the alkaline batteries should be removed to prevent leakage.

Quick Start: Connect the light blue coiled pump hose to the fitting labeled AIR OUT on the MP10. Connect the red (or black, depending on your air source) air supply hose to a compressed air or gas source and connect it to the fitting labeled AIR IN on the MP10. Supply up to 125 psi compressed air or gas to the controller. Turn the controller throttle until the gauge reads the approximate depth of the sample pump (See Page 6) Follow instructions on the battery panel:

Opening the MP10 case turns power ON.

Note: It may take up to 20 seconds for the unit to power up.

Select desired Cycles Per Minute (CPM) with ◀▶ (default value is 4 CPM, lower CPM for deeper wells, higher CPM possible with shallow wells-See Page 6).

Turn throttle to set depth on gauge to 10-20 feet deeper than the pump location in the well.

Press Cycle to START pumping.

When water discharge begins, adjust throttle until a slow, steady flowstream is achieved.

Press ▼ ▲ keys to set the desired purge flow rate.

To collect samples, continue purge flow, or use II key to directly control sample flow and pause.

Bladder Pump Operation in Low-Submergence Applications

Pump submergence is defined as the height of the static water column above the top of the pump. In wells in which this water column height is 5 feet or less, the pump is considered to be in a low-submergence application.

QED sampling bladder pumps fill by hydrostatic pressure. As the inside of the pump's bladder fills with water, the bladder expands. This filling and expanding of the bladder is referred to as the "refill" half of the pump cycle. When air pressure is applied to the outside of the bladder, the bladder is squeezed, forcing the water up the discharge tubing. This is referred to as the "discharge" half of the pump cycle. In low-submergence applications, there is less water pressure available to expand the bladder during the refill.

This can result in a smaller volume of water being pumped with each pump cycle because the bladder may not fully expand.

As a result of the lower volume per cycle, more time will be required to bring the water to the surface. An easy way to verify that the pump is working, prior to the water reaching the surface, is to submerge the pump's discharge tubing in a beaker of water. Each time the pump goes into discharge, air in the discharge tubing, which is displaced as the water level in the tubing rises, can be seen as air bubbles coming from the end of the tubing. To optimize the pumping rate, the refill time should be set long enough to achieve the maximum volume of air bubbles on each pump cycle, and the discharge time should be set long enough to ensure that the air has stopped bubbling out of the tube before the pump controller switches back into refill.

In low submergence wells, ***it is critical that the air pressure driving the pump not be more than 10-15psi higher than the minimum requirement of 0.42psi per foot of pump depth.*** Higher pressures than this can cause the bladder to be squeezed too tightly during discharge, a condition which can prevent the bladder from expanding during refill. To avoid this condition in deeper wells, it is suggested that the air pressure applied to the pump be gradually increased as the water level in the pump's discharge tubing rises. It is recommended that the air pressure be set at 15 psi initially, and slowly increased in increments of 10 psi as needed until the water reaches the surface. Submerging the end of the discharge tubing under water as described above will verify whether the air pressure is set high enough.

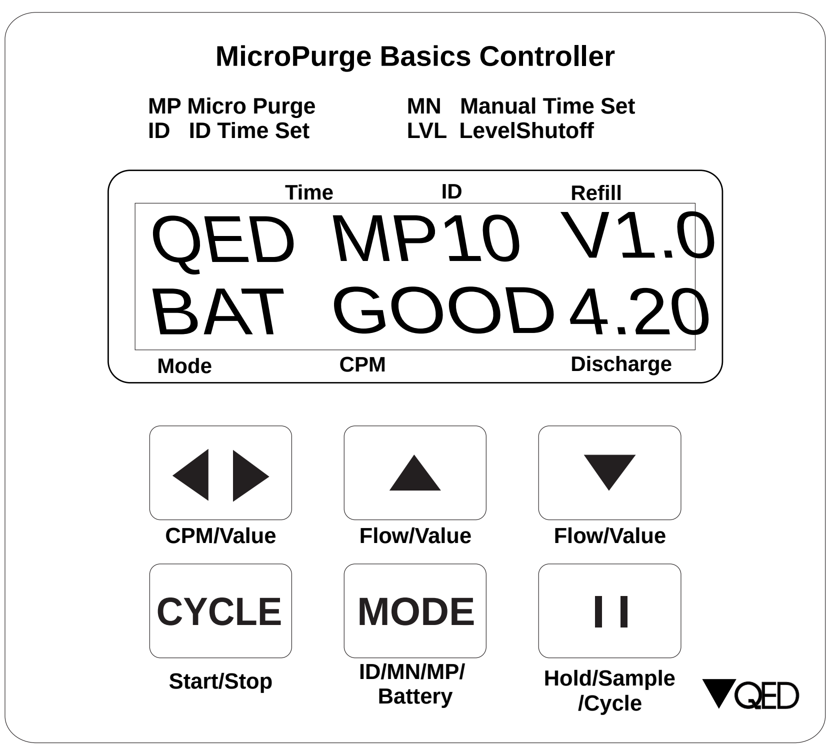
Operation

Turning the MP10 Display On - The MP10 is powered on automatically by opening the lid. The MP10 displays an opening screen for 5 seconds, after which it displays the default Micro-Purge screen. At this point the MP10 is in MicroPurge mode (MP) but not cycling the pump. This initial state allows the user to adjust time and throttle settings before the pump starts to operate. Pressing the Cycle key begins pump cycling. Times and modes may be adjusted while the pump is cycling or before. Pressing the Cycle key a second time will stop pump cycling.

Note: *all user-entered time settings are lost when the MP10 is turned off. Also, the MP10 automatically powers down when the lid is closed, so make sure the MP10 is stored with its lid closed.*

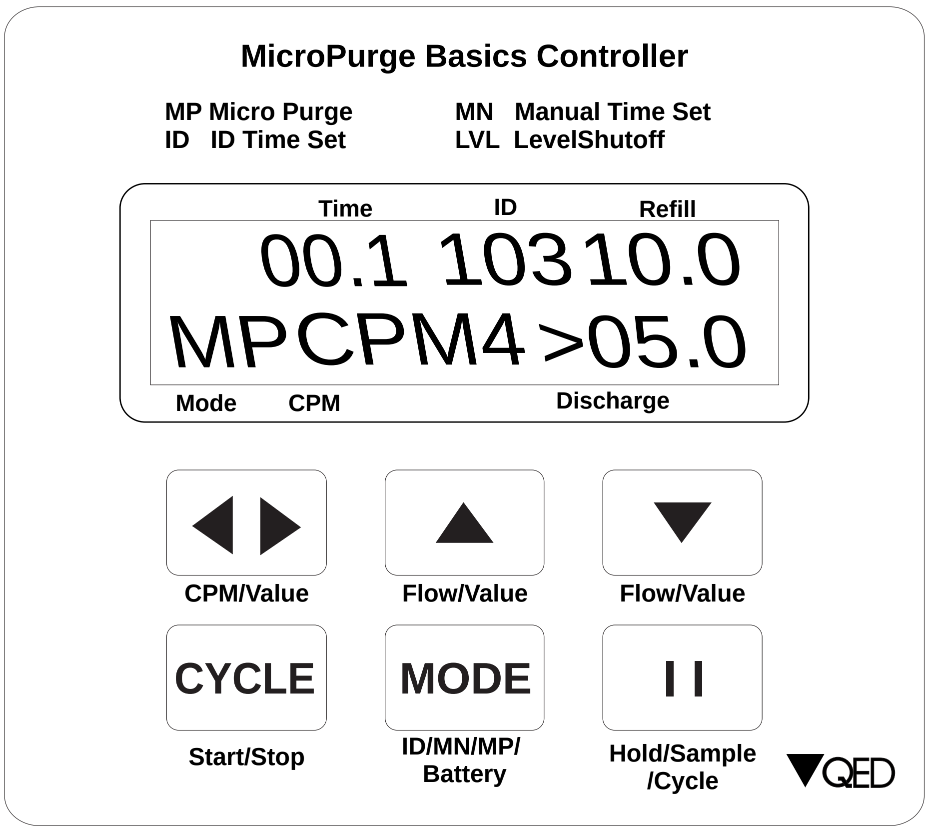
Opening Display - The opening display is shown for 5 seconds and displays the controller name, the version number and the battery voltage, as shown in Figure 1. Figure 1 shows that the battery is GOOD, that the battery voltage is 4.20 volts and that the software version in the cont-roller is 1.0. Battery voltage must be greater than 3.6 volts for the unit to operate. If the unit fails to cycle replace the 3-AA batteries with fresh cells. The opening screen is displayed for 5 seconds, if you wish to by pass the opening screen, hitting any key, such as the CPM key will bring you to the default MP display.

Figure 1 Opening Screen



MicroPurge Mode Most MP10 users will leave the controller in the default MicroPurge (MP) mode. See Figure 2 for an example of the MP10 in MP mode. MP mode lets you to use the UP and DOWN keys to directly increase and decrease pump flow rates. The MP10 has a broad range of other CPM settings to ensure the availability of a time setting that will match your specific conditions. MP mode also displays an ID, with a value of 1 to 165 that matches the flow settings (CPM and refill and discharge times you have set). This ID should be noted alongside the well identification (QED provides custom weatherproof ID badges for purchasers of our MP series of well caps) for quick setting of the optimal controller settings on the next visit by using the MP10 in ID mode.

Figure 2 MP10 MicroPurge Mode



Using CPM The MP10 introduces a revolutionary, simpler way to control bladder pump flow rate and achieve the low-flow method used by experts. Up/down arrow keys are used to adjust pump flow even at very low rates, with excellent control and repeatability.

With previous bladder pump controllers, a leading low-flow technique called for selecting the number of pump cycles per minute, then adjusting the bladder pump discharge and refill times to achieve the desired volume per cycle. These adjustments were interrelated, complex, and varied by operator. The new MicroPurge Mode (MP) of the MP10 builds in a "cycles per minute", or CPM, method of flow control.

With this method, the number of complete pump cycles per minute is fixed, within a range of 1 to 6; 4 CPM is the default value which appears at startup. Each time the up/down arrow keys are pressed, the pump refill and discharge times are both automatically adjusted to maintain the selected CPM value. Each adjustment increases or decreases the volume pumped per cycle, and the per-minute flow rate is the volume per cycle X the CPM value.

For example, with a 4 CPM setting, 60 ml volume per cycle equates to 4 X 60 = 240 ml/min flow rate. A single press of the Flow up arrow key could change the volume per cycle to 80 ml, for example, resulting in a new, increased flow rate of 4 X 80 = 320 ml/min. And the MP10 assigns a unique identification value to each setting, the ID value, which can be directly set during later sampling events.

"MP" displayed in the lower left corner of the display indicates MicroPurge mode. The default CPM setting of 4 cycles per minute is a good starting point for wells with depths from 25-100 ft. MicroPurge mode starts at a time setting of 10 seconds refill and 5 seconds discharge, close to optimal for many wells. This startup settings corresponds to a 4 cycles per minute setting (CPM4) and an ID setting of 103.

Using the CPM key will change the CPM setting on the controller. The range of CPM settings is CPM1 through CPM6. CPM changes like this each time you hit the CPM key: 4 5 6 1 2 3 4 5, etc. The UP and DOWN keys change the flow rate directly, by altering the refill and discharge times *within* a CPM setting.

Note: *changes in settings that are entered while the controller is cycling are reflected on the next cycle change (so a long refill time of 15 seconds will time out before a new refill time becomes valid).*

Here is an example of the use of the UP (faster) key:

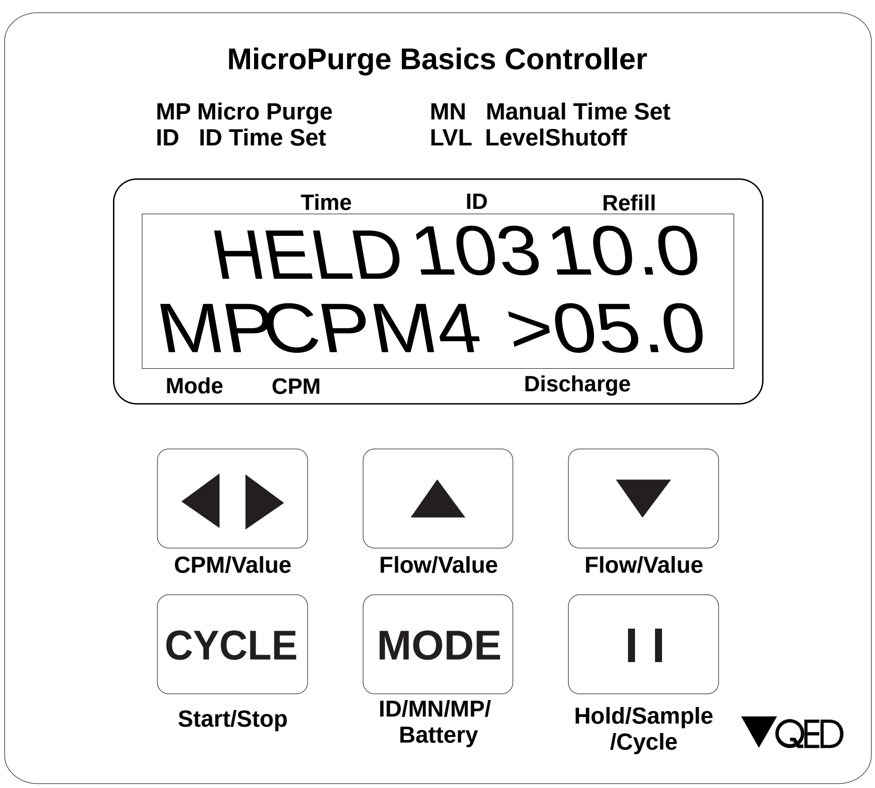
Key Press	Refill (sec)	Discharge (sec)	ID
---	10.0	5.0	103
1	9.5	5.5	104
2	9.0	6.0	105
3	8.5	6.5	106

Each of the 165 possible ID settings corresponds to a unique ID that is associated with CPM, refill and discharge time values. For typical usage, only the UP/DOWN arrow keys are required to set flow, and the ID number is provided for easy, direct return to past settings. Appendix 1 lists all possible ID settings and the default refill and discharge time settings for each CPM. Appendix 1 also shows how the refill and dis-charge time will change within a CPM setting as you press the UP or DOWN keys.

Sample Collection The PAUSE key (I I) is used to freeze the controller action to allow the user time to collect a sample or carry out other steps that might be difficult if the controller continued to automatically cycle and cause the pump to produce water. While the controller is cycling, pressing the PAUSE key causes the controller to immediately enter the Hold state. Drive air is vented from the pump (this is the pump refill cycle) and the pump fills and waits. Pressing the PAUSE key a second time causes the controller to immediately enter the Sample state. Drive air is directed to the pump causing the pump to discharge its volume of liquid. Bladder pumps typically hold 400-500 ml of liquid, so use of the Hold and Sample states allow the full volume of the pump to be discharged into a sample container. Pressing PAUSE once again returns the MP10 to its normal Automatic Cycling state. During Hold and Sample a HELD is displayed to remind you that the controller is in a paused state. Figure 3 shows an example of the MP10 in MP mode, but HELD in the Sample state.

Note: *Pressing the Cycle key also freezes controller cycling. However, using the Cycle key rather than the Pause key causes the startup screen to be displayed upon restart. Use of the Pause key is recommended for typical operation.*

Figure 3 MP10 Held State (MP mode)



Warning: *in the HELD SAMPLE state the pump, tubing and hoses are all under pressure.* ***DO NOT*** *attempt to disconnect or disassemble any part of the system when it is under pressure. The system is under pressure if the pressure gauge shows a value greater than 0 and the RED Discharge Cycle Indicator is showing.*

Flow Throttle Use The flow throttle is used during sampling to regulate the pressure applied to the pump. Turning the throttle clockwise increases the pressure and counterclockwise decreases the pressure. The pressure gauge shows the approximate pressure applied to the pump and reads in units of Feet - H^2O. This allows easy adjustment of the throttle giving pressures that will produce gentle, non-turbulent flow (normally 10-20 Feet - H^2O deeper than pump depth). For traditional, high volume purging pressure may be increased with the throttle to maximize pump flow during well purging.

Use with the MP30 Automatic Drawdown Control The MP10 may optionally be used with the MP30 MicroPurge Drawdown / Water Level Meter. See Figure 4 for an example of the MP10 in MP mode with the controller in a level paused state enacted by an MP30 meter.

Figure 4 MP10 Level Paused State (MP mode)

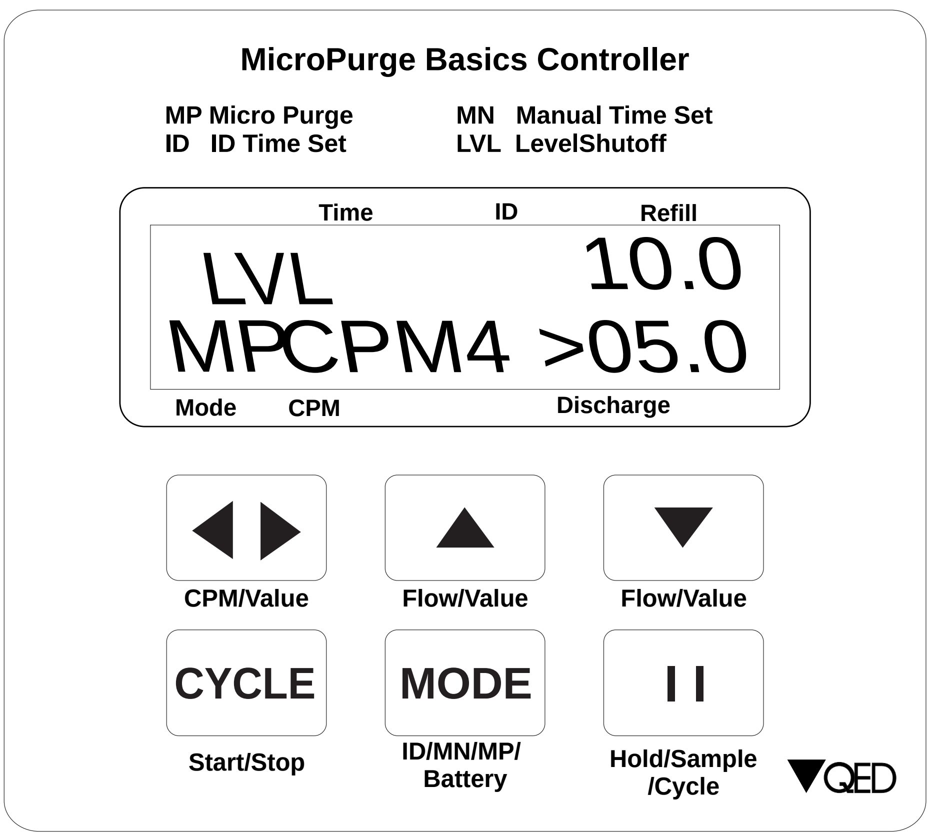


Figure 5 MP10 MP30 Use

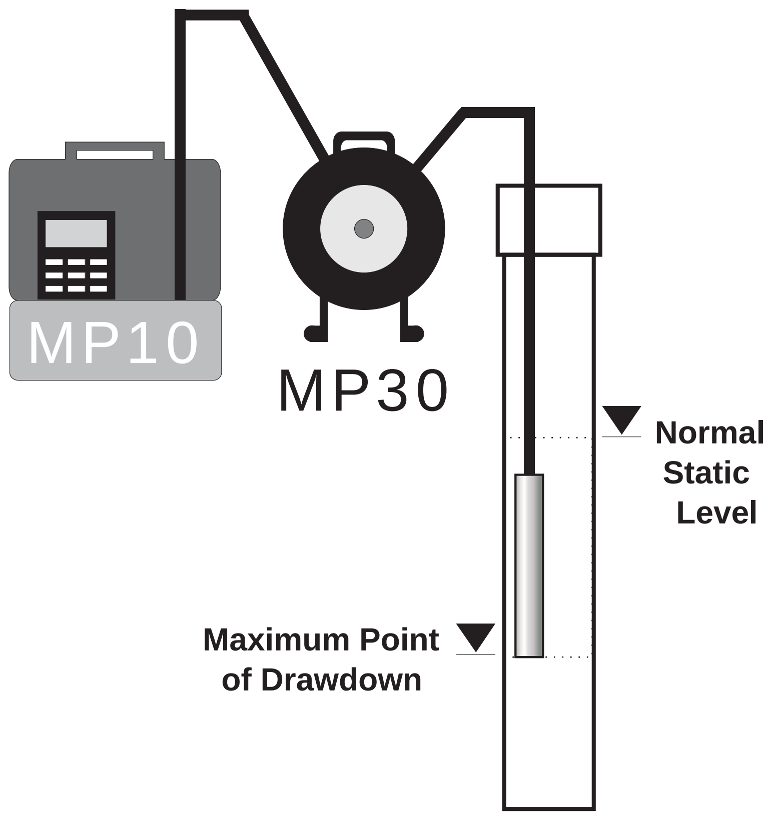
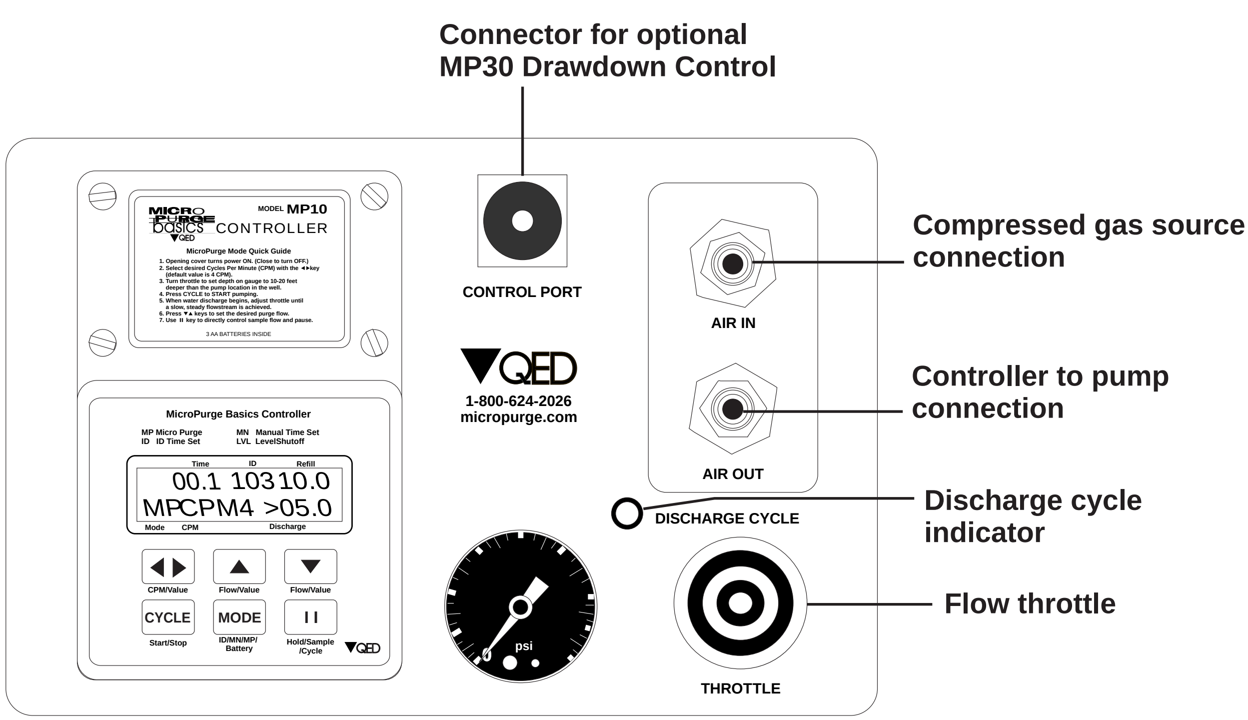


Figure 6 MP10 MP30 Use



The MP10 and MP30 are connected with a cable (see Figures 5 and 6). The MP30 is switched into mode and the water level probe is lowered to the desired maximum drawdown level. Limiting the maximum drawdown depth limits the differential head driving flow into the well and the velocity of the water flowing into the well from the surrounding formation important in Micro-Purge sampling. The MP10 and MP30 work together to automatically adjust the pump operation so as to maintain drawdown at the set level. When the water level drops below the probe, the MP30 sends a signal to the MP10 to pause pumping. Both the MP10 and the MP30 give visual signals (and the MP30 emits an audio signal) that pump operation has stopped because of too much drawdown. Once the level recovers, the MP30 signals the MP10 to resume pump operation. The MP10 resumes by starting in the refill leg of the pump cycle. "DRAWDOWN CONTROL"

The normal operating mode for using the MP30 with the MP10 is:

1. Use the MP30 in standard WLM mode to determine the static water level in the well

2. Decide what the maximum drawdown for that well is during sampling

3. Lower the probe to the maximum drawdown level

4. Switch the MP30 into Drawdown Control mode

5. Begin pumping with the MP10

6. Observe the interactions between the two devices, if the MP30 is frequently pausing the MP10, it may be appropriate to slow the flow down (using the DOWN key in MP mode) to better match pump flow to well recharge.

When switched into mode, the MP30 has a flashing red light and an optional (can be switched off by the user) audio alarm to indicate when the probe is in the dry state. A submerged probe in all modes is indicated by a solid green light. When the MP10 is paused by the MP30 the MP 10 display indicates this as shown in Figure 4 "DRAWDOWN CONTROL"

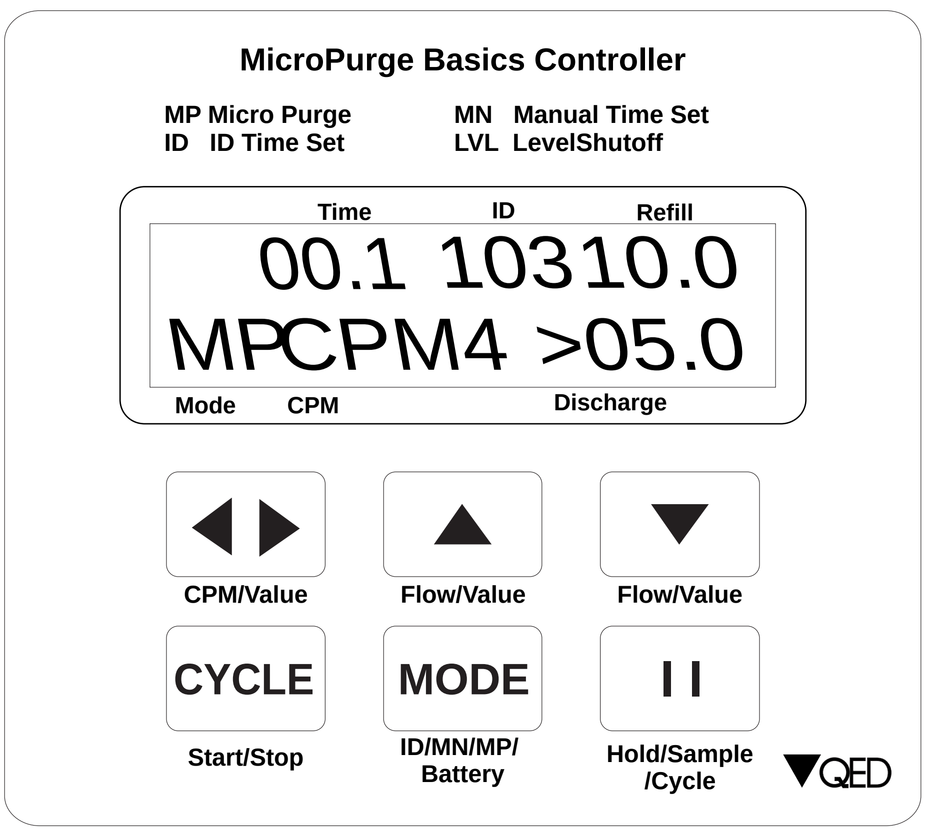
If the MP30 is signaling the MP10 too frequently, the operator can slow down the pump flow rate by using the DOWN key (effectively increasing the pump refill time period). MP30 probe position may also be varied to provide a buffer zone for your drawdown limit and gauge rate of pumping effect on water level in the well.

If the selected maximum drawdown level is being reached even with the lowest desirable pump flow rate more drawdown may be required to attain equilibration, or a passive sampling approach may be required. In passive sampling, used where well recovery is extremely slow, samples are taken after just a few pump strokes sufficient to purge the pump and tubing volumes.

Additional information on the MP30 is given in the MP30 O&M manual

ID Mode Figure 6 shows an example of the MP10 in ID time set mode. Once you've used the MP10 in MP mode and found proper settings for your wells, subsequent sampling events are speeded along by using the controller in ID mode. Once the controller is turned on, a single press of the MODE key places the controller in ID time set mode (the default initial mode is MP mode). This mode allows the user to enter a 3-digit ID, which then is translated into the correct flow settings (CPM and refill / discharge time settings) for that well.

Figure 7 MP10 ID Set Mode



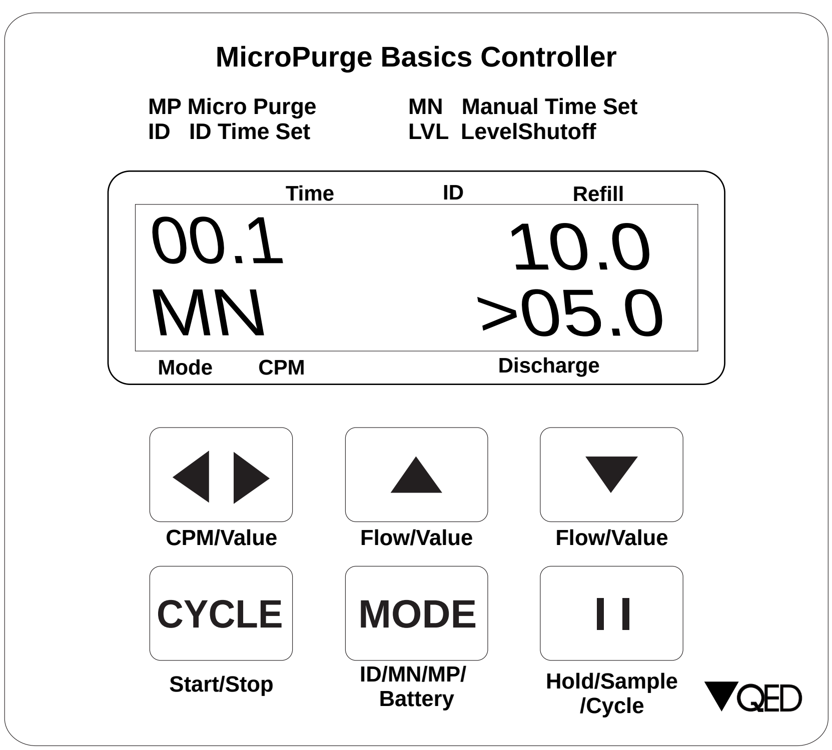
In this mode the CPM and UP, DOWN keys function differently. The CPM key becomes a key used to scroll between the one's and the ten's digits of the ID. The UP and DOWN keys are used to change the ID number (the MP10 has IDs that range from 1-165) up or down in value. Sampling in ID mode is the same as explained, above, for MP mode.

Appendix 1 lists all possible ID settings and the default refill and discharge time settings for each CPM. Appendix 1 also shows how the refill and discharge time will change within a CPM setting as you press the UP or DOWN keys. As you change IDs you will see the CPM change and the refill and discharge time setting change.

Note: *changes in time settings that are entered while the controller is cycling are reflected on the next cycle change (so a long refill time of 15 seconds will time out before a new refill time becomes valid).*

User Set Mode A final controller mode, User Set mode (MN on the display), is useful for manually setting refill and discharge times on the controller as in traditional controllers (like previous model QED pump controllers). An example of the MP10 in User Set mode is shown in Figure 8. User set mode is also used when the wells being sampled are at extreme depths or there are other conditions where one of the 165 possible preset times of ID and MP modes will not match your needs. MN mode is entered when the MODE key is pressed twice from the default MP mode. As shown in Figure 8, the display indicates MN mode in the lower left corner and CPM and ID are not displayed.

Figure 8 MP10 User Set Mode (MN mode)



In User Set mode the CPM and UP, DOWN keys function differently than MP mode. The CPM key becomes a key used to select the digits of the refill and discharge time settings found at the rightmost positions on the display. The UP and DOWN keys are used to adjust the digit value up or down. By selecting and adjusting digits up and down a user can quickly set any time from 00.1 seconds to 99.9 seconds. Sampling in User Set mode is the same as explain-ed, above, for MP mode.

The MP10 does not attempt to translate a user set time into a corresponding ID or CPM. Also, any settings you have entered in MP or ID modes are lost once you press the MODE key to enter MN mode.

Note: *changes in time settings that are entered while the controller is cycling are reflected on the next cycle change (so a long refill time of 15 seconds will time out before a new refill time becomes valid).*

MP10 Battery - The MP10 features sophisticated power-supply circuitry that optimizes battery life. A fresh set of AA batteries will provide more than 100 hours of controller operation at normal operating temperatures. As ambient temperatures drop below 15-20˚F (-9˚C to -6˚C), the ability of the alkaline batteries to deliver energy is affected. Continuous operation may be difficult in extremely cold conditions. Once the batteries and MP10 warm, additional cycle cap-acity will be regained from a set of batteries.

Replace alkaline batteries by removing the 4 thumbscrews located on the battery cover and inserting 3 fresh **cells**. The MP10 battery holder includes space for ***3 spare AA cells*** so you should never be without power in the field. Properly dispose of the spent alkaline cells.

Note: *If you are storing the MP10 for more than 3 months, remove the AA batteries to prevent leakage. The MP10 power supply is automatically shut off by closing the lid. Make sure the lid is closed during storage.*

Troubleshooting

Use the following troubleshooting table to assist in troubleshooting the MP10:

Symptom	Possible Cause	Action / Fix
Display not showing	Low or dead batteries Batteries installed wrong	Check battery voltage on opening display (>3.6 volts required) Replace batteries Check battery connection
Controller not cycling	Low or dead batteries	See, above
	Lid not open	Open lid
	Temperature below 10° F	Warm controller
	MP10 not STARTED with CYCLE key MP10 in HELD mode	Operate CYCLE and/or PAUSE key to return MP10 to cycling state
	MP10 in LEVEL hold	Make sure MP30 probe is submerged when in MP mode
Air not cycling through controller	Throttle turned too low	Turn throttle clock-wise to produce pressure
	Air source not delivering air	Verify air source
Pump not pumping	Throttle turned too low	Turn throttle clock-wise to produce pressure
	Time settings not correct	Try different CPM settings (lower CPM for deeper wells) and/or different refill and discharge time settings
	Air source pressure too low	Verify air source pressure
Battery life too short	Controller left on while strored	Turn MP10 off before storing and remove batteries when storing more than 1 month
	Temperature below 10° F	Warm controller

MP10 Specifications

Maximum Pressure:	125 psi
Temperature Range:	Operating range of -20º F to +150º F
Humidity:	Circuitry sealed to provide operation to 100% humidity
Protection:	Circuitry protected against transient surges introduced from improper battery installation or switch connect-ions.
Display:	LCD display, 32-character (2 lines, 16 characters, each)
Window:	Non-glare, double hardened optical acrylic
Battery type:	3 user replaceable AA alkaline cells
Drain:	Unit off: 2mA, Unit on: 4mA, Valve Cycle: 6mA
Reserve:	100 hours operating time (1sec/1sec cycles) with fresh AA alkaline cells At 65º F (approx.)
Emergency battery:	3 AA cells stored within battery compartment

For additional assistance contact QED Service at:

Phone:	1-800-624-2026 1-734-995-2547
Fax:	1-734-995-1170
E-mail:	service@qedenv.com
24-Hour Service Hot Line:	1-800-272-9559

QED Monitoring System WARRANTY

QED ENVIRONMENTAL SYSTEMS, INC. ("QED") warrants to the original purchaser of its products that, subject to the limitations and conditions provided below, the products, materials and/or workmanship shall reasonably conform to descriptions of the products and shall be free of defects in materials and workmanship. Any failure of the products to conform to this warranty will be remedied by QED in the manner provided herein.

This warranty shall be limited to the duration and the conditions set forth below. Warranty duration is calculated from the original date of purchase.

1. **Dedicated-Use System Products**-10-year warranty on dedicated bladder pumps equipped with QED inlet screens, and purge pumps used in periodic, non-continuous groundwater sampling (up to 52 samples events per year.) All other components, equipment and accessories are warranted for one year.

2. **Portable-Use Systems -** Controllers and Water Level Meters are warranted for one year. Hose reels, pumps and caps are warranted for ninety (90) days. Tubing and Purge Mizers are covered by a ninety-(90) days material and workmanship warranty. There will be no warranty for application on tubing and Purge Mizers when used as part of a Portable System.

3. **Separately Sold Parts and Spare Parts Kits -** Separately sold parts and spare parts are warranted for ninety (90) days. Repairs performed by QED are warranted for ninety (90) days from date of repair or for the full term of the original warranty, whichever is longer.

Buyers' exclusive remedy for breach of said warranty shall be as follows: if, and only if, QED is notified in writing within the applicable warranty period of the existence of any such defect in the said products, and QED upon examination of any such defects, shall find the same to be within the term of and covered by the warranty running from QED to Buyer, QED will, at its option, as soon as reasonably possible, replace or repair any such product, without charge to Buyer. If QED for any reason, cannot repair a product covered hereby within four (4) weeks after receipt of the original Purchaser's/Buyer's notification of a warranty claim, then QED's sole responsibility shall be, at its option, either to replace the defective product with a comparable new unit at no charge to the Buyer, or to refund the full purchase price. In no event shall such allegedly defective products be returned to QED without its consent, and QED's obligations of repair, replacement or refund are conditioned upon the Buyer's return of the defective product to QED.

IN NO EVENT SHALL QED ENVIRONMENTAL SYSTEMS, INC. BE LIABLE FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES FOR BREACH OF SAID WARRANTY.

The foregoing warranty does not apply to major sub-assemblies and other equipment, accessories, and parts manufactured by others, and such other parts, accessories, and equipment are subject only to the warranties, if any, supplied by the respective manufacturers. QED makes no warranty concerning products or accessories not manufactured by QED. In the event of failure of any such product accessory, QED will give reasonable assistance to Buyer in obtaining from the respective manufacturer whatever adjustments is reasonable in light of the manufacturer's own warranty.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY (INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE). WHICH OTHER WARRANTIES ARE EXPRESSLY EXCLUDED HEREBY, and of any other obligations or liabilities on the part of QED, and QED neither assumes nor authorizes any person to assume for it any other obligation or liability in connection with the said products, materials and/or workmanship.

It is understood and agreed that QED shall in no event be liable for incidental or consequential damages resulting from its breach of any of the terms of this agreement, not for special damages, nor for improper selection of any product described or referred to for a particular application.

This warranty will be void in the event of unauthorized disassembly of component assemblies. Defects in any equipment that result from abuse, operation in any manner outside the recommended procedures, use and applications other than for intended use, or exposure to chemical or physical environmental beyond the designated limits of materials and construction will also void this warranty. QED shall be released from all obligations under all warranties if any product covered hereby is repaired or modified by persons other than QED's service personnel unless such repair by others is made with the written consent of QED.

This warranty will be void in the event of unauthorized disassembly of component assemblies. Defects in any equipment that result from abuse, operation in any manner outside the recommended procedures, use and applications other than for intended use, or exposure to chemical or physical environmental beyond the designated limits of materials and construction will also void this warranty. QED shall be released from all obligations under all warranties if any product covered hereby is repaired or modified by persons other than QED's service personnel unless such repair by others is made with the written consent of QED.

If any product covered hereby is actually defective within the terms of this warranty, Purchaser must contact QED for determination of warranty coverage. If the return of a component is determined to be necessary, QED will authorize the return of the component, at owner's expense. If the product proves not be defective within the terms of this warranty, then all costs and expenses in connection with the processing of the Purchaser's \ claim and all costs for repair, parts and labor as authorized by owner hereunder shall be borne by the Purchaser.

RESPONSIBILITY OF THE PURCHASER

The original Purchaser's sole responsibility in the instance of a warranty claim shall be to notify QED of the defect, malfunction, or other manner in which the terms of this warranty are believed to be violated. You may secure performance of obligations hereunder by contacting the Customer Service Department of QED and:

1. Identifying the product involved (by model or serial number or other sufficient description that will allow QED to determine which product is defective).

2. Specifying where, when, and from whom the product was purchased.

3. Describing the nature of the defect or malfunction covered by this warranty.

4. Sending the malfunction component, after authorization by QED to :

QED Environmental Systems Inc.
2355 Bishop Circle West
Dexter, MI 48130
(800) 624-2026
(734) 995-2547
www.qedenv.com
info@qedenv.com

Appendix 1 ID Data Table

NOTE: Bold Shaded values are default for that CPM

CYCLES / min (CPM)																	
1 / min			2 / min			3 / min			4 / min			5 / min			6 / min		
ID	Disch (sec)	Refill (sec)	ID	Disch (sec)	Refill (sec)	ID	Disch (sec)	Refill (sec)	ID	Disch (sec)	Refill (sec)	ID	Disch (sec)	Refill (sec)	ID	Disch (sec)	Refill (sec)
1	1	59	41	1	29	66	1	19	95	1	14	114	1	11	145	1	9
2	2	58	42	2	28	67	1.5	18.5	96	1.5	13.5	115	1.2	10.8	146	1.2	8.8
3	3	57	43	3	27	68	2	18	97	2	13	116	1.4	10.6	147	1.4	8.6
4	4	56	44	4	26	69	2.5	17.5	98	2.5	12.5	117	1.6	10.4	148	1.6	8.4
5	5	55	45	5	25	70	3	17	99	3	12	118	1.8	10.2	149	1.8	8.2
6	6	54	46	6	24	71	3.5	16.5	100	3.5	11.5	119	2	10	150	2	8
7	7	53	47	7	23	72	4	16	101	4	11	120	2.2	9.8	151	2.2	7.8
8	8	52	48	8	22	73	4.5	15.5	102	4.5	10.5	121	2.4	9.6	152	2.4	7.6
9	9	52	49	9	21	74	5	15	**103**	**5**	**10**	122	2.6	9.4	153	2.6	7.4
10	10	50	**50**	**10**	**20**	75	5.5	14.5	104	5.5	9.5	123	2.8	9.2	154	2.8	7.2
11	11	49	51	11	19	76	6	14	105	6	9	124	3	9	**155**	**3**	**7**
12	12	48	52	12	18	77	6.5	13.5	106	6.5	8.5	125	3.2	8.8	156	3.2	6.8
13	13	47	53	13	17	78	7	13	107	7	8	126	3.4	8.6	157	3.4	6.6
14	14	46	54	14	16	79	7.5	12.5	108	7.5	7.5	127	3.6	8.4	158	3.6	6.4
15	15	45	55	15	15	80	8	12	109	8	7	128	3.8	8.2	159	3.8	6.2
16	16	44	56	16	14	81	8.5	11.5	110	8.5	6.5	**129**	**4**	**8**	160	4	6
17	17	43	57	17	13	**82**	**9**	**11**	111	9	6	130	4.2	7.8	161	4.2	5.8
18	18	42	58	18	12	83	9.5	10.5	112	9.5	5.5	131	4.4	7.6	162	4.4	5.6
19	19	41	59	19	11	84	10	10	113	10	5	132	4.6	7.4	163	4.6	5.4
20	**20**	**40**	60	20	10	85	10.5	9.5				133	4.8	7.2	164	4.8	5.2
21	21	39	61	21	9	86	11	9				134	5	7	165	5	5
22	22	38	62	22	8	87	11.5	8.5				135	5.2	6.8			
23	23	37	63	23	7	88	12	8				136	5.4	6.6			
24	24	36	64	24	6	89	12.5	7.5				137	5.6	6.4			
25	25	35	65	25	5	90	13	7				138	5.8	6.2			
26	26	34				91	13.5	6.5				139	6	6			
27	27	33				92	14	6				140	6.2	5.8			
28	28	32				93	14.5	5.5				141	6.4	5.6			
29	29	31				94	15	5				142	6.6	5.4			
30	30	30										143	6.8	5.2			
31	31	29										144	7	5			
32	32	28															
33	33	27															
34	34	26															
35	35	25															
36	36	24															
37	37	23															
38	38	22															
39	39	21															
40	40	20															

QED Environmental Systems

P.O. Box 3726 Ann Arbor, MI 48106-3726 USA
1-800-624-2026 Fax (734) 995-1170
info@qedenv.com www.qedenv.com

MICRO PURGE® basics

QED

MODEL MP50

CONTROLLER/COMPRESSOR

PATENT PENDING

Instruction Manual

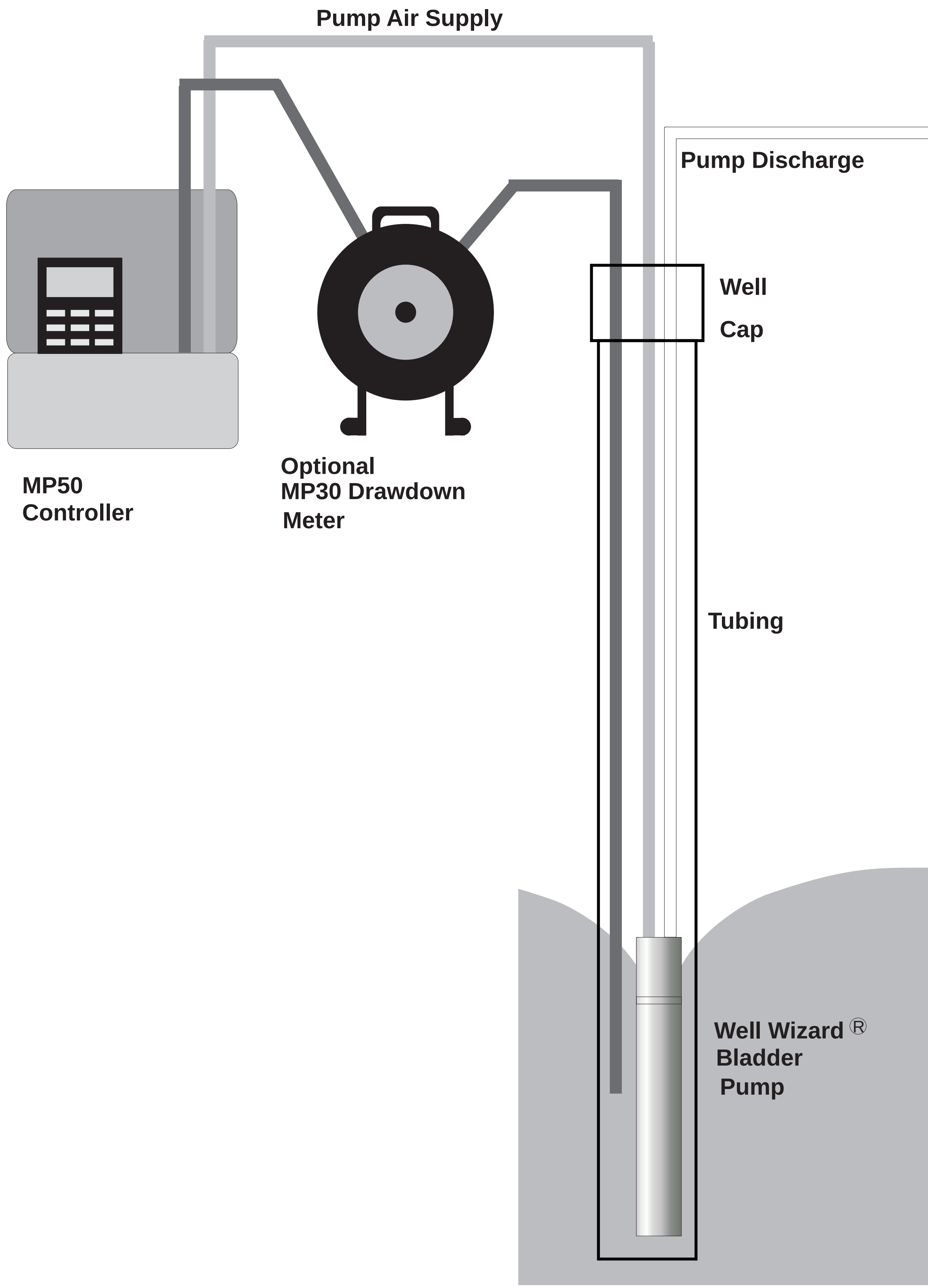
Part No. 95258 2-15-10

QED Environmental Systems

P.O. Box 3726 Ann Arbor, MI 48106-3726 USA
1-800-624-2026 Fax (734) 995-1170
info@qedenv.com www.qedenv.com

QED
CYCLE
MODE
THROTTLE

MP50 Basic Setup



Contents

Topic

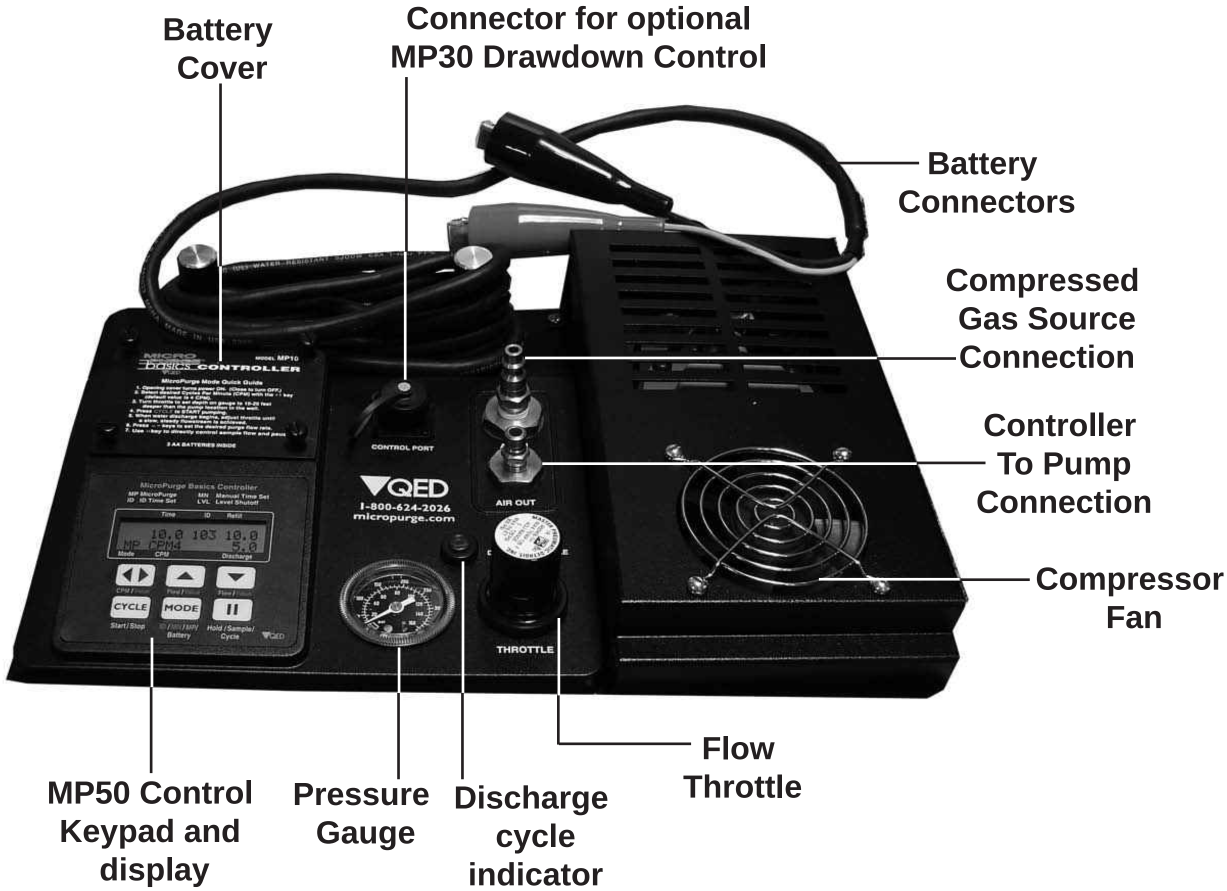
Safety warnings

Compressed air - Use caution when working with compressed air or gas. Compressed gas cylinders are under extreme pressure and can cause unrestrained hoses to whip about dangerously. Do not over pressurize your controller. Failure to operate the controller within the pressure limits could result in failure. Read all operating instructions before operating the MP50 controller.

Warning - Do not disassemble the pneumatic pump while it is connected to a compressed gas source. Dangerous pressures could cause injury.

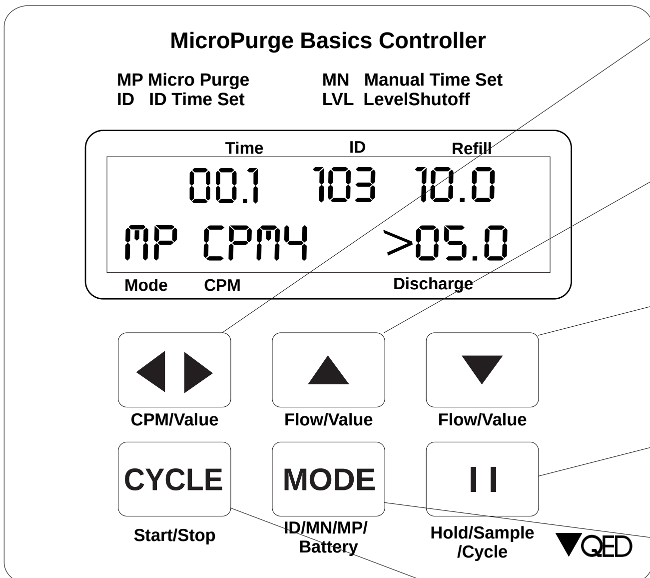
Diagrams and Conventions used in the Text

MP50 Panel Layout:



Diagrams And Conventions Used In The Text (Cont.)

MP50 Control Keys:

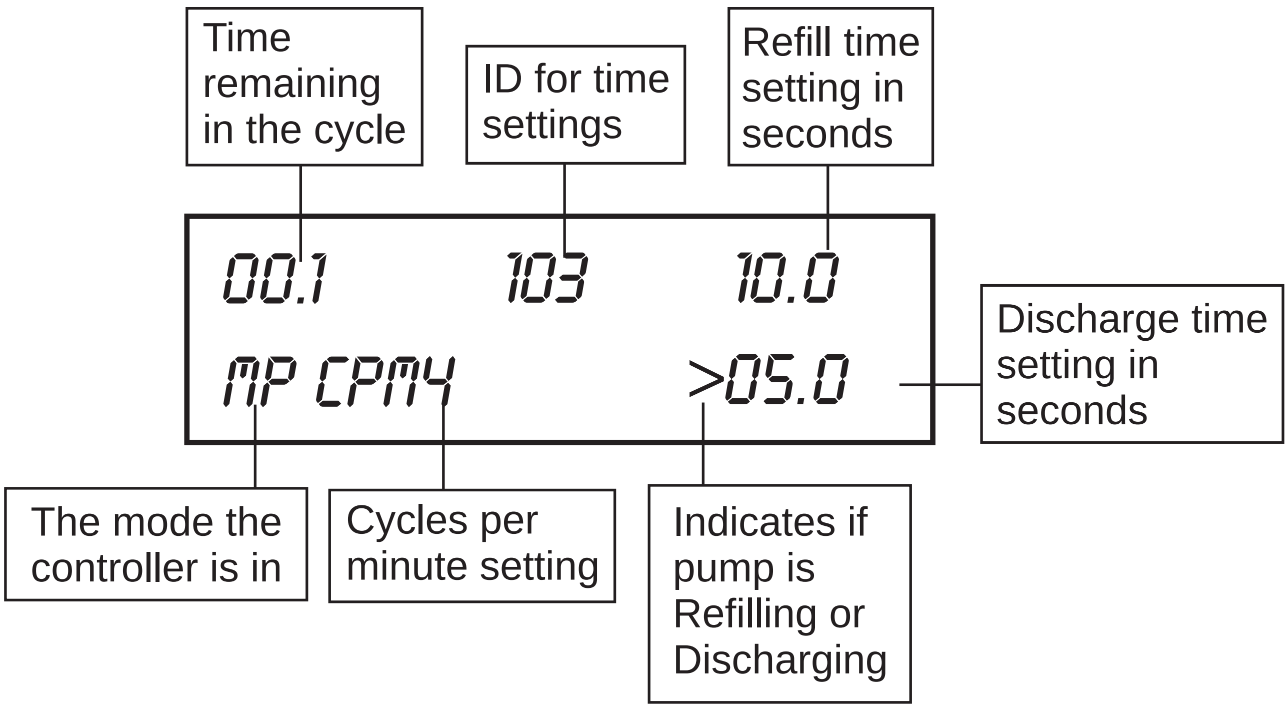


In MP Mode	In Other Modes
Cycle Per Minute key - Changes cycle per minute	Scrolls cursor
Faster key - Speeds up flow	Changes a value at the cursor location
Slower key - Slows down flow	Changes a value at the cursor location
Pause key - Pauses flow for sampling	
Mode key -Selects the operation mode. Also battery check	
Cycle key -Selects Start and Stop of pump cycling	

◀ ▶	CPM Button (also scroll for item selects)	CYCLE	CYCLE Button
▲	UP Button, faster pumping (also increase item)	MODE	MODE Button (also battery check)
▼	DOWN Button, slower pumping (also decrease item)	I I	PAUSE Button (also manual sample)

Diagrams And Conventions Used In The Text (Cont.)

MP50 Display:



Abbreviations:

CPM	Cycles Per Minute
MP	MicroPurge Mode
ID	ID Time Set Mode
HELD	Held In A Cycle
MN	Manual Time Set Mode
BAT	Battery
LVL	Level Pause
>	Indicates Refill Or Discharge Cycle

Introduction / Quick Start

Introduction: The MP50 Micro Purge Basics Controller/Compressor is used to operate QED *Well Wizard*™ bladder sampling pumps to purge and sample ground water. The MP50 has specific design features to make *MicroPurge* ™ sampling easier. These features include:

- **MicroPurge Mode Operation** Simple Increase / Decrease keys allow you to easily set the flow rate you need for each well.

- **ID Time Set Mode Operation** Quickly recalls pre-determined settings for each well by specifying a 3-digit ID.

- **Level Delay Interface** The controller plugs into the optional MP30 MicroPurge Drawdown / Water Level Meter to provide direct feedback of well drawdown and to pause pump operation until the level recovers.

The optional MP30 MicroPurge Drawdown / Water Level Meter plugs into the MP50 to provide water level feedback. The MP30 uses a standard conductivity probe to detect the ground water surface and a marked tape allowing the user to measure the depth. When the meter is set in MicroPurge mode, the probe is lowered a specific distance below the static water level and fixed in this position. During well sampling if the water level drops below the user-set probe position, the MP50 is paused which prevents further drawdown by the pump. Once the level recovers the MP50 begins pump operation again, starting in the pump refill cycle. Use of the MP50 with the MP30 is detailed later in this manual.

Insert Batteries: Remove the battery cover on the top of the MP50. Insert 3, AA alkaline batteries into the battery holder and carefully replace the holder in the carrier. Replace the battery cover and tighten the 4 screws. Batteries should last for about 6-8 weeks of typical full-time field use. If the MP50 will be stored longer than about 3 months, the alkaline batteries should be removed to prevent leakage.

Quick Start: Attach Red Positive (+) cable clamp to the Positive (+) terminal of battery. Attach Black Negative (-) cable clamp to the Negative (-) terminal of battery. Connect the light blue coiled pump hose to the fitting labeled “AIR OUT” on the MP50. Turn the controller throttle until the gauge reads the approximate depth of the sample pump (*See Page 6*) Follow instructions on the battery panel:

Opening the MP50 case turns power ON.

Note: It may take up to 20 seconds for the unit to power up.

Select desired Cycles Per Minute (CPM) with ◀ ▶ (default value is 4 CPM, lower CPM for deeper wells, higher CPM possible with shallow wells-See Page 6).

Turn throttle to set depth on gauge to 10-20 feet deeper than the pump location in the well.

Press Cycle to START pumping.

When water discharge begins, adjust throttle until a slow, steady flow-stream is achieved.

Press ▼ ▲ keys to set the desired purge flow rate.

To collect samples, continue purge flow, or use II key to directly control sample flow and pause.

Note: An option to use an external air source is built into the MP50. To use external air source (rather than the built-in air compressor) simply connect the air source to the “*Air In*” port.

Note: A moisture vent is provided and located on the side of the MP50 case. Excessive accumulation of moisture can impede proper operation of the MP50. During cold and/or damp weather conditions, it is recommended that the moisture vent be pushed at frequent intervals during operation of the MP50.

Bladder Pump Operation In Low-Submergence Applications

Pump submergence is defined as the height of the static water column above the top of the pump. In wells in which this water column height is 5 feet or less, the pump is considered to be in a low-submergence application.

QED sampling bladder pumps fill by hydrostatic pressure. As the inside of the pump's bladder fills with water, the bladder expands. This filling and expanding of the bladder is referred to as the "refill" half of the pump cycle. When air pressure is applied to the outside of the bladder, the bladder is squeezed, forcing the water up the discharge tubing. This is referred to as the "discharge" half of the pump cycle. In low-submergence applications, there is less water pressure available to expand the bladder during the refill.

This can result in a smaller volume of water being pumped with each pump cycle because the bladder may not fully expand.

As a result of the lower volume per cycle, more time will be required to bring the water to the surface. An easy way to verify that the pump is working, prior to the water reaching the surface, is to submerge the pump's discharge tubing in a beaker of water. Each time the pump goes into discharge, air in the discharge tubing, which is displaced as the water level in the tubing rises, can be seen as air bubbles coming from the end of the tubing. To optimize the pumping rate, the refill time should be set long enough to achieve the maximum volume of air bubbles on each pump cycle, and the discharge time should be set long enough to ensure that the air has stopped bubbling out of the tube before the pump controller switches back into refill.

In low submergence wells, ***it is critical that the air pressure driving the pump not be more than 10-15psi higher than the minimum requirement of 0.42psi per foot of pump depth.*** Higher pressures than this can cause the bladder to be squeezed too tightly during discharge, a condition which can prevent the bladder from expanding during refill. To avoid this condition in deeper wells, it is suggested that the air pressure applied to the pump be gradually increased as the water level in the pump's discharge tubing rises. It is recommended that the air pressure be set at 15 psi initially, and slowly increased in increments of 10 psi as needed until the water reaches the surface. Submerging the end of the discharge tubing under water as described above will verify whether the air pressure is set high enough.

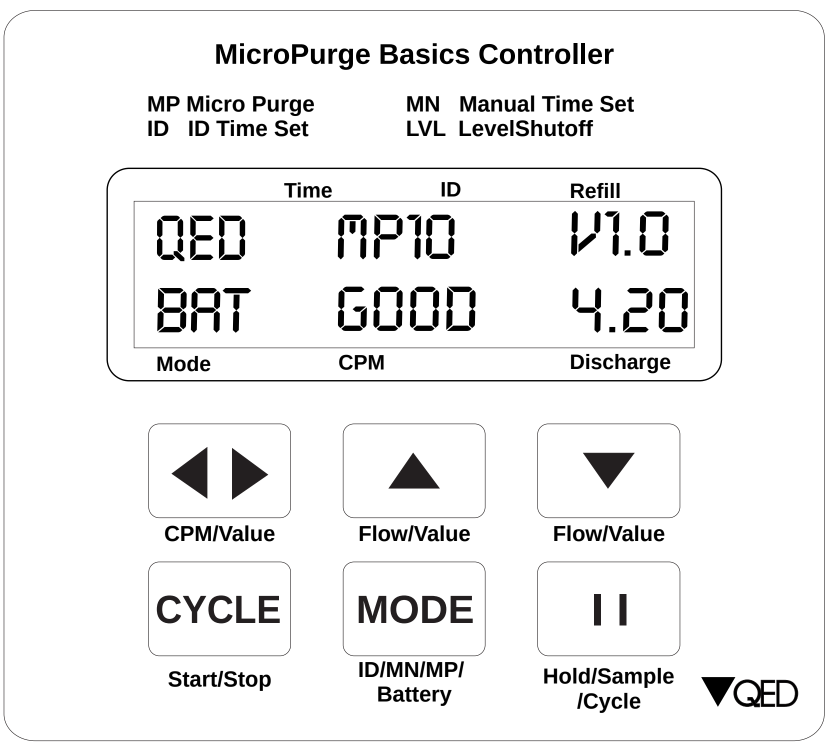
Operation

Turning the MP50 Display On - The MP50 is powered on automatically by opening the lid. The MP50 displays an opening screen for 5 seconds, after which it displays the default Micro-Purge screen. At this point the MP50 is in MicroPurge mode (MP) but not cycling the pump. This initial state allows the user to adjust time and throttle settings before the pump starts to operate. Pressing the Cycle key begins pump cycling. Times and modes may be adjusted while the pump is cycling or before. Pressing the Cycle key a second time will stop pump cycling.

Note: *all user-entered time settings are lost when the MP50 is turned off. Also, the MP50 automatically powers down when the lid is closed, so make sure the MP50 is stored with its lid closed.*

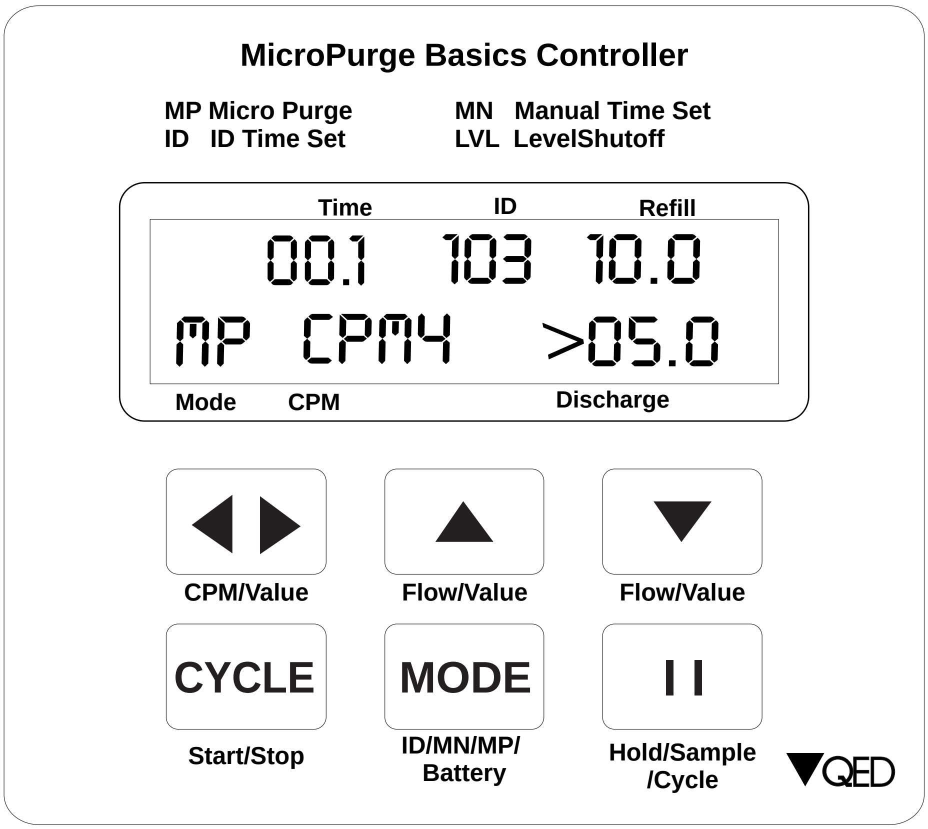
Opening Display - The opening display is shown for 5 seconds and displays the controller name, the version number and the battery voltage, as shown in Figure 1. Figure 1 shows that the battery is GOOD, that the battery voltage is 4.20 volts and that the software version in the cont-roller is 1.0. Battery voltage must be greater than 3.6 volts for the unit to operate. If the unit fails to cycle replace the 3-AA batteries with fresh cells. The opening screen is displayed for 5 seconds, if you wish to by pass the opening screen, hitting any key, such as the CPM key will bring you to the default MP display.

Figure 1 Opening Screen



MicroPurge Mode Most MP50 users will leave the controller in the default MicroPurge (MP) mode. See Figure 2 for an example of the MP50 in MP mode. MP mode lets you to use the UP and DOWN keys to directly increase and decrease pump flow rates. The MP50 has a broad range of other CPM settings to ensure the availability of a time setting that will match your specific conditions. MP mode also displays an ID, with a value of 1 to 165 that matches the flow settings (CPM and refill and discharge times you have set). This ID should be noted alongside the well identification (QED provides custom weatherproof ID badges for purchasers of our MP series of well caps) for quick setting of the optimal controller settings on the next visit by using the MP50 in ID mode.

Figure 2 MP50 MicroPurge Mode



Using CPM The MP50 introduces a revolutionary, simpler way to control bladder pump flow rate and achieve the low-flow method used by experts. Up/down arrow keys are used to adjust pump flow even at very low rates, with excellent control and repeatability.

With previous bladder pump controllers, a leading low-flow technique called for selecting the number of pump cycles per minute, then adjusting the bladder pump discharge and refill times to achieve the desired volume per cycle. These adjustments were interrelated, complex, and varied by operator. The new MicroPurge Mode (MP) of the MP50 builds in a "cycles per minute", or CPM, method of flow control.

With this method, the number of complete pump cycles per minute is fixed, within a range of 1 to 6; 4 CPM is the default value which appears at startup. Each time the up/down arrow keys are pressed, the pump refill and discharge times are both automatically adjusted to maintain the selected CPM value. Each adjustment increases or decreases the volume pumped per cycle, and the per-minute flow rate is the volume per cycle X the CPM value.

For example, with a 4 CPM setting, 60 ml volume per cycle equates to 4 X 60 = 240 ml/min flow rate. A single press of the Flow up arrow key could change the volume per cycle to 80 ml, for example, resulting in a new, increased flow rate of 4 X 80 = 320 ml/min. And the MP10 assigns a unique identification value to each setting, the ID value, which can be directly set during later sampling events.

"MP" displayed in the lower left corner of the display indicates MicroPurge mode. The default CPM setting of 4 cycles per minute is a good starting point for wells with depths from 25-100 ft. MicroPurge mode starts at a time setting of 10 seconds refill and 5 seconds discharge, close to optimal for many wells. This startup settings corresponds to a 4 cycles per minute setting (CPM4) and an ID setting of 103.

Using the CPM key will change the CPM setting on the controller. The range of CPM settings is CPM1 through CPM6. CPM changes like this each time you hit the CPM key: 4 5 6 1 2 3 4 5, etc. The UP and DOWN keys change the flow rate directly, by altering the refill and discharge times *within* a CPM setting.

Note: *changes in settings that are entered while the controller is cycling are reflected on the next cycle change (so a long refill time of 15 seconds will time out before a new refill time becomes valid).*

Here is an example of the use of the UP (faster) key:

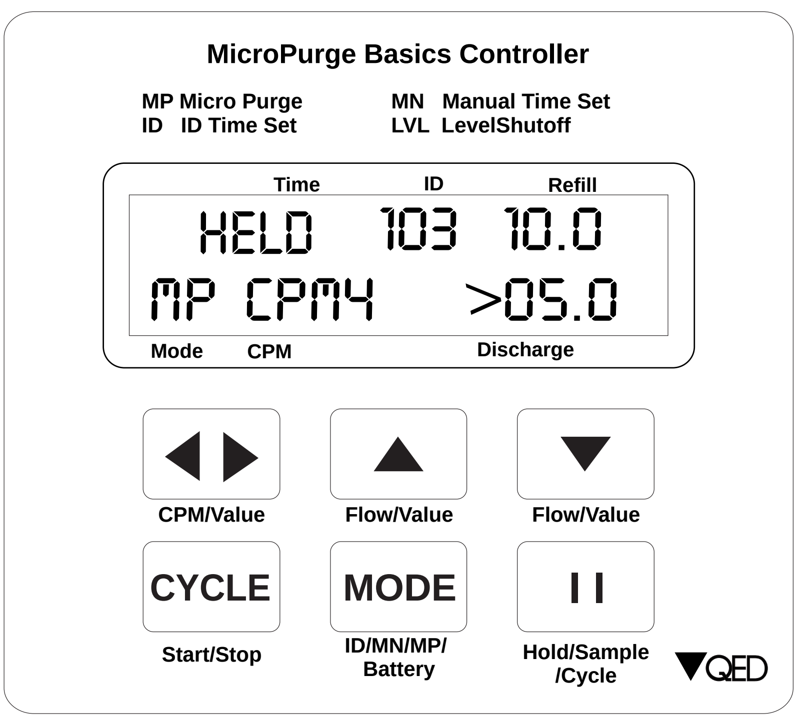
Key Press	Refill (sec)	Discharge (sec)	ID
---	10.0	5.0	103
1	9.5	5.5	104
2	9.0	6.0	105
3	8.5	6.5	106

Each of the 165 possible ID settings corresponds to a unique ID that is associated with CPM, refill and discharge time values. For typical usage, only the UP/DOWN arrow keys are required to set flow, and the ID number is provided for easy, direct return to past settings. Appendix 1 lists all possible ID settings and the default refill and discharge time settings for each CPM. Appendix 1 also shows how the refill and dis-charge time will change within a CPM setting as you press the UP or DOWN keys.

Sample Collection The PAUSE key (I I) is used to freeze the controller action to allow the user time to collect a sample or carry out other steps that might be difficult if the controller continued to automatically cycle and cause the pump to produce water. While the controller is cycling, pressing the PAUSE key causes the controller to immediately enter the Hold state. Drive air is vented from the pump (this is the pump refill cycle) and the pump fills and waits. Pressing the PAUSE key a second time causes the controller to immediately enter the Sample state. Drive air is directed to the pump causing the pump to discharge its volume of liquid. Bladder pumps typically hold 400-500 ml of liquid, so use of the Hold and Sample states allow the full volume of the pump to be discharged into a sample container. Pressing PAUSE once again returns the MP50 to its normal Automatic Cycling state. During Hold and Sample a HELD is displayed to remind you that the controller is in a paused state. Figure 3 shows an example of the MP50 in MP mode, but HELD in the Sample state.

Note: *Pressing the Cycle key also freezes controller cycling. However, using the Cycle key rather than the Pause key causes the startup screen to be displayed upon restart. Use of the Pause key is recommended for typical operation.*

Figure 3 MP50 Held State (MP mode)



Warning: *in the HELD SAMPLE state the pump, tubing and hoses are all under pressure.* ***DO NOT*** *attempt to disconnect or disassemble any part of the system when it is under pressure. The system is under pressure if the pressure gauge shows a value greater than 0 and the RED Discharge Cycle Indicator is showing.*

Flow Throttle Use The flow throttle is used during sampling to regulate the pressure applied to the pump. Turning the throttle clockwise increases the pressure and counterclockwise decreases the pressure. The pressure gauge shows the approximate pressure applied to the pump and reads in units of Feet - H^{2}O. This allows easy adjustment of the throttle giving pressures that will produce gentle, non-turbulent flow (normally 10-20 Feet - H^{2}O deeper than pump depth). For traditional, high volume purging pressure may be increased with the throttle to maximize pump flow during well purging.

Use with the MP30 Automatic Drawdown Control The MP50 may optionally be used with the MP30 MicroPurge Drawdown / Water Level Meter. See Figure 4 for an example of the MP50 in MP mode with the controller in a level paused state enacted by an MP30 meter.

Figure 4 MP50 Level Paused State (MP mode)

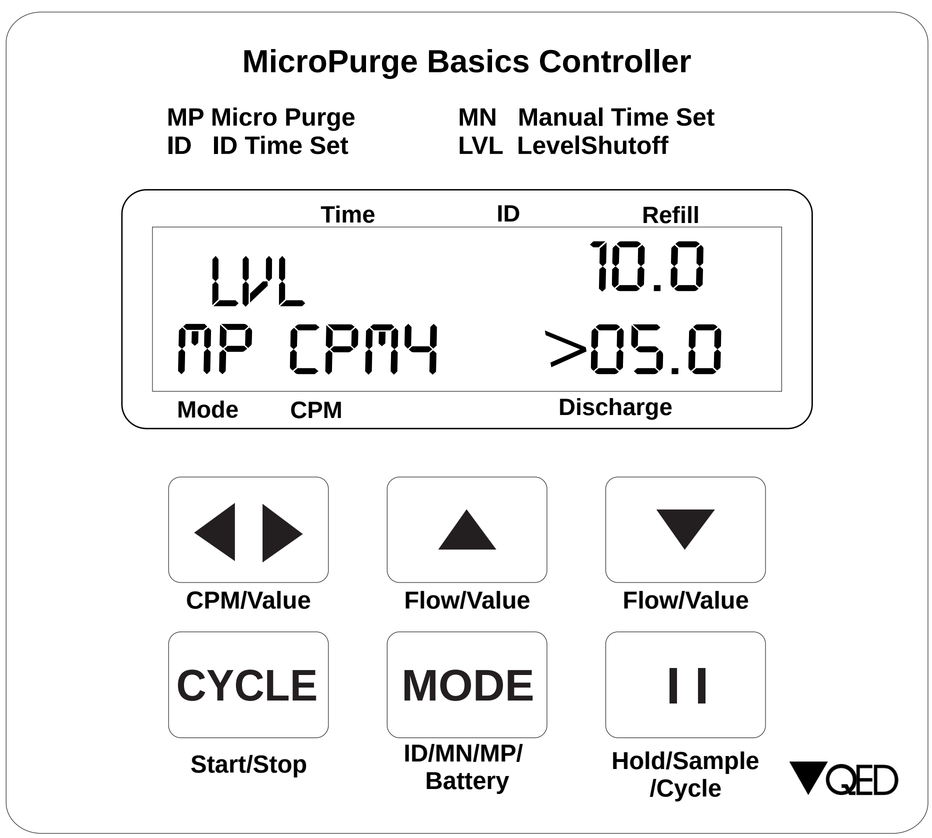


Figure 5 MP50 MP30 Use

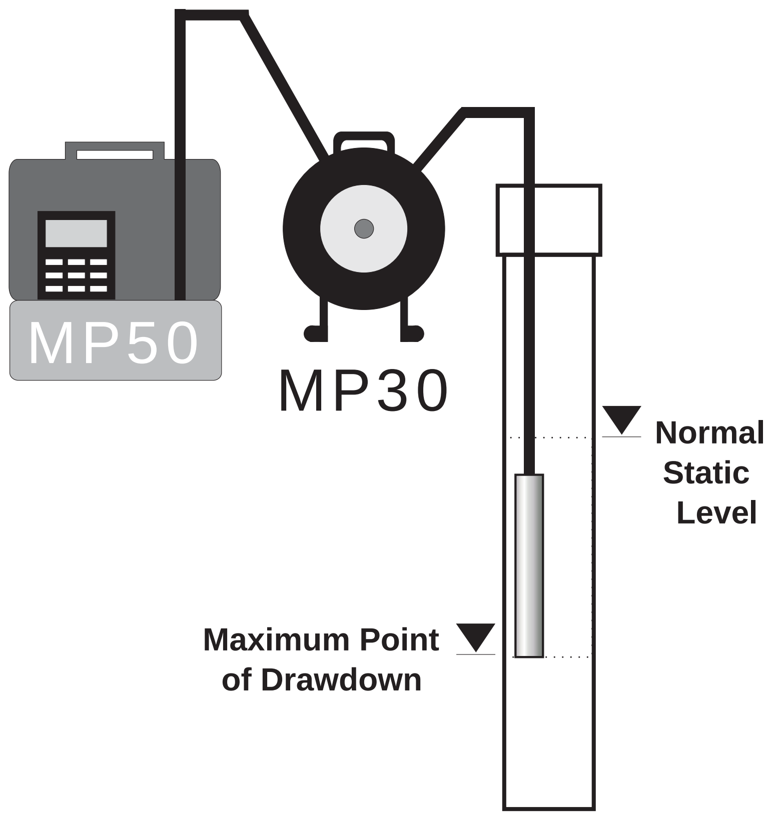
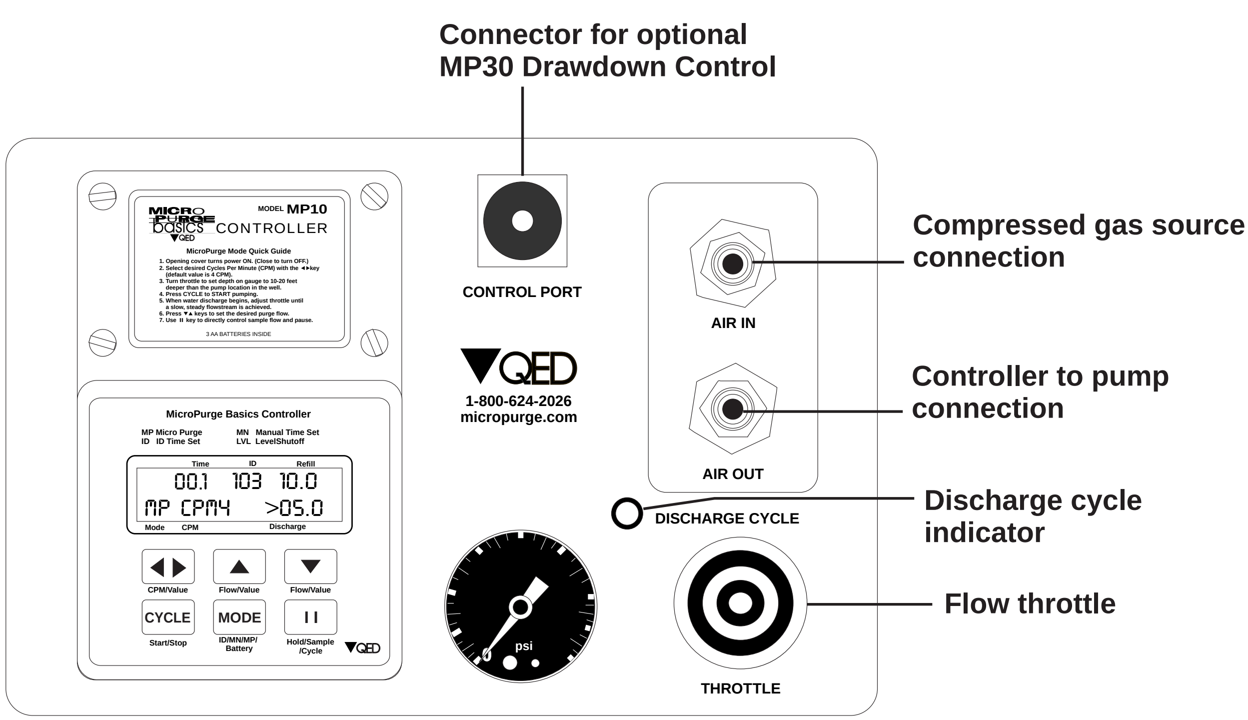


Figure 6 MP50 MP30 Use



The MP50 and MP30 are connected with a cable (see Figures 5 and 6). The MP30 is switched into mode and the water level probe is lowered to the desired maximum drawdown level. Limiting the maximum drawdown depth limits the differential head driving flow into the well and the velocity of the water flowing into the well from the surrounding formation important in Micro-Purge sampling. The MP50 and MP30 work together to automatically adjust the pump operation so as to maintain drawdown at the set level. When the water level drops below the probe, the MP30 sends a signal to the MP50 to pause pumping. Both the MP50 and the MP30 give visual signals (and the MP30 emits an audio signal) that pump operation has stopped because of too much drawdown. Once the level recovers, the MP30 signals the MP50 to resume pump operation. The MP50 resumes by starting in the refill leg of the pump cycle. "DRAWDOWN CONTROL"

The normal operating mode for using the MP30 with the MP50 is:

1. Use the MP30 in standard WLM mode to determine the static water level in the well

2. Decide what the maximum drawdown for that well is during sampling

3. Lower the probe to the maximum drawdown level

4. Switch the MP30 into Drawdown Control mode

5. Begin pumping with the MP50

6. Observe the interactions between the two devices, if the MP30 is frequently pausing the MP50, it may be appropriate to slow the flow down (using the DOWN key in MP mode) to better match pump flow to well recharge.

When switched into mode, the MP30 has a flashing red light and an optional (can be switched off by the user) audio alarm to indicate when the probe is in the dry state. A submerged probe in all modes is indicated by a solid green light. When the MP50 is paused by the MP30 the MP 50 display indicates this as shown in Figure 4 "DRAWDOWN CONTROL"

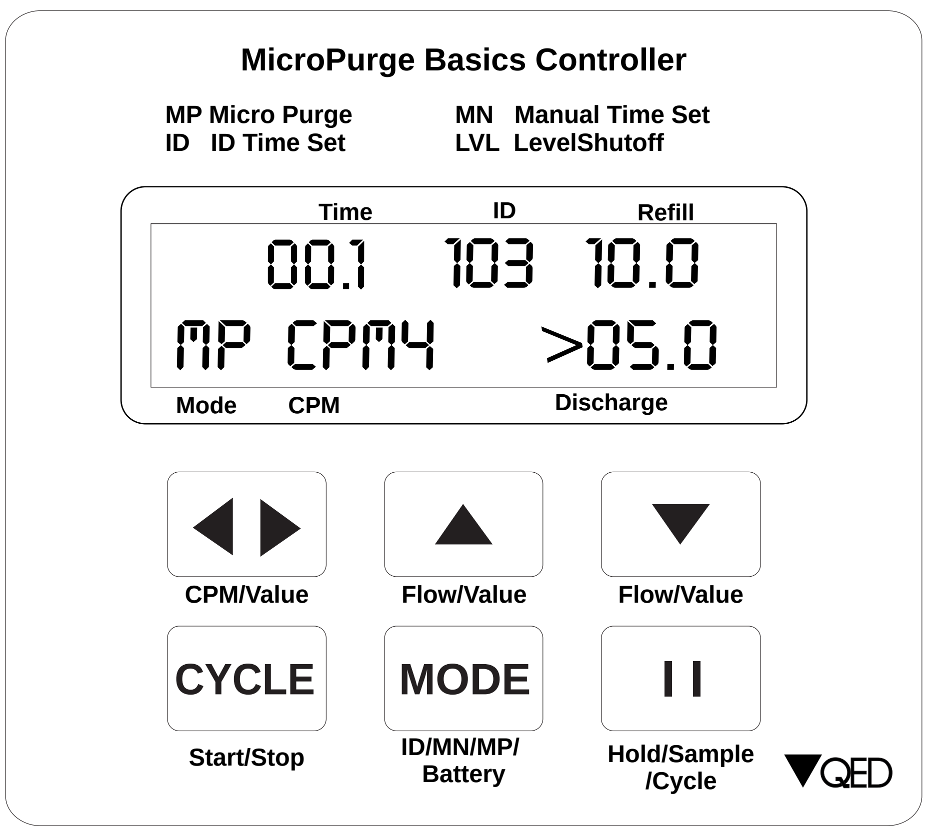
If the MP30 is signaling the MP50 too frequently, the operator can slow down the pump flow rate by using the DOWN key (effectively increasing the pump refill time period). MP30 probe position may also be varied to provide a buffer zone for your drawdown limit and gauge rate of pumping effect on water level in the well.

If the selected maximum drawdown level is being reached even with the lowest desirable pump flow rate more drawdown may be required to attain equilibration, or a passive sampling approach may be required. In passive sampling, used where well recovery is extremely slow, samples are taken after just a few pump strokes sufficient to purge the pump and tubing volumes.

Additional information on the MP30 is given in the MP30 O&M manual

ID Mode Figure 6 shows an example of the MP50 in ID time set mode. Once you've used the MP50 in MP mode and found proper settings for your wells, subsequent sampling events are speeded along by using the controller in ID mode. Once the controller is turned on, a single press of the MODE key places the controller in ID time set mode (the default initial mode is MP mode). This mode allows the user to enter a 3-digit ID, which then is translated into the correct flow settings (CPM and refill / discharge time settings) for that well.

Figure 7 MP50 ID Set Mode



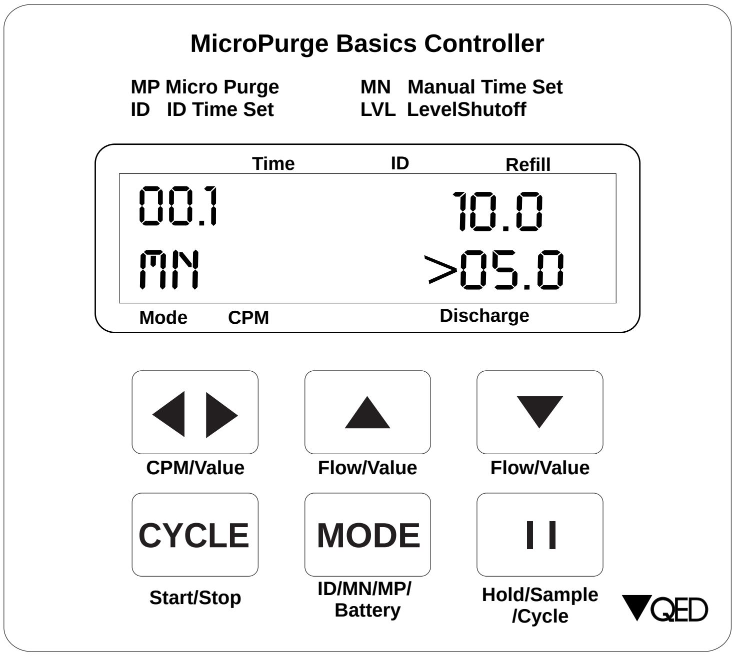
In this mode the CPM and UP, DOWN keys function differently. The CPM key becomes a key used to scroll between the one's and the ten's digits of the ID. The UP and DOWN keys are used to change the ID number (the MP50 has IDs that range from 1-165) up or down in value. Sampling in ID mode is the same as explained, above, for MP mode.

Appendix 1 lists all possible ID settings and the default refill and discharge time settings for each CPM. Appendix 1 also shows how the refill and discharge time will change within a CPM setting as you press the UP or DOWN keys. As you change IDs you will see the CPM change and the refill and discharge time setting change.

Note: *changes in time settings that are entered while the controller is cycling are reflected on the next cycle change (so a long refill time of 15 seconds will time out before a new refill time becomes valid).*

User Set Mode A final controller mode, User Set mode (MN on the display), is useful for manually setting refill and discharge times on the controller as in traditional controllers (like previous model QED pump controllers). An example of the MP50 in User Set mode is shown in Figure 8. User set mode is also used when the wells being sampled are at extreme depths or there are other conditions where one of the 165 possible preset times of ID and MP modes will not match your needs. MN mode is entered when the MODE key is pressed twice from the default MP mode. As shown in Figure 8, the display indicates MN mode in the lower left corner and CPM and ID are not displayed.

Figure 8 MP50 User Set Mode (MN mode)



In User Set mode the CPM and UP, DOWN keys function differently than MP mode. The CPM key becomes a key used to select the digits of the refill and discharge time settings found at the rightmost positions on the display. The UP and DOWN keys are used to adjust the digit value up or down. By selecting and adjusting digits up and down a user can quickly set any time from 00.1 seconds to 99.9 seconds. Sampling in User Set mode is the same as explained, above, for MP mode.

The MP50 does not attempt to translate a user set time into a corresponding ID or CPM. Also, any settings you have entered in MP or ID modes are lost once you press the MODE key to enter MN mode.

Note: *changes in time settings that are entered while the controller is cycling are reflected on the next cycle change (so a long refill time of 15 seconds will time out before a new refill time becomes valid).*

MP50 Battery - The MP50 features sophisticated power-supply circuitry that optimizes battery life. A fresh set of AA batteries will provide more than 100 hours of controller operation at normal operating temperatures. As ambient temperatures drop below 15-20˚F (-9˚C to -6˚C), the ability of the alkaline batteries to deliver energy is affected. Continuous operation may be difficult in extremely cold conditions. Once the batteries and MP50 warm, additional cycle capacity will be regained from a set of batteries.

Replace alkaline batteries by removing the 4 thumbscrews located on the battery cover and inserting 3 fresh **cells**. The MP50 battery holder includes space for ***3 spare AA cells*** so you should never be without power in the field. Properly dispose of the spent alkaline cells.

Note: *If you are storing the MP50 for more than 3 months, remove the AA batteries to prevent leakage. The MP50 power supply is automatically shut off by closing the lid. Make sure the lid is closed during storage.*

Troubleshooting

Use the following troubleshooting table to assist in troubleshooting the MP50:

Symptom	Possible Cause	Action / Fix
Display not showing	Low or dead batteries Batteries installed wrong	Check battery voltage on opening display (>3.6 volts required) Replace batteries Check battery connection
Controller not cycling	Low or dead batteries	See, above
	Lid not open	Open lid
	Temperature below 10º F	Warm controller
	MP50 not STARTED with CYCLE key MP50 in HELD mode	Operate CYCLE and/or PAUSE key to return MP50 to cycling state
	MP50 in LEVEL hold	Make sure MP30 probe is submerged when in MP mode
Air not cycling through controller	Throttle turned too low	Turn throttle clock-wise to produce pressure
	Air source not delivering air	Verify air source
Pump not pumping	Throttle turned too low	Turn throttle clock-wise to produce pressure
	Time settings not correct	Try different CPM settings (lower CPM for deeper wells) and/or different refill and discharge time settings
	Air source pressure too low	Verify air source pressure
Battery life too short	Controller left on while strored	Turn MP50 off before storing and remove batteries when storing more than 1 month
	Temperature below 10º F	Warm controller

MP50 Specifications

Temperature Range:	Operating range of -20º F to +120º F
Humidity:	Circuitry sealed to provide operation to 100% humidity
Protection:	Circuitry protected against transient surges introduced from improper battery installation or switch connections
Dimensions:	16" x 13" x 6.5"
Weight:	21 lbs
Case Material:	Structural Resin
Keypad:	6 keys
Display:	LCD display, 32-character (2 lines, 16 characters, each)
Window:	Non-glare, double hardened optical acrylic
Controller Power:	3 “AA” Batteries
Controller Battery Life:	50,000 Cycles @ 70° F (21° C)
Drain:	Unit off: 2mA, Unit on: 4mA, Valve Cycle: 6mA
Reserve:	100 hours operating time (1sec/1sec cycles) with fresh AA alkaline cells At 65º F (approx.)
Emergency battery:	3 AA cells stored within battery compartment
Compressor Power:	12 VDC (Battery Cable)
***Max. Lift:**	200 Feet (60 m)
Output:	0.21 SCFM@ 100 psi (0.357 m 3/h@ 6.89 kPa)
Max. Pressure:	105 psi (7.24 kPa)
Operating Temperature:	-20º - 120º F (-29º - 49º C)
Connection to MP30 Drawdown Meter:	Heavy-Duty Cable (Supplied with MP30)

*Pump flow rates in deeper wells (>100 feet) will be reduced, especially for pumps with less than 10 feet liquid submergence.

For additional assistance contact QED Service at:

Phone:	1-800-624-2026 1-734-995-2547
Fax:	1-734-995-1170
E-mail:	service@qedenv.com
24-Hour Service Hot Line:	1-800-272-9559

QED Monitoring System WARRANTY

QED ENVIRONMENTAL SYSTEMS, ("**Q.E.D.**") warrants to the original purchaser of its products that, subject to the limitations and conditions provided below, the products, materials and/or workmanship shall reasonably conform to descriptions of the products and shall be free of defects in materials and workmanship. Any failure of the products to conform to this warranty will be remedied by Q.E.D. in the manner provided herein.

This warranty shall be limited to the duration and the conditions set forth below. All warranty durations are calculated from the original date of purchase.

1. ***Dedicated-Use Systems Products-*** 10 year warranty on dedicated bladder pumps equipped with Q.E.D. inlet screens, and purge pumps used in periodic, non continuous groundwater sampling (up to 52 sampling events per year.)All other components, equipment and accessories are warranted for one year.

2. ***Portable-Use Systems-*** Sample Pro Pumps, Controllers and water level meters are warranted for one year. Hose Reels, Caps and non-Sample Pro pumps are warranted for ninety (90) days. Tubing and Purge Mizers are covered by a ninety (90) day material and workmanship warranty. There will be no warranty for application on tubing and Purge Mizers when used as part of a Portable System.

3. ***Separately sold parts and Spare Parts Kits-*** Separately sold parts and spare parts kits are warranted for ninety (90) days. Repairs performed by Q.E.D. are warranted for ninety (90) days from date of repair or for the full term of the original warranty, whichever is longer.

Buyers' exclusive remedy for breach of said warranty shall be as follows: if, and only if, Q.E.D. is notified in writing within applicable warranty period of the existence of any such defect in the said products, and Q.E.D. upon examination of any such defects, shall find the same to be within the term of and covered by the warranty running from Q.E.D. to Buyer, Q.E.D. will, at its option, as soon as reasonably possible, replace or repair any such product, without charge to Buyer. If Q.E.D. for any reason, cannot repair a product covered hereby within four (4) weeks after receipt of the original Purchaser's/Buyer's notification of a warranty claim, then Q.E.D.'s sole responsibility shall be, at its option, either to replace the defective product with a comparable new unit at no charge to the Buyer, or to refund the full purchase price. In no event shall such allegedly defective products be returned to Q.E.D. without its consent, and Q.E.D.'s obligations of repair, replacement or refund are conditioned upon the Buyer's return of the defective product to Q.E.D.

IN NO EVENT SHALL Q.E.D. ENVIRONMENTAL SYSTEMS, INC. BE LIABLE FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES FOR BREACH OF SAID WARRANTY

The foregoing warranty does not apply to major sub-assemblies and other equipment, accessories and parts manufactured by others, and such other parts, accessories, and equipment are subject only to the warranties, if any, supplied by the respective manufacturers. Q.E.D. makes no warranty concerning products or accessories not manufactured by Q.E.D. In the event of failure of any such product accessory Q.E.D. will give reasonable assistance to the Buyer in obtaining from the respective manufacturer whatever adjustment is reasonable in light of the manufacturer's own warranty.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY (INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE), WHICH OTHER WARRANTIES ARE EXPRESSLY EXCLUDED HEREBY, and of any other obligations or liabilities on the part of Q.E.D.,neither assumes nor authorizes any person to assume for it any other obligation or liability in connection with said products, materials and/or workmanship.

It is understood and agreed that Q.E.D. shall in no event be liable for incidental or consequential damages resulting from its breach of any of the terms of this agreement, nor for special damages, nor for improper selection of any product described or referred to for a particular application.

This warranty will be void in the event of unauthorized disassembly of component assemblies. Defects in any equipment that result from abuse, operation in any manner outside the recommended procedures, use and applications other than for intended use, or exposure to chemical or physical environment beyond the designated limits of materials and construction will also void this warranty. Q.E.D. shall be released from all obligations under all warranties if any product covered hereby is repaired or modified by persons other than Q.E.D.'s service personnel unless such repair by others is made with the written consent of Q.E.D.

If any product covered hereby is actually defective within the terms of this warranty, Purchaser must contact Q.E.D. for determination of warranty coverage. If the return of a component is determined to be necessary, Q.E.D. will authorize the return of the component, at owner's expense. If the product proves not to be defective within the terms of this warranty, then all costs and expenses in connection with the processing of the Purchaser's claim and all costs for repair, parts and labor as authorized by owner hereunder shall be borne by the purchaser.

RESPONSIBILITY OF THE PURCHASER

The original Purchaser's sole responsibility in the instance of a warranty claim shall be to notify Q.E.D. of the defect, malfunction, or other manner in which the terms of this warranty are believed to be violated. You may secure performance of obligations hereunder by contacting the Customer Service Department of Q.E.D. and:

1. Identifying the product involved (by model or serial number or other sufficient description that will allow Q.E.D. to determine which product is defective).
2. Specifying where, when, and from whom the product was purchased.
3. Describing the nature of the defect or malfunction covered by this warranty.
4. Sending the malfunctioning component, after authorization by Q.E.D. to:

QED Environmental Systems
6155 Jackson Rd.
Ann Arbor, Michigan 48103

Appendix 1 ID Data Table

NOTE: Bold Shaded values are default for that CPM

CYCLES / min (CPM)																	
1 / min			2 / min			3 / min			4 / min			5 / min			6 / min		
ID	Disch (sec)	Refill (sec)	ID	Disch (sec)	Refill (sec)	ID	Disch (sec)	Refill (sec)	ID	Disch (sec)	Refill (sec)	ID	Disch (sec)	Refill (sec)	ID	Disch (sec)	Refill (sec)
1	1	59	41	1	29	66	1	19	95	1	14	114	1	11	145	1	9
2	2	58	42	2	28	67	1.5	18.5	96	1.5	13.5	115	1.2	10.8	146	1.2	8.8
3	3	57	43	3	27	68	2	18	97	2	13	116	1.4	10.6	147	1.4	8.6
4	4	56	44	4	26	69	2.5	17.5	98	2.5	12.5	117	1.6	10.4	148	1.6	8.4
5	5	55	45	5	25	70	3	17	99	3	12	118	1.8	10.2	149	1.8	8.2
6	6	54	46	6	24	71	3.5	16.5	100	3.5	11.5	119	2	10	150	2	8
7	7	53	47	7	23	72	4	16	101	4	11	120	2.2	9.8	151	2.2	7.8
8	8	52	48	8	22	73	4.5	15.5	102	4.5	10.5	121	2.4	9.6	152	2.4	7.6
9	9	52	49	9	21	74	5	15	**103**	**5**	**10**	122	2.6	9.4	153	2.6	7.4
10	10	50	**50**	**10**	**20**	75	5.5	14.5	104	5.5	9.5	123	2.8	9.2	154	2.8	7.2
11	11	49	51	11	19	76	6	14	105	6	9	124	3	9	**155**	**3**	**7**
12	12	48	52	12	18	77	6.5	13.5	106	6.5	8.5	125	3.2	8.8	156	3.2	6.8
13	13	47	53	13	17	78	7	13	107	7	8	126	3.4	8.6	157	3.4	6.6
14	14	46	54	14	16	79	7.5	12.5	108	7.5	7.5	127	3.6	8.4	158	3.6	6.4
15	15	45	55	15	15	80	8	12	109	8	7	128	3.8	8.2	159	3.8	6.2
16	16	44	56	16	14	81	8.5	11.5	110	8.5	6.5	**129**	**4**	**8**	160	4	6
17	17	43	57	17	13	**82**	**9**	**11**	111	9	6	130	4.2	7.8	161	4.2	5.8
18	18	42	58	18	12	83	9.5	10.5	112	9.5	5.5	131	4.4	7.6	162	4.4	5.6
19	19	41	59	19	11	84	10	10	113	10	5	132	4.6	7.4	163	4.6	5.4
20	**20**	**40**	60	20	10	85	10.5	9.5				133	4.8	7.2	164	4.8	5.2
21	21	39	61	21	9	86	11	9				134	5	7	165	5	5
22	22	38	62	22	8	87	11.5	8.5				135	5.2	6.8			
23	23	37	63	23	7	88	12	8				136	5.4	6.6			
24	24	36	64	24	6	89	12.5	7.5				137	5.6	6.4			
25	25	35	65	25	5	90	13	7				138	5.8	6.2			
26	26	34				91	13.5	6.5				139	6	6			
27	27	33				92	14	6				140	6.2	5.8			
28	28	32				93	14.5	5.5				141	6.4	5.6			
29	29	31				94	15	5				142	6.6	5.4			
30	30	30										143	6.8	5.2			
31	31	29										144	7	5			
32	32	28															
33	33	27															
34	34	26															
35	35	25															
36	36	24															
37	37	23															
38	38	22															
39	39	21															
40	40	20															

QED Environmental Systems
P.O. Box 3726 Ann Arbor, MI 48106-3726 USA
1-800-624-2026 Fax (734) 995-1170
info@qedenv.com www.qedenv.com

MultiRAE
User's Guide

Rev C
May 2013
P/N: M01-4003-000

IMPORTANT!

This User's Guide covers instruments with application firmware version 1.14 and sensor firmware version 1.04.

Product Registration

Register your product online by visiting:

http://www.raesystems.com/support/product-registration

By registering your product, you can:

- Receive notification of product upgrades or enhancements
- Be alerted to Training classes in your area
- Take advantage of RAE Systems special offers and promotions

Contents

⚠ WARNINGS ⚠

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.

CAUTION!

Never operate the monitor when the cover is removed. Remove the monitor rear cover or battery only in an area known to be non-hazardous.

ANY RAPID UP-SCALE READING FOLLOWED BY A DECLINING OR ERRATIC READING MAY INDICATE A GAS CONCENTRATION BEYOND UPPER SCALE LIMIT, WHICH MAY BE HAZARDOUS.

TOUTE LECTURE RAPIDE ET POSITIVE, SUIVIE D'UNE BAISSE SUBITE AU ERRATIQUE DE LA VALEUR, PEUT INDIQUER UNE CONCENTRATION DE GAZ HORS GAMME DE DÉTECTION QUI PEUT ÊTRE DANGEREUSE

ONLY THE COMBUSTIBLE GAS DETECTION PORTION OF THIS INSTRUMENT HAS BEEN ASSESSED FOR PERFORMANCE.

UNIQUMENT, LA PORTION POUR DÉTECTOR LES GAZ COMBUSTIBLES DE CET INSTRUMENT A ÉTÉ ÉVALUÉE.

CAUTION: BEFORE EACH DAY'S USAGE, SENSITIVITY OF THE LEL SENSOR MUST BE TESTED ON A KNOWN CONCENTRATION OF METHANE GAS EQUIVALENT TO 20 TO 50% OF FULL-SCALE CONCENTRATION. ACCURACY MUST BE WITHIN 0 AND +20% OF ACTUAL. ACCURACY MAY BE CORRECTED BY CALIBRATION PROCEDURE.

ATTENTION: AVANT CHAQUE UTILISATION JOURNALIERE, VERIFIER LA SENSIBILITE DU CAPTEUR DE LIE AVEC UNE CONCENTRATION CONNUE DE METHANE EQUIVALENTE DE 20 A 50% DE LA PLEINE ECHELLE. LA PRECISION DOIT ETRE COMPRISE ENTRE 0 ET 20% DE LA VALEUR VRAIE ET PEUT ETRE CORRIGEE PAR UNE PROCEDURE D'ETALONNAGE.

CAUTION: HIGH OFF-SCALE READINGS MAY INDICATE AN EXPLOSIVE CONCENTRATION.

ATTENTION: DES LECTURES HAUTES ET HORS D'ECHELLE PEUVENT INDIQUER DES CONCENTRATIONS DE GAZ INFLAMMABLES

CAUTION: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.

Note: Users are recommended to refer to ISA-RP12.13, Part II-1987 for general information on installation, operation, and maintenance of combustible gas detection instruments.

The MultiRAE multi-gas detector must be calibrated if it does not pass a bump test, or at least once every 180 days, depending on use and sensor exposure to poisons and contaminants.

SPECIAL CONDITIONS FOR SAFE USE

1. The PGM-62xx shall only be fitted with RAE Systems Battery Pack type M01-3051-000 or M01-3053-000 or Battery Adapter M01-3052-000 or M01-3054-000 fitted with Duracell MN1500 batteries.
2. The PGM62xx shall only be charged outside hazardous areas.
3. No precautions against electrostatic discharge are necessary for portable equipment that has an enclosure made of plastic, metal, or a combination of the two, except where a significant static-generating mechanism has been identified. Activities such as placing the item in a pocket or on a belt, operating a keypad or cleaning with a damp cloth, do not present a significant electrostatic risk. However, where a static-generating mechanism is identified, such as repeated brushing against clothing, then suitable precautions shall be taken, e.g., the use of anti-static footwear.

The model PGM62xx is certified according to the IECEx scheme, ATEX and cCSAus (for US and Canada). PGM62xx is intrinsically safe and may be used in hazardous locations. SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.

MARKING

The product is marked with the following information:

RAE SYSTEMS
3775 N. 1st. St., San Jose
CA 95134, USA

Type PGM62x0, PGM 62x6, PGM 62x8
Serial No/matrix: XXX-XXXX-000

IECEx SIR 11.0069X, Ex ia IIC T4 Ga (PGM62x0/PGM62x6) Ex ia d IIC T4 Gb (PGM62x8)	CE 0575 SIRA 11ATEX2152X Ex II 1G Ex ia IIC T4 Ga (PGM62x0/PGM62x6) Ex II 2G Ex ia d IIC T4 Gb (PGM62x8)	c SP us Exia Cl I, Dv 1 Gr. A, B, C, D, T4 C22.2 No 152-1984 ISA-12.13.01-2000

Warnings: Understand manual first before operating.
Warning: Do not change batteries in hazardous location.
Do not mix old/new or different type of batteries

PGM62x0: Use only RAE Systems battery pack, PN: M01-3051-000 or M01-3052-000.
PGM62x6/62x8: Use only RAE Systems battery pack, PN: M01-3053-000 or M01-3054-000.
Um: 20V
-20º C ≤ Tamb ≤ +50º C

FCC Part 15 Statement

This device complies with Part 15 of the FCC rules. 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.

Operation Area and Conditions

Hazardous Areas classified by Zones

PGM62x0/PGM62x6 are intended to be used in hazardous areas zone 0, zone 1 or zone 2, and PGM62x8 in hazardous areas zone 1 or zone 2 within the temperature range of -20º C to +50º C, where gases of explosion groups IIA, IIB or IIC and T4 may be present.

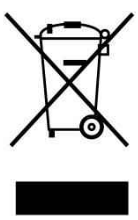
Hazardous Areas classified by Divisions

PGM62x0/PGM62x6/PGM62x8 are intended to be used in hazardous areas classified for Class I Div. 1 or 2, within the temperature range of -20º C to +50º C, where gases of explosion groups A, B, C or D and temperature class T4 may be present.

WARNINGS:

1. NDIR sensors shall not be installed in PGM62x0 or PGM 62x6 models.
2. NDIR LEL sensors shall not be installed in PGM62x8 diffusion models bearing **cCSAus** logo.

Proper Product Disposal At End Of Life



The Waste Electrical and Electronic Equipment (WEEE) directive (2002/96/EC) is intended to promote recycling of electrical and electronic equipment and their components at end of life. This symbol (crossed-out wheeled bin) indicates separate collection of waste electrical and electronic equipment in the EU countries. This product may contain one or more Nickel-metal hydride (NiMH), Lithium-ion, or Alkaline batteries. Specific battery information is given in this user guide. Batteries must be recycled or disposed of properly.

At the end of its life, this product must undergo separate collection and recycling from general or household waste. Please use the return and collection system available in your country for the disposal of this product.

Sensor Specifications, Cross-Sensitivities, And Calibration Information

For information on sensor specifications, cross-sensitivities, and calibration information, refer to RAE Systems Technical Note TN-114: Sensor Specifications And Cross-Sensitivities (available for free download from www.raesystems.com/downloads/tech-notes). All specifications presented in this Technical Note reflect the performance of stand-alone sensors. Actual sensor characteristics may vary when the sensor is installed in different instruments. As sensor performance may change over time, specifications provided are for brand-new sensors.

1 Standard Contents

The MultiRAE is available in four configurations, each with different kits, outlined below.

MultiRAE Pro	MultiRAE
MultiRAE Pro monitor with pump, sensors, battery, and wireless options as specified and protective black rubber boot, external filter, and belt clip installed	MultiRAE monitor with pump, sensors, battery, and wireless options as specified and protective rubber boot, filter, and belt clip installed
Travel Charger / PC communications adapter	Travel Charger / PC communications adapter
Desktop charging / PC communications cradle	
PC communication cable	PC communication cable
AC adapter	AC adapter
Calibration adapter	Calibration adapter
6" flexible probe	6" flexible probe
Alkaline battery adapter	Alkaline battery adapter
3 spare external filters	3 spare external filters
PID sensor cap removal tool	PID sensor cap removal tool
PID zeroing charcoal filter	Toolkit
Toolkit	QuickStart Guide
QuickStart Guide	CD with documentation
CD with ProRAE Studio II instrument configuration and data management software	CD with ProRAE Studio II instrument configuration and data management software
CD with documentation	Calibration and test certificate
Calibration and test certificate	Warranty / registration card
Technical Note TN-106 with ionization energies and correction factors for 300+ VOCs	Technical Note TN-106 with ionization energies and correction factors for 300+ VOCs
Warranty / registration card	10 charcoal filters (reduce CO sensor's cross-sensitivity to VOCs)
10 charcoal filters (reduce CO sensor's cross-sensitivity to VOCs)	Ships in a hard transport case
Ships in a Pelican case	

MultiRAE Lite Diffusion	MultiRAE Lite Pumped
MultiRAE Lite monitor with sensors, battery, and wireless options as specified and protective rubber boot installed	MultiRAE Lite monitor with pump, sensors, battery, and wireless options as specified and protective rubber boot, filter, and belt clip installed
Travel Charger / PC communications adapter	Travel Charger / PC communications adapter
PC communication cable	PC communication cable
AC adapter	AC adapter
Calibration adapter	Calibration adapter
Alkaline battery adapter (included with rechargeable configurations only)	Alkaline battery adapter (included with rechargeable configurations only)
Toolkit	3 spare filters
QuickStart Guide	PID sensor cap removal tool
CD with documentation	Toolkit
CD with ProRAE Studio II instrument configuration and data management software	QuickStart Guide
Calibration and test certificate	CD with documentation
Warranty / registration card	10 charcoal filters (reduce CO sensor's cross-sensitivity to VOCs)
Ships in a cardboard box with a colorful sleeve	CD with ProRAE Studio II instrument configuration and data management software
	Calibration and test certificate
	Warranty / registration card
	Ships in a cardboard box with a colorful sleeve

2 General Information

The MultiRAE is a family of multi-threat gas detectors that combine continuous monitoring capabilities for volatile organic compounds (VOCs), toxic and combustible gases, and radiation, with Man Down Alarm functionality in one highly portable instrument. MultiRAE monitors offer an industry-leading selection of interchangeable field-replaceable electrochemical, combustible, infrared, PID (photoionization detector), and gamma radiation sensors to fit a wide variety of applications. The MultiRAE family's wireless capability elevates worker protection to the next level by providing safety officers real-time access to instrument readings and alarm status from any location for better visibility and faster response.

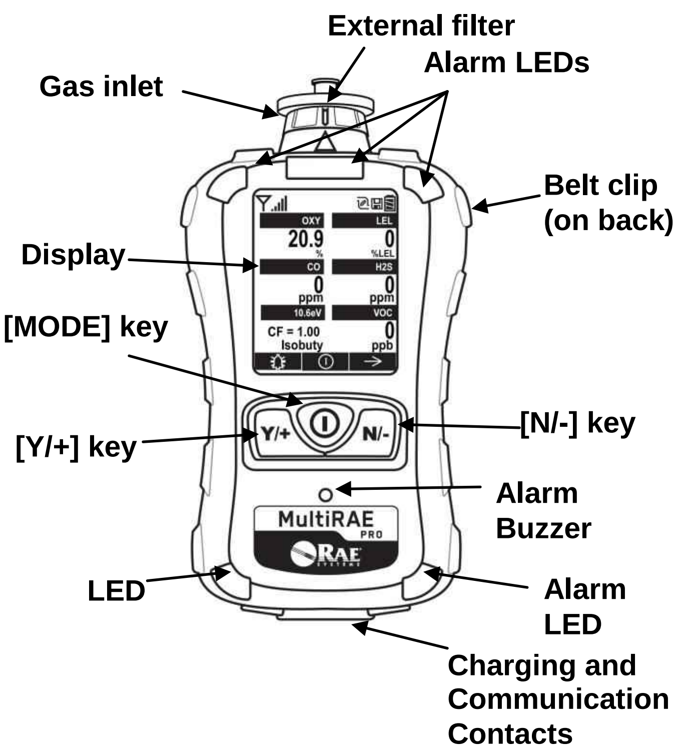
Notes:

- NDIR combustible sensors are not supported on the diffusion version with CSA certification.
- The PID sensor requires a pumped configuration.
- If a %Vol. NDIR sensor is installed in an instrument, a catalytic bead %LEL sensor must also be installed in the instrument for CSA certification.

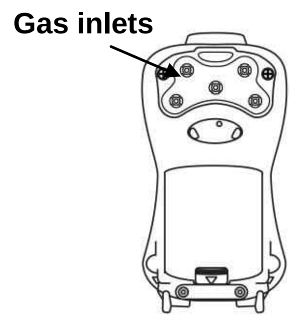
2.1 Key Features

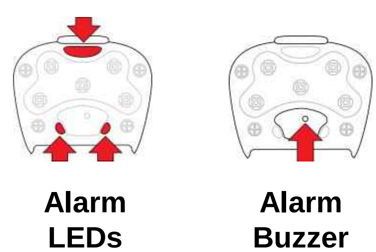
- All-in-one continuous monitoring capabilities for gamma radiation, VOCs, oxygen, toxic and combustible gases, for a total of up to six threats at a time
- Highly customizable with over 25 field-interchangeable intelligent sensor options
- Wireless access to real-time instrument readings and alarm status from any location through ProRAE Guardian Real-Time Wireless Safety System
- Unmistakable five-way local and remote wireless notification of alarm conditions, including Man Down Alarm
- Large graphical display with easy-to-use, icon-driven user interface
- Simple maintenance with easily accessible sensors, pump, and plug-and-play battery
- Fully automated charging, data management, bump testing and calibration with AutoRAE 2

MultiRAE With Pump, front view

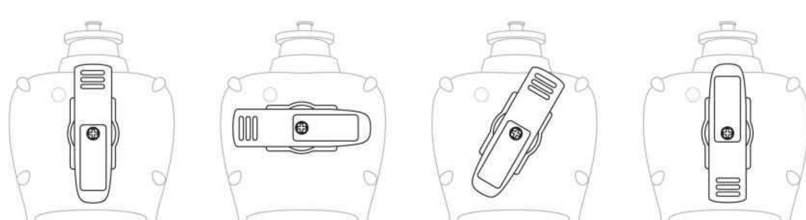


MultiRAE Lite Diffusion Model, rear view





Note: The front of the diffusion model of the MultiRAE Lite is the same as the pumped model, but instead of a single gas inlet at the top, there are five inlets on the back side, as well as an extra alarm buzzer and LEDs.



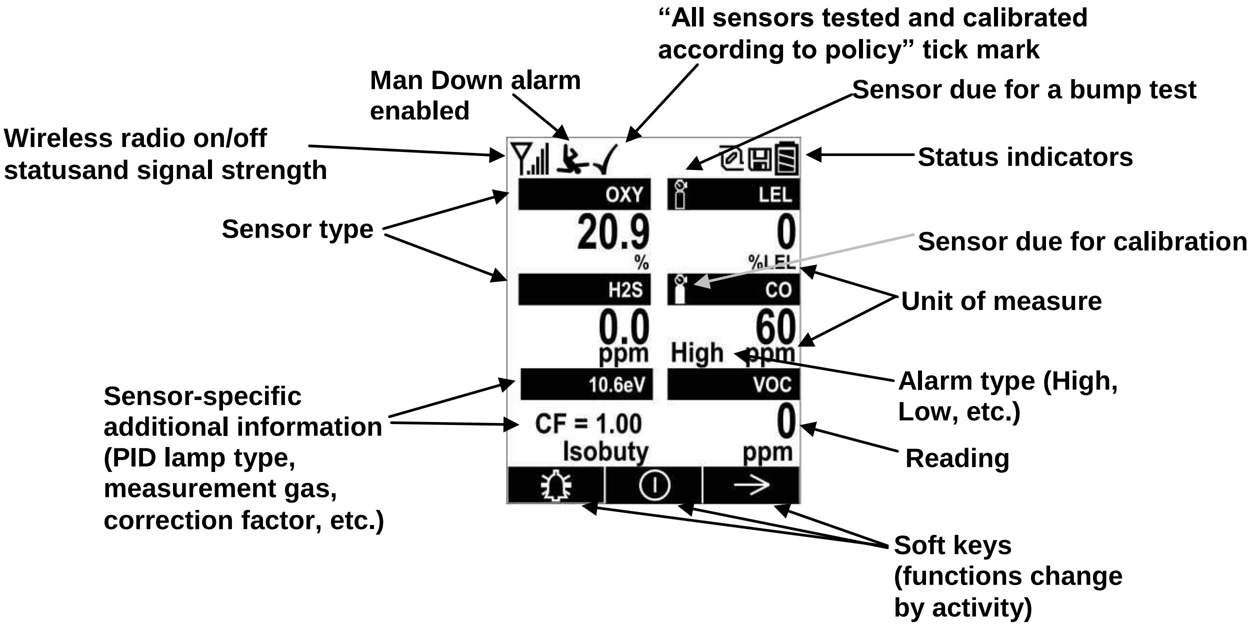
The belt clip on the back of the pump-equipped MultiRAE can be swiveled for carrying it at different angles.

3 User Interface

The MultiRAE's user interface consists of the display, alarm LEDs, an alarm buzzer, and three keys.

3.1 Display Overview

The LCD display provides visual feedback that includes the sensor types, readings, alarm status, battery condition, and other information.



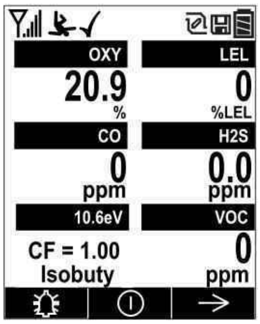
3.1.1 Status Indicator Icons

Along the top of most screens are status indicators that tell you whether a function is operating and/or its strength or level.

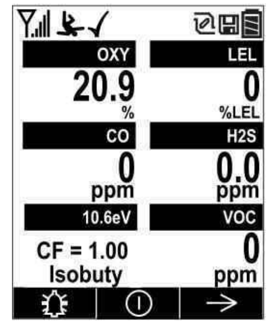
Icon	Function
	Wireless status: the radio is on
	Wireless status: the radio is off
	The instrument is not equipped with a radio (no icon)
	Wireless strength (0 to 5 bars)
	Pump status (only on pump-equipped models)
	Datalogging status (shown when datalogging is on, blank when off)
	Battery status (three segments show battery charge level)
	Man Down alarm enabled
	Sensor due for calibration
	Sensor due for a bump test
✓	"All sensors tested and calibrated to policy" tick mark (all sensors have been bump tested and calibrated; no sensor is overdue for a bump test or calibration according to the intervals configured on the instrument)

3.1.2 LCD Flip

The MultiRAE senses its vertical/horizontal orientation, and can automatically flip the display 180 degrees, making it easy to read if the MultiRAE is upside down. (You can turn this feature on or off in Programming Mode, under "Monitor/LCD Flip.")



As the MultiRAE is tilted, the gravity sensor detects its orientation and inverts the screen when it is past its horizontal position.



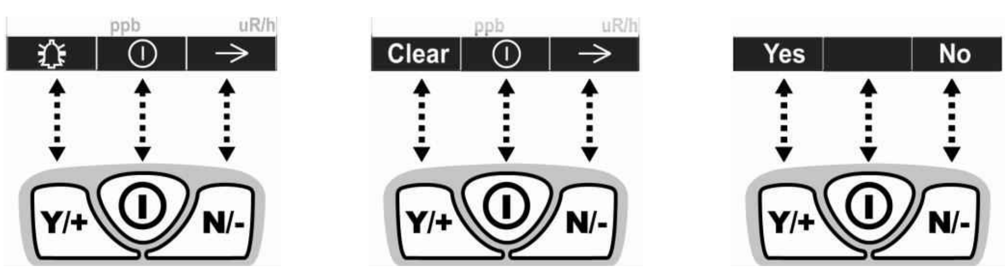
3.1.3 Keys And Interface

The MultiRAE has three keys:

Y/+ MODE N/-

In addition to their labeled functions, [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 examples that show the relationships of the keys and functions:



In addition to the functions described above, any of the keys can be used to manually activate display backlighting. Press any key when the backlighting is off to turn it on. A subsequent key press is required to carry out an actual function corresponding to that key.

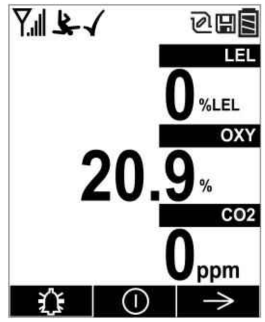
3.2 Screen Display For Various Numbers Of Active Sensors

The MultiRAE family of instruments can display readings from one to six sensors (including dual sensors), depending on the configuration. In order to maximize readability and the amount of information shown, the display is automatically reconfigured, according to the number and types of sensors in the MultiRAE.

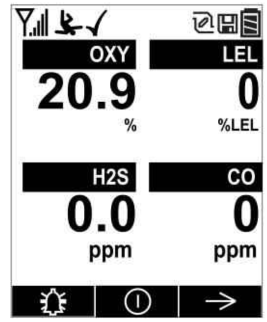
If the configuration includes five sensors, and one of them is a PID, then the lamp value (9.8eV or 10.6eV) is shown, along with the currently applied correction factor (CF) and measurement gas.

One sensor.

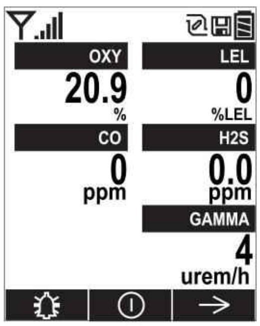
Two sensors.



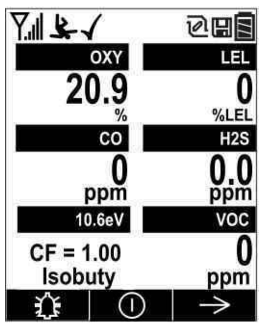
Three sensors.



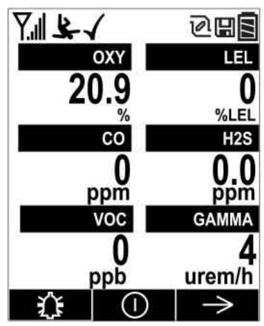
Four sensors.



Five sensors, including Gamma radiation sensor.



Five sensors, including PID, showing lamp type, correction factor, and measurement gas.



Six-sensor configuration with CO+H_2S combo sensor.

3.3 Menus

The reading menus are easy to step through by pressing the [N/-] key.

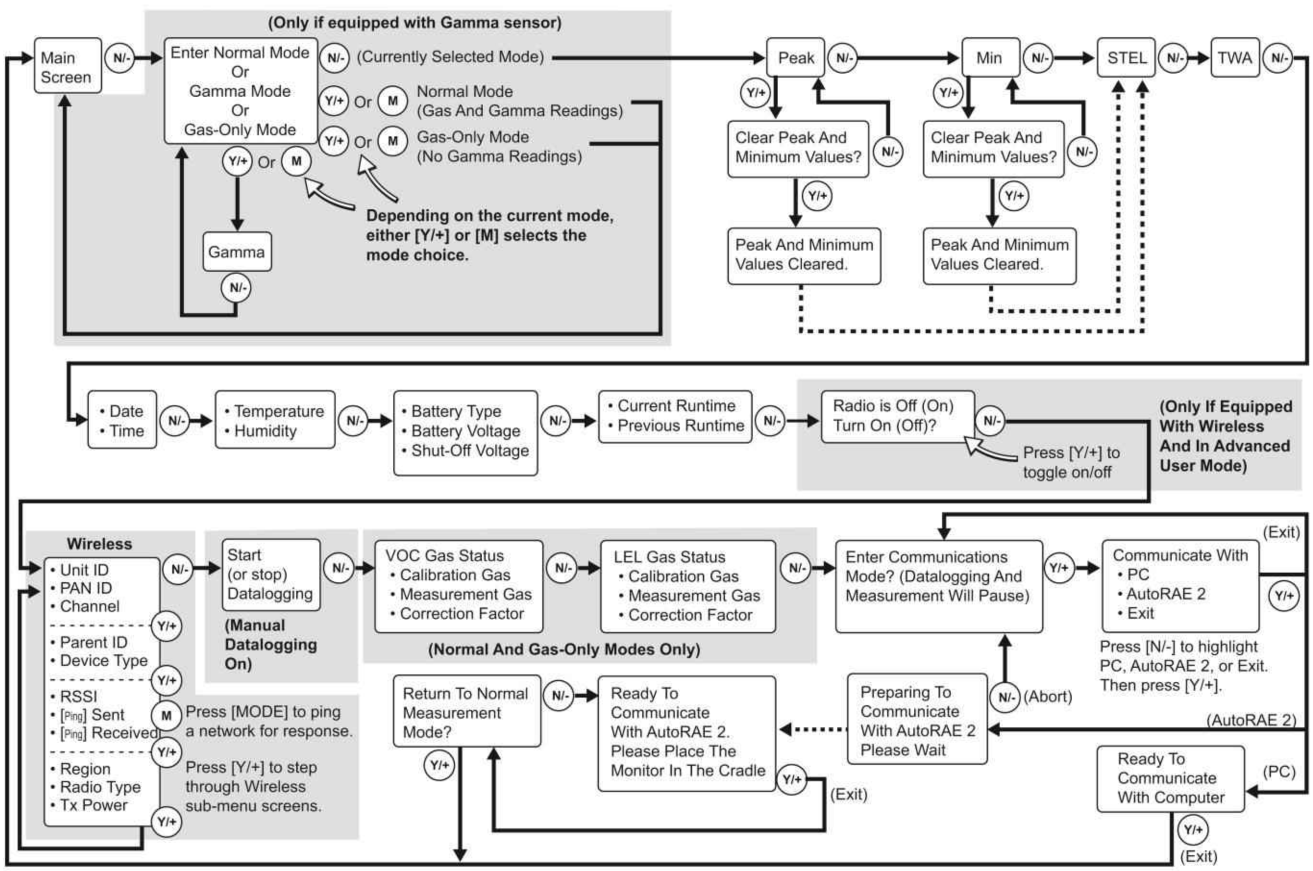
Hygiene Mode: Sampling is continuous, and Hygiene Mode allows you to clear peak and minimum values at any time.

Search Mode: Samples only when you tell it to sample. This allows you to save sample readings as individual events in the datalog. You can also clear peak and minimum values.

Note: You can switch between Hygiene and Search modes via the Programming Menu (Select Monitor and then Operation Mode).

Note: If the instrument is not equipped with a VOC sensor (PID), or is not equipped with an LEL sensor, then screens for those sensors (VOC Gas Status and LEL Gas Status, respectively) are not shown.

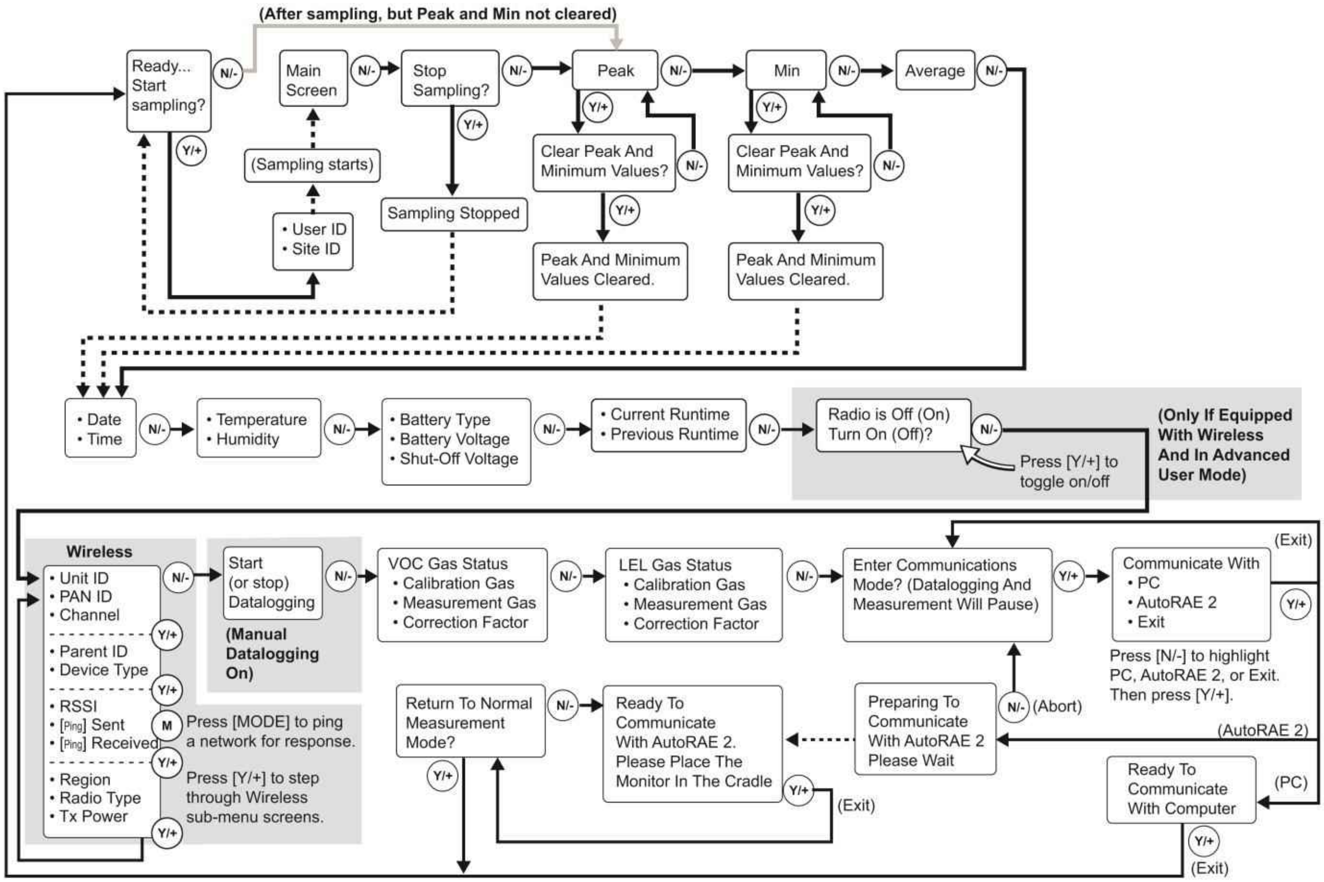
Hygiene Mode



Note: Dashed line indicates automatic progression.

Search Mode

Note: If the instrument is not equipped with a VOC sensor (PID), or is not equipped with an LEL sensor, then screens for those sensors (VOC Gas Status and LEL Gas Status, respectively) are not shown.

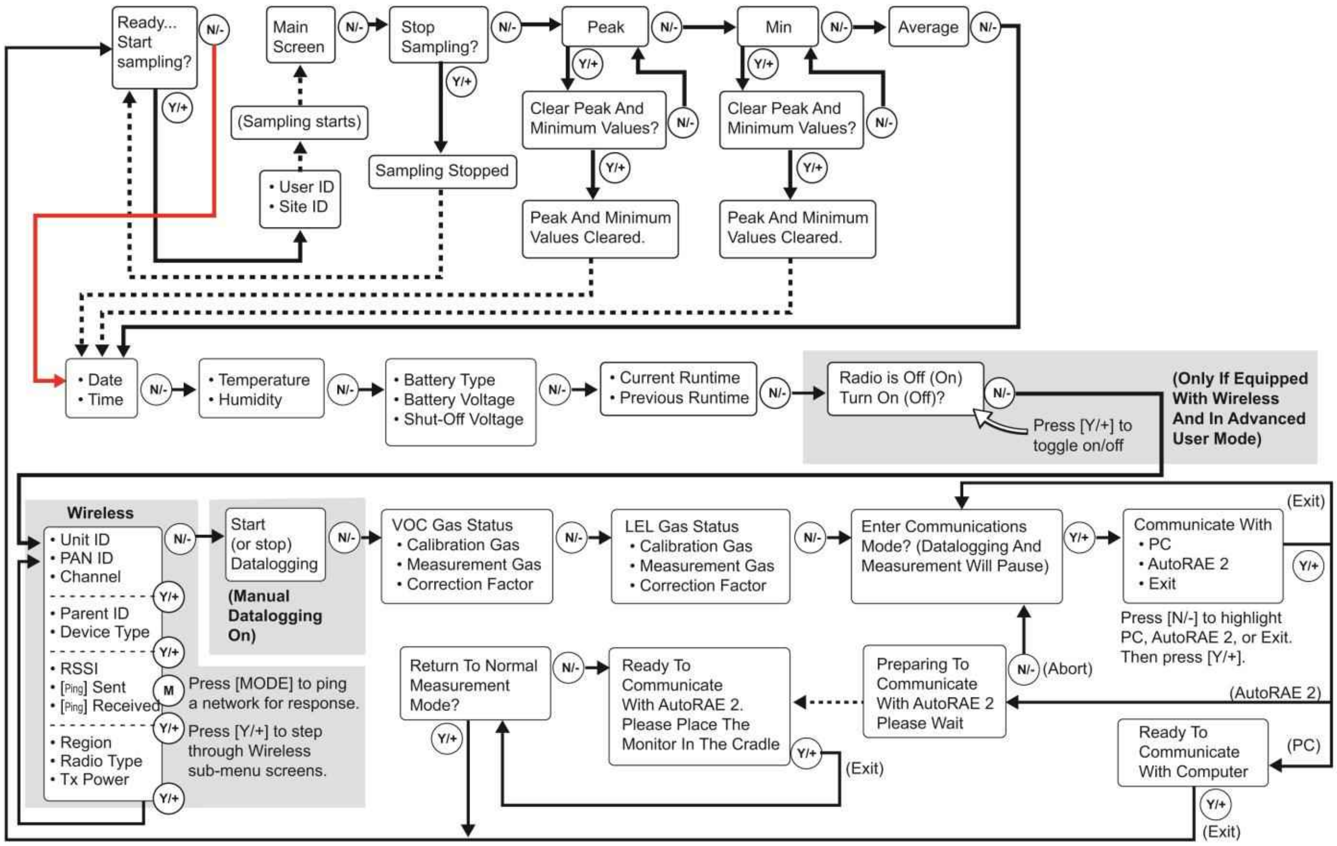


Note: Dashed line indicates automatic progression.

WARNING!

Gamma readings are not taken in Search Mode.

Note: If the Peak or Min is cleared, the Average is also cleared. In addition, each cycle through the main screen after they are cleared will route from "Ready… Start sampling?" directly to Date and Time if you press [N/-] (see red line in diagram below), until you perform a new sample. Also, if you start sampling again and stop sampling, clear the Peak, or clear the Min, it advances to Date and Time, as well.



Note: Dashed line indicates automatic progression.

WARNING!

Gamma readings are not taken in Search Mode.

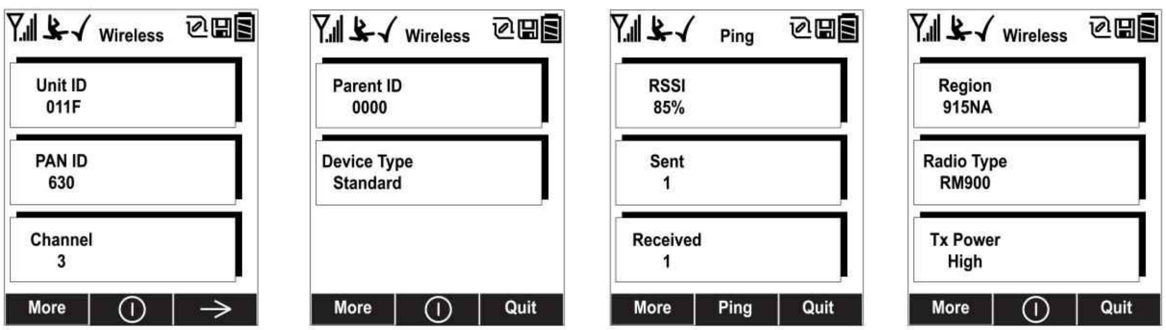
4 Wireless Control And Submenus

When you step through the main menu, as shown in the previous three diagrams, there are two screens for wireless communication.

Note: These are only present if the MultiRAE is equipped with a wireless module.

At the Radio On/Off screen, you can turn the radio on or off, if the MultiRAE is in Advanced User Mode. The radio turns off instantly, but turning on the radio takes a few seconds, so you see a screen that indicates the radio is being turned on. If the instrument is in Basic User Mode, the option for turning the radio on or off does not appear (you can turn it on or off in Programming Mode).

At the Wireless screen, you can check communication with other wireless devices and get other useful information about the wireless settings. The Wireless menu is divided into a sequence of four "pages," each presenting different information. As you press [Y/+] on each of the "pages," you advance to the next one.



Unit ID (unique identifier of the instrument's radio), Pan ID, and Channel are read-only parameters that help you to check whether the instrument's wireless settings are correct (very helpful for troubleshooting).

The next "page," Parent ID and Device Type are also read-only. The Parent ID (the ID of the "Parent" wireless device to which the monitor is connected) is not changeable. The device type tells you that it is "Standard," meaning it transmits and receives.

The third "page" is labeled "Ping," where you can check the signal strength via RSSI (received signal strength indication) and "ping" the network to confirm an active two-way communication network. Each time you press [MODE] to "ping" the network, a number of sends is included under "Sent." If the network receives the signal and sends one back, which is in turn received by the MultiRAE, then a number is added under "Received."

The fourth "page" includes the type of transmitter (Region), Radio Type (model), and Tx Power (transmission power). These are primarily for diagnostics and troubleshooting.

When you reach the fourth "page," you can wrap around to the first one by pressing [Y/+]. Otherwise, you can press [N/-] to quit, which advances to the next screen.

5 Battery

Always make sure the batteries are fully charged before using the MultiRAE. Three battery options are available for the MultiRAE:

1. Standard duration rechargeable Li-ion battery (PN: M01-3053-000)
2. Extended-duration rechargeable Li-ion battery delivering 50% more runtime than the standard battery (PN: M01-3055-000)
3. Alkaline battery pack for four standard AA-sized batteries (PN: M01-3054-000)

Its standard or extended-duration batteries are charged inside the instrument by placing the MultiRAE in its cradle or using the Travel Charger. Contacts on the bottom of the instrument meet the cradle's contact pins, transferring power.

Note: Before setting the MultiRAE into its MultiRAE Desktop Cradle or attaching its Travel Charger, visually inspect the contacts to make sure they are clean. If they are not, wipe them with a soft, dry cloth. Do not use solvents or cleaners.

WARNING

To reduce the risk of ignition of hazardous atmospheres, recharge, remove or replace the battery only in an area known to be non-hazardous! Do not mix old and new batteries or batteries from different manufacturers.

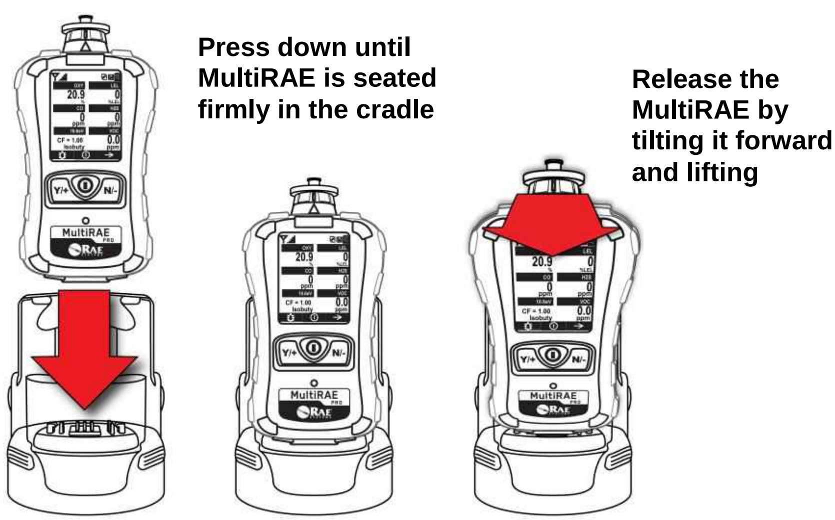
5.1 Charging With The MultiRAE Desktop Cradle

Follow this procedure to charge the MultiRAE:

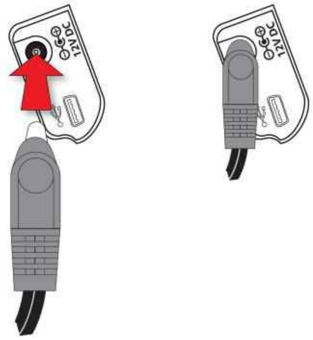
1. Plug the AC/DC adapter into the MultiRAE's Desktop Cradle.
2. Plug the AC/DC adapter into the wall outlet.
3. Place the MultiRAE into the cradle (make sure the bottom of the instrument and the alignment pins on the cradle mate properly) and press down until it is locked in place.

The MultiRAE begins charging automatically. The LED in the cradle should glow red to indicate charging. When charging is complete, the LED in the cradle glows green.

To remove the MultiRAE from the Desktop Cradle, tilt it toward you until it releases, and then lift it up.



Next, put the plug from the power supply into the jack on the side of the Desktop Cradle:



Plug the other end of the charger into a power source.

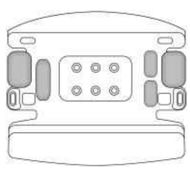
Automatic PID Lamp Cleaning

When a MultiRAE equipped with a PID (photoionization detector) is placed in the Desktop Cradle, its PID is automatically cleaned. During the first four hours of charging, continuous lamp auto-cleaning is performed. After that, cleaning stops. The battery continues to be charged, if necessary.

5.2 Charging With The Travel Charger

The Travel Charger is a lightweight portable alternative to the Desktop Cradle for charging and PC communications. Follow these steps to use the Travel Charger.

Before attaching the Travel Charger, check that it is aligned correctly with the base of the MultiRAE. There are two alignment pins on one side and one alignment pin on the other side, designed to mate with matching points on the bottom of the MultiRAE:



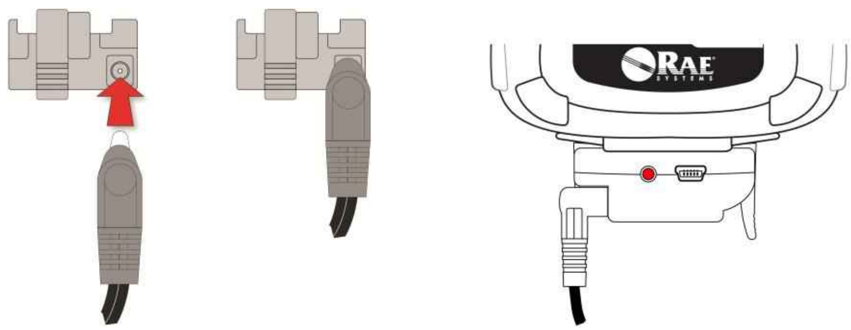
1. Check bottom of MultiRAE Travel Charger’s alignment pins for correct orientation with the MultiRAE.

2. Align Travel Charger with bottom of MultiRAE.

3. Press Travel Charger onto bottom of MultiRAE.

4. Make sure the Travel Charger clicks into place and attaches firmly.

Next, put the plug from the power supply into the jack on the side of the Travel Charger:



Plug the other end of the charger into a power source (AC outlet or 12VDC mobile power port, depending on the model). When power is applied and the MultiRAE's battery is charging, the LED glows red. The LED glows green when the battery is fully charged.

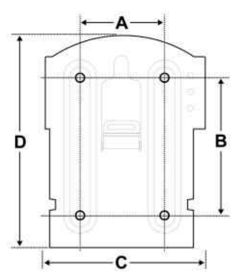
5.3 Carrying The MultiRAE In A Vehicle

The MultiRAE Truck Mount, used in conjunction with the front part of the Desktop Cradle, provides an NFPA requirement-compliant way to mount and carry the MultiRAE in a vehicle.

Truck Mount Installation

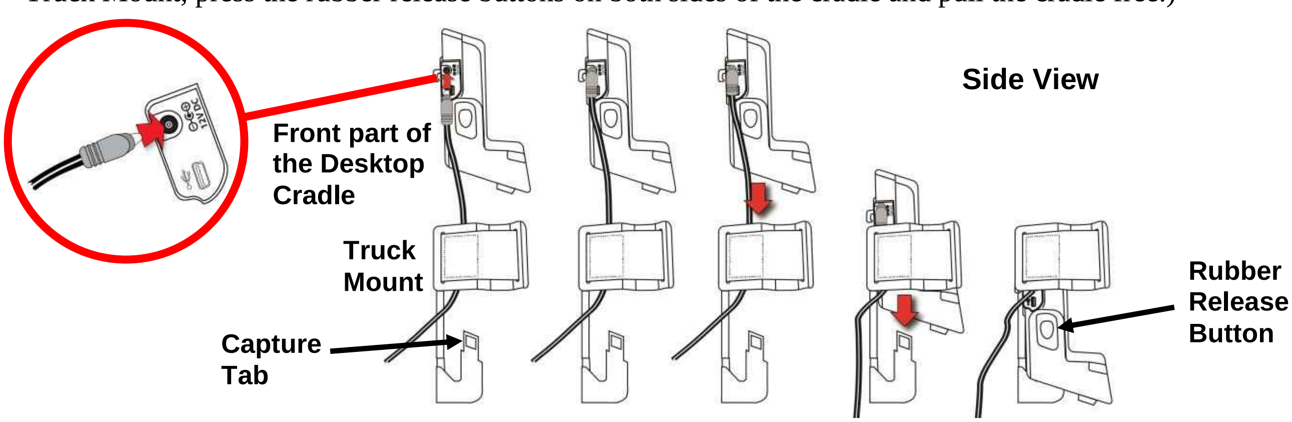
The Truck Mount must be used in conjunction with the front part of the MultiRAE Desktop Cradle. Follow the guidelines below to select the correct mounting hardware for the Truck Mount and install it in your vehicle. Use these dimensions to pre-drill a flat surface to accept the Truck Mount. The maximum screw diameter must not exceed 6.4mm (0.25"). Vertical clearance should be at least 26cm (10").

Letter	Measurement
A	61.6 mm (2.42")
B	96 mm (3.8")
C	113 mm (4.5")
D	150.8 mm (6")

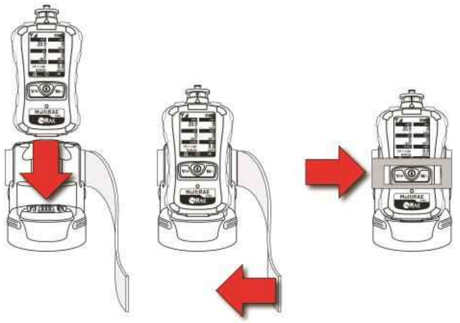


Important!
Make sure that there is sufficient clearance around and above the mounting plate so that the MultiRAE can be easily placed in the cradle and removed.

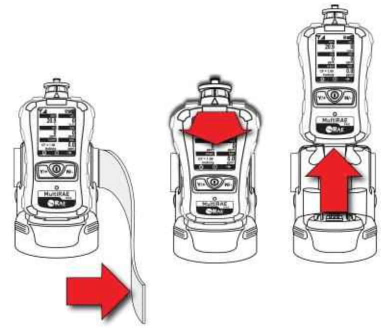
Once the Truck Mount is attached, disconnect the front part of the Desktop Cradle from its base by pressing on the rubber release buttons on both sides of the cradle. Next, insert the plug from the power supply into the jack on the side of the front part of the Desktop Cradle. Then slide the cradle into the Truck Mount as shown below. The capture tabs on both sides of the Truck Mount slip into the cradle and lock it in place. Make sure the cradle sits securely in the Truck Mount. (To separate the cradle from the Truck Mount, press the rubber release buttons on both sides of the cradle and pull the cradle free.)



Place the MultiRAE into the cradle (make sure the bottom of the instrument and the alignment pins on the cradle mate properly) and press down until it is locked in place. Then wrap the Velcro strap around the MultiRAE and fasten its end to the mating Velcro on the side of the Truck-Mount.



To secure: Press the MultiRAE into the cradle and fasten the Velcro strip.



To remove: Unfasten the Velcro strip, tilt the MultiRAE forward, and lift it out

Plug the other end of the charger into a power source. When power is applied and the MultiRAE's battery is charging, the LEDs on the left and right sides of the front of the cradle glow red. The LEDs glow green when the battery is fully charged.

5.4 Charging With The AutoRAE 2

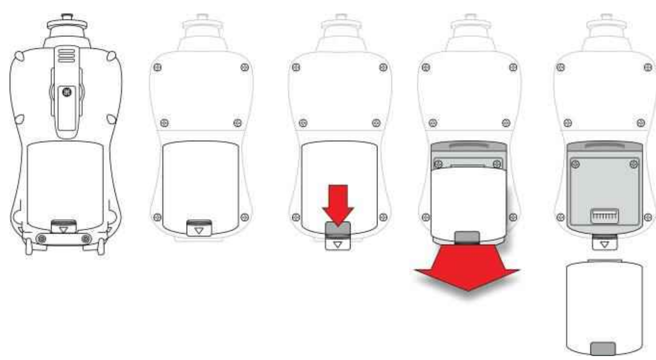
A MultiRAE's battery can be charged by placing the monitor in an AutoRAE 2 Cradle. Details are covered in the AutoRAE 2 User's Guide.

5.5 Replacing A Battery

The MultiRAE battery packs are plug-and-play, and can be replaced on the go without tools. To replace the MultiRAE battery:

1. Remove the battery from the instrument by sliding the tab and tilting out the adapter.

   Note: The belt clip and rubber boot are removed in the illustration for clarity. They can be left on while replacing a battery.



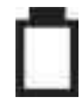
2. Tilt a fully charged battery (or alkaline battery adapter) into the battery compartment and place it in the instrument.
3. Slide the tab back into place to secure the battery.

5.6 Battery States

The battery icon on the display shows how much charge is in the battery and alerts you to any charging problems.

				
Full charge	**2/3 charge**	**1/3 charge**	**Low charge**	**Battery alert**

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. The instrument automatically powers down within 10 minutes, after which you will need to either recharge the battery, or replace it with a fresh one with a full charge.



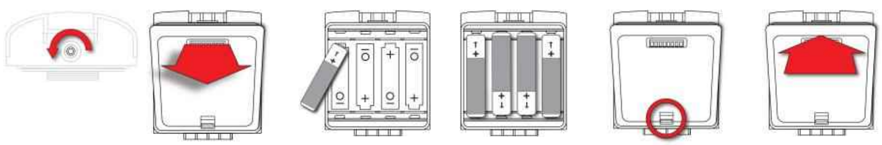
5.7 Alkaline Battery Pack

An alkaline battery adapter is supplied with each instrument. The adapter (part number M01-3054-000) is installed and removed just like the rechargeable battery. It accepts four AA alkaline batteries (use only Duracell MN1500) and provides approximately 8 hours of normal operation.

Note: The vibration alarm is disabled whenever the alkaline adapter is used.

To replace the alkaline adapter's batteries:

1. Remove the hex-socket screw at the end of the adapter.
2. Lift the cover off the battery compartment.
3. Insert four fresh AA batteries as indicated by the polarity (+/-) markings.
4. Replace the cover and replace the hex screw.



IMPORTANT!

Alkaline batteries cannot be recharged. The instrument's internal circuit detects alkaline battery pack and will not allow recharging. If you try to charge alkaline batteries installed in the instrument, the Charging Cradle or Travel Charger's charging LED does not glow, indicating that it will not charge them.

The alkaline battery adapter accepts four AA alkaline batteries (use only Duracell MN1500). Do not mix old and new batteries or batteries from different manufacturers.

Note: When replacing alkaline batteries, properly dispose of old ones.

6 Turning The MultiRAE On And Off

6.1 Turning The MultiRAE On

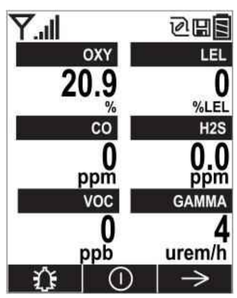
With the instrument turned off, press and hold the [MODE] key until the beep sounds and the display and LED alarm lights turn on, and then release.

A RAE Systems logo (or a company name) should appear first. This is followed by a progression of screens that tell you the MultiRAE's current settings:

- Product name and model number, air flow type, and serial number
- Application firmware version, build date, and build time
- Sensor firmware, build date, build time
- Installed sensors (including serial number/production/expiration/calibration date and alarm limit settings)
- Current date, time, temperature, and relative humidity
- User mode and operation mode
- Battery type, voltage, shutoff voltage
- Alarm mode and alarm settings
- Datalog period (if it is activated) and interval
- Policy Enforcement settings (whether calibration and/or bump testing are enforced)

Note: To speed up the startup time, the number of screens shown on startup can be reduced by enabling the Fast Startup option under Programming/Monitor.

Then the MultiRAE's main reading screen appears. It may take a few minutes for sensors to show a reading, so if any have not warmed up by the time the main screen is shown, you will see "- - -" instead of a numerical value until the sensor provides data (typically less than 2 minutes). Then it displays instantaneous readings similar to the following screen (depending on the sensors installed) and is ready for use.



Note: If the battery is completely empty, then the display briefly shows the message "Battery Fully Discharged," and the MultiRAE shuts off. You should charge the battery or replace it with a fully charged battery before turning it on again.

6.2 Turning The MultiRAE Off

Press and hold [MODE]. A 5-second countdown to shutoff begins. You must hold your finger on the key for the entire shutoff process until the MultiRAE is powered off.

6.3 Testing Alarm Indicators

Under normal-operation mode and non-alarm conditions, the buzzer, vibration alarm, LED, and backlight can be tested at any time by pressing [Y/+] once.

IMPORTANT!

If any of the alarms does not respond to this test, check the Alarm Settings in Programming Mode. It is possible that any or all of the alarms have been turned off. If all of the alarms are turned on, but one or more of them (buzzer, LED lights, or vibration alarm) does not respond to this test, do not use the instrument. Contact your RAE Systems distributor for technical support.

6.4 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:

If there is a pump failure or obstruction that disrupts the pump, the alarm sounds and you see this icon blinking on and off:

Once the obstruction is removed, you can try to restart the pump by pressing the [Y/+]. If the pump does not restart, and the pump stall alarm continues, consult the Troubleshooting section of this guide or contact RAE Systems Technical Support.

It is advisable to perform a pump stall test periodically, to make sure the pump is working properly and there are no leaks in the system. To perform a pump stall test, simply block the gas inlet with your finger. To pass the test, the instrument should go into a pump alarm. Press [Y/+] to disable the alarm and return to normal operation.

Note: Pump Status is not indicated on diffusion MultiRAEs.

6.5 Calibration Status

The instrument displays this icon next to the sensor that 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 module has been replaced with one whose calibration is overdue.
- The defined period of time between calibrations has been exceeded.
- If you have changed the calibration gas type without recalibrating the instrument.
- The sensor has failed a previous calibration.

6.6 Bump Status

The instrument displays this icon next to the sensor that requires bump test:

A bump test is required (and indicated by this icon) if:

- The defined period of time 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 Modes Of Operation

The MultiRAE has two operation modes and two user modes.

7.1 Hygiene Operation Mode

Hygiene Mode provides continuous monitoring.

7.2 Search Operation Mode

Search Mode provides monitoring only when monitoring is initiated. This allows specific samples to be taken at different times, rather than continuously.

7.3 Basic User Mode

In Basic User Mode, some restrictions are applied, including password protection that guards against entering Programming Mode by unauthorized personnel.

7.4 Advanced User Mode

In Advanced User Mode, there are no access restrictions (you do not need a password), and MultiRAE provides the indications and data you need most for typical monitoring applications.

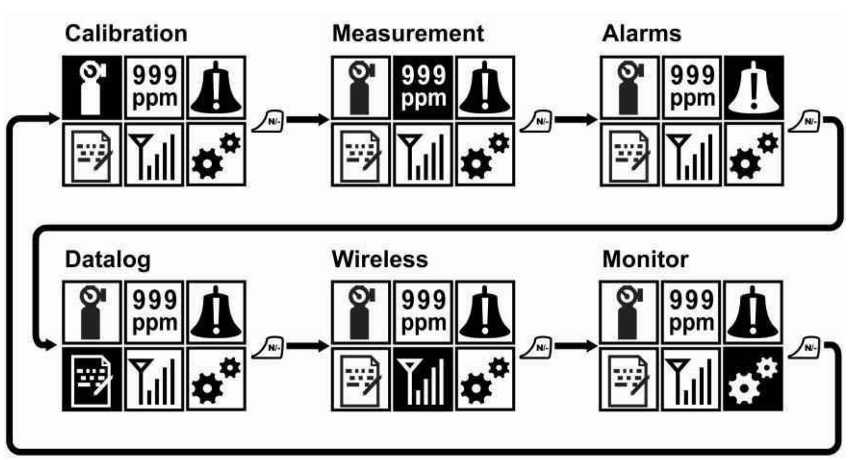
8 Programming

The menu in Programming Mode is to adjust settings, calibrate sensors, and initiate communication with a computer. It has the following submenus:

- Calibration
- Measurement
- Alarms
- Datalog
- Wireless
- Monitor

8.1 Enter Programming In Advanced Mode

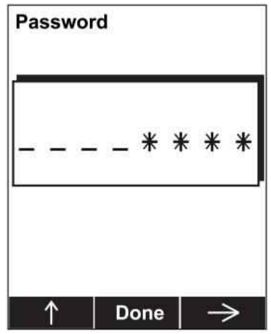
1. To enter Programming Mode, press and hold [MODE] and [N/-] until you see the Calibration screen. No password is necessary in Advanced Mode.
2. Press [N/-] to step through the programming screens.



To enter a menu and view or edit parameters in its submenus, press [Y/+].

8.2 Enter Programming In Basic Mode

1. To enter Programming Mode, press and hold [MODE] and [N/-] until you see the Password screen.



2. Input the 4-digit password:

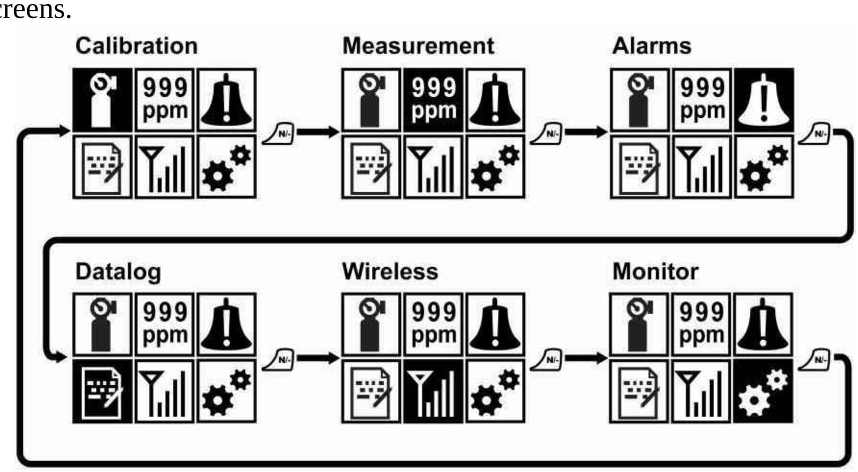
- Increase the number from 0 through 9 by pressing [Y/+].
- Step from digit to digit using [N/-].
- Press [MODE] when you are done.

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.

Note: The password screen only appears when you enter the Programming Mode the first time after turning the instrument on in Basic Mode. If you have input the correct password, you do not have to input it again to enter Programming Mode until you turn the instrument off and on again.

Once you enter Programming Mode, the Calibration menu is highlighted. Press [N/-] to step through the programming screens.



To enter a menu and view or edit parameters in its submenus, press [Y/+].

8.3 Menus And Submenus

In Programming Mode, menus and submenus are organized as shown here:

Calibration	Measurement	Alarms	Datalog	Wireless*	Monitor
Fresh Air	Sensor On/Off	Alarm Limits	Clear Datalog	Radio ON/OFF	LCD Contrast
Multi Sensor Span	Change Meas. Gas	Alarm Mode	Datalog Interval	PAN ID	Operation Mode
Single Sensor Zero	Measurement Units	Alarm Settings	Sensor Selection	Channel	Pump Speed**
Single Sensor Span		Comfort Beep	Data Selection	Join Network	Zero At Start
Multi Sensor Bump		Man Down Alarm	Datalog Type	Interval	Fast Startup
Single Sensor Bump			Memory Full Action	Off Network Alarm	Temperature Units
Cal. Reference				Factory Reset	Language
Change Cal. Gas					Site ID
Multi Cal. Select					User ID
Change Span Value					Date Format
Change Span2 Value***					Date
					Time Format
					Time
					User Mode
					Backlight
					LCD Flip

* This menu is available on wirelessly equipped instruments only.
** Pump-equipped version only.
*** This menu item is shown only if a 3-point calibration is enabled. Change Span2 Value menu item is only shown if a 3-point calibration is enabled on the instrument. Three-point calibration is disabled by default, but can be enabled on MultiRAE and MultiRAE Pro instruments with 10.6eV PID sensors, including high-range ppm and ppb PID sensors. The MultiRAE Lite PID sensor only supports 2-point calibration.

8.3.1 Editing And Selecting Parameters And Sensors

There are a few basic ways to edit parameters, select sensors, and perform other activities in the MultiRAE. The actions performed by pressing keys always match 1-to-1 with the boxes along the bottom of the display and the three keys. Some parameters are edited by scrolling and selecting individual items (black bars behind white text act as highlighters). Some include a choice via "radio buttons," where only one item in a list can be selected, while other menus use boxes for you to "check" with an "X," and these allow for multiple items in a list to be selected. In all cases of editing, you can save or undo your choice.

8.3.2 Calibration

Use this menu to perform a bump test or zero or span calibration for one or more sensors, and change the gas concentration value used in bump tests and span calibration, as well as choose which sensors will be calibrated at the same time.

8.3.2.1 Fresh Air

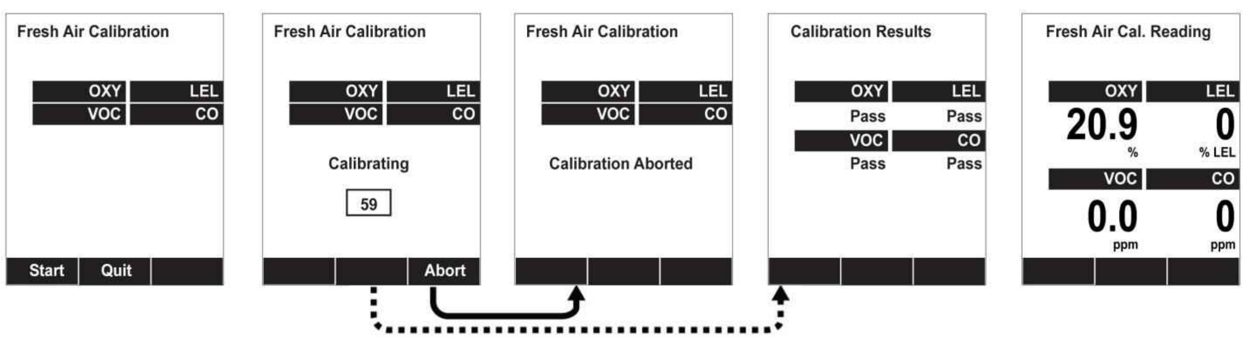
This procedure determines the zero point of the sensor calibration curve for all the sensors that require a zero calibration. For the oxygen sensor, Fresh Air calibration sets the point equal to the concentration of oxygen in ambient air (approximately 20.9% volume).

Note: Fresh air calibration is performed on all enabled gas sensors at the same time.

To perform Fresh Air calibration on multiple sensors:

1. If using dry air, install the calibration adapter and connect it to a source of dry air. Otherwise do not use calibration adapter to perform fresh air calibration.
2. At the Calibration Menu, select "Fresh Air." Press [Y/+] once to enter the fresh air calibration sub-menu.

3. Start the flow of dry air, if used.
4. Press [Y/+] to start fresh air calibration.
5. A countdown screen appears. You can abort the calibration at any time during the countdown by pressing [N/-].



Note: Dotted line indicates automatic progression.

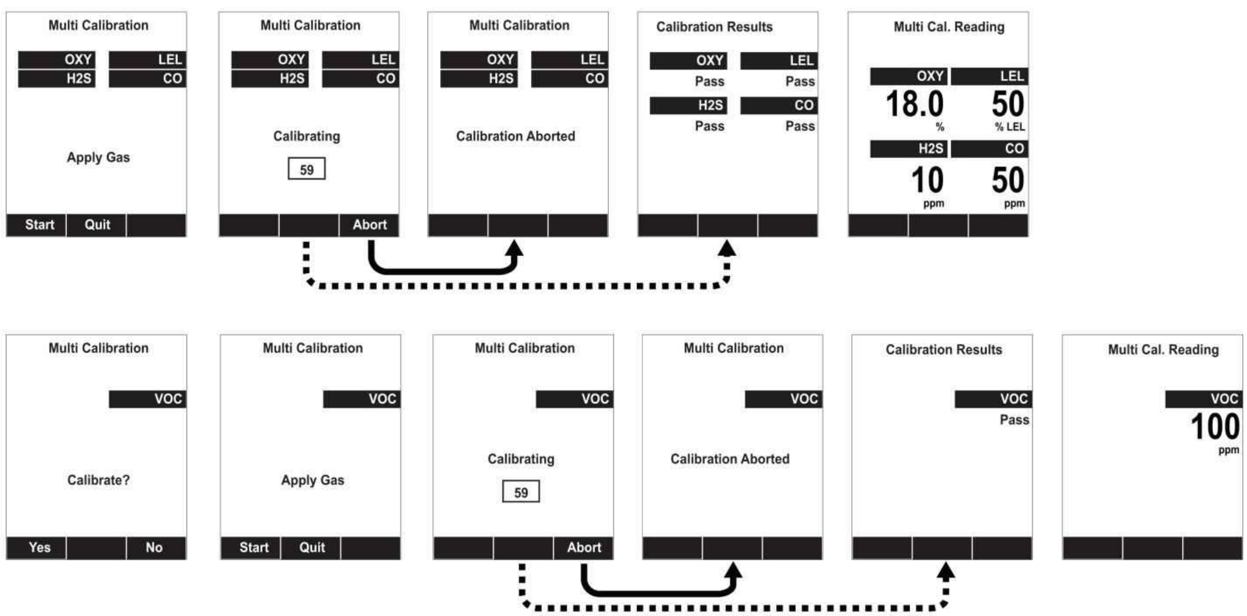
6. If the calibration is not aborted, the display shows the sensor names and tells you whether the fresh air calibration passed or failed, followed by the sensors' fresh air readings.

8.3.2.2 Multi Sensor Span

Depending on the configuration of your MultiRAE and span gas you have, you can perform a span calibration simultaneously on multiple sensors. You can define which sensors are calibrated together using the Multi Cal Select menu described in section 8.3.2.9.

In case all sensors in the instrument cannot be calibrated with the same gas, the MultiRAE will intelligently split the span calibration process into several steps and will provide menu prompts accordingly.

1. At the Calibration Menu, select "Multi Sensor Span."
2. Install the calibration adapter and connect it to a source of calibration gas.
3. Start the flow of calibration gas.
4. Press [Y/+] to start calibrating or wait for calibration to start automatically.
5. A countdown screen is shown. You can abort the calibration at any time during the countdown by pressing [N/-].



Note: Dotted line indicates automatic progression.

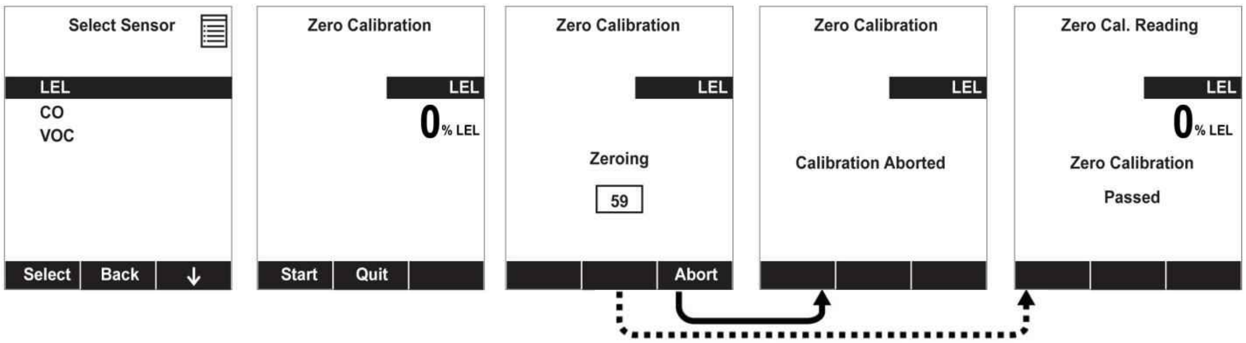
6. If the calibration is not aborted, the display shows the sensor names and tells you whether the calibration passed or failed, followed by the sensor readings.

8.3.2.3 Single Sensor Zero

This allows you to perform zero (fresh air) calibration on individual sensors. Even though most toxic gas sensors can be zeroed in fresh air, sensors such as the CO_2 and parts-per-billion PID sensor for volatile organic compounds (VOCs) should not be zeroed in fresh air. Both CO_2 gas and VOCs are normally present in ambient air, so zeroing these sensors in ambient air will not allow for a true zero to be set for such sensors. The CO_2 sensor should be zeroed in 99.9% nitrogen, and the parts-per-billion PID sensor with ambient air using a charcoal filter or a VOC zeroing tube.

1. If you are using a charcoal filter, connect it to the instrument.
2. If you are using dry air, install the calibration adapter and connect it to a source of dry air.

3. At the Calibration Menu, select "Single Sensor Zero." Press [Y/+] once to enter the zero calibration sub-menu.
4. Start the flow of dry air, if used.
5. Press [Y/+] to start zero calibration.
6. A countdown screen appears. You can abort the calibration at any time during the countdown by pressing [N/-].



Note: Dotted line indicates automatic progression.

7. If the calibration is not aborted, the display shows the sensor names and tells you whether the zero calibration passed or failed, followed by the sensors' zero calibration readings.

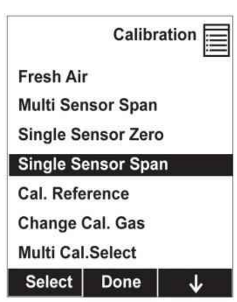
8.3.2.4 Single Sensor Span

Instead of performing a span calibration on multiple sensors simultaneously, you can select a single sensor and perform a span calibration.

Note: If a calibration icon (bottle with bottom portion filled in) is shown next to any of the sensors, it means that the sensor is due for a full calibration.

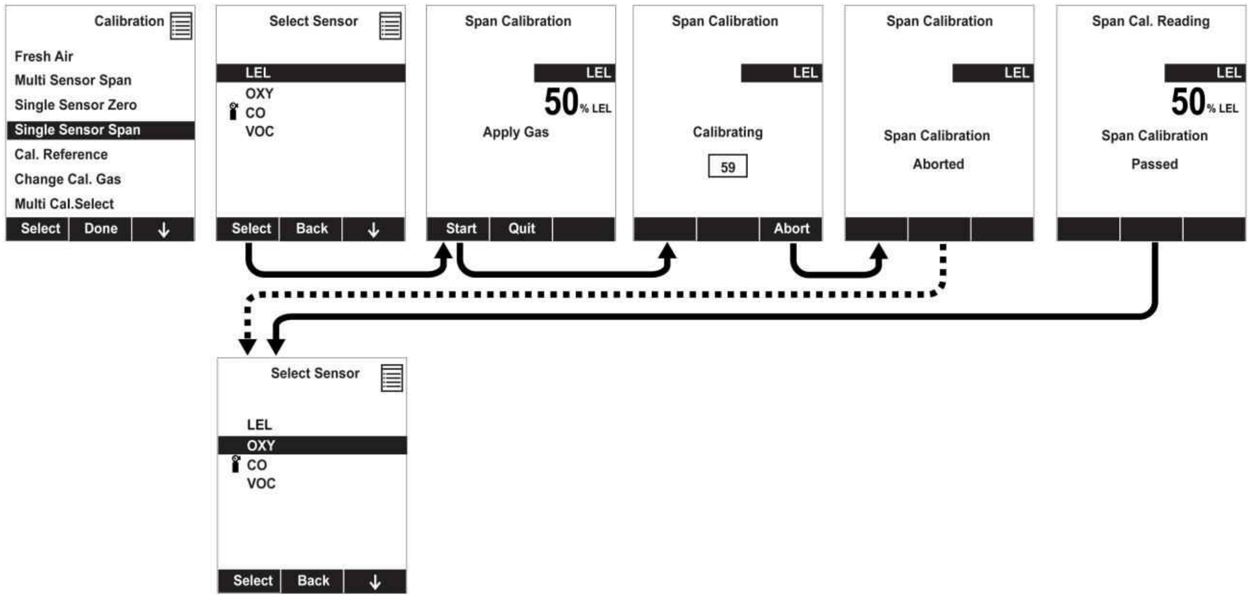
To perform span calibration of an individual sensor, follow these steps:

1. At the Calibration Menu, select "Single Sensor Span."
2. Select a sensor to calibrate from the list.
3. Install the calibration adapter and connect it to a source of calibration gas.
4. Verify that the displayed calibration value meets the concentration specified on the gas cylinder.
5. Start the flow of calibration gas.



6. Press [Y/+] to start calibrating or wait for calibration to start automatically.

7. A countdown screen appears. You can abort the calibration at any time during the countdown by pressing [N/-].



Note: Dotted line indicates automatic progression.

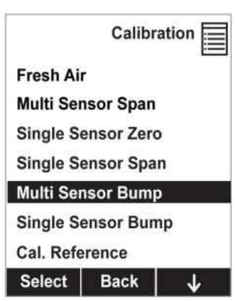
8. If the calibration is not aborted, the display shows the sensor names and tells you whether the calibration passed or failed, followed by the sensor readings.

Note: The gamma radiation sensor comes pre-calibrated from the factory and does not require routine calibration. However, you can check it by placing a check-source on the rear of the MultiRAE equipped with a gamma sensor to check the readings. There is a raised dot on the rubber boot that marks where the sensor is located inside the instrument.

8.3.2.5 Multi Sensor Bump

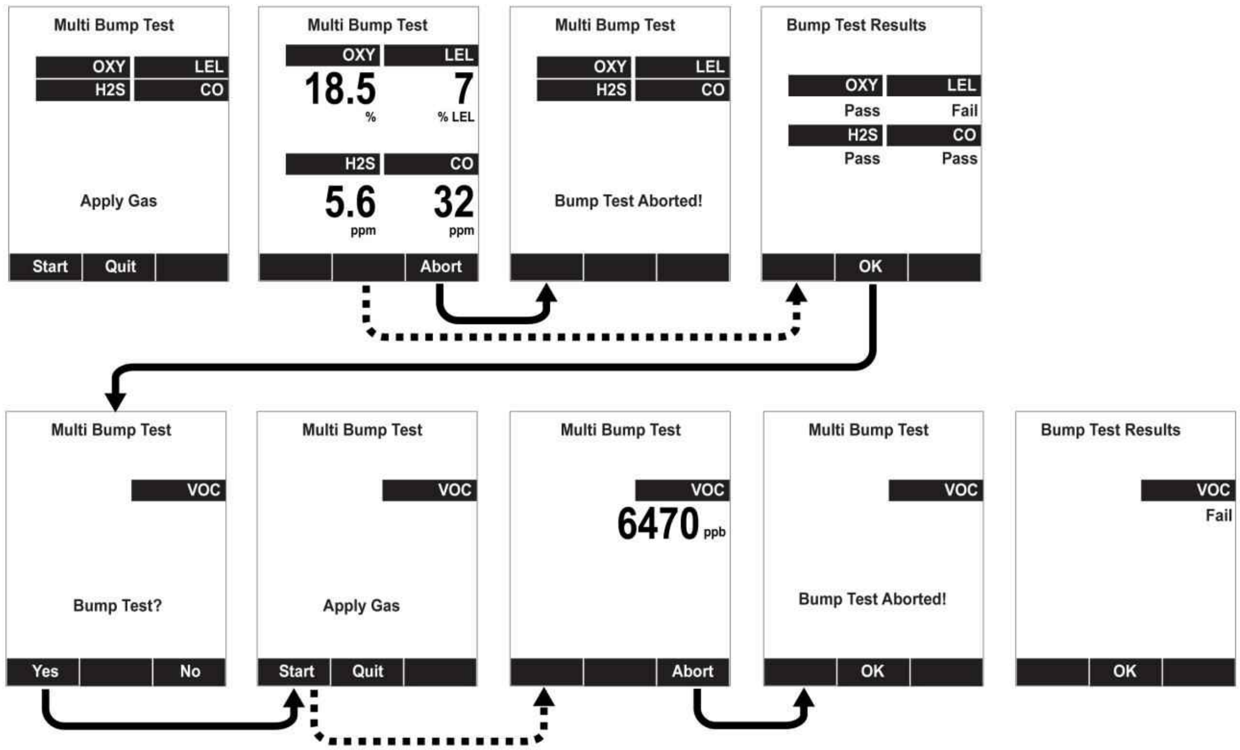
Depending on the configuration of your MultiRAE and span gas you have, you can perform a bump test simultaneously on multiple sensors. Which sensors are bump tested simultaneously is defined in the Multi Cal Select menu. Refer to section 8.3.2.9 for more information.

In case all sensors in the instrument cannot be calibrated with the same gas, the MultiRAE will intelligently split the span calibration process into several steps and will provide menu prompts accordingly.



1. At the Calibration Menu, select "Multi Sensor Bump."
2. Install the calibration adapter and connect it to a source of calibration gas.

3. Start the flow of calibration gas.
4. Press [Y/+] to start calibrating or wait for calibration to start automatically.
5. A countdown screen is shown. You can abort the calibration at any time during the countdown by pressing [N/-].



Note: Dotted line indicates automatic progression.

6. If the calibration is not aborted, the display shows the sensor names and tells you whether the calibration passed or failed, followed by the sensor readings.
7. If a sensor requires different gas (such as a PID for VOCs), you are prompted. Change the calibration gas, and when you are ready, start bump testing by pressing [Y/+].

Note: You can quit the bump calibration procedure and exit to the menu whenever you see "Quit." Press [MODE] to quit.

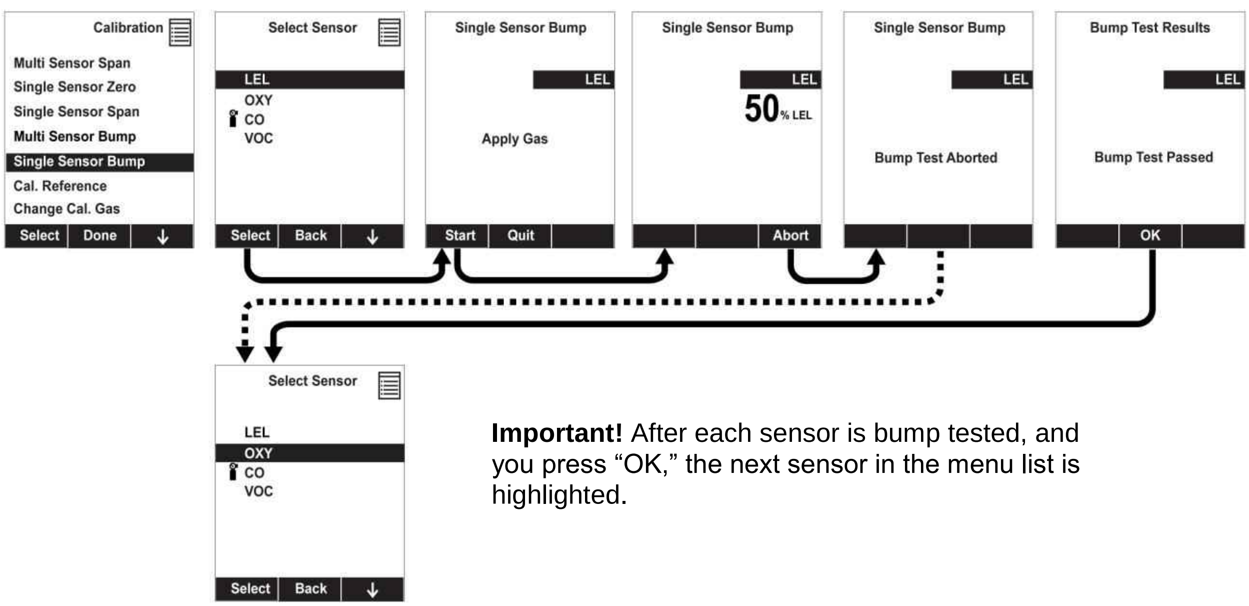
8.3.2.6 Single Sensor Bump

This menu allows a bump test to be performed on an individual sensor of your choice.

Note: If a bump test icon (bottle with bottom portion not filled in) is shown next to any of the sensors, it means that the sensor is due for a bump test.

To perform a bump test on an individual sensor, follow these steps:

1. At the Calibration Menu, select "Single Sensor Bump."
2. Scroll down the list using [N/-], and then press [Y/+] to select a sensor to calibrate.
3. Install the calibration adapter and connect it to a source of calibration gas.
4. Verify that the displayed calibration value meets the concentration specified on the gas cylinder.
5. Start the flow of calibration gas.



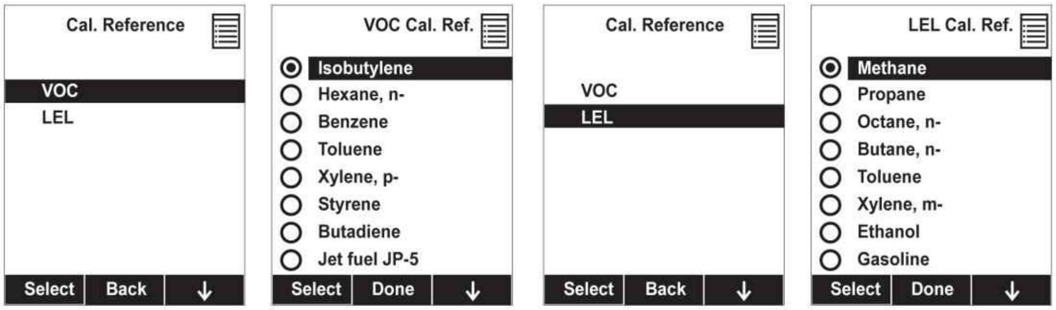
Important! After each sensor is bump tested, and you press "OK," the next sensor in the menu list is highlighted.

Note: Dotted line indicates automatic progression.

6. Press [Y/+] to start calibrating or wait for calibration to start automatically.
7. A countdown screen appears. You can abort the calibration at any time during the countdown by pressing [N/-].
8. If the calibration is not aborted, the display shows the sensor names and tells you whether the calibration passed or failed, followed by the sensor readings.

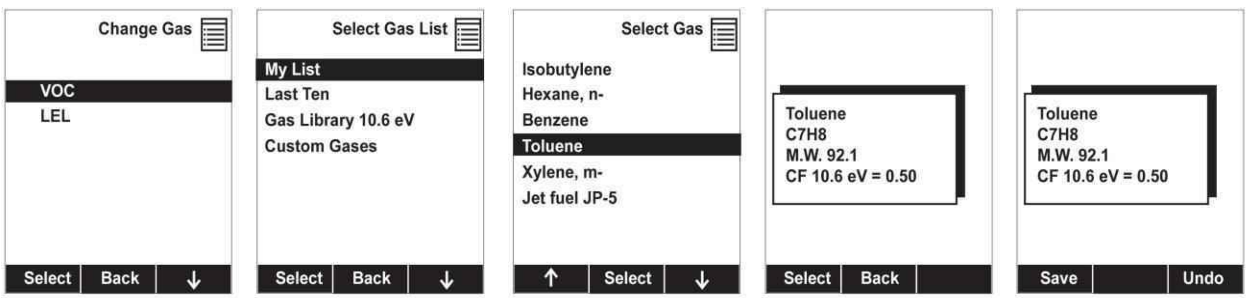
8.3.2.7 Cal. Reference

It is sometimes desirable to calibrate a sensor (PID for VOC, and LEL) with a specific gas for best response to a gas you are surveying. The Cal. Reference library contains calibration curves for the PID and LEL sensors for select gases. Choose the sensor, and then select from the list of reference gases.



8.3.2.8 Change Cal. Gas

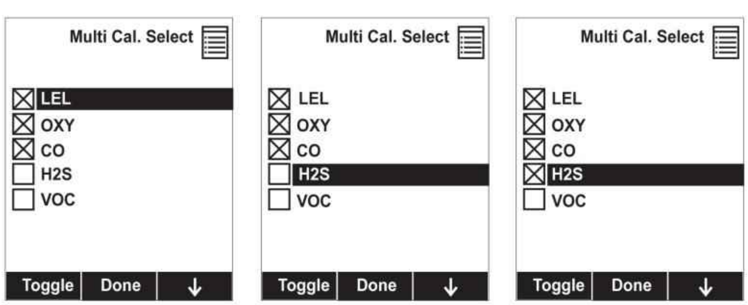
You can change the calibration gas for the MultiRAE's PID and LEL sensors. Select from a custom list that you create (My List), the last ten gases used, the built-in gas library for your PID lamp, and user-defined custom gases. Each gas is shown in the list for selection and the screen automatically changes to show its full name, chemical formula, molecular weight (M.W.) and correction factor (CF).



8.3.2.9 Multi Cal Select

This menu allows you to define a group of sensors to be bump tested and span calibrated together. Simultaneous testing and calibration of multiple sensors shortens the bump test and calibration processes and reduces the number of individual gas cylinders you need. For example, it may be more efficient to use a single cylinder with a four-gas mix including 50% LEL Methane, 18% O_2, 10 ppm H_2S, and 50 ppm CO, to calibrate the LEL, O_2, CO, and H_2S sensors at one time, compared to using four distinct gas cylinders and calibrate these sensors individually in sequence. In order for sensors to be calibrated together, all of them must be selected using Multi Cal. Select.

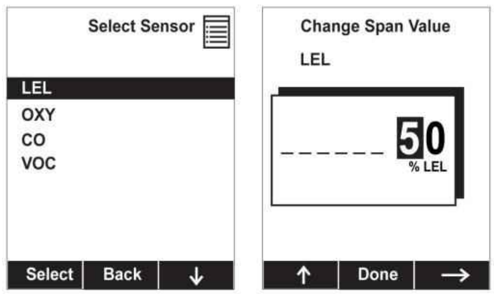
1. Scroll down the list of sensors using the [N/-] key.
2. Add or remove that gas from the list by pressing [Y/+]. An "X" in a box to the left of a sensor's name indicates it is selected.
3. Once you have made all your selections, press [MODE] for "Done."



8.3.2.10 Change Span Value

You can individually set the span gas concentration for each sensor. This concentration setting will also be used for a bump test. The units of measure (ppm, %LEL, etc.) are shown on the display.

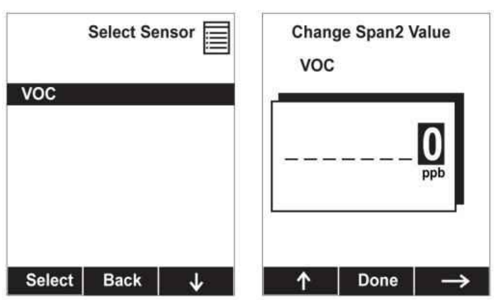
1. Scroll down the list of sensors using the [N/-] key.
2. Press [Y/+] to select it.
3. Press [N/-] to step through the digits.
4. Press [Y/+] to increase the number from 0 through 9. Once the number 9 is reached, pressing [Y/+] causes the numbers to "wrap around" to 0 and count up again.
5. Once you have set the desired value, press [MODE] for "Done." This registers the new span value.



8.3.2.11 Change Span2 Value

If your MultiRAE is equipped with a high-range, or parts-per billion, PID sensor, you can set the span gas value for a third calibration point (Span2). The unit of measure is shown on the display.

1. Press [Y/+] to select the highlighted sensor (VOC).
2. Press [N/-] to step through the digits.
3. Press [Y/+] to increase the number from 0 through 9. Once the number 9 is reached, pressing [Y/+] causes the numbers to "wrap around" to 0 and count up again.
4. Once you have set the desired value, press [MODE] for "Done." This registers the new Span 2 value.



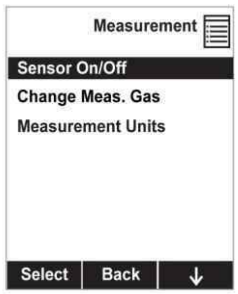
Note: Three-point calibration is disabled by default, but can be enabled on MultiRAE and MultiRAE Pro instruments with 10.6eV PID sensors, including high-range ppm and ppb PID sensors. The MultiRAE Lite PID sensor only supports 2-point calibration.

8.3.3 Measurement

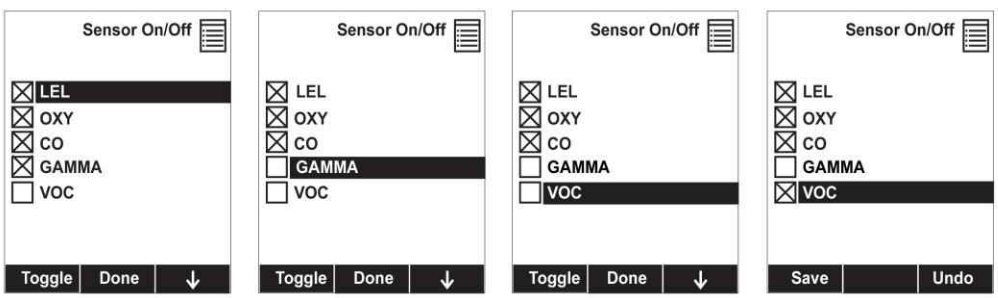
The submenus for Measurement include Sensor On/Off, Change Measurement Gas, and VOC and Gamma (if equipped) Measurement Units.

8.3.3.1 Sensor On/Off

You can turn sensors on or off via this submenu. An "X" in a box to the left of a sensor's name indicates it is turned on.

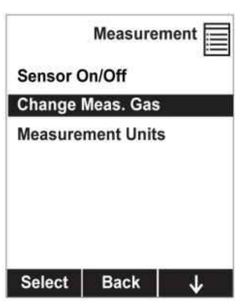


1. Scroll down the list of sensors using the [N/-] key.
2. Add or remove that gas from the list by pressing [Y/+]. An "X" in a box to the left of a sensor's name indicates it is selected.
3. Once you have made all your selections, press [MODE] for "Done."



8.3.3.2 Change Meas. Gas

The MultiRAE has extensive onboard gas libraries for combustible gases and VOCs that you can use to configure your MultiRAE to automatically apply the appropriate correction factors and produce readings in the units of the desired combustible gas or VOC.

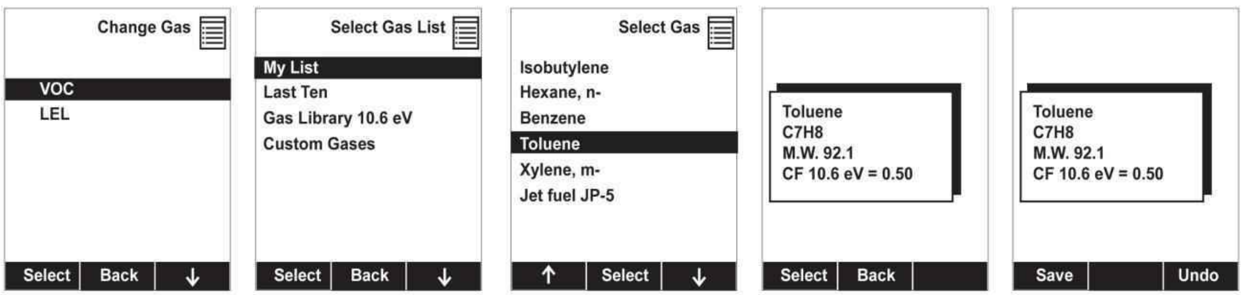


Measurement gases are organized in four lists:

- **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 on a PC and transferred to the instrument.

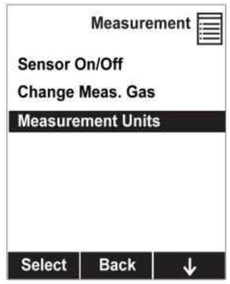
  Note: The first gas in the list is always isobutylene (it cannot be removed from the list).

- **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 more than 200 gases for the PID sensor and more than 50 for the catalytic LEL sensor.
- **Custom Gases** are gases with user-modified parameters. Using ProRAE Studio II, all parameters defining a gas can be modified, including the name, span value(s), correction factor, and default alarm limits.



8.3.3.3 Measurement Units

In some cases, the measurement unit for displaying data from sensors can be changed.

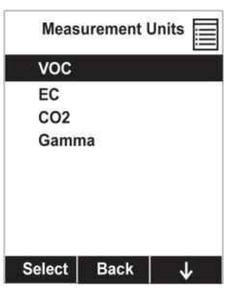


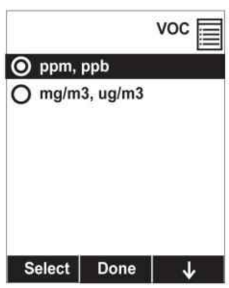
Standard available measurement units include:

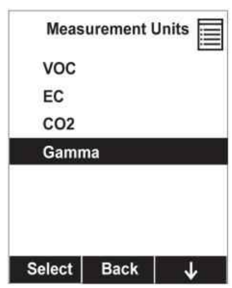
Abbreviation	Unit	Sensor Type
ppm, ppb	parts per million, parts per billion	PID for VOC
mg/m3, ug/m3	milligrams per cubic meter, micrograms per cubic meter	PID for VOC
ppm, mg/m3	parts per million, milligrams per cubic meter	EC (electrochemical)
ppm Only, %VOL only, Auto Range	parts per million, percent by volume, automatically switch from ppm to %VOL at 10,000 ppm and higher*	CO_2
urem, mrem	microrems and millirems	Gamma
uSv, mSv	microSieverts and milliSieverts	Gamma
uR, mR	microRoentgens and milliRoentgens	Gamma
uGy, mGy	microGrays and milliGrays	Gamma

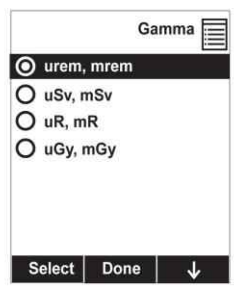
* The CO_2 switch point from ppm to %VOL can be changed via ProRAE Studio 2.

Here are two examples of menu hierarchies (select the sensor type and then the measurement unit):









8.3.4 Alarms

Use this menu to change high, low, STEL, and TWA alarm limits - the points at which alarms are triggered. The Alarms menu also allows changing alarm mode (latched or automatic reset) and alarm output methods (combinations of light, buzzer, and vibration alarm indications).

8.3.4.1 Alarm Limits

There are four groups of alarm settings that you can adjust for each individual sensor for which a particular alarm type is available.

Settings:

- High Alarm
- Low Alarm
- STEL (Short-Term Exposure Limit) Alarm
- TWA (Time-Weighted Average) Alarm

Note: Some alarm settings are not applicable to all sensors. If a setting is irrelevant to a sensor (for example, STEL for a gamma radiation sensor), then that sensor does not appear in the list.

8.3.4.2 Alarm Mode
You can program the MultiRAE so that there are two ways to shut off an alarm:

Auto Reset	When the alarm condition is no longer present, the alarm stops automatically.
Latch	You must manually turn off an alarm when one is triggered. The latched setting only controls alarms for High Alarm, Low Alarm, STEL Alarm, and TWA Alarm.

8.3.4.3 Alarm Settings
You can enable/disable any combination of light (visible), buzzer (audible), and vibration alarms.

Settings:

- All Enabled
- Light
- Vibration
- Buzzer
- Buzzer & Light
- Buzzer & Vibration
- Vibration & Light
- All Disabled

8.3.4.4 Comfort Beep
A Comfort Beep is a single beep of the audible alarm at 60-second intervals that informs the person using the MultiRAE that it is functioning. It can be turned on or off.

8.3.4.5 Man Down Alarm
The Man Down Alarm is a critical and potentially lifesaving feature of every MultiRAE. The Man Down Alarm is based on the premise that if the instrument is motionless when it is not supposed to be, something wrong may be happening to its user. If that is the case, a wirelessly enabled MultiRAE not only goes into alarm locally on the instrument to notify people in the vicinity, but also remotely, over the RAE Systems Dedicated Wireless Network, to transmit the alarm to remote safety officers at a command center, that a person is down, so that help can be dispatched quickly.

Whenever the Man Down feature is enabled, the main screen displays a Man Down icon along the top to indicate it is active:

The MultiRAE has a 3D gravity sensor that can track the slightest motion of the instrument in any direction. If the instrument is not moved during that time, then a pre-alarm is activated to alert the user, and shows the “Are You OK?” screen. Pressing [Y/+] clears the alarm and returns the MultiRAE to its normal operation. Pressing [N/-] sets it into Man Down Alarm (and if wireless connectivity is enabled, a Man Down message is sent in real time to remote observers). If neither key is pressed, then after the count-down, it goes into Man Down Alarm (again sending a message to remote observers if wirelessly enabled).

Settings are available for:

- Off/On (off by default)
- Motionless Time: time the instrument is motionless before initiating a pre-alarm (30 seconds by default)
- Motion Sensitivity: set to low, medium, or high to compensate for ambient vibration or motion (medium by default)
- Warning Time: countdown, in seconds, from pre-alarm to Man Down alarm (30 seconds by default)

When the Man Down pre-alarm is activated, the buzzer sounds and LEDs flash twice per second, and a countdown begins.

- If the MultiRAE's user presses [Y/+] for "Yes" in response to the "Are You OK?" question on the screen before the countdown reaches zero, the Man Down alarm stops and the main reading screen is displayed.
- If the person does not press [Y/+] for "Yes" in response to the "Are You OK?" question on the screen before the countdown reaches zero, the Man Down alarm is triggered.
- If the person presses [N/-] during the countdown, answering the "Are You OK?" question with "No," the Man Down alarm starts.

If wireless connectivity is enabled, a Man Down message is also sent to remote observers.

IMPORTANT!

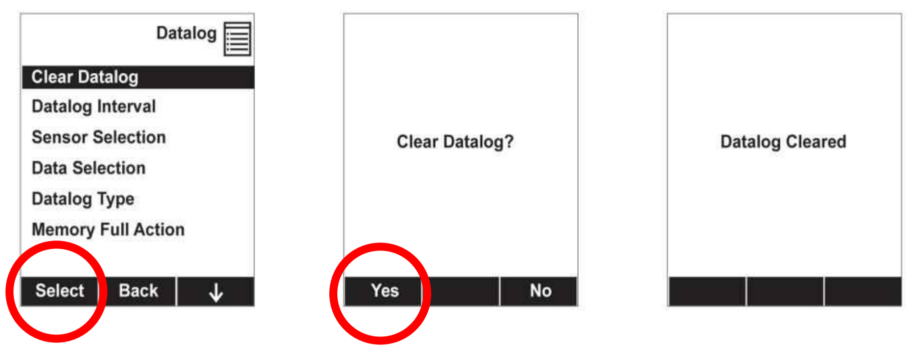
When gas or radiation alarm conditions exist at the same time as the Man Down is activated, the pre-alarm stage is skipped and the instrument goes straight into a Super Alarm (gas or radiation and Man Down) with four beeps/flashes per second.

8.3.5 Datalog

The instrument displays a floppy disk icon to indicate that a datalog is being recorded. The instrument stores the measured gas concentration for each sensor, date and time for each measurement, Site ID, User ID, and other parameters. The MultiRAE memory is sufficient to record six months' worth of data for five sensors at one-minute intervals, 24/7. All data are retained (even after the unit is turned off) in non-volatile memory so that they can be downloaded at a later time to a PC.

8.3.5.1 Clear Datalog

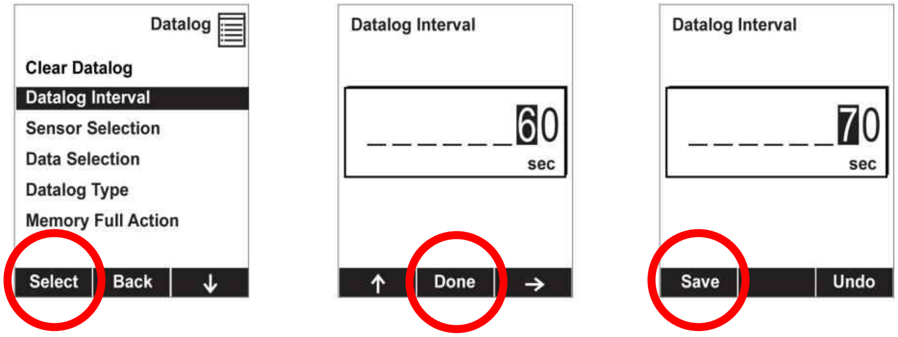
This operation erases all data stored in the datalog. Select "Clear Datalog," and then "Yes."



Note: Once the datalog is cleared, the data cannot be recovered.

8.3.5.2 Datalog Interval

Intervals are shown in seconds. The default value is 60 seconds. The maximum interval is 3600 seconds, and the minimum is 1 second.



8.3.5.3 Sensor Selection

You can choose which sensors' data are included in the datalog. The entire list of installed sensors is shown, and you can individually select whether their data is included.

Note: Turning a sensor off in the list does not change or erase its settings.

8.3.5.4 Data Selection

Data Selection allows you to select which types of data are stored and made available when you download your datalog to a computer via ProRAE Studio II (version 1.04 or higher) software.

You can choose any or all of four types of data (you must choose at least one):

- Minimum
- Average
- Maximum
- Real Time

8.3.5.5 Datalog Type

The instrument offers three options for starting the datalogging process:

Auto Automatically collects datalog information every time the instrument is sampling until the datalog memory is full.
Manual Datalogging occurs only when you manually initiate it (see below for details).
Snapshot Captures a single event when you press [MODE].

Note: You can only choose one datalog type to be active at a time.

About Manual Datalogging

When the instrument is set to Manual Datalog, you can turn datalogging on and off by repeatedly pressing [N/-] and stepping through the screens from the main display until you reach the screen that says "Start Datalog?"

- When you reach the screen that says "Start Datalog?" press [Y/+] to start it. You see "Datalog Started," confirming that datalogging is now on. You can turn it off by pressing [Y/+] again.
- If datalogging is running, you can leave it running. However, if you want to turn it off, follow this procedure:

  Press [N/-] repeatedly to step through the screens until you reach the screen that says, "Stop Datalog?" Press [Y/+] to stop datalogging. The screen displays "Datalog Stopped" for a few seconds, before displaying "Start Datalog?" and the datalog interval. You can restart it anytime by pressing [Y/+] from that screen.

About Snapshot Datalogging

When the instrument is in Snapshot datalogging mode, it captures a single "snapshot" of the data at the moment of your choosing. All you have to do is press [MODE] each time you want to capture a snapshot of the data at that instant.

No snapshot.

Press [MODE] for a snapshot.

Datalog icon is shown momentarily during a snapshot

8.3.5.6 Memory Full Action

When the internal datalog memory is full, the MultiRAE can either stop collecting data (Stop when full) or go back to the beginning and overwrite the data from the first entry, second entry, etc. (Wraparound).

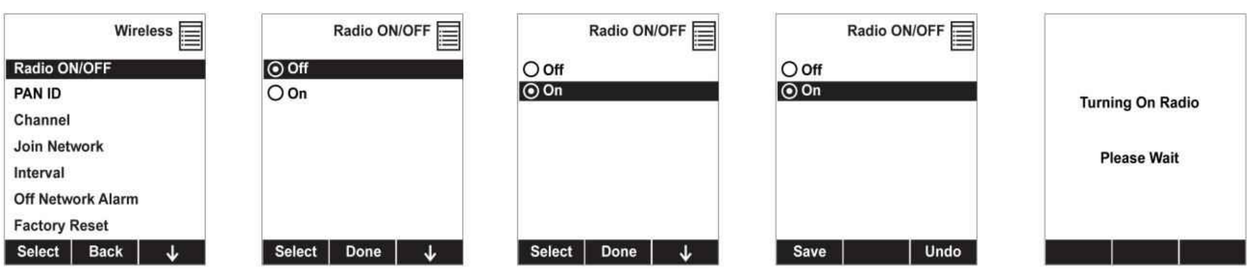
8.3.6 Wireless

When a MultiRAE is equipped with a wireless modem, its settings are controlled via the menu items under "Wireless."

8.3.6.1 Radio ON/OFF

Turn the radio on or off via this menu.

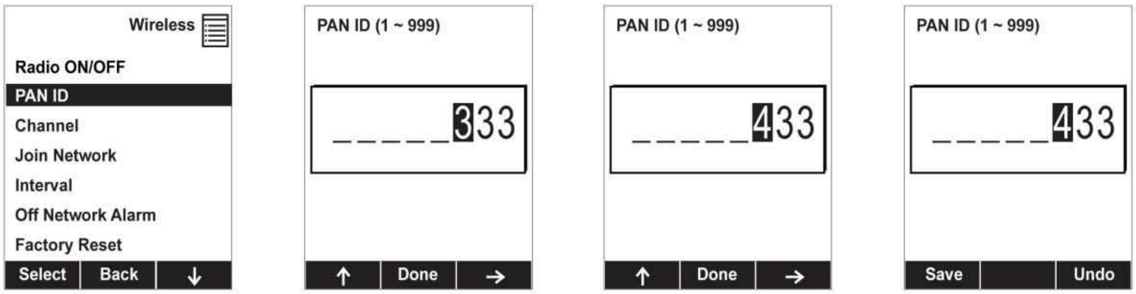
1. Choose between "On" and "Off" by pressing [N/-].
2. Select the highlighted state by pressing [Y/+].
3. Save or register the change:
   - Press [Y/+] to save the change.
   - Press [N/-] to undo the change.



8.3.6.2 PAN ID

The MultiRAE and any other devices that you want to interconnect wirelessly must have the same PAN ID.

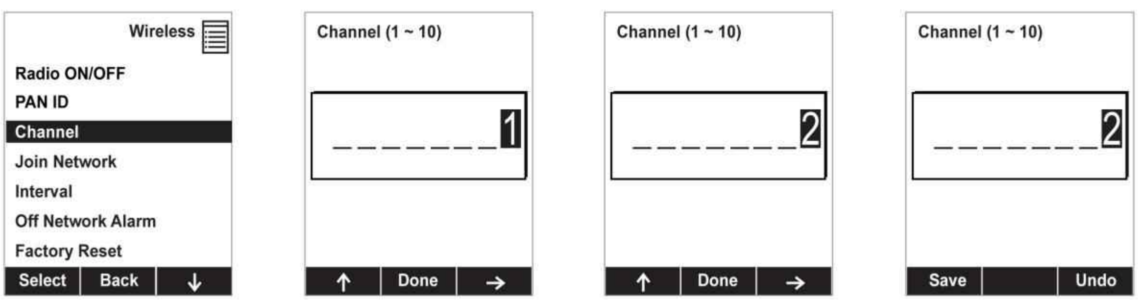
1. Press [Y/+] to increase the number and [N/-] to advance to the next digit.
2. After moving to the last digit and making changes, press [MODE].
   - Press [Y/+] to save the change.
   - Press [N/-] to undo the change.



8.3.6.3 Channel

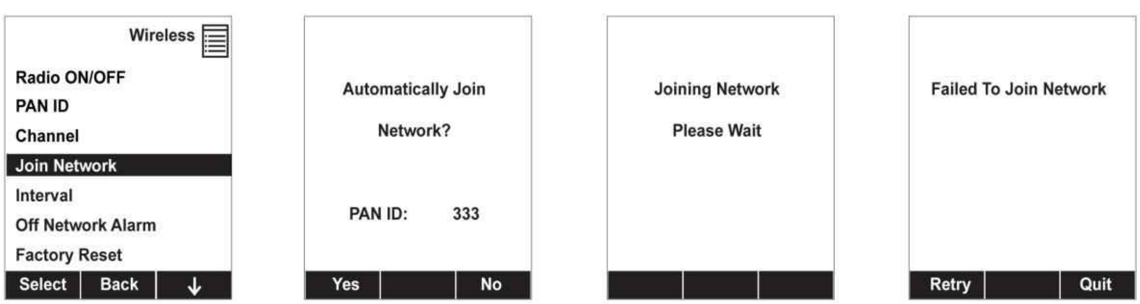
The MultiRAE and any other devices that you want to interconnect wirelessly must be operating on the same channel.

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.



8.3.6.4 Join Network

You can tell the MultiRAE to automatically join a network with a certain PAN ID without having to specify the communications channel. The PAN ID is shown for reference (if it is incorrect, you can change it, as described above). Press [Y/+] to join.



While it is searching for a network to join, the display shows this message:

Joining Network
Please Wait

If it is unsuccessful, you will see this message:

Failed To Join Network

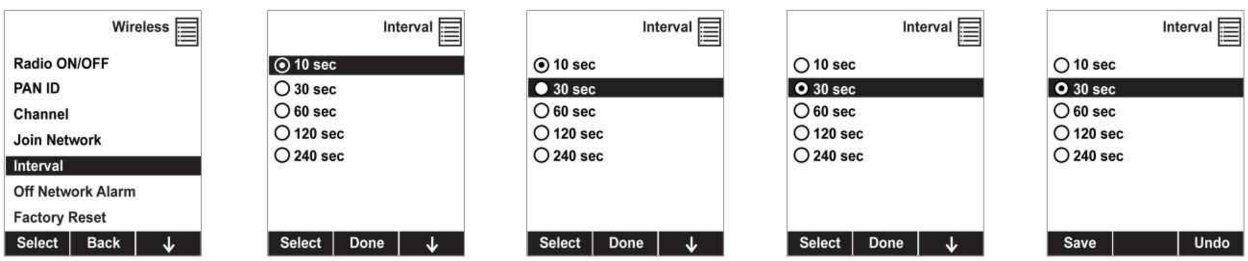
Check your other settings, as well as those of the network you are trying to join.

You can press [Y/+] to retry or [N/-] to quit.

8.3.6.5 Interval

This menu allows you to change the interval between wireless transmissions. The interval can be set to 10, 30, 60, 120, or 240 seconds.

1. Scroll down the list of intervals by pressing [N/-] until the interval you want is highlighted.
2. Select the highlighted interval by pressing [Y/+].
3. Save or register the change:
   - Press [Y/+] to save the change.
   - Press [N/-] to undo the change.

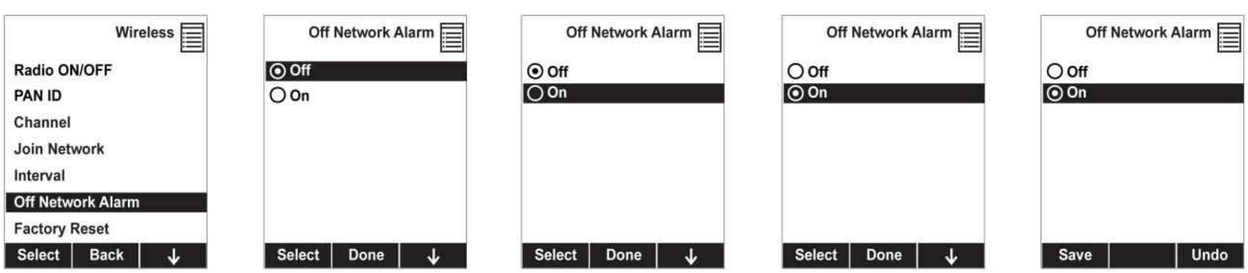


Note: The default interval is 30 seconds.

8.3.6.6 Off Network Alarm

If you would like the MultiRAE to notify you when it loses connection with a network, turn this on.

1. Choose between “On” and “Off” by pressing [N/-].
2. Select the highlighted state by pressing [Y/+].
3. Register the change.
   - Press [Y/+] to save the change.
   - Press [N/-] to undo the change.



8.3.6.7 Factory Reset

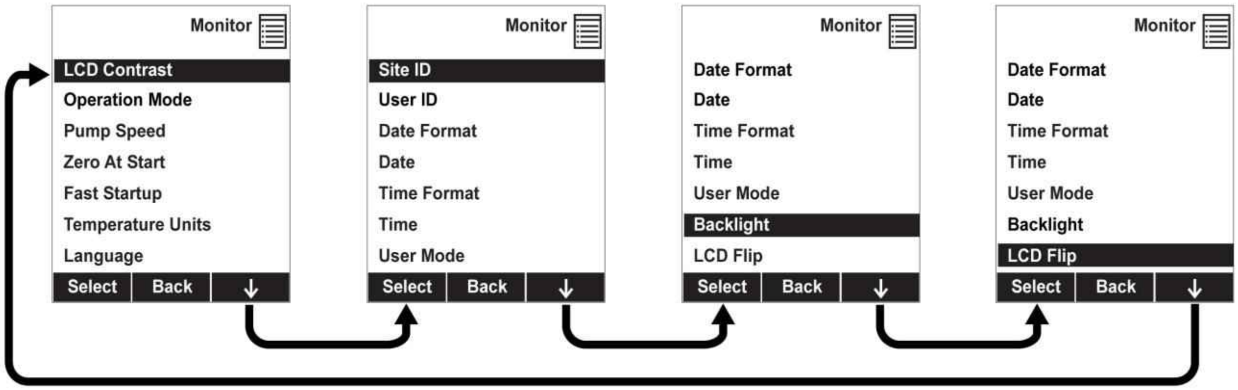
Restore all the wireless settings to their original factory defaults.

Caution! Once you reset the wireless settings, you cannot retrieve any of the settings deleted by performing this reset.

- Press [Y/+] to reset the wireless settings.
- Press [N/-] to exit without resetting the wireless settings.

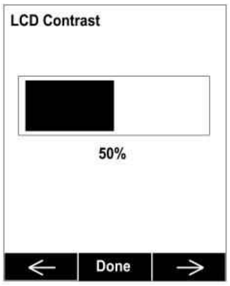
8.3.7 Monitor

The submenus under "Monitor" control the LCD's contrast, operation mode, pump speed, and other parameters. Press [N/-] to advance through the submenus, and when you reach the last one, it returns to the first selection.



8.3.7.1 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.



Use the [Y/+] and [N/-] keys to decrease or increase LCD contrast, respectively (the bar graph aids in setting it). When you are done, press [MODE] to select "Done." If you have not made a change, it exits to the submenu's next selection. If you have made a change, you are prompted at the next screen to press [Y/+] to save the change or [N/-] to undo the change and exit to the next submenu selection.

8.3.7.2 Operation Mode
There are two operation modes, outlined below.

Hygiene Mode
When the MultiRAE is in Hygiene Mode, it continuously monitors, and if datalogging is on, it saves data continuously. Refer to page 25 for more information on operation in Hygiene Mode.

Search Mode
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 instrument automatically assigns a new Site ID to each measurement you take. 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. Refer to page 25 for more information on operation in Search Mode.

8.3.7.3 Pump Speed
If the MultiRAE is equipped with a pump, the pump can operate at two speeds, high and low. Running at low speed is quieter, extends pump lifespan, and conserves a small amount of power. There is almost no difference in sampling accuracy.

8.3.7.4 Zero At Start
If your MultiRAE has been configured to perform a zero (fresh air) calibration upon startup, called Zero At Start, then the startup routine is interrupted so that you can perform a fresh air calibration for all sensors prior to using the instrument.

If you do not want to perform a zero calibration, press [MODE] to bypass it. If you start a zero calibration and want to abort it, press [N/-], and the calibration stops and the main display is shown.

8.3.7.5 Fast Startup
Fast Startup reduces the amount of time between when the instrument is turned on and is ready for use. It skips showing you many settings and is best suited to environments where the MultiRAE is turned on and off very often during a given day. If Fast Startup is not selected, then when the instrument starts, it shows you details of each sensor, including calibration information, high and low alarm settings, etc.

8.3.7.6 Temperature Units
The display unit of the internal temperature sensor can be switched between Fahrenheit and Celsius.

8.3.7.7 Language
English is the default language, but other languages can also be selected for the instrument.

8.3.7.8 Site ID
Choose and enter an 8-digit Site ID to uniquely identify the particular site where the instrument is to be used. The first four digits can be an alphabet letter or number, while the last four digits can only be numbers. This Site ID is included in the datalog report.

Note: Advance through the alphabet and numbers (0 through 9) by one with each press of the [Y/+] key. To scroll quickly, hold down the [Y/+] key for as long as you want it to scroll rapidly.

8.3.7.9 User ID
Enter an 8-digit alphanumeric User ID to uniquely identify a user. This User ID is included in the datalog report. The first four characters of a customized User ID act as an identifier for the monitor on the screen of the EchoView Host Wireless Mini-Controller to which the MultiRAE is wirelessly connected.

Note: Advance through the alphabet and numbers (0 through 9) by one with each press of the [Y/+] key. To scroll quickly, hold down the [Y/+] key for as long as you want it to scroll rapidly.

8.3.7.10 Date Format

Month (MM) and Day (DD) have two digits each, while the year (YYYY) uses four digits. The Date can be expressed in three different formats:

- MM/DD/YYYY
- DD/MM/YYYY
- YYYY/MM/DD

8.3.7.11 Date

Set the date according to the format selected in Date Format.

8.3.7.12 Time Format

The time format can be either of these two options:

- 12 Hour (AM/PM)
- 24 Hour

8.3.7.13 Time

Regardless of the Time Format you select, the MultiRAE's time must be set using the 24-hour format, following hours, minutes, and seconds (HH:MM:SS).

8.3.7.14 User Mode

Two User Modes are available: Advanced and Basic. The Advanced User Mode allows a greater number of parameters to be changed than Basic User Mode. It can be used with either of the Operation Modes, Hygiene or Search. No password is required to enter the Programming Menu when in Advanced User Mode.

8.3.7.15 Backlight

The display's backlight can be set to illuminate either automatically, based on ambient light conditions, or manually, or it can be shut off. If manual backlighting is selected, when the backlight is turned off, pressing any key turns backlighting on. A key needs to be pressed again to perform its main function.

8.3.7.16 LCD Flip

The display can be configured to flip 180° automatically when the MultiRAE is turned upside-down. The LCD Flip feature can be set to On or Off.

9 Policy Enforcement

The MultiRAE 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 MultiRAE screen:

√

If Policy Enforcement is enabled, then after startup the MultiRAE 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.

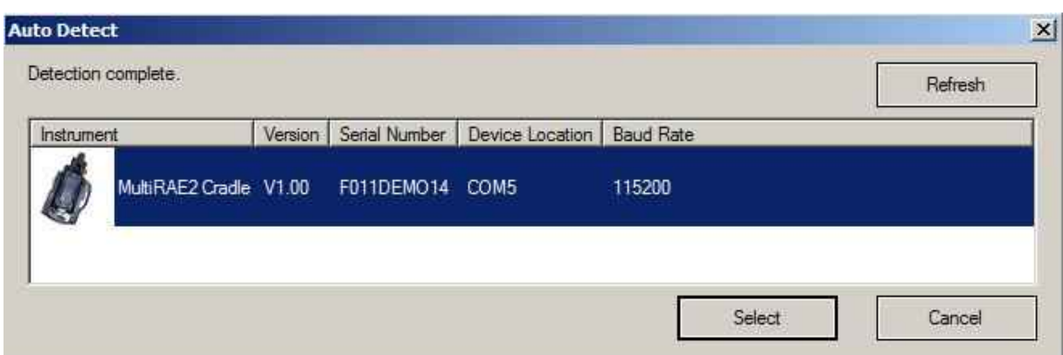
9.1 Setting Policy Enforcement

You must use ProRAE Studio II to make changes to Policy Enforcement settings. The procedure differs, depending on whether you are using an AutoRAE 2, a MultiRAE Travel Charger, or a MultiRAE Desktop Cradle. Policy violations are captured in the datalog.

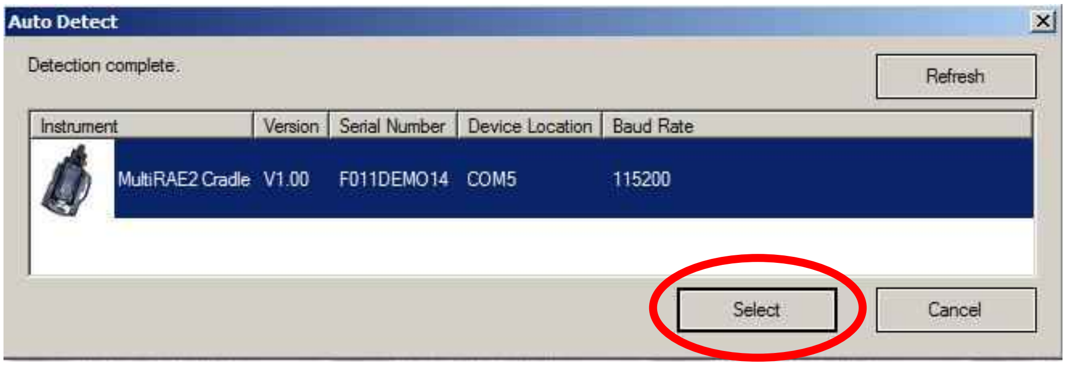
9.1.1 Using The AutoRAE 2 Automatic Test And Calibration System

To program a MultiRAE 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.

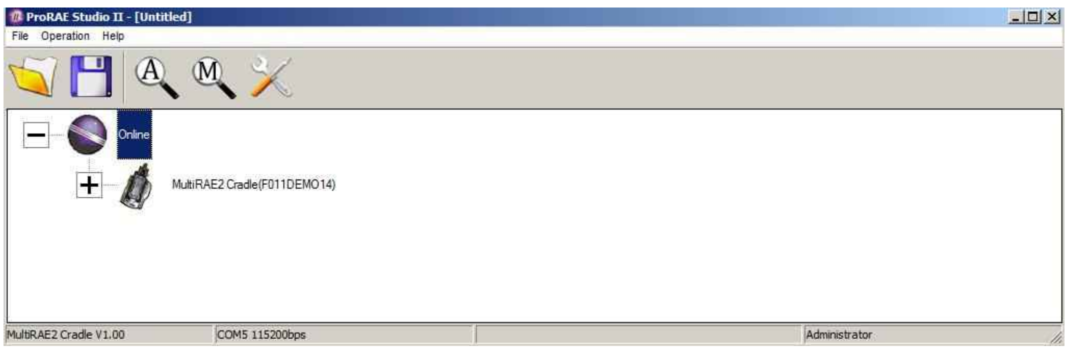
1. Connect a USB cable between a PC with ProRAE Studio II and the AutoRAE 2.
2. Apply power to the AutoRAE 2.
3. Turn off the MultiRAE (or put the MultiRAE into AutoRAE 2 Mode) and set it in the cradle.
4. Start ProRAE Studio II software on the PC.
5. Select "Administrator" and input the password (the 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:



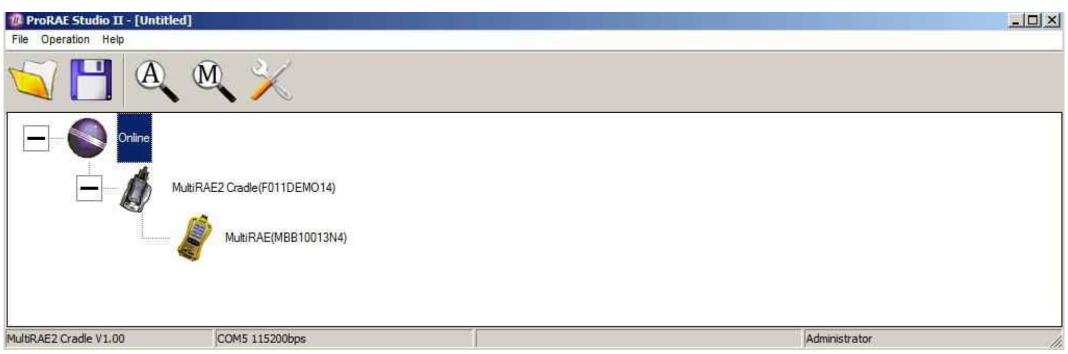
7. Click on the icon to highlight it, and then click "Select."



8. In ProRAE Studio II, the AutoRAE 2 Cradle is shown, including its Serial Number, under "Online":

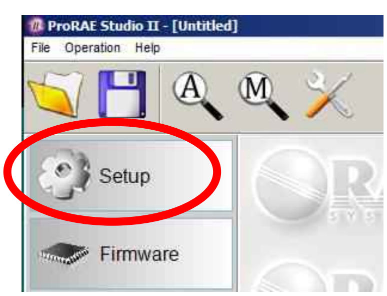


9. Expand the view to show the MultiRAE in the AutoRAE 2 Cradle by clicking the "+" to the left of the image of the AutoRAE 2 Cradle:

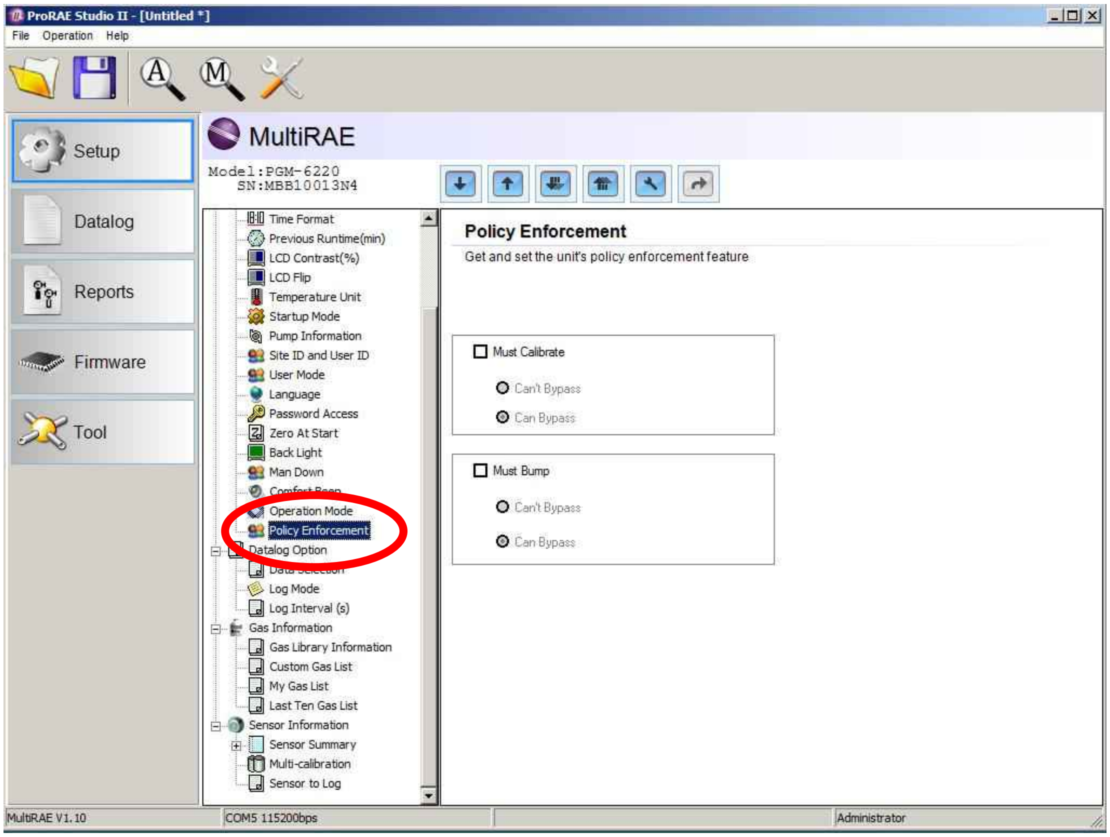


10. Double-click on the icon representing the MultiRAE.

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").

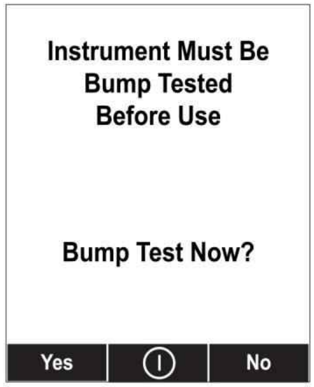
Must Calibrate. The user is prompted to calibrate the instrument when calibration is due (as set by the calibration interval). There are two programmable options:

- **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.

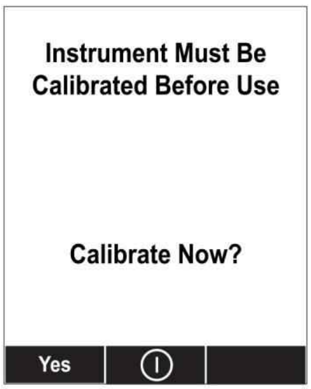
Must Bump. The user is prompted to bump test the instrument when a bump test is due (as set by the bump test interval). There are two programmable options:

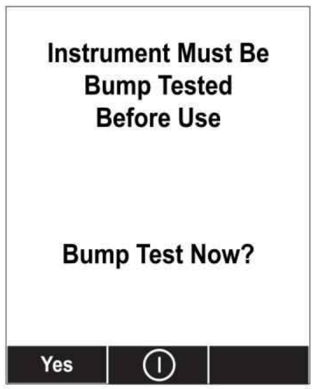
- **Can't Bypass.** Unless a bump test is performed, the instrument cannot be used, and the only option is to turn off the instrument.
- **Can Bypass.** If a bump test is due but the user does not want to perform one, the instrument can still be used. In this case, the instrument records that the user has bypassed the bump testing requirement in a Policy Violation report.

These are the screens that are shown on a MultiRAE after startup if "Can Bypass" is selected:



If "Can't Bypass" is selected, the display looks like this, and only allows the options of performing the test or shutting down:





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 MultiRAE to exit Communication Mode.

9.1.2 Using The MultiRAE Desktop Cradle Or Travel Charger

Make sure the AC adapter is connected and that a USB cable is connected to a computer running ProRAE Studio II.

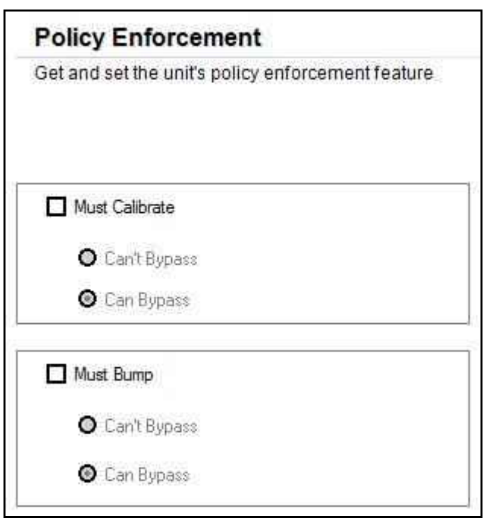
1. Turn on the MultiRAE.
2. Hold down [MODE] and [N/-] to enter Programming Mode.
3. Provide the password.
4. Press [N/-] until "Enter Communications Mode?" is displayed.
5. Press [Y/+]. The screen shows three options:

   - PC
   - AutoRAE 2
   - Exit

6. With "PC" highlighted, press [Y/+] to select it.
   The screen now displays: "Ready To Communicate With Computer."

7. Start ProRAE Studio II.
8. Select "Administrator."
9. Input the password (the default is "rae").
10. Click "OK."
11. Click "A" (detects instruments automatically).
12. Click on the instrument's icon when it appears to highlight it.
13. Click "Select."
14. Click "Setup."
15. Click "Policy Enforcement."

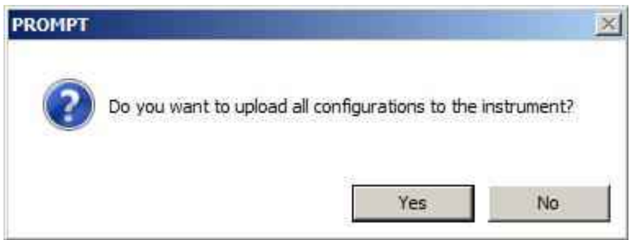
The Policy Enforcement pane is shown:



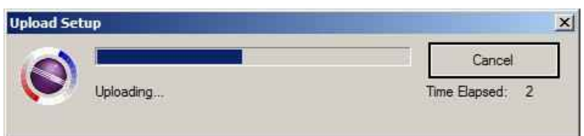
You can select "Must Calibrate" and/or "Must Bump" and then set whether the user must perform the selected operation in order to use the instrument.

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 this progress bar is shown. You can abort the upload by clicking "Cancel."



18. Exit ProRAE Studio II.
19. Press [Y/+] on the MultiRAE to exit Communication Mode.

9.2 Deactivating Policy Enforcement

9.2.1 AutoRAE 2 Cradle

To deactivate Policy Enforcement when using an AutoRAE 2 Cradle, follow the procedure for changing settings. See page 48 for details.

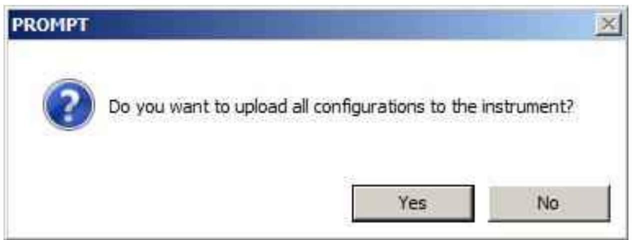
9.2.2 MultiRAE Desktop Cradle Or Travel Charger

If the MultiRAE screen displays the message that it must be bump tested or calibrated, and if the option to bypass bump testing or calibration is not available, you should shut off the instrument and follow the procedure outlined here if you want to change the Policy Enforcement settings:

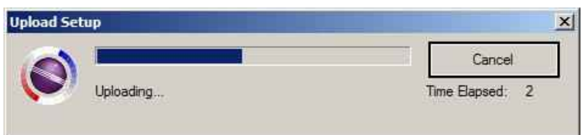
1. Use a USB cable to connect the MultiRAE in its Travel Charger or Desktop Cradle to a computer running ProRAE Studio II.
2. Enter Diagnostic Mode on the MultiRAE (with the instrument turned off, press and hold [Y/+] and [MODE] until it starts up.
3. After startup, enter the password when prompted (default is "0000") and press [MODE].
4. Press [N/-] repeatedly until you see the "Enter Communications Mode?" screen.
5. Press [Y/+] to enter Communications Mode.
6. Start ProRAE Studio II.
7. Select "Administrator."

8. Input the password (the default is "rae").
9. Click "OK."
10. Click "A" (detect instruments automatically).
11. Click on the instrument's icon when it appears.
12. Click "Select."
13. Click "Setup."
14. Click "Policy Enforcement." The Policy Enforcement pane is shown.
15. Deselect Policy Enforcement features you do not wish to use.
16. Click "Upload all settings to the instrument."

17. When you see this confirmation. Click "Yes."



Uploading will take a few seconds, and this progress bar is shown:



18. When the upload is done, exit ProRAE Studio II.
19. Press [Y/+] on the MultiRAE to exit Communication Mode.

10 Calibration And Testing

10.1 Manual Alarms Test

Under Normal Operation Mode and non-alarm conditions, the buzzer (audible alarm), vibration, visible alarms, and backlight can all be tested anytime by pressing [Y/+] twice. If any alarm does not respond, check the alarm settings in the Programming Menu to make sure all alarms are enabled (selected setting under Programming/Alarms/Alarm Settings should be "All Enabled"). If any alarms are enabled but not functional, the instrument should not be used.

10.2 Bump Testing And Calibration

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 MultiRAE multi-gas detector 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.

A bump test or calibration can be performed either manually or using the AutoRAE 2 Automatic Test and Calibration System. When a bump test or calibration 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.

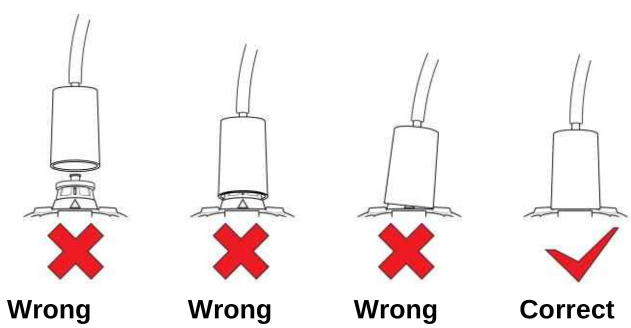
An AutoRAE 2 bump test or calibration takes care of both the sensor and alarm tests. Consult the AutoRAE 2 User's Guide for details.

10.2.1 MultiRAE Equipped With A Pump

With its pump speed setting of low or high, a MultiRAE normally draws in air at a flow rate of between 200 cc/min and 300 cc/min. RAE Systems recommends that a calibration cap used with calibration gas flow rates from 500 cc/min to 1000 cc/min.

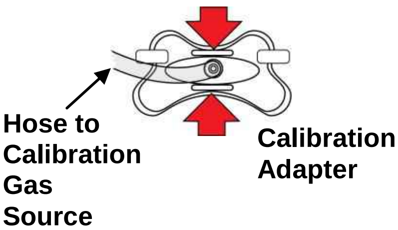
Installing The Calibration Adapter

WARNING: Make sure the calibration cap clips on and stays in the correct position during calibration, as illustrated below. Otherwise, the calibration cap must be manually held in the correct position.

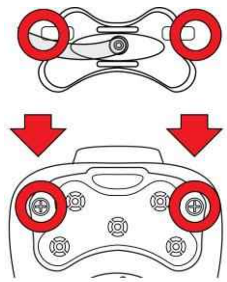


10.2.2 MultiRAE Lite Diffusion Model (No Pump)

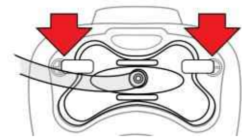
Because there is no single inlet on the diffusion (non-pumped) version of the MultiRAE, a Calibration Adapter is used for supplying calibration gas to all sensors at one time. Follow these steps for attaching the Calibration Adapter.



Grasp the small handles on the Calibration Adapter.



Align the Calibration Adapter's two connectors with the screws on both sides of the MultiRAE's gas inlets.



Make sure the connectors are securely in place before starting the flow of calibration gas. (The Calibration Adapter has small grooves on its underside to allow gas to escape after passing over the sensors.

10.2.3 Bump (Functional) Testing

A bump test can be performed on an individual sensor (Single Sensor Bump) or a group of sensors (Multi Sensor Bump) combined into Multi Cal. Select. The same gas is used for a bump test as for calibration. Typically, two cylinders of calibration gas are needed to perform a bump test or calibration on an instrument with a PID sensor and electrochemical and LEL sensors. This may require one gas cylinder with Isobutylene or another VOC test gas to test the PID sensor, and another with a 4-gas mix to test electrochemical (such as CO, H_2S, and O_2) and LEL sensors. As with calibration, the instrument intelligently splits the process into two consecutive steps: first, the wizard prompts for testing electrochemical and LEL sensors, and then it tests the PID sensor.

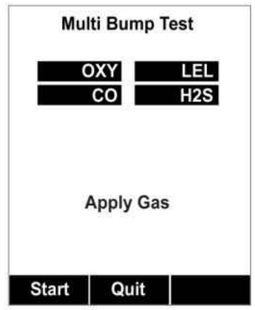
For a manual bump test, a constant-flow regulator producing 0.5 to 1 liters per minute should be used, and the calibration cap must be installed on the instrument. Testing and calibration with an AutoRAE 2 must be performed using demand-flow regulators. A calibration cap must not be used. Teflon tubing must be used to test or calibrate the PID sensor. Follow the steps described here to perform a manual bump test:

1. Turn on your MultiRAE by pressing and holding [MODE] (the middle button) and allow the instrument to boot up fully until the main measurement screen with sensor names and readings is shown.

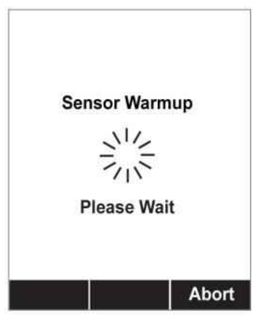
Important! Make sure all of the instrument's sensors have warmed up before performing the bump test. The instrument will take the time to warm up the sensors prior to enabling access to bump test menus. You can tell a sensor has warmed up if you see a reading next to it name on the display. If it has not warmed up, you see three dashes ("---") next to it.

2. Enter the Bump Test menu. It is accessible either through Programming Menu/Calibration or using the following easy shortcut:

   With the instrument running in Normal Mode and the main measurement screen shown, press both [Y/+] and [N/-] at the same time and hold them for 5 seconds. If all the sensors have warmed up, the Multi-Bump Test menu then appears:



   Otherwise, the menu appears after the warm-up is complete (while it is warming up, the screen indicates that you must wait for the sensors to warm up).



   Note: If you do not apply gas within a couple of minutes, the screen changes briefly to indicate gas has not been applied, and then the instrument returns to its normal reading screen.

3. Install the calibration cap on the MultiRAE and connect it to the calibration gas. Turn on the gas to initiate flow.

4. Press [Y/+] to start the bump test. While the bump test is being performed, the readings for each sensor are shown. Once the bump test completes, pass/fail test results and readings are shown for each sensor.

   Note: If a PID or other sensors are installed in the instrument require a dedicated cylinder of gas to calibrate, the instrument will prompt for calibrating such sensors at this point.

5. If a PID or other sensors installed in the instrument require a dedicated gas cylinder to calibrate, the instrument will prompt to calibrate such sensors at this point. Disconnect the gas cylinder and connect the next (for example, 100 ppm Isobutylene for a PID).

6. Press "OK" to proceed to the PID sensor test. Turn on the gas and press Start ([Y/+] button). While the bump test is being performed, PID sensor readings are shown. Once the bump test completes, pass/fail test results and readings are shown for the PID sensor.

   Note: If other installed sensors require a dedicated cylinder of gas to calibrate, the instrument prompts for calibrating these sensors at this point.

Important! If one or more sensors fails a bump test, be sure to calibrate those sensors.

7. The bump test is now complete. Press Exit to return to the main measurement screen.

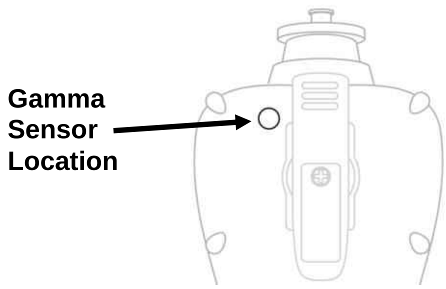
8. Now perform a manual alarms test, as described in section 10.1.

If all the alarms and all sensors have passed and no sensor is due for a calibration, the instrument is now ready for use.

Note: When a manual bump test is performed, the readings shown are in the equivalent units of the calibration gas, and not the measurement gas (if different).

10.2.4 Testing The Gamma Radiation Sensor

The gamma radiation sensor does not require user calibration. You can check it by placing a check-source on the rear of the MultiRAE equipped with a gamma sensor to check the readings. A raised dot on the rubber boot marks where the sensor is located inside the instrument.



10.3 Zero/Fresh Air Calibration

This operation sets the zero point of the sensor calibration curve for clean air. It should be performed before other calibrations.

IMPORTANT!

Even though most toxic gas sensors can be zeroed in fresh air, sensors such as the CO_2 and the parts-per-billion PID sensor for volatile organic compounds (VOCs) should not be zeroed in fresh air. Both CO_2 gas and VOCs are normally present in ambient air, so zeroing these sensors in ambient air will not allow for a true zero to be set for such sensors. The CO_2 sensor should be zeroed in 99.9% nitrogen and the parts-per-billion PID sensor should be zeroed with ambient air using a charcoal filter or a VOC zeroing tube.

Note: If you use a zero air or other gas cylinder, you must use the MultiRAE Calibration Adapter. A calibration adapter is not necessary for calibration in fresh air.

10.3.1 Zero Calibration For A CO_2 Sensor

Important! If your MultiRAE is equipped with a CO_2 sensor, it must be zero calibrated using 100% Nitrogen (N_2), which is inert, instead of fresh air or zero air.

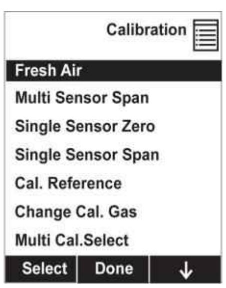
10.3.2 Zero Calibration For Parts-Per-Billion (ppb) Sensor

Important! The parts-per-billion PID sensor for volatile organic compounds (VOCs) should not be zeroed in fresh air. VOCs are normally present in ambient air, so zeroing the sensor in ambient air will not allow for a true zero to be set. The parts-per-billion PID sensor should be zeroed with ambient air using a charcoal filter or a VOC zeroing tube.

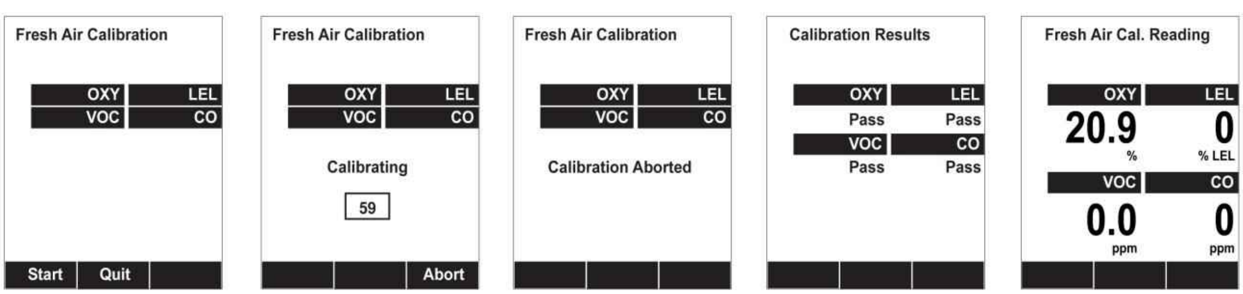
10.3.3 Fresh Air Calibration

This procedure determines zero points of most sensors. The MultiRAE should be zero-calibrated in clean air with 20.9% oxygen or with a cylinder of clean zero air.

At the Calibration menu, select "Fresh Air" by pressing [Y/+] once to enter fresh air calibration.



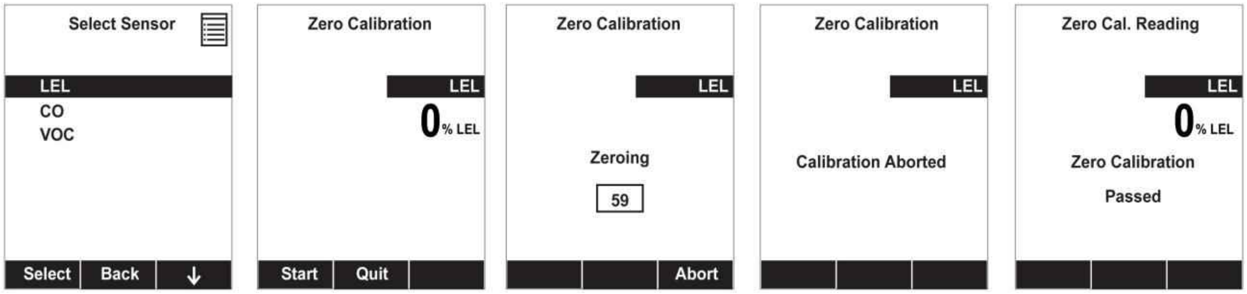
After a timer countdown, the zero calibration is done. The LCD displays the sensor names and tells you whether each calibration passed or failed, followed by the sensor readings.



Note: You can abort the calibration at any time during the countdown by pressing [N/-].

10.3.4 Single-Sensor Zero Calibration

Select the sensor and then start the calibration by pressing [Y/+]. You can abort the procedure anytime by pressing [N/-].



10.4 Span Calibration

This procedure determines the second point of the sensor calibration curve for the sensor.

Note: When a manual calibration is performed, the readings shown are in the equivalent units of the calibration gas, and not the measurement gas.

10.5 Three-Point Calibration For Enhanced Linearity With Extended-Range And ppb PID Sensors

For better linearity at higher concentrations when a MultiRAE is equipped with a PID sensor, a 3-point calibration can be performed.

IMPORTANT!

Three-point calibration is disabled by default, but can be enabled using ProRAE Studio II Instrument Configuration and Data Management software on MultiRAE and MultiRAE Pro instruments with 10.6eV PID sensors, including high-range ppm and ppb PID sensors. The MultiRAE Lite PID sensor does not support three-point calibration.

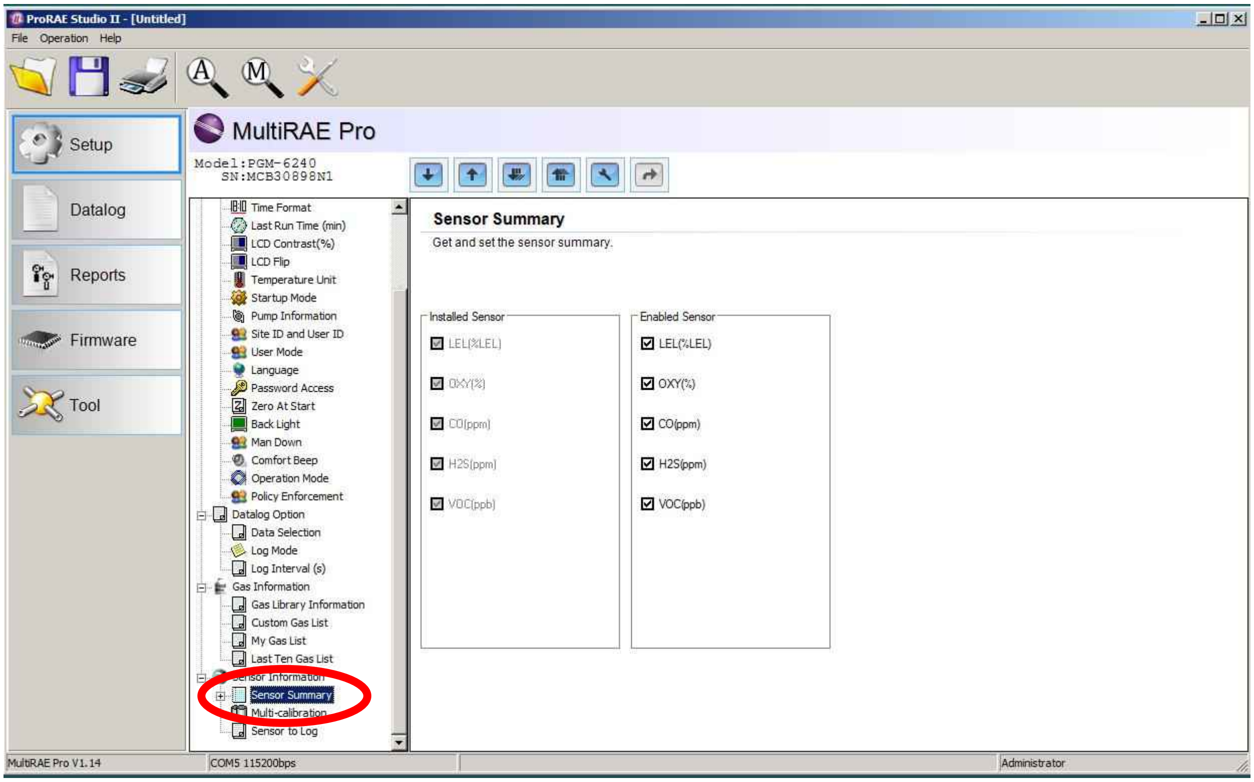
Default calibration gas settings for MultiRAE PID sensors are as follows:

Sensor	Specifications	Zero	Span	Span 2 (Third calibration point, if enabled)
MultiRAE Pro parts-per-billion (ppb) PID	0 to 2,000 ppm range, 10 ppb resolution	With a charcoal filter or VOC zeroing tube	10 ppm Isobutylene	100 ppm Isobutylene
MultiRAE extended-range ppm PID	0 to 5,000 ppm range, 0.1 ppm resolution	Fresh air or dry air	100 ppm Isobutylene	1,000 ppm Isobutylene
MultiRAE Lite PID (same as the ToxiRAE Pro Safety Configuration PID)	0 to 1,000 ppm range, 1 ppm resolution	Fresh air or dry air	100 ppm Isobutylene	Not supported

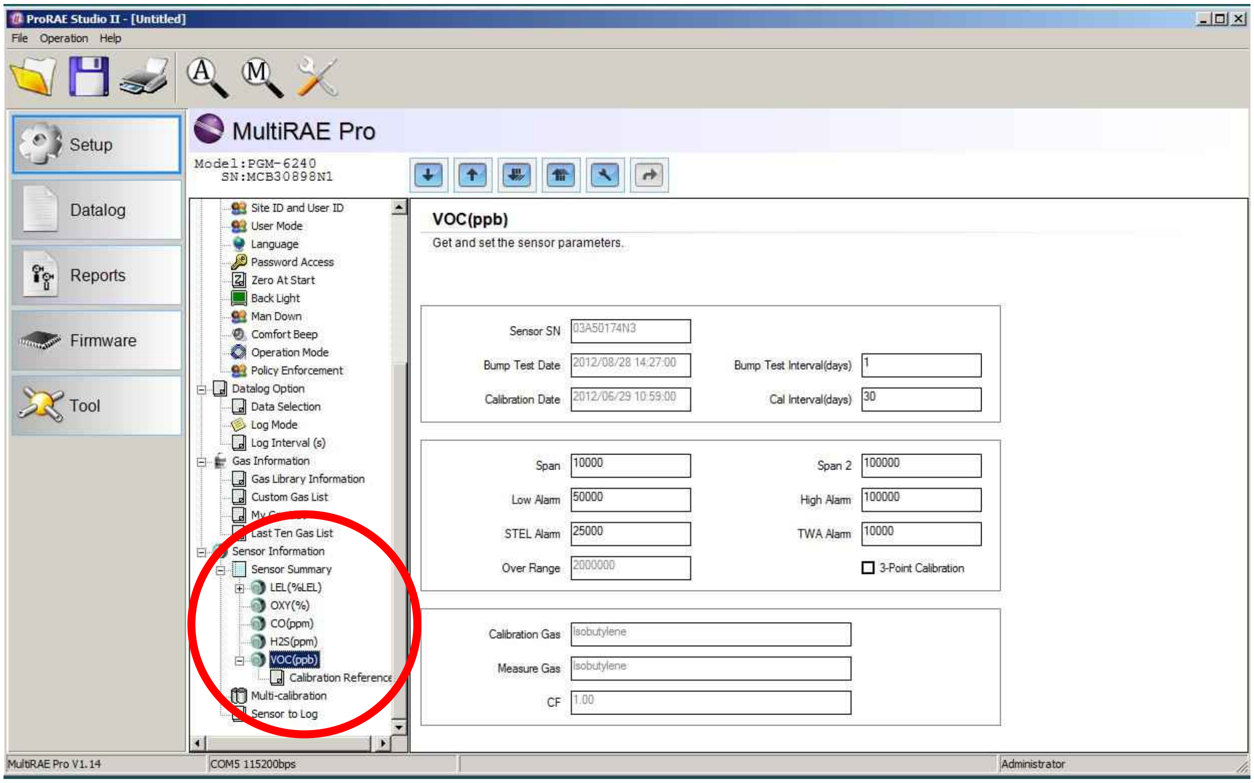
10.5.1 Enabling 3-Point Calibration Via ProRAE Studio II

The MultiRAE must be connected to a PC through the supplied Desktop Cradle, Travel Charger, or AutoRAE 2 and must be in the PC or AutoRAE 2 communications mode.

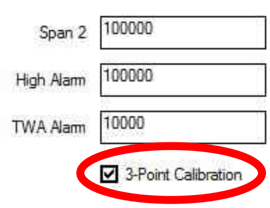
1. Start up the ProRAE Studio II software, enter a password, and detect the instrument following the directions provided in the ProRAE Studio II User's Manual.
2. Click "Setup" to download the MultiRAE's current configuration information.
3. Click "Sensor Summary" to show the list of installed sensors.



4. Click "VOC(ppm)" or "VOC(ppb)" to get and set sensor parameters.



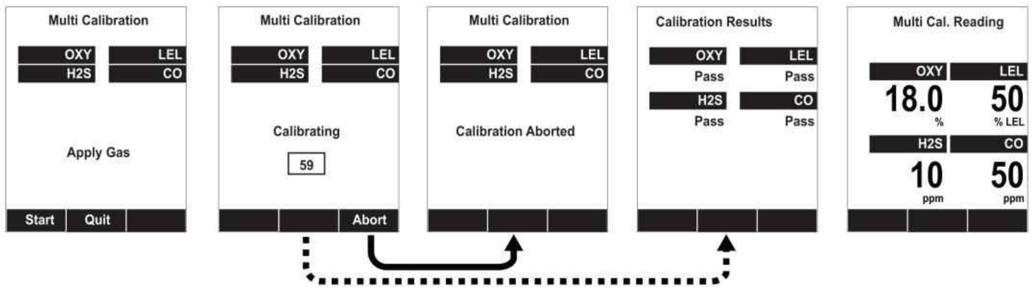
5. Click 3-Point Calibration (the check mark should now be showing).

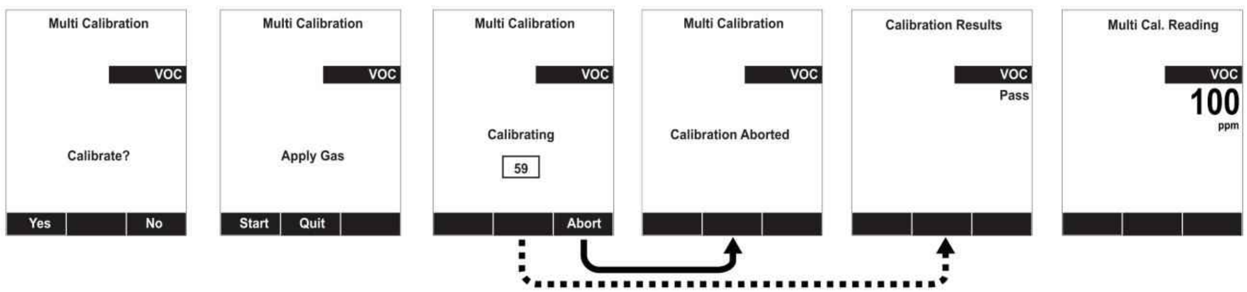


6. Click the "Upload all settings to the instrument" icon. You will be asked whether you want to upload all configurations to the instrument. Click "Yes."
7. When you are done, quit ProRAE Studio II and then press [Y/+] on the MultiRAE to exit the PC communications mode. The instrument returns to operating in Normal mode.

10.5.2 Multi-Sensor Span Calibration

This lets you perform a span calibration on multiple sensors simultaneously. It requires using the appropriate span gas and that the concentration labeled on the gas cylinder matches the concentration programmed in the MultiRAE.





For a multi-sensor span calibration, a constant-flow regulator producing 0.5 to 1 liters per minute should be used, and the calibration cap must be installed on the instrument. Testing and calibration with an AutoRAE 2 must be performed using demand-flow regulators. A calibration cap must not be used. Teflon tubing must be used to test or calibrate the PID sensor. Follow the steps described here to perform a multi-sensor span calibration:

1. Attach the calibration adapter and connect gas to the MultiRAE.
2. Start the flow of gas and then either press [Y/+] to begin calibration or wait for calibration to start automatically once the sensor “senses” the gas. A countdown screen is shown. You can abort the calibration at any time during the countdown by pressing [N/-].

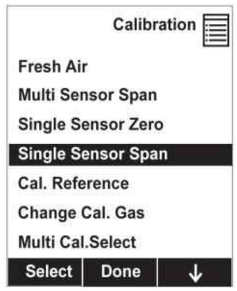
If the calibration reaches its conclusion, it shows the sensor names and tells you whether the calibration passed or failed, followed by the sensor readings.

Note: If there are other sensors to be calibrated at this stage, the screens will guide you through the process.

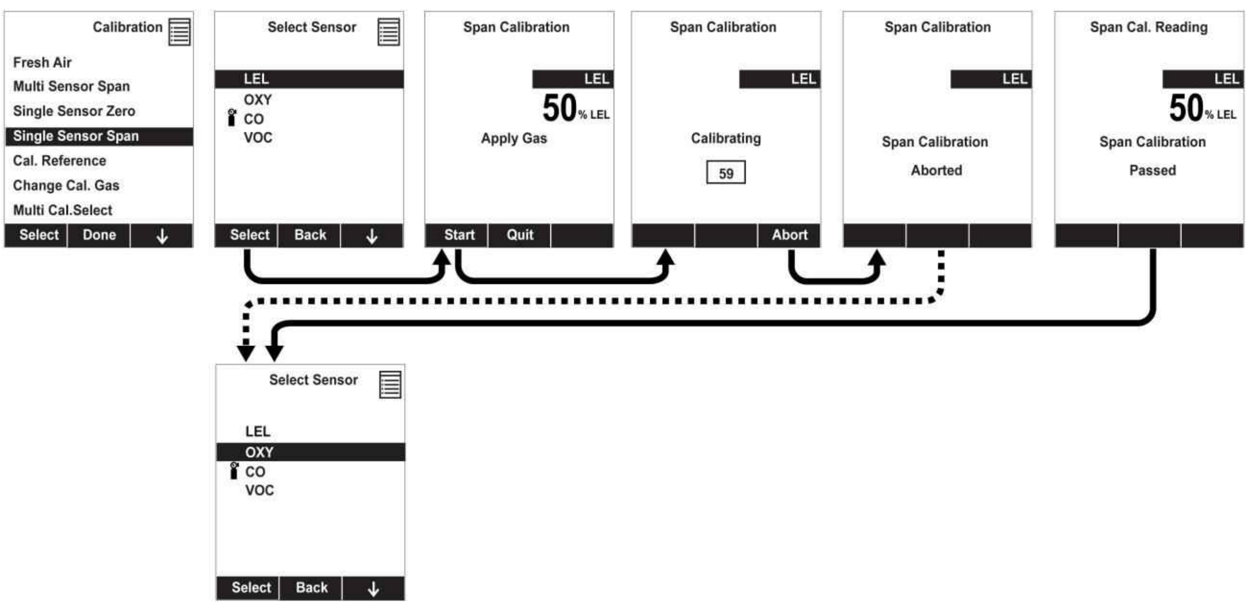
10.5.3 Single-Sensor Span Calibration

To perform span calibration of an individual sensor, follow these steps:

1. At the Calibration Menu, select "Single Sensor Span."
2. Select a sensor from the list.
3. Connect the calibration adapter and connect it to a source of calibration gas.
4. Verify that the displayed calibration value meets the concentration label on the gas cylinder.
5. Start the flow of calibration gas.



6. Press [Y/+] to start calibrating. You can abort the calibration at any time during the countdown by pressing [N/-].



After a timer countdown, the span calibration is done. The LCD will display whether the calibration was successful and the reading for that calibration gas.

Note: If the sensor calibration fails, try again. If calibration fails repeatedly, turn off the instrument and then replace the sensor.

WARNING: Do not replace sensors in hazardous locations.

11 MultiRAE Pro Multi-Threat & Gamma Operation

MultiRAE Pro monitors equipped with a gamma radiation sensor in addition to one or more sensors for detecting chemical threats can operate in three measurement modes:

- **Multi-threat mode**, in which the instrument monitors for both chemical threats and radiation on a sequential basis
- **Radiation-only mode**, in which the instrument continuously monitors for gamma radiation and does not monitor for chemical threats
- **Gas-only mode**, in which the instrument continuously monitors for gaseous threats and not for radiation

The specifics of each operating mode are described in the following sections.

11.1 Multi-Threat Mode For Simultaneous Radiation & Gaseous Threat Measurements

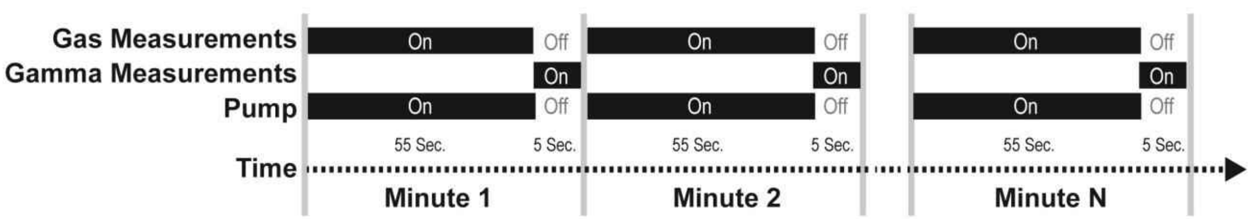
Multi-threat mode is the default mode of MultiRAE Pro's operation. Multi-threat mode is only available on MultiRAE Pro monitors equipped with a gamma radiation sensor, provided the gamma sensor is enabled. The minimum instrument firmware requirements for the gamma sensor are:

- Application firmware: v.1.14 or higher
- Sensor firmware: v.1.04 or higher

When the monitor is turned on, it boots up in multi-threat mode to monitor for both gamma radiation and gaseous threats. Measurements are done in sequence: Gas measurements are taken first, followed by gamma radiation measurements.

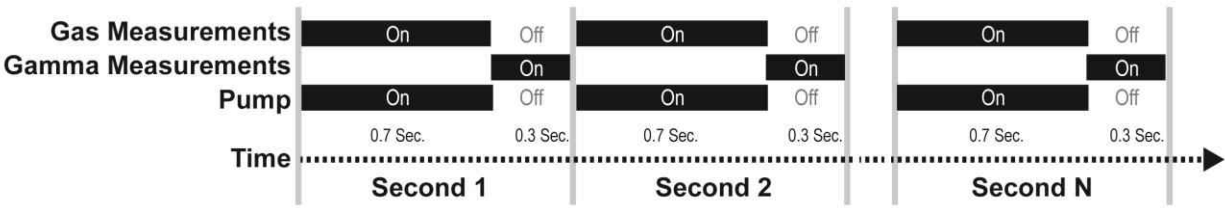
Under alarm-free conditions, gas measurements are taken during 55 consecutive seconds out of every minute, followed by gamma radiation measurements that are taken during the remaining 5 consecutive seconds. When gas measurements are taken, the instrument's internal sampling pump is turned on, and when radiation measurements are taken, the pump is always turned off.
In other words, out of every minute of alarm-free operation, the instrument monitors for gas during the first 55 seconds, followed by the 5 seconds of gamma radiation monitoring, as illustrated below:

MultiRAE Pro Operation in Multi-Threat Mode under Alarm-Free Conditions



If gas or radiation alarm conditions exist (High, Low, Max, Over, STEL, or TWA alarms), the operation pattern switches to a much shorter, one-*second*-long cycle in which gas measurements are taken for 0.7 seconds followed by gamma radiation measurements that are taken during the remaining 0.3 seconds. Like under non-alarm conditions, the pump stays on when gas measurements are taken, but it is turned off when gamma radiation is measured.

MultiRAE Pro Operation in Multi-Threat Mode in Alarm Conditions



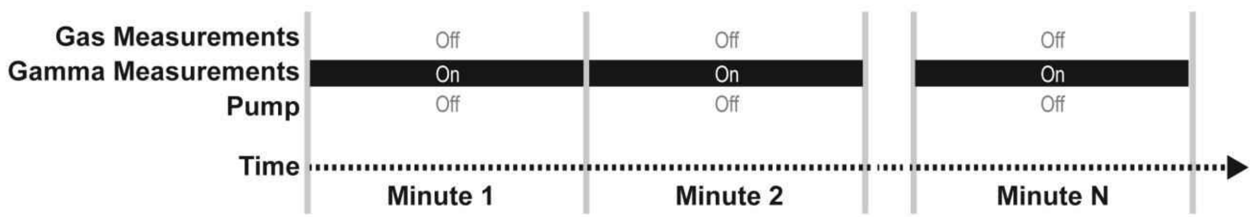
Once alarm conditions subside, the operation pattern returns to the "55 sec. gas / 5 sec. radiation" cycle.

Note: Because of the MultiRAE Pro's intermittent pump operation in multi-threat mode, during the part of the cycle in which the pump is turned off, the PID sensor lamp is automatically cleaned by ozone that forms above the PID lamp crystal (this ozone is removed by the air flow when the pump is running.) This auto-clean feature reduces PID sensor maintenance frequency.

11.2 Gamma Radiation-Only Measurement Mode

When the instrument is in gamma-only mode, gas sensors are not shown on the display and gas measurements are not taken. The pump remains off and gamma radiation is measured all the time in all cases, as illustrated below:

MultiRAE Pro Operation in Gamma-Only Mode



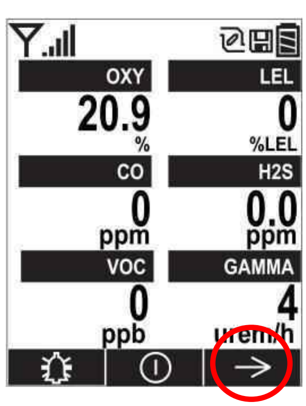
WARNING

Toxic and combustible gases cannot be detected by the MultiRAE when it is operated in gamma-only mode.

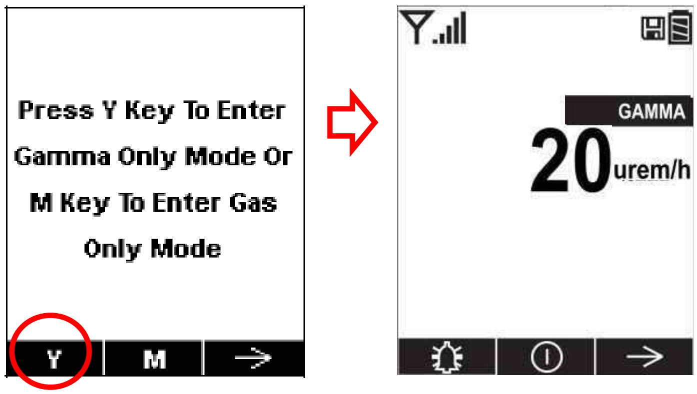
Activating Gamma-Only Measurement Mode

To activate gamma-only measurement mode:

1. Press [N/-] when the instrument is running in normal (multi-threat) mode:



2. Press [Y/+] when the following screen appears:

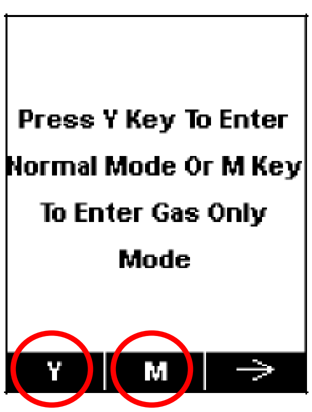


Exiting Gamma-Only Measurement Mode

To exit gamma-only mode and either switch back to multi-threat mode (where both gamma radiation and gaseous threats are measured) or to gas-only mode:

1. Press [N/-] when the instrument is running in gamma-only mode:

2. The following screen appears:



- Press [Y/+] to enter normal (multi-threat) mode.
- Press [MODE] to enter gas-only mode.

11.3 Gas-Only Measurement Mode

The MultiRAE Pro can be switched to gas-only measurement mode. When in this mode, the gamma radiation sensor is not displayed and gamma radiation measurements are not taken. The pump runs constantly, as illustrated below:

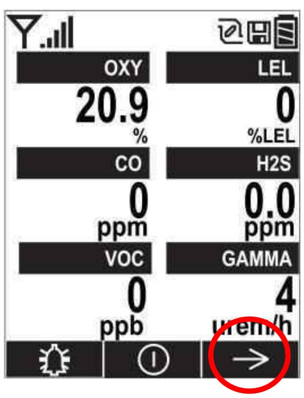
MultiRAE Pro Operation in Gas-Only Mode

WARNING
Gamma radiation cannot be detected by the MultiRAE when it is operated in gas-only mode.

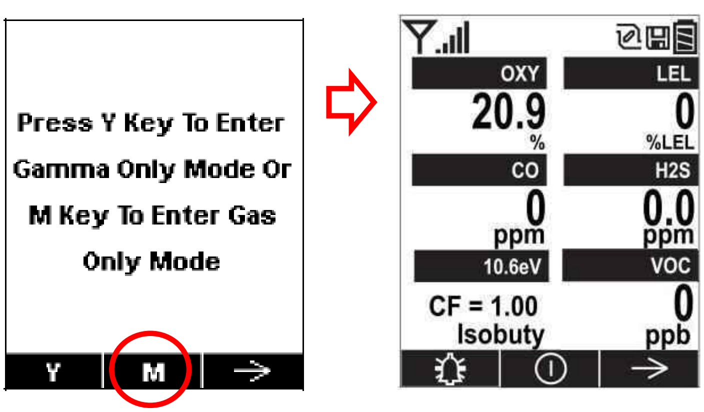
Activating Gas-Only Measurement Mode

To activate gas-only measurement mode:

1. Press [N/-] when the instrument is running in normal (multi-threat) mode:



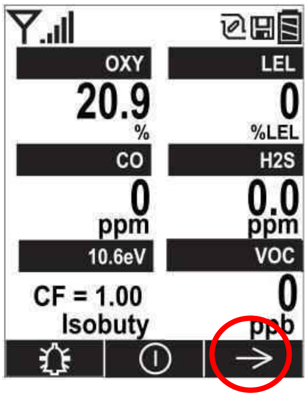
2. Press [MODE] when the following screen appears:



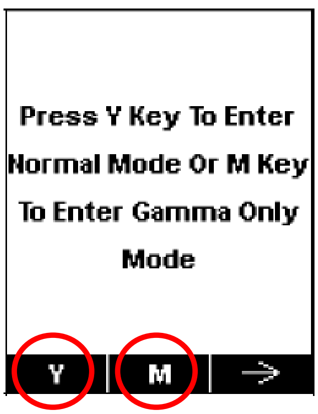
Exiting Gas-Only Measurement Mode

To exit gas-only mode and either switch back to multi-threat mode (where both gamma radiation and gaseous threats) are measured or to gamma-only mode:

1. Press [N/-] when the instrument is running in gas-only mode:



2. The following screen appears:



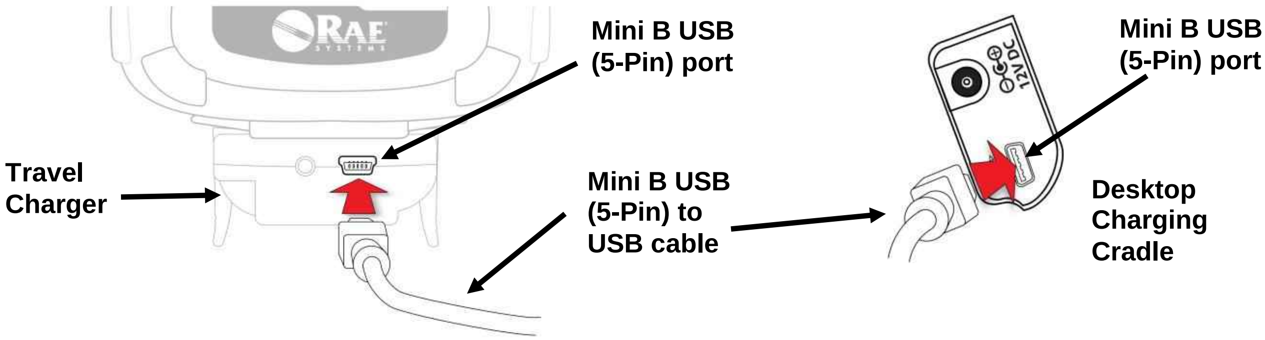
- Press [Y/+] to enter normal (multi-threat) mode.
- Press [MODE] to enter gamma-only mode.

Notes:

- The gamma radiation sensor is always disabled when the MultiRAE Pro is used in Search Mode.
- Radiation dose is not calculated for the gamma sensor.
- If the monitor runs in gamma-only mode for over 20 minutes, TWA is not calculated for gas sensors.
- STEL is reset for gas sensors when the instrument exits gamma-only mode.
- PID sensor auto-cleaning is only performed in multi-threat mode and is not available in either gamma-only or gas-only mode (PID auto-cleaning is done automatically for any MultiRAE with a PID sensor when the monitor is turned off and docked in the desktop charging cradle.)

12 Datalog Transfer, Monitor Configuration, and Firmware Upgrades Via Computer

Datalogs can be downloaded from the MultiRAE to a computer, and firmware updates can be uploaded to the MultiRAE via the USB port on the Travel Charger, Desktop Cradle, or AutoRAE 2. Use the included Mini B USB (5-pin)-to-USB cable to connect the Travel Charger or Desktop Cradle to a computer running ProRAE Studio II or a USB A to USB B cable to connect the AutoRAE 2.



12.1 Downloading Datalogs And Performing PC-Based Instrument Configuration And Firmware Upgrades

The MultiRAE communicates with a PC running ProRAE Studio II Instrument Configuration and Data Management software to download datalogs, configure the instrument, or upgrade the instrument's firmware.

Note: The most recent version of ProRAE Studio II Instrument Configuration and Data Management software is available for a free-of-charge download at: http://www.raesystems.com/downloads/product-software

The MultiRAE must be connected to a PC through the supplied Desktop Cradle, Travel Charger, or AutoRAE 2 and must be in the PC or AutoRAE 2 communications mode.

Desktop Cradle or Travel Charger

1. Use the supplied PC Communications Cable (USB to mini-USB cable) to connect the Desktop Cradle or Travel Charger to a PC.
2. Turn on the MultiRAE. Make sure it is running in Normal mode (with the main measurement screen showing).
3. Insert the MultiRAE in the Desktop Cradle or connect it to the Travel Charger.
4. Activate the PC communications mode on the MultiRAE by pressing [N/-] repeatedly, starting from the main measurement screen until you reach the "Communicate With Computer?" screen.
5. Press [Y/+]. Measurement and datalogging stop, and the instrument is now ready to communicate with the PC. The display now says "Ready To Communicate With Computer."
6. Start up the ProRAE Studio II software, enter a password, and detect the instrument following the directions provided in the ProRAE Studio II User's Guide.
7. Follow the instructions in the ProRAE Studio II User's Guide to download the datalog, configure the instrument settings, or update the MultiRAE's firmware.
8. When you are done, press [Y/+] to exit the PC communications mode on the MultiRAE. The instrument returns to operating in Normal mode.

AutoRAE 2

1. Follow the instructions in the AutoRAE 2 User's Guide to connect the AutoRAE 2 and the PC using the included cable.
2. Make sure the monitor is either turned off or is in AutoRAE 2 Communications Mode.
3. Place the instrument into the cradle face-down, making sure that it is aligned correctly with the contacts on the AutoRAE 2 Cradle's charging port. There are two alignment points on one side and one alignment point on the other side, designed to mate with matching points on the bottom of the MultiRAE.
4. Press in on the capture mechanism to lock the MultiRAE in place.
5. Start up the ProRAE Studio II software, enter a password, and detect the instrument following the directions provided in the ProRAE Studio II User's Guide.
6. Follow the instructions in the ProRAE Studio II User's Guide to download the datalog, configure the instrument settings, or to update the MultiRAE's firmware.
7. When you are done, press [Y/+] to exit the AutoRAE 2 Communications Mode on the MultiRAE. The instrument returns to operating in Normal mode.

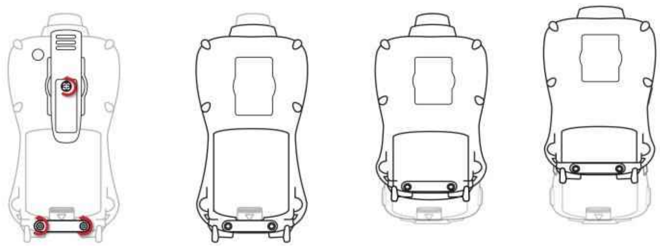
13 Maintenance

The MultiRAE requires little maintenance, aside from replacing sensors, the filter, and the battery. If the instrument is equipped with a pump, it may need replacement, as well. If the instrument has a PID, then the PID sensor lamp and sensor electrode panel may require periodic cleaning.

13.1 Removing/Installing The Rubber Boot

In order to open the MultiRAE, it is necessary to remove the belt clip and the rubber boot. Note that there are two hex screws on the bottom rear side that secure the boot.

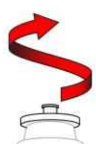
1. Remove the belt clip by unscrewing the Philips screw (pumped version only).
2. Remove the two hex screws located below the battery area.
3. Pull the bottom of the boot back over the rear side of the instrument.
4. Carefully slide the boot upward, and slide it over the D-ring and clamp.



13.2 Replacing The Filter(s)

Pumped Version

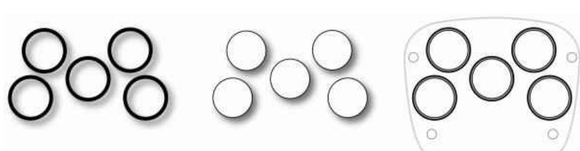
If a filter is dirty or clogged, remove it by unscrewing it from the black gas inlet adapter. Discard it and replace it with a new filter. Perform a pump stall test to make sure the inlet and the external filter are installed properly so that there are no leaks in the system.



Diffusion Version

If the filters appear dirty, remove the sensor compartment cover to access them (this requires removing the rubber boot first).

Remove the four screws holding the sensor compartment cover in place.

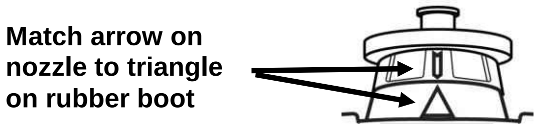


Remove the O-rings and then remove the filters. Replace them with new filters (press around the perimeter of each to ensure that the adhesive holds them firmly) and install the O-rings in their proper locations. O-rings may need to be replaced as well if they appear worn down, cracked, or dirty

Replace the sensor compartment cover and tighten the four screws.

13.3 Replacing The Gas Inlet Adapter (Pumped Versions Only)

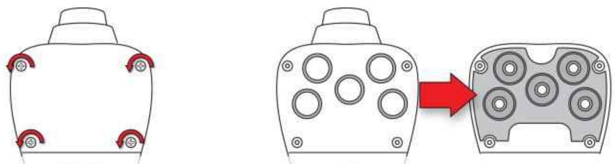
When you remove the black gas inldet adapter, unscrew it in the same manner as the external filter. When replacing it, make sure that the arrow on the front points to the triangle on the rubber boot. Perform a pump stall test to make sure the inlet and the external filter are installed properly so that there are no leaks in the system.



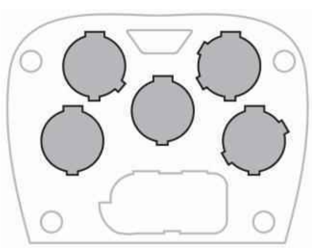
13.4 Removing/Cleaning/Replacing Sensor Modules

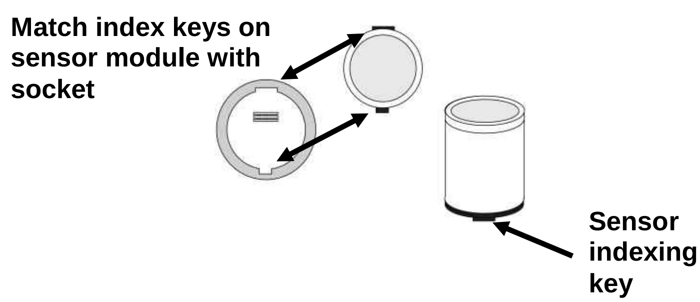
WARNING! Do not replace sensors in hazardous locations.

All sensors are located inside the sensor compartment in the upper half of the MultiRAE. They are accessed by removing the cover that is held on by four screws.



1. Turn off the instrument.
2. Remove the four screws holding the sensor compartment.
3. Remove the cover. The sensors are plugged into the slots.
4. Gently lift out the desired sensor module with your fingers.
5. Install the replacement sensor. It can only go into its slot one way. The connector inside the MultiRAE and the indexing guides are good visual indicators of how to set the sensor into position. Make sure the indexing keys are aligned and that the sensor is seated firmly.





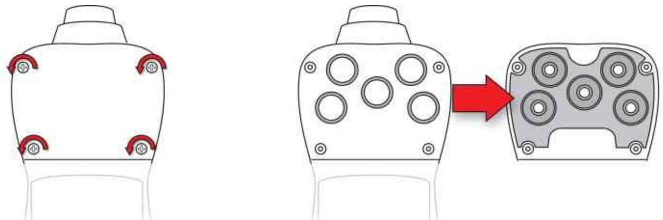
WARNING!

If you are removing a sensor and not replacing it, the slot cannot be left empty. A MultiRAE “dummy” sensor must be installed in such slot.

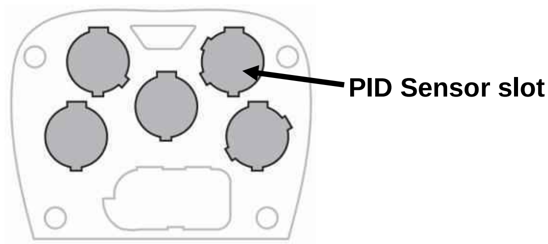
13.5 Removing/Cleaning/Replacing A PID (Pumped Versions Only)

Note: If you need to access a PID for cleaning or replacement, you must remove the rubber boot and belt clip first.

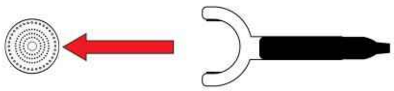
1. Turn off the instrument.
2. Remove the four screws holding the MultiRAE sensor compartment cover in place.
3. Remove the cover to expose the sensors.



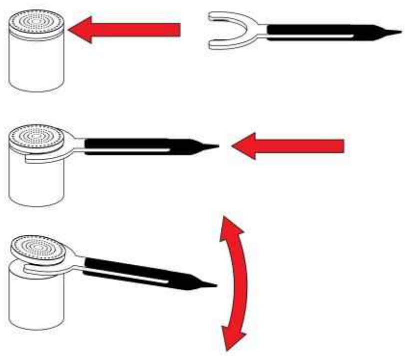
4. Gently lift out the PID module with your fingers.
5. If the module requires replacement (for example, because the lamp does not illuminate, or the sensor repeatedly fails calibrations), place a new module into the slot, being careful to match the indexing keys. The sensor can only go into its slot one way.



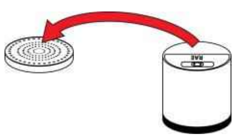
6. If you want to open the sensor module to inspect and clean the lamp and sensor electrode panel, you must use the special tool (part number G02-0306-003, package of three). Its "C"-shaped end has small "teeth" inside. Slide the tool so that the teeth slip into the notch between the module's cap and body:



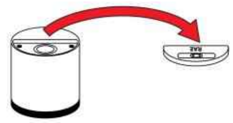
7. Gently pry up the cap using a rocking motion:



8. Once the cap is removed, set it aside.

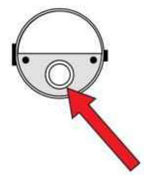


9. Now lift the sensor electrode panel from the module:

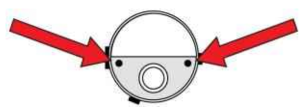


10. Clean the sensor electrode panel (crystal) in a solution of isopropanol or methanol lamp cleaner (included, along with cleaning swabs, in a PID Lamp Cleaning Kit, sold separately), and allow it to dry.

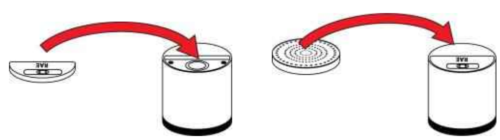
11. Clean the lamp's window with a cleaning swab dipped in isopropanol or methanol lamp cleaner, and allow it to dry. Do not touch the lamp window with your fingers, as the residual oils will affect its performance and shorten its life.



12. Inspect the electrical contacts. Clean them with a swab dipped in lamp cleaner if they appear to need cleaning:



13. Reassemble the sensor module by placing the sensor electrode panel back in place and firmly pressing the cap back onto the top.



14. Place the sensor module back into the MultiRAE. Make sure the index points are aligned (it can only go in one way).
15. Reinstall the rear cover.
16. Tighten all four screws.

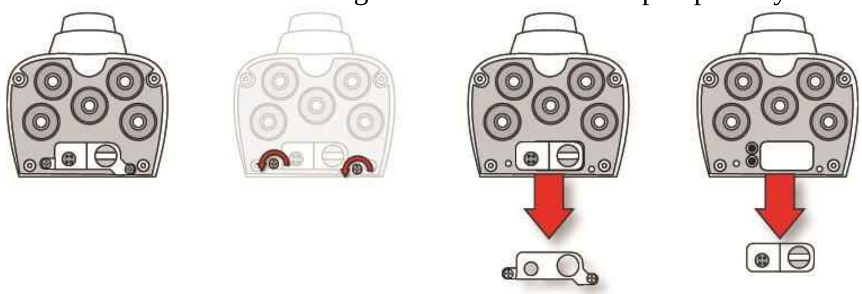
Note: Always calibrate the MultiRAE after replacing the sensor module.

13.6 Replacing The Pump

If your MultiRAE has a pump and it requires replacement, follow these steps. Make sure the rubber boot and the battery are removed before proceeding.

1. Remove the sensor compartment cover.

   Turn it upside down and set it on a soft flat surface.
2. The pump is to the sensor compartment cover by a metal bracket and two Philips screws. Remove the two screws.
3. Lift off the metal bracket.
4. Pressing down on the gas plate with one hand, disconnect the pump from internal tubing by gently pulling it out. It has an inlet and outlet
   that are held in the two holes with rubber gaskets to the left of the pump cavity.



5. Press a new pump into place (a small amount of wiggling helps), making sure that both the inlet and outlet from the pump go into the two holes.
6. Place the metal bracket over the pump.
7. Insert and tighten the two screws that attach the bracket to the housing.
8. Replace the cover.
9. Turn on the instrument and check for proper pump operation.

14 Alarms Overview

The MultiRAE provides an unmistakable five-way alarm notification system that combines local alarms on the device with real-time remote wireless alarm notification (if the instrument is equipped with the optional wireless functionality) to take worker safety to the next level. Local alarms include audible buzzer alarm, visible alarm via bright LED lights, vibration alarm, and an alarm notification on the display. These can be selectively turned on or off.

Note: The vibration alarm is automatically disabled whenever the instrument is run on alkaline batteries.

14.1 Alarm Signals

During each measurement period, the gas concentration and radiation levels are compared with the programmed alarm limits for Low, High, TWA, STEL, and other alarms, as applicable. If the concentration exceeds any of the preset limits, the alarms are activated immediately to warn both the MultiRAE user and a remote safety officer (if wireless is enabled) of the alarm condition. In addition to gas and radiation alarms, Man Down and other alarms are available.

Furthermore, the MultiRAE alarms if one or more of the following conditions occurs: battery voltage low, pump blocked, PID lamp failed, etc.

When the low battery alarm occurs, there may be approximately 10 minutes of operating time remaining. In this case, it is recommended that you promptly change or charge the battery in a non-hazardous location.

14.2 Changing The Alarm Mode

Your choices are Auto Reset and Latched. A latched alarm stays on until you acknowledge the alarm by pressing a button. An auto-reset alarm turns off when the condition that set off the alarm is no longer present (for instance, a high H_2S reading that exceeds the preset threshold and triggers an alarm, but then lowers below that threshold, turning the alarm off).

1. Enter the Alarm Mode sub-menu of the Alarms section under the Programming Menu.
2. Select Auto Reset or Latched by pressing [N/-] to select, and [Y/+] to confirm the choice.
3. Press [Y/+] to save your selection.

14.3 Alarm Signal Summary

Hygiene Mode

Alarm Type	Buzzer & LED	Display	Vibration	Reading	Backlight	Priority
Super Alarm	4 beeps/sec	"Super Alarm" screen	400ms	-	On	Highest
Man Down Alarm	3 beeps/sec	"Man Down Alarm" screen	400ms	-	On	
Man Down Warning	2 beeps/sec	"Are you OK" screen	400ms	-	On	
Fail	3 beeps/sec	"Lamp" at PID location "Off" at LEL location	400ms	Blinking reading	On	
Pump	3 beeps/sec	Blinking pump symbol	400ms	Reading	On	
Max	3 beeps/sec	"Max" at sensor location	400ms	Blinking reading	On	
Over Range	3 beeps/sec	"Over" at sensor location	400ms	Blinking 9999	On	
High	3 beeps/sec	"High" at sensor location	400ms	Reading	On	
Low	2 beeps/sec	"Low" at sensor location	400ms	Reading	On	
Negative	1 beep/sec	"Neg" at sensor location	400ms	0	On	
STEL	1 beep/sec	"STEL" at sensor location	400ms	Reading	On	
TWA	1 beep/sec	"TWA" at sensor location	400ms	Reading	On	
Calibration Fail	1 beep/sec	"Cal" at sensor location	400ms	Reading	On	
Bump Fail	1 beep/sec	"Bump" at sensor location	400ms	Reading	On	
Datalog Full	1 beep/sec	Blinking datalog symbol	400ms	Reading	On	
Calibration Required	-	"Full" Bottle symbol	-	Reading	-	
Bump Required	-	"Empty" Bottle symbol	-	Reading	-	
Battery	1 beep/min	Blinking battery symbol	400ms	Reading	Stays as is	
Nwk Lost	1 beep/min	Blinking RF offline symbol	400ms	Reading	On	
Nwk Joined	1 beep	RF symbol with RSSI	400ms	Reading	On	
Comfort Beep	1 beep/min no LED flash	-	-	Reading	-	Lowest

Notes

"Negative" means that the true sensor reading is below zero, even though a zero reading is shown for the sensor.

"Nwk Lost" means "Network Lost." This indicates that the MuliRAE has lost wireless connectivity with its network.

"Nwk Joined" means that the MultiRAE has joined a wireless network.

Search Mode

<table>
<tr><th colspan="2">Alarm Type</th><th>Buzzer & LED</th><th>Display</th><th>Vibration</th><th>Reading</th><th>Backlight</th><th>Priority</th></tr>
<tr><td colspan="2">Super Alarm</td><td>4 beeps/sec</td><td>“Super Alarm” screen</td><td>400ms</td><td>-</td><td>On</td><td>Highest</td></tr>
<tr><td colspan="2">Man Down Alarm</td><td>3 beeps/sec</td><td>“Man Down Alarm” screen</td><td>400ms</td><td>-</td><td>On</td><td rowspan="23">↕</td></tr>
<tr><td colspan="2">Man Down Warning</td><td>2 beeps/sec</td><td>“Are You OK?” screen</td><td>400ms</td><td>-</td><td>On</td></tr>
<tr><td colspan="2">Fail</td><td>3 beeps/sec</td><td>“Lamp” at PID location
“Off” at LEL location</td><td>400ms</td><td>Blinking reading</td><td>On</td></tr>
<tr><td colspan="2">Pump</td><td>3 beeps/sec</td><td>Blinking pump symbol</td><td>400ms</td><td>Reading</td><td>On</td></tr>
<tr><td colspan="2">Max</td><td>3 beeps/sec</td><td>“Max” at sensor location</td><td>400ms</td><td>Blinking reading</td><td>On</td></tr>
<tr><td colspan="2">Over Range</td><td>3 beeps/sec</td><td>“Over” at sensor location</td><td>400ms</td><td>Blinking 9999</td><td>On</td></tr>
<tr><td rowspan="7">Geiger Counter-style Alarm</td><td>G7 (>High)</td><td>7 beeps(30ms)/sec</td><td rowspan="7">No change</td><td rowspan="7">400ms</td><td rowspan="7">Reading</td><td rowspan="7">On</td></tr>
<tr><td>G6</td><td>6 beeps(40ms)/sec</td></tr>
<tr><td>G5</td><td>5 beeps(50ms)/sec</td></tr>
<tr><td>G4</td><td>4 beeps(60ms)/sec</td></tr>
<tr><td>G3</td><td>3 beeps(70ms)/sec</td></tr>
<tr><td>G2</td><td>2 beeps(80ms)/sec</td></tr>
<tr><td>G1 (>Low)</td><td>1 beep(90ms)/sec</td></tr>
<tr><td colspan="2">Negative</td><td>1 beep/sec</td><td>“Neg” at sensor location</td><td>400ms</td><td>0</td><td>On</td></tr>
<tr><td colspan="2">STEL</td><td>1 beep/sec</td><td>“STEL” at sensor location</td><td>400ms</td><td>Reading</td><td>On</td></tr>
<tr><td colspan="2">TWA</td><td>1 beep/sec</td><td>“TWA” at sensor location</td><td>400ms</td><td>Reading</td><td>On</td></tr>
<tr><td colspan="2">Calibration Fail</td><td>1 beep/sec</td><td>“Cal” at sensor location</td><td>400ms</td><td>Reading</td><td>On</td></tr>
<tr><td colspan="2">Bump Fail</td><td>1 beep/sec</td><td>“Bump” at sensor location</td><td>400ms</td><td>Reading</td><td>On</td></tr>
<tr><td colspan="2">Datalog Full</td><td>1 beep/sec</td><td>Blinking datalog symbol</td><td>400ms</td><td>Reading</td><td>On</td></tr>
<tr><td colspan="2">Calibration Required</td><td>-</td><td>“Full” bottle symbol</td><td>-</td><td>Reading</td><td>-</td></tr>
<tr><td colspan="2">Bump Required</td><td>-</td><td>“Empty” bottle symbol</td><td>-</td><td>Reading</td><td>-</td></tr>
<tr><td colspan="2">Battery</td><td>1 beep/min</td><td>Blinking battery symbol</td><td>400ms</td><td>Reading</td><td>Stays as is</td></tr>
<tr><td colspan="2">Nwk Lost</td><td>1 beep/min</td><td>Blinking RF offline symbol</td><td>400ms</td><td>Reading</td><td>On</td></tr>
<tr><td colspan="2">Nwk Joined</td><td>1 beep</td><td>RF symbol with RSSI</td><td>400ms</td><td>Reading</td><td>On</td></tr>
<tr><td colspan="2">Comfort Beep</td><td>1 beep/min
No LED flashing</td><td>-</td><td>-</td><td>Reading</td><td>-</td><td>Lowest</td></tr>
</table>

General Alarms

Message	Condition	Alarm Indications
HIGH	Gas exceeds "High Alarm" limit	3 beeps/flashes per second
OVR	Gas exceeds sensor's measurement range	3 beeps/flashes per second
MAX	Gas exceeds electronic circuit's 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
Crossed pump icon flashes	Inlet blocked or pump failure	3 beeps/flashes per second
"Lamp" flashes	PID lamp failure	3 beeps/flashes per second
Empty battery icon flashes	Low battery	1 flash, 1 beep per minute
CAL	Calibration failed, or needs calibration	1 beep/flash per second
NEG	True sensor reading is below zero, even though a zero reading is shown for the sensor.	1 beep/flash per second

* For oxygen, "low alarm limit" means a concentration is lower than the low alarm limit.

15 Troubleshooting

Problem	Possible Reasons & Solutions
Cannot turn on power after charging the battery	**Reasons:** Defective charging circuit. Defective battery. **Solutions:** Replace battery or charger. Try another charge of battery.
Lost password	**Solutions:** Call Technical Support at +1 408-952-8461 or toll-free at +1 888-723-4800
Buzzer, LED lights, and vibration motor inoperative	**Reasons:** Buzzer and/or other alarms disabled. Bad buzzer, LED lights, PCB, or vibration motor(s). **Solutions:** Check under "Alarm Settings" in Programming Mode that buzzer and/or other alarms are not turned off. Call authorized service center.
"Lamp" message when power on. Lamp alarm.	**Reasons:** Low ion concentration inside PID lamp especially in cold environment when first powered on. Defective PID lamp or defective circuit. **Solutions:** Turn the unit off and back on. Replace UV lamp.
Pump failed message. Pump alarm.	**Reasons:** Inlet probe blocked. Direct connection to a gas outlet while the gas value is turned off. Water trap filter sucks in water. Water trap filter too dirty. Water condensed along the inlet probe. Bad pump or pump circuit. **Solutions:** Remove the blocking objects and then press [Y/+] key to reset the pump alarm. Replace contaminated water trap filter. Be careful not to allow water condensation inside the unit. Replace the pump.

If you need replacement parts, a list is available online:

www.raesystems.com

16 Specifications

Instrument Specifications

Size	7.6" H x 3.8" W x 2.6" D (193 x 96.5 x 66 mm)
Weight	Pumped models: 31 oz. (880 g) Diffusion models: 26.8 oz. (760 g)
Sensor	Over 25 intelligent interchangeable field-replaceable sensors, including Gamma radiation, ppb and ppm PIDs, electrochemicals for toxics and oxygen, combustible LEL and NDIR, and CO_2 NDIR
Battery Options	• Rechargeable Li-ion (over 12 hours runtime, pumped/over 18 hours, diffusion; < 6 hours recharge time) • Extended-duration rechargeable Li-ion (over 18 hours runtime, pumped; over 27 hours, diffusion) • Alkaline adapter for 4 x AA batteries (approximately 6 hours runtime, pumped/ 8 hours, diffusion)
Display	• Monochrome graphical LCD display (128 x 160) with backlighting (activated automatically in dim ambient lighting conditions, when monitor is in alarm, or with a button press) • Automatic screen flipping.
Display Readout	• Real-time reading of gas concentrations; PID measurement gas and correction factor; battery status; datalogging on/off; wireless on/off and reception quality. • STEL, TWA, peak, and minimum values • Various instrument status-related information
Keypad	3 operation and programming keys (MODE, Y/+, and N/-)
Sampling	Built-in pump or diffusion. Average flow rate, pumped: 250 cc/min. Auto shutoff in low-flow conditions
Calibration	Automatic with AutoRAE 2 Test and Calibration Station or manual
Alarms	• Wireless remote alarm notification; multi-tone audible (95 dB @ 30 cm), vibration, visible (flashing bright red LEDs), and on-screen indication of alarm conditions • Man Down Alarm with pre-alarm and real-time remote wireless notification
Datalogging	• Continuous datalogging (six months for 5 sensors at 1-minute intervals, 24/7) • User-configurable datalogging interval (from 1 to 3,600 seconds)
Communication and Data Download	• Data download and instrument set-up and upgrades on PC via charging and PC communication cradle, Travel Charger, or AutoRAE 2 Automated Test and Calibration Station[1] • Wireless data and status transmission via built-in RF modem (optional)
Wireless Network	RAE Systems Dedicated Wireless Network
Wireless Frequency	ISM license-free bands
EM Immunity	No effect when exposed to $0.43 mW/cm^2$ RF interference (5-watt transmitter at 12")
Operating Temperature	-4° to 122° F (-20° to 50° C)

Instrument Specifications

continued

Humidity	0% to 95% relative humidity (non-condensing)
Dust and Water Resistance	IP-65 (pumped), IP-67 (diffusion)
Hazardous Location Approvals	Exia Class I, Division 1, Groups A, B, C, D, T4 SIRA 11ATEX2152X, CE 0575 II 1G Ex ia IIC T4 Ga (for PGM62x0/PGM62x6) SIRA 11ATEX2152X, CE 0575 II 2G Ex ia d IIC T4 Gb (for PGM62x8) UM=20V IECEx SIR 11.0069X, Ex ia IIC T4 Ga (for PGM62x0/PGM62x6) IECEx SIR 11.0069X, Ex ia d IIC T4 Gb (for PGM62x8)
CE Compliance (European Conformity)	EMC directive: 2004/108/EC R&TTE directive: 1999/5/EC ATEX directive: 94/9/EC
FCC Compliance	FCC Part 15
Performance Tests	LEL CSA C22.2 No. 152; ISA-12.13.01
Languages	Arabic, Chinese, Czech, Danish, Dutch, English, French, German, Indonesian, Italian, Japanese, Korean, Norwegian, Polish, Portuguese, Russian, Spanish, Swedish, and Turkish
Warranty	• Two years on non-consumable components and catalytic LEL, CO, H_2S, and O_2 sensors • One year on all other sensors, battery, and other consumable parts

Specifications are subject to change.

Sensor Specifications

Radiation Sensor	Range	Resolution
Gamma	0 to 20,000 µRem/h	1 µRem/h
PID Sensors	**Range**	**Resolution**
VOC 10.6 eV (HR) VOC 10.6 eV (LR)* VOC 10.6 eV (ppb) VOC 9.8 eV	0.1 to 5,000 ppm 1 to 1,000 ppm 10 ppb to 2,000 ppm 0.1 to 1,000 ppm	0.1 ppm 1 ppm 10 ppb 0.1 ppm
Combustible Sensors	**Range**	**Resolution**
Catalytic bead LEL NDIR (0-100% LEL Methane) NDIR (0-100% Vol. Methane)	0 to 100% LEL 0 to 100% LEL 0 to 100% Vol.	1% LEL 1% LEL 0.1% Vol.
Carbon Dioxide Sensor	**Range**	**Resolution**
Carbon Dioxide (CO_2) NDIR	0 to 50,000 ppm	100 ppm
Electrochemical Sensors	**Range**	**Resolution**
Ammonia (NH_3)	0 to 100 ppm	1 ppm
Carbon Monoxide (CO) Carbon Monoxide (CO), Ext. Range Carbon Monoxide (CO), H_2-comp. Carbon Monoxide (CO) + Hydrogen Sulfide (H_2S) Combo	0 to 500 ppm 0 to 2,000 ppm 0 to 2,000 ppm 0 to 500 ppm 0 to 200 ppm	1 ppm 10 ppm 10 ppm 1 ppm 0.1 ppm
Chlorine (Cl_2)	0 to 50 ppm	0.1 ppm
Chlorine Dioxide (ClO_2)	0 to 1 ppm	0.03 ppm
Ethylene Oxide (EtO-A) Ethylene Oxide (EtO-B) Ethylene Oxide (EtO-C), Ext. Range	0 to 100 ppm 0 to 10 ppm 0 to 500 ppm	0.5 ppm 0.1 ppm 10 ppm
Formaldehyde (HCHO)	0 to 10 ppm	0.01 ppm
Hydrogen (H_2)**	0 to 1,000 ppm	2 ppm
Hydrogen Sulfide	0 to 100 ppm	0.1 ppm
Hydrogen Sulfide (H_2S), Ext. Range*	0 to 1,000 ppm	1 ppm
Hydrogen Cyanide (HCN)	0 to 50 ppm	0.5 ppm
Methyl Mercaptan (CH_3-SH)	0 to 10 ppm	0.1 ppm
Nitric Oxide (NO)	0 to 250 ppm	0.5 ppm
Nitrogen Dioxide (NO_2)	0 to 20 ppm	0.1 ppm
Oxygen (O_2)	0 to 30% Vol.	0.1% Vol.
Phosphine (PH_3)	0 to 20 ppm	0.1 ppm
Sulfur Dioxide (SO_2)	0 to 20 ppm	0.1 ppm

* Supported in MultiRAE Lite Pumped version only.
** Supported in Diffusion version only.

All specifications are subject to change without notice.

LEL Range, Resolution & Response Time

LEL 0-100% 1 % 15 sec

LEL Cross-Sensitivity

Compound	LEL Relative Sensitivity*	LEL CF
Methane	100	1.0
Propane	62	1.6
Propene	67	1.5
n-Butane	50	2.0
Isobutylene	67	1.5
n-Pentane	45	2.2
n-Hexane	43	2.3
Cyclohexane	40	2.5
Benzene	45	2.2
Toluene	38	2.6
n-Heptane	42	2.4
n-Octane	34	2.9
Turpentine	34	2.9
Leaded Gasoline	48	2.1
Methanol	67	1.5
Ethanol	59	1.7
Isopropanol	38	2.6
Acetone	45	2.2
Methyl Ethyl Ketone	38	2.6
Ethyl Acetate	45	2.2
Carbon Monoxide	75	1.2
Hydrogen	91	1.1
Ammonia	125	0.80

* Response of the RAE Systems LEL sensor to a range of gases at the same LEL, expressed as percent of methane response (=100). These figures are for guidance only and are rounded to the nearest 5%. For the most accurate measurements, the instrument should be calibrated with the gas under investigation. See RAE Systems Technical Note TN-156 for more details and other compounds.

Caution:
Refer to RAE Systems Technical Note TN-144 for LEL sensor poisoning.

Year Of Manufacture

To identify the year of manufacture, refer to the serial number of the instrument.

The second to last digit in the serial number indicates the year of manufacture. For example, "M" indicates the manufacturing year is 2010.

First digit	Year
J	2008
K	2009
M	2010
N	2011
P	2012
Q	2013
R	2014
S	2015
T	2016
U	2017
V	2018
W	2019

17 Technical Support

To contact RAE Systems Technical Support Team:

Monday through Friday, 7:00AM to 5:00PM Pacific (US) Time
Phone (toll-free): +1 888-723-4800
Phone: +1 408-952-8461
Email: tech@raesystems.com

Critical after-hours support is available:
+1 408-952-8200 select option 8

18 RAE Systems Contacts

RAE Systems
World Headquarters

3775 N. First St.
San Jose, CA 95134-1708 USA
Phone: +1 408.952.8200
Fax: +1 408.952.8480

E-mail: customerserv@raesystems.com
Web Site: www.raesystems.com

RAE Systems Technical Support
Monday through Friday, 7:00AM to 5:00PM Pacific Time
Phone: +1.408.952.8461
Email: tech@raesystems.com

Critical after-hours support is available
+1.408.952.8200 select option 8

RAE Systems Europe ApS
Kirstinehøj 23 A
DK-2770 Kastrup
Denmark
Phone: +45 86 52 51 55
Fax: +45 86 52 51 77
orders@raeeurope.com
sales@raeeurope.com
service@raeeurope.com
Web: www.raesystems.eu

RAE Systems UK Ltd
D5 Culham Innovation Centre
Culham Science Centre
Abingdon, Oxon OX14 3DB
United Kingdom
Phone: +44 1865408368
Fax: +44 1235531119
Mobile: +44 7841362693
Email: raeuk@raeeurope.com

RAE Systems France
ZI des Ayats
679390 MILLERY
France
Phone: +33 4 78 46 16 65
Fax: +33 4 78 46 25 98
Email: info-france@raeeurope.com
Web: www.raesystems.fr

RAE BeNeLux BV
Hoofdweg 34C
2908 LC Capelle a/d IJssel
The Netherlands
Phone: +31 10 4426149
Fax: +31 10 4426148
Email: info@rae.nl
Web: www.rae.nl

RAE Systems Spain, s.l.
Av. Remolar, 31
08820 El Prat de Llobregat
Spain
Phone: +34 933 788 352
Fax: +34 933 788 353
Mobile: +34 687 491 106
Email: mdelgado@raespain.com
Web: www.raespain.com

RAE Systems Germany GmbH
Felix-Wankel-Str. 5
82152 Krailing, Germany
Phone: +49 89 20 70 40 248
Fax: +49 89 850 93 74
Email: orders@raeeurope.com

RAE Middle East
LOB 7, Ground Floor, Office 19
Jebel Ali Free Zone
Dubai, United Arab Emirates
Phone: +971.4.887.5562
Email: mesales@raesystems.com

RAE Systems (Hong Kong) Ltd.
Room 8, 6/F, Hong Leong Plaza
33 Lok Yip Road
Fanling, N.T, Hong Kong
Phone: +852.2669.0828
Fax: +852.2669.0803
Email: hksales@raesystems.com

RAE Systems Japan
Marunouchi Nakadori Bldg 6F-617-B,
2-3, Marunouchi 2-Chome, Chiyoda-ku,
Tokyo, 100-0005 Japan
Phone: +81-3-6269-9646
Fax: +81-3-6269-9647
Email: jpsales@raesystems.com

RAE Systems Korea
#1010, DaeMyungAnsVill First,
Sang-Dong 412-2, Wonmi-Gu, Bucheon,
Kyungki-Do, Korea
Phone: 82-32-328-7123
Fax: 82-32-328-7127
Email: krsales@raesystems.com

RAE Systems
World Headquarters
3775 N. First St.
San Jose, CA 95134-1708 USA
Phone: 408.952.8200
Fax: 408.952.8480

E-mail: customerserv@raesystems.com
Web Site: www.raesystems.com

Rev C
May 2013
P/N: M01-4003-000

Passive Diffusion (PDB) Samplers Instructions
(Contains certified ASTM Type II deionized water)

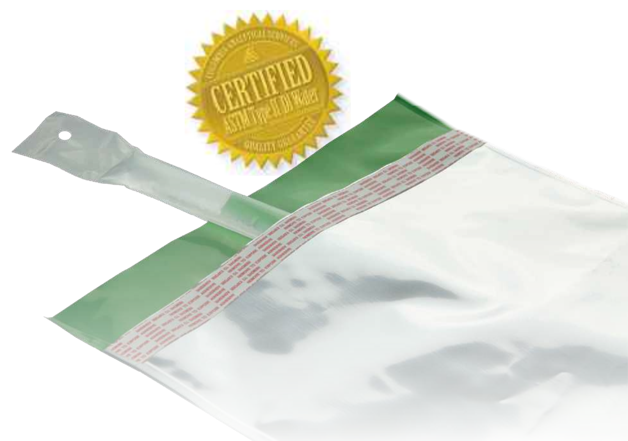
Thank you for your recent PDB order. Following you will find instructions for storage, deploying and retrieving of your PDB. Please read through the following carefully prior to opening your package.

For an instructional video on how to deploy and retrieve of your PDB visit our website at **http://www.caslab.com/PDB**

PDB Storage:

- Columbia Analytical recommends storing the PDB in their shipping pouch in a dry location (between 50-75° F) until deployment if you will be deploying them within 14 days of receiving them.
- If you will be storing them for over 14 days before deployment, we recommend that they be stored in a foil pouch (These are available from Columbia Analytical) to avert any possible diffusion from the storage ambient air.

PDB Deployment:



1. Deploy the PDB as soon as possible upon removal from the shipping/storage pouch.
2. The long seams of the PDB are designed to resist wear and tearing, however, the construction of some wells may lead to excessive stress on the PDB. To avoid any possible tearing under these circumstances (rock boreholes, pore or uncertain well construction), we recommend placing the PDB in a mesh cover. (These are available from Columbia Analytical.)
3. The PDB should be attached to your hanging line at a depth ensuring they hang at the desired location in the well screen.
4. If using a hanging assembly supplied by Columbia Analytical, secure the line to the plastic disk or well cap before lowering the PDB and assembly into the well.
5. Lower the weight into the well first, followed by the line and PDB.
6. Secure the line to the well head.
7. Secure the well.

PDB Retrieval:

1. Field experience has shown that using a plastic winder or a spool winder to retrieve the PDB allows the sampler to keep the line from tangling and makes deployment of the new PDB easier.
2. If a single individual is retrieving the PDB, it is helpful to have a 2-4 foot long PVC pipe that has been cut in half length-wise. The field sampler can lay the PDB in the pipe after retrieval prior to sample replacement into the VOA vials. A PVC pipe may be procured from any building or hardware supplier.
3. The contents of the PDB should be poured into the VOA vials at the well head. Studies have shown that there is loss of volatile organics from the PDB within 30 minutes after retrieval. Using decontaminated scissors, cut off the angled end of the PDB then pour the contents of the PDB carefully into the VOA vials, taking care to avoid splashing or unnecessary mixing of air into the sample.
4. Fill each vial just to overflowing and maintain a reverse meniscus. Cap the vial, making sure there are no bubbles or headspace.
5. Dispose of the remnants of the PDB and any unused sample appropriately.
6. Deploy a new PDB for your next sampling round.

Unfilled PDB Sampler Instructions:

The only difference in the procedures for deployment of pre-filled and unfilled PDB concerns testing of the water used to fill the PDB. A sample of the water used and rinseate of the equipment used to fill the PDB, if any, should be submitted to the laboratory for testing to verify it does not contain any of the analytes of interest.

All PDB

If trip blanks/equipment blanks are required, an extra PDB should be ordered. This extra PDB should be sampled into VOA vials or appropriate containers and sent to the laboratory for testing to ensure that no contamination took place during the deployment process.

SNAP SAMPLER® ZERO

PASSIVE SAMPLING SYSTEM

STANDARD OPERATING PROCEDURE FOR THE SNAP SAMPLER® PASSIVE GROUNDWATER SAMPLING METHOD (NOVEMBER 2019)

PFAS FREE
TESTED FOR PURITY

2019 UPDATE

The 2019 update includes minor additions to reflect further technical validation of the Snap Sampler® method add and clarifications to some sample and equipment handling procedures, including the PFAS-Zero™ version of the Snap Sampler passive groundwater sampler. The update includes reference to the ASTM Standard Guide for Passive Sampling, D7929-14 (ASTM, 2014).

This Standard Operating Procedure (SOP) should be used to familiarize the user with the application and protocol for use the Snap Sampler® passive groundwater monitoring system. *The laminated picture instruction cards contain step-by-step field instructions. The picture instructions in the Appendices, rather than the SOP itself, should be the primary tool for Snap Sampler® operation in the field.* The SOP is designed for overall understanding and rationale for passive groundwater sampling with the Snap Sampler®, and for regulatory submittal with Sampling and Analysis Plans. Should the user require information beyond that included in this SOP, additional information can be found on the Snap Sampler® website **www.SnapSampler.com, www.qedenv.com/global** or by contacting your Snap Sampler representative at **QED Environmental Systems, Inc.**

FORWARD

This SOP was adapted from SOPs in USEPA's groundwater guidance for RCRA and Superfund project managers (U.S. Environmental Protection Agency 2002). Portions of the applicable text are included here. With this forward, the authors and USEPA are acknowledged in sincerest appreciation. Edited and supplemental text is added to detail application information and procedures for use and deployment of the Snap Sampler® passive groundwater sampling device and method.

INTRODUCTION

The goal of groundwater sampling is to collect samples that are representative of *in situ* groundwater conditions and to minimize changes in groundwater chemistry during sample collection and handling. Experience has shown that groundwater sample collection and handling procedures can be a source of variability in water quality concentrations due to differences in sampling personnel, sampling procedures, and equipment (U.S. Environmental Protection Agency 1995; McHugh *et al.* 2010; Parker and Britt, 2012).

Traditionally, the collection of representative water samples from wells is neither straightforward nor easily accomplished. Groundwater sample collection through pumping or bailing can be a source of variability through differences in sampling personnel and their individual sampling procedures, the equipment used, and ambient temporal variability in subsurface and environmental conditions. Many site inspections and remedial investigations require the sampling at groundwater monitoring wells within a defined criterion of data confidence or data quality, which necessitates that the personnel collecting the samples are trained and aware of proper sample collection procedures.

The purpose of this SOP is to provide a description of the Snap Sampler® passive groundwater sampling method. The method and specialized equipment is designed to minimize the impact the sampling process on groundwater chemistry. This is accomplished through deployment and passive re-equilibration of the monitoring well to ambient groundwater flow and/or diffusive contaminant flux within the well/aquifer system. The Snap Sampler® method eliminates well purging prior to sample collection.

As a passive groundwater sampling device, the Snap Sampler® is a proven, cost-effective alternative to well purge and low-flow sampling (Parker *et al.* 2011; Britt *et al.* 2010). Historical and recent research shows that most if not virtually all well screen zones exhibit ambient flow-through under natural groundwater gradients (Gillham

1982; Pankow *et al.* 1985; Robin and Gillham 1987; Powell and Puls 1993; Puls and Barcelona 1996; Vroblesky *et al.* 2001a; ASTM 2002; ITRC 2004, 2007, ASTM 2014). The screen sections of these wells naturally exchange formation water without pumping. Ongoing research suggests that natural ambient flow-through induces a contaminant redistribution effect within wells (Britt *et al.* 2011; Britt 2005, 2006; Martin-Hayden and Britt 2006; Vroblesky *et al.* 2006; Britt and Calabria 2008). This redistribution regularly results in a flow-weighted averaging effect in the well *without purging*. Though not all wells are thoroughly mixed, many wells show relatively narrow ranges of vertical concentrations when vertically profiled (Vroblesky *et al.* 2001b; Parsons 2003; Britt and Calabria 2008). These studies and others indicate flow-weighted contaminant concentration averaging within wells is common. The Snap Sampler® takes advantage of these "naturally purged" wells by capturing a whole water sample after a period of sampler deployment in the well.

Wells in poor yielding formations with slow recharge during pumping have always been problematic for pumping methods. Wells with short water columns are also problematic for some of the same reasons. Passive sampling of poorly yielding wells has been suggested as a better method than purging to dryness in VOC impacted wells (McAlary and Barker 1987; Puls and Powell 1993; Puls and Barcelona 1996). *The Snap Sampler® can be deployed in low yield and short water column wells to take advantage of this passive sampling approach*.

The Snap Sampler® (Figure 1) passive groundwater sampling method limits sample collection variables by sealing the sample while it is still in the well, at the same position in the well during each sampling event. Where appropriate, the sample is maintained in the same sample container that is transmitted to the laboratory rather than pouring into sample bottles at the ground surface. Using this approach, sampling personnel are essentially prevented from introducing error, variability, or bias during the sample collection process. Sample collection is virtually the same for any user because the sample is captured downhole the same way every event, without impact from user technique, and in many cases, not exposed to the ambient air from the well to the laboratory. Research shows that variability reduction may improve long-term data trend analysis (Britt *et al.* 2011; McHugh *et al.* 2010; Britt *et al.* 2010; Britt 2008).

SCOPE AND APPLICATION

This SOP should be used primarily for monitoring wells that have a screen or an open interval large enough to

FIGURE 1, example with 2 of the VOA-size Snap Sampler Modules. Up to 6 modules can be assembled in any combination of sizes.

accept a downhole device of 1.8 inches (46mm) in diameter or larger. Long screen interval sampling may be conducted, but stratification testing may be warranted if previous information about aquifer and/or well contaminant stratification is not available. Vertical profiling requirements depend on site-specific data quality objectives (DQO's) and site-specific requirements (ASTM 2014, Vroblesky 2001a; ITRC 2004, 2007).

Groundwater samples that are collected using this procedure are useable for the analyses of groundwater contaminants that may be found at Superfund and RCRA contamination sites, as well as sites with a variety of contamination types. The analytes may be volatile organic compounds, semi-volatile organic compounds, pesticides, PCBs, metals, and other inorganic compounds, including perchlorate and other emerging contaminants such as explosive compounds, 1,4-dioxane, 1,2,3-TCP, NDMA and others. No analyte limitations have been found for the Snap Sampler® (Parker and Mulherin, 2007, Parker *et al*. 2008, 2009, 2011a and 2011b; Britt *et al*. 2010). Sufficient sample volume is the only practical analyte limiting factor for the method. When sampling for Per- and Polyfluoroalkonated compounds (PFAS), the user should choose the PFAS Zero™ versions of the Snap Sampler product line. These components contain no fluorinated compounds. The user should note that bottles and pneumatic actuator devices not specifically marked as "PFAS Zero™" items may contain fluoropolymers. Lot testing shows these tested items to be PFAS free, but some sampling plans prohibit use of any fluoropolymers regardless of testing status.

For contaminant plume monitoring, the sampler should be placed within the screened interval of the well. For consistency and comparability of results over time, the sampler should be placed in same location and depth for each subsequent sampling event. To accommodate this preference, dedicated sampling devices with dedicated trigger lines should be used whenever possible. The Snap Sampler® should not be placed resting on the bottom well to avoid disturbing any sediment at the bottom of the well during deployment or when the sampler is triggered.

The Snap Sampler® relies on natural flow-through and/or diffusion of contaminants from the aquifer to the well (Powell and Puls 1993; ASTM 2002; ITRC 2004, 2007). Well purging is not conducted before sampling, therefore, measurement of water-quality-indicator parameters is not a prerequisite to sample collection. If parameters are required for certain monitoring programs independent of sampling method (e.g. for monitored natural attenuation assessment), parameters can be collected by utilizing one of the deployed Snap Sampler® bottles or post-sampling by another method (*e.g.* a downhole probe).

Samples collected for metals, semi-volatile organic compounds, pesticides, and other analytes may be impacted by sample turbidity. They also may be subject to transport by colloidal flow in the natural groundwater regime (Kearl *et al.* 1992; Puls and Powell 1992). Deployment and re-equilibrium of the Snap Sampler® allows natural colloidal flow to be monitored within the well. This is a distinct advantage over sampling methods such as the polyethylene diffusion bag (PDB), where colloidal particles are excluded from the sample; and an advantage over purge methods where colloids may be artificially mobilized (Britt *et al.* 2010). Field filtering is not required for samples collected with the Snap Sampler® but can be conducted if required by the site Sampling and Analysis Plan.

Proper well construction, development, and maintenance are essential for any groundwater sampling procedure. Prior to conducting field work, information on the construction of the well and well development should be obtained and that information factored into the site specific sampling procedure. This SOP is not to be used where non-aqueous phase liquids (NAPL) (immiscible fluids) are present in the monitoring well.

MATERIALS AND EQUIPMENT

- Field Sampling and Quality Assurance Project Plan.
- Site Health and Safety Plan with specifications for personal protective equipment and air monitoring equipment.
- Personal protective equipment in good working order as specified in the site Health and Safety Plan.
- Air monitoring equipment in good working order as specified in the Site Health and Safety Plan.
- Site access/permission documentation for site entry.
- Well keys and map of well locations.
- Tool box - All needed tools for all site equipment used.
- Snap Sampler® Modules - Dedicated samplers are recommended in most applications.
- Snap Sampler® Trigger lines, – Dedicated trigger lines are recommended in most applications. Trigger lines may be manual, with a mechanical wire connection from surface to sampler; or pneumatic, with an airline from surface to sampler.
- Snap Sampler® Well Caps – Lockable well caps for Snap Sampler® -deployed wells—includes a support ring to hang Snap Sampler equipment.
- Sample bottles, sample preservation supplies, sample tags or labels, and chain-of-custody forms.
- Well construction, field, and water quality data from the previous sampling event.
- Field notebook, groundwater sampling logs, and calculator.
- Polyethylene sheeting placed on ground around the well head.
- Depth-to-water measuring device - An electronic water-level indicator or steel tape and chalk, with marked intervals of 0.01 foot. Interface probe for determination of liquid products (NAPL) presence, if needed.

- Steel tape and weight - Used for measuring total depth of well.

- Multi-parameter meter, if required. The water-quality-indicator parameters that may be monitored under common monitoring programs include pH, ORP/Eh, (ORP) dissolved oxygen (DO), turbidity, specific conductance, and temperature. Turbidity readings, if required, must be collected from a sacrificed Snap Sampler® bottle because retrieving the sampler may agitate the well, increasing turbidity values not present in the actual samples. Calibration fluids for all instruments should be traceable and there should be enough for daily calibration throughout the sampling event.

- Decontamination supplies, including a reliable and documented source of distilled water and any solvents (if used). Pressure sprayers, buckets or decontamination tubes for pumps, brushes and non-phosphate soap will be needed for non-dedicated equipment that is moved from well to well.

- A suitable container for excess sample and decontamination water, as needed or required.

Construction materials of non-dedicated sampling equipment (samplers, tubing, and other equipment that comes in contact with the sample) should be limited to inert materials. This will reduce the chance that sampling materials alter the groundwater where concentrations of the site contaminants are expected to be near the detection limits. The tendency of organics to sorb into and desorb out of plastic materials makes dedicated equipment preferable where possible.

It should be noted that plastic materials used in the Snap Sampler® are not usually problematic for sorption. Using methods described in this SOP, the sampler is deployed for one to two weeks (or more). This deployment period allows materials prone to sorption to achieve equilibrium with groundwater before the sample is collected (Parker, et al. 2007).

DEPLOYMENT/SAMPLING PROCEDURES

The following describes the deployment and sampling procedures for the Snap Sampler® passive groundwater sampling method. These procedures describe steps for dedicated and non-dedicated systems.

Pre-Sampling Activities

1. Well location maps, construction information, keys and sampling equipment should be assembled and transported to the site.

2. Water level monitoring and sampling must begin at the monitoring well with the least contamination, generally up-gradient or farthest from the site or suspected source. Then proceed systematically to the monitoring wells with the most contaminated ground water.

3. Check and record the condition of the monitoring well for damage or evidence of tampering. Lay out polyethylene sheeting around the well to minimize the likelihood of contamination of sampling equipment from the soil and exposure of soil to liquids dripping from the sampling equipment.

4. Unlock well head. Record location, time, date, and appropriate information in a field logbook or on the groundwater sampling log.

5. Remove inner casing cap.

6. If required, monitor the headspace of the monitoring well at the rim of the casing for volatile organic compounds (VOC) with a photo-ionization detector (PID) or flame ionization detector (FID) and record in the logbook. If the existing monitoring well currently has or has a history of positive headspace readings, then the sampling must be conducted in accordance with the Health and Safety Plan.

7. Measure the depth to water (water level must be measured to nearest 0.01 feet) relative to a reference measuring point on the well casing with an electronic water level indicator or other appropriate measuring device and record in logbook or groundwater sampling log. If no reference point is found, measure relative to the top of the inner casing, then mark that reference point and note that location in the field logbook. Record information on depth to ground water in the field logbook or groundwater sampling log. Measure the depth to water a second time to confirm initial measurement; measurement should agree within 0.01 feet or re-measure.

8. Check the available well information or field check for the total depth of the monitoring well.

Deployment Activities

Selection of the deployment depth within the screen interval is dependent on site specific DQO's. Normally, deployment depth is targeted at the center of the well screen. If depth-specific monitoring is desired, multiple samplers may be deployed at intervals appropriate for the sampling objective.

If multiple sample zones within a well, zone isolation using a packer or baffle device to limit in-well mixing can be used (Britt 2006; Britt and Calabria 2008). These can be attached to the Snap Sampler® trigger line or deployed separately. Installation of an upper baffle designed to isolate the unscreened well casing or well headspace may be desired. The upper baffle will limit mixing of "stagnant" casing water with screen-interval water, an/or gas exchange with the headspace air.

1. Remove the Snap Sampler bottle(s) from its packaging.

2. Turn the translucent "Snap Cap" on each end of the bottle slightly to release any sticking of the o-ring.

3. Insert the bottle into the upper end of the sampler as shown in Figure 2.

4. Place the sampler twist-on connector onto each end of the sampler; turn clockwise to align the set pins/screw (Figure 3); then gently tighten the set screw with the Snap Driver Tool (Figure 4).

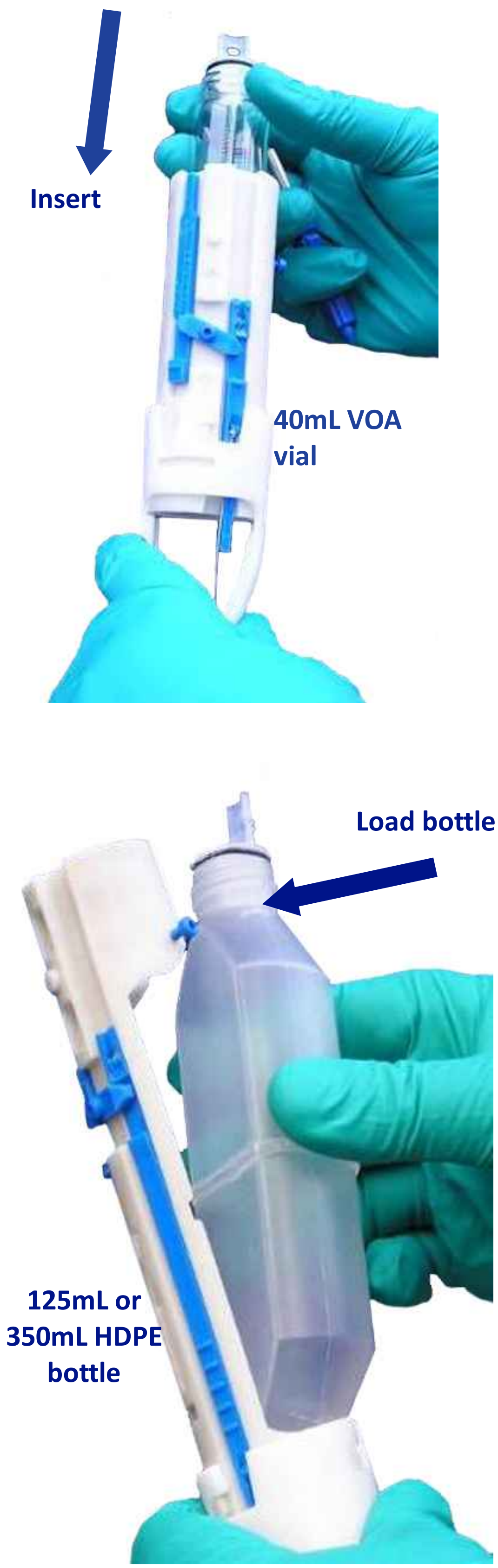


FIGURE 2

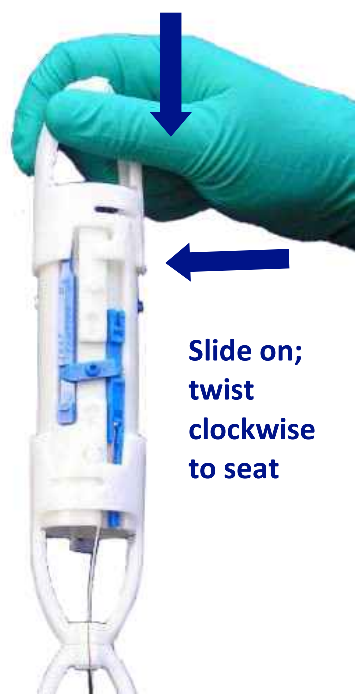


FIGURE 3

FIGURE 4

5. Pivot the vial cap (Snap Cap) into its seat with the Snap driver. Push up the retainer pin through the lower hole in the vial cap. Repeat for all Snap Caps (Figure 5). If an o-ring should dislodge from its seat during setting, remove the sample bottle and carefully replace it in the o-ring groove; repeat setting procedure.

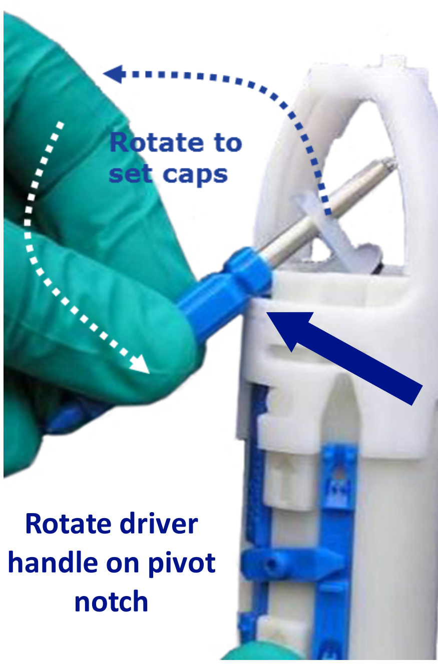


FIGURE 5

6. For the manual trigger, feed ball-fitting end of trigger cable through lower release pin groove; click tube fitting into connector (Figure 6).

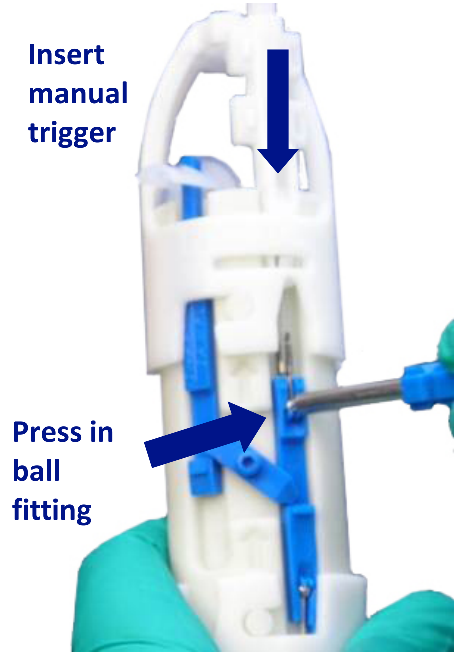


FIGURE 6

7. Press in the ball fitting to attach to lower release pin (Figure 6).

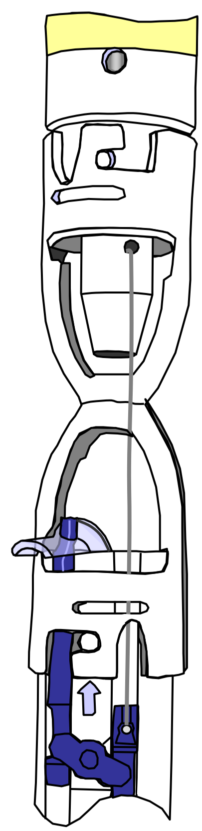


FIGURE 7

8. For the pneumatic trigger system, attach the wireline from the plunger (Figure 7).

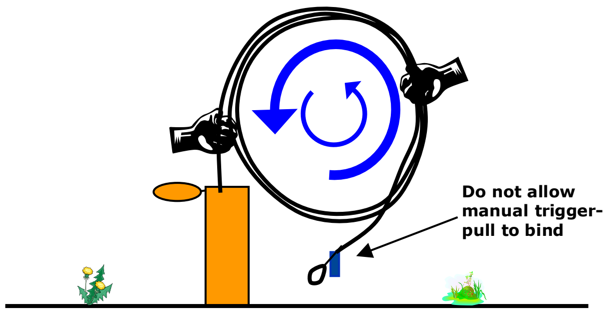


Figure 8

9. Deploy to selected depth with trigger cable/tubing and attach to well head docking station (Figure 8, Figure 9).

10. Additional Snap Samplers® can be deployed with separate trigger lines or in series with a single trigger. If separate triggers are used, the ID tags should be marked at the surface for later reference.

FIGURE 9

11. The recommended deployment period is one to two weeks. There may be hydrogeologic conditions where a shorter deployment is possible, but one to two weeks would generally assure a return of the well to its steady-state condition (Vroblesky, 2001a, 2001b). Parker et al (2009) found that a 72 hour submergence time was sufficient for most analytes tested, but this does not account for well disturbance or other-well-specific factors. The user may determine that shorter or longer deployment times than the standard 1-2 weeks are appropriate for a specific application.

12. The Snap Sampler® can be deployed for extended periods. No upper bound for sampler deployment has been found. Rather, conditions at individual wells seem to control the applicability of deployments lasting a year or longer.

Sample Collection Activities

When the deployment period is completed, the sampler should be triggered at the well head without disturbing the sampler position. For the manual trigger, the cable end should be pulled with sufficient force to move the cable up the tubing. Depending on the length of the cable, closure of the samplers usually can be felt through the trigger line when the samplers trip. For the pneumatic trigger system, pressure is added to the downhole air line to trigger the Snap Samplers to close. If more than one triggering line is present, closure should proceed from the deepest to the shallowest sampler position to limit capture of sediment potentially re-suspended by closure of the first sampler. Additional details on collection activities are included in the Appendices and “Quick Check” instructions.

After the sampler is triggered and retrieved, the upper connector should be removed by loosening the blue retainer screw and turning the white cover piece. The bottom connector piece does not need to be disassembled to remove the bottles.

While the bottles should not leak with reasonable handling, they should not be agitated (to check for headspace, for example) until after the screw caps are tightened. Under most circumstances there will be no air in the vials at retrieval. However, some field conditions—including deep groundwater, natural effervescence, or other causes—may cause some small air bubbles to be present in the bottle or on the spring when retrieved. This is not a concern if the air was entrained while deployed. Air adhering to the vial during deployment would be in equilibrium with the sample water upon sampler closure. Therefore it is not “headspace air” into which sample VOCs could volatilize. Deployment air could be attached to the spring or cap, and should not be larger than 1-2 mm upon retrieval. Pankow (1986) showed that small headspace gas from these or other causes do not substantially impact results for most common volatiles. If gas bubbles are larger than 5 mm before placing the screw cap, or water is clearly leaking from the vial, the sample may not have sealed properly. There are three options for addressing bubbles: 1) the bottle can be submitted to the laboratory with the headspace bubble, noting the occurrence; 2) the cap can be opened slightly and sample water from another bottle added to fill the vial; or 3) the bottle can be discarded. The user can determine which approach is most appropriate depending on the size of the bubble. For a 1mm bubble, option #1 may be most appropriate; for a 5mm bubble, #2 may be appropriate, while #3 may be appropriate for a 50% full bottle.

There are no special laboratory preparation procedures for Snap Sample bottles. The bottles can be analyzed using common 40-ml autosamplers. The spring inside the VOAs is polymer-coated and will deflect away from the autosampler extraction needle during insertion.

The appendices include step-by-step instructions for deployment and bottle preparation procedures.

<u>Appendix A</u> contains step-by-step field procedures for deployment of both 40 ml Snap Sampler VOAs and 125 ml Snap Sampler POLY bottles.

<u>Appendix B</u> contains step-by-step procedures for preparation of both 40 ml Snap Sampler VOAs and 125 ml Snap Sampler POLY bottles.

DECONTAMINATION PROCEDURES

The electronic water level indicator probe/steel tape, the water-quality field parameter sensors and any <u>*non-dedicated*</u> Snap Sampler® groundwater sampling equipment should be decontaminated by the following procedures:

1. The water level meter will be hand washed with phosphate-free detergent and a scrubber, then thoroughly rinsed with distilled water.

2. Water quality field parameter sensors with distilled water between sampling locations where utilized. No other decontamination procedures are necessary or recommended for these probes since they are sensitive. After the sampling event, the sensors must be cleaned and maintained per the manufacturer's requirements.

3. For <u>*non-dedicated*</u> applications, the Snap Sampler® and trigger tubing must be pressure-sprayed or bristle-brush scrubbed with soapy water, tap water, and distilled water prior to use in a different well. Depending on the condition of the Snap Sampler®, the release pin mechanism may need to be disassembled to effectively clean the pins and grooves. Disassembly can be accomplished by removing the lever screw.

FIELD QUALITY CONTROL

Quality control (QC) samples must be collected to verify that sample collection and handling procedures were performed adequately and that they have not compromised the quality of the groundwater samples. The appropriate EPA or other appropriate program guidance must be consulted in preparing the field QC sample requirements for the site-specific Quality Assurance Project Plan (QAPP).

There are five primary areas of concern for quality assurance (QA) in the collection of representative groundwater samples:

1. Obtaining a groundwater sample that is representative of the aquifer or zone of interest in the aquifer. Verification is based on the field log documenting that the field procedures were followed appropriately during sample deployment and collection.

2. Ensuring that the sampling devices are made of materials, and utilized in a manner that will not interact with or alter the analyses.

3. Ensuring that results generated by these procedures are reproducible; therefore, the sampling scheme should incorporate co-located samples (duplicates).

4. Preventing cross-contamination. Sampling should proceed from least to most contaminated wells, if known. Field equipment blanks should be incorporated for all sampling, and decontamination of the equipment is therefore required.

5. Properly preserving, packaging, and shipping samples.

All field QC samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The chain-of custody procedures for the QC samples will be identical to the field groundwater samples. The following are QC samples that should be collected during the sampling event:

Field duplicates	See QAPP/SAP
Matrix spike	See QAPP/SAP
Matrix spike dup.	See QAPP/SAP
Equipment blank	See QAPP/SAP
Trip blank (VOCs)	See QAPP/SAP
Temperature blank	See QAPP/SAP

HEALTH AND SAFETY CONSIDERATIONS

Depending on the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. The site Health and Safety Plan should be reviewed with specific emphasis placed on the protection program planned for the sampling tasks. Standard safe operating practices should be followed, such as minimizing contact with potential contaminants in both the liquid and vapor phase through the use of appropriate personal protective equipment.

Depending on the type of contaminants expected or determined in previous sampling efforts, the following safe work practices should be employed:

Particulate or metals contaminants

1. Avoid skin contact with, and incidental ingestion of sample water.

2. Use protective gloves and splash protection.

Volatile organic contaminants

1. Avoid breathing constituents venting from well.

2. Pre-survey the well head space with an appropriate device as specified in the site Health and Safety Plan.

3. If monitoring results indicate elevated organic constituents, sampling activities may be conducted in elevated protective equipment (e.g. level C protection). At a minimum, skin protection will be afforded by disposable protective clothing, such as Tyvek®, appropriate gloves and face protection.

General practices should include avoiding skin contact with water from preserved sample bottles, as this water will have pH less than 2 or greater than 10. Also, when field acidifying VOA bottles, hydrochloric acid fumes may be released and should not be inhaled. Acid should not contact skin, eyes, or unprotected clothing.

POST-SAMPLING ACTIVITIES

Several activities need to be completed and documented once groundwater sampling has been completed.

These activities include, but are not limited to the following:

1. Ensuring that all field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.

2. Processing all sample paperwork, including copies provided to the appropriate sample handling and tracking facility.

3. Compiling all field data for site records.

4. Verifying all analytical data processed by the analytical laboratory against field sheets to ensure all data has been returned to sampler.

REFERENCES

American Society of Testing Materials (ASTM). 2002, *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations.* ASTM Subcommittee D18.21: Designation D 6771-02.

ASTM, 2014, Standard Guide for Selection of Passive Techniques for Sampling Groundwater Monitoring Wells, 14p. ASTM International, West Conshohocken, Pennsylvania, United States. D7929-14

Britt, S.L., 2005, *Testing the In-Well Horizontal Laminar Flow Assumption with a Sand Tank Well Model.* Ground Water Monitoring and Remediation 25:3 p. 73-81.

Britt, S.L., 2006, *Multilevel Sampling in Traditional Monitoring Wells: A Mixing-Limited Passive Sampling Approach,* Proceedings of the Ground Resources Association of California High-Resolution Characterization and Monitoring Conference, November 14-16, 2006, Long Beach, California.

Britt, S. L. and Calabria, 2008, *Baffles may Allow Effective Multilevel Sampling in Traditional Monitoring Wells* (Abstract), Proceedings of the Battelle Conference on Chlorinated and Recalcitrant Compounds, Monterey, California, May 2008.

Britt, S.L., B.L. Parker, and J.A Cherry, 2010, *A Downhole Passive Sampling System to Avoid Bias and Error in Groundwater Sample Handling*, Environmental Science and Technology, v.44 p 4917-4923

Britt, S.L., Plummer, M., Martin-Hayden, J.M, 2011, *Groundwater Sampling Results May Differ when Sampling Methods Differ: Methods and Mechanisms*, Proceedings of the North American Field Conference and Exposition, San Diego, California, January 10-13, 2011.

Gillham, R.W., 1982, *Syringe Devices for Ground-Water Sampling,* Ground Water Monitoring Review, Spring 1982 Issue, p. 36-39.

Kearl, P.M., N.E. Korte, and T.A. Cronk, 1992, *Suggested Modifications to Ground Water Sampling Procedures Based on Observations from the Colloid Borescope*. Ground Water Monitoring Review, Vol. 12, No. 2, pp. 155-161.

Martin-Hayden, J.A. and S.L. Britt, 2006, *Revealing the Black Box of Groundwater Sampling: effects of Well-Bore Flow and Mixing,* Proceedings of the North American Field Conference and Exposition, January 10-12, 2006, Tampa Florida.

McAlary, T.A. and J.F. Barker, 1987, *Volatilization Losses of Organics During Ground Water Sampling from Low Permeability Materials*. Ground Water Monitoring Review, Vol. 7, No. 4, pp. 63-68.

McHugh, T. 2010, Groundwater Sampling Variability, SERDP/ESTCP Partners Symposium, Washington, DC, December 2010.

Pankow, J.F., L.M. Isabelle, J.P. Hewetson, and J.A. Cherry, 1985, *A Tube and Cartridge Method for Down-Hole Sampling for Trace Organic Compounds and Ground Water,* Ground Water 6: 775-782.

Pankow, J.F. 1986, *Magnitude of Artifacts Caused by Bubbles and Headspace in the Determination of Volatile Compounds in Water,* Analytical Chemistry 58: 1822-1826.

Parker, Louise and Nathan Mulherin, 2007, *Evaluation of the Snap Sampler for Sampling Ground Water Monitoring Wells for VOCs and Explosives.* U.S. Army Corps of Engineers, ERDC/CRREL TR-07-14, 68p.

Parker, Louise V., Nathan D. Mulherin, and Gordon E. Gooch, 2008. *Evaluation of the Snap Sampler for Sampling Ground Water Monitoring Wells for Inorganic Analytes.* U.S. Army Corps of Engineers, ERDC/CRREL TR 08-25, 74p.

Parker, Louise, Nathan Mulherin, Gordon Gooch, William Major, Richard Willey, Thomas Imbrigiotta, Jacob Gibs, and Donald Gronstal, 2009, *Demonstration/Validation of the Snap Sampler Passive Ground Water Sampling Device for Sampling Inorganic Analytes at the Former Pease Air Force Base,* U.S. Army Corps of Engineers, ERDC/CRREL TR 09-12, 101p.

Parker, Louise, Nathan Mulherin, Gordon Gooch, Tommie Hall, Constance Scott, Jay Clausen, William Major, Richard Willey, Thomas Imbrigiotta, Jacob Gibs, and Donald Gronstal, 2011a, *Environmental Security Technology Certification Program - Project ER 0630, Demonstration/Validation of the Snap Sampler Passive Groundwater Sampling Device at the Former McClellan Air Force Base,* U.S. Army Corps of Engineers, ERDC/CRREL TR 11-3, 117p.

Parker, Louise, Nathan Mulherin, Gordon Gooch, Tommie Hall, Constance Scott, Jay Clausen, William Major, Richard Willey, Thomas Imbrigiotta, Jacob Gibs, and Donald Gronstal, 2011b, *ESTCP Cost and Performance Report – Demonstration/ Validation of the Snap Sampler - Project ER-0630,* U.S. Army Corps of Engineers, ERDC/CRREL TR 11-11, 55p.

Parker, L.V. and S.L. Britt, 2012, The Effect of Bottle Fill Rate and Pour Technique on the Recovery of Volatile Organics, submitted to Ground Water Monitoring and Remediation 32, no. 4/ Fall 2012/pages 78–86.

Parsons, 2003, *Final Comprehensive Results Report for the Passive Diffusion Bag Sampler Demonstration.* prepared for the Air Force Center for Environmental Excellence (AFCEE).

Powell, R.M., and R.W. Puls, 1993, *Passive sampling of groundwater monitoring wells without purging: multilevel well chemistry and tracer disappearance*. Journal of Contaminant Hydrology 12: 51-77.

Puls, R.W. and M.J. Barcelona, 1996, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures,* USEPA Ground Water Issue Paper, 12p. EPA/540/S-95/504.

Puls, R.W. and R.M. Powell, 1992, *Acquisition of Representative Ground Water Quality Samples for Metals.* Ground Water Monitoring Review, Vol. 12, No. 3, pp. 167-176.

Robin, M.J.L., and R.W. Gillham, 1987, *Field Evaluation of Well Purging Procedures.* Ground Water Monitoring Review 7, no. 4: 85-93.

U.S. Environmental Protection Agency, 1995, *Ground Water Sampling - A Workshop Summary.* Texas, November 30-December 2, 1993, EPA/600/R-94/205, 146 pp.

U.S. Environmental Protection Agency, 2002, *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers.* Ground Water Forum Issue Paper by D. Yeskis and B. Zevala. EPA 542-S-02-001, 53 pp.

Vroblesky, D.A., 2001a, *User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells, Part 1: Deployment, Recovery, Data Interpretation, and Quality Control and Assurance.* U.S. Geological Survey Water-Resources Investigations Report 01-4060, 18 pp.

Vroblesky, D.A. ed., 2001b, *User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells, Part 2: Field Tests.* U.S. Geological Survey Water-Resources Investigations Report 01-4061.

Vroblesky, D.A., C.C. Casey, and M.A. Lowery, 2007, *Influence of In-Well Convection on Well Sampling,*, USGS Scientific Investigations Report 2006-5247, 21p.

Technology websites: www.QEDENV.com www.SnapSampler.com

QED Environmental Systems Inc.

2355 Bishop Circle West
Dexter, MI 48130
UNITED STATES
(800) 624-2026

QED Environmental Systems Ltd.

Cyan Park – Unit 3
Jimmy Hill Way
Coventry
CV2 4QP
UNITED KINGDOM

YSI Environmental

Pure Data for a Healthy Planet.™

YSI 550A Dissolved Oxygen Instrument

Operations Manual

CONTENTS

GENERAL DESCRIPTION

The YSI 550A Handheld Dissolved Oxygen Instrument is a rugged, microprocessor based, digital instrument with a field-replaceable YSI dissolved oxygen probe. The YSI 550A DO Instrument is impact-resistant and waterproof.

The YSI 550A DO Instrument is designed for field use and is available with cable lengths of 12, 25, 50, or 100 feet (3.5, 7.5, 15, 30.5 meters). The body of the probe has been manufactured with stainless steel to add rugged durability and sinking weight. The large Liquid Crystal Display (LCD) is easy to read and is equipped with a backlight for use in dark or poorly lighted areas.

The YSI 550A DO Instrument can be easily calibrated with the press of a few keys. Additionally, the instrument's microprocessor performs a self-diagnostic routine each time the instrument is turned on. The self-diagnostic routine provides you with useful information about the function of the instrument circuitry and the quality of the readings you obtain.

The system displays temperature in either ^{o}C or ^{o}F and dissolved oxygen in either mg/L (milligrams per liter) or % air saturation. The system requires only a single calibration regardless of which dissolved oxygen display is used, and will calibrate in either mode. Salinity compensation values can be changed at any time without performing a new calibration.

A detachable calibration chamber is mounted to the back of the instrument. A small sponge in the chamber can be moistened to provide a water saturated air environment that is ideal for air calibration. This chamber is also designed for transporting and storing the probe. When the probe is stored in the chamber, the moist environment will prolong effective membrane performance and probe life.

The YSI 550A DO Instrument is powered by 4 C-size alkaline batteries. A new set of alkaline batteries will provide approximately 2000 hours of continuous operation. If the backlight is used often, batteries will be depleted faster.

The YSI 550A case is waterproof with an IP-67 rating. The instrument is 100% corrosion proof and can be operated in a wet environment without damage to the instrument.

INITIAL INSPECTION

When you unpack your new YSI 550A DO Handheld Instrument for the first time, check the packing list to make sure you have received everything. If there is anything missing or damaged, call the dealer from whom you purchased the YSI 550A. If you do not know which authorized dealer sold the system to you, call YSI Customer Service at 800-897-4151 or 937-767-7241.

WARRANTY REGISTRATION

Please complete the Product Registration on the YSI website at www.ysi.com. If you are not online, you may complete the Warranty Card included with your instrument and return it to YSI Incorporated. Your purchase of this quality instrument will then be recorded in YSI's customer database. Once your purchase is recorded, you will receive prompt, efficient service in the event any part of your YSI 550A DO Instrument should ever need repair.

WARRANTY

The YSI 550A DO Instrument is warranted for three years from date of purchase by the end user against defects in materials and workmanship. YSI 550A DO probes and cables are warranted for one year from date of purchase by the end user against defects in material and workmanship. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, write or call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

Limitation of Warranty

This Warranty does not apply to any YSI product damage or failure caused by (i) failure to install, operate or use the product in accordance with YSI's written instructions, (ii) abuse or misuse of the product, (iii) failure to maintain the product in accordance with YSI's written instructions or standard industry procedure, (iv) any improper repairs to the product, (v) use by you of defective or improper components or parts in servicing or repairing the product, or (vi) modification of the product in any way not expressly authorized by YSI.

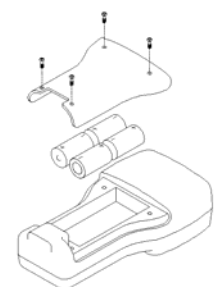
THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI's LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.

FEATURES OF THE YSI 550A

KEYPAD

⏻	Powers the unit on or off. The instrument will activate all segments of the display for a few seconds, and then will show a self-test procedure for several more seconds. During this power on self-test sequence, it is normal to error messages appear and disappear. If the instrument were to detect a problem, a **continuous** error message would be displayed.
☼	Turns the display backlight on or off. The light will turn off automatically after two minutes of non-use.
Mode	During DO calibration it allows the user to select between % and mg/L. After selection, it may be pressed several times to exit back to measurement mode without completing the calibration. During measurement, it switches the instrument display between DO %, DO mg/L, and salinity calibration.
▲ and ▼	Increases or decreases the value during calibrations.
▼ and **Mode**	Press at the same time to switch the temperature units between Fahrenheit (F) and Celsius (C).
▲ and **Mode**	Press at the same time to increase or decrease the resolution of the instrument in mg/L or % measurement mode.
↵	This is the Enter Key Button for execution of commands.

BATTERIES

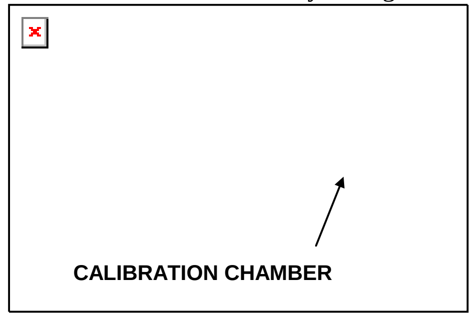


The YSI 550A DO Instrument is powered by 4 C-size alkaline batteries. A new set of alkaline batteries will provide approximately 2000 hours of continuous operation. When batteries need to be replaced, the LCD will display a **"LO BAT"** message. When the message first appears, the instrument will have approximately 50 hours of life left, provided the back light is not used.

INSTRUMENT CASE

The waterproof instrument case is sealed at the factory and is not to be opened, except by authorized service technicians.

Caution: Do not attempt to separate the two halves of the instrument case as this may damage the instrument, break the waterproof seal, and will void the manufacturer's warranty.

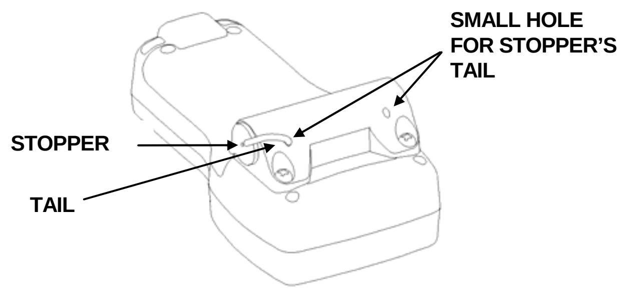


CALIBRATION/STORAGE CHAMBER

The YSI 550A DO Instrument has a convenient calibration/storage chamber that can be attached to the instrument's back. The calibration chamber can be used from either side of the instrument, by moving the rubber stopper to either end.

If you look into the chamber, you should notice a small round sponge in the bottom. Carefully put 3 to 6 drops of clean water into the sponge. Turn the instrument over and allow any excess water to drain out of the chamber. The wet sponge creates a 100% water saturated air environment for the probe. This environment is ideal for dissolved oxygen calibration and for storage of the probe during transport and non-use.

The YSI 550A DO Instrument's storage chamber can be conveniently used from either side of the instrument.



1. Remove the chamber from the instrument by unscrewing the two screws.
2. Remove the rubber stopper from the chamber by pulling the "tail" free of the small hole on the chamber.
3. Re-attached the rubber stopper to the storage chamber by threading the "tail" through the opposite small hole on the chamber.
4. Re-attached the storage chamber to the instrument using the two screws.

HAND STRAP

The hand strap is designed to allow comfortable operation of the YSI 550A DO Instrument with minimum effort. If the hand strap is adjusted correctly, it is unlikely that the instrument will be dropped or bumped from your hand. The hand strap can be conveniently used from either side of the instrument.

To switch the hand strap from one side to the other:
1. Pull the two velcro strips apart.
2. Pull the strap free of the upper and lower hooks.
3. Feed the strap through the hooks on the other side of the instrument.
4. Adjust the strap length so that your hand is snugly held in place.

5. Press the two velcro strips back together.

PRINCIPLES OF OPERATION

The sensor consists of a silver body as the anode and a circular gold cathode embedded in the end. In operation, this end of the sensor is filled with a solution of electrolyte containing a small amount of surfactant to improve wetting action.

A thin semi-permeable membrane, stretched over the sensor, isolates the electrodes from the environment, while allowing gases to enter. When a polarizing voltage is applied to the sensor electrodes oxygen that has passed through the membrane reacts at the cathode causing a current to flow.

The membrane passes oxygen at a rate proportional to the pressure difference across it. Since oxygen is rapidly consumed at the cathode, it can be assumed that the oxygen pressure inside the membrane is zero. Hence, the force causing the oxygen to diffuse through the membrane is proportional to the partial pressure of oxygen outside the membrane. As the oxygen partial pressure varies, so does the oxygen diffusion through the membrane. This causes the probe current to change proportionally.

PREPARING THE PROBE

MEMBRANE CAP INSTALLATION

The YSI 550A DO probe is shipped with a dry, protective membrane. Before using the instrument for the first time, remove the protective cap and replace it with a new one following these instructions:

1. Remove the probe sensor guard to access the probe tip.
2. Unscrew and remove the old membrane cap and discard.
3. Thoroughly rinse the sensor tip with distilled or DI water.
4. Fill a new membrane cap with O_2 probe solution that has been prepared according to the directions on the bottle. Be very careful not to touch the membrane surface. Lightly tap the side of the membrane cap to release bubbles that may be trapped.
5. Thread the membrane cap onto the probe. It is normal for a small amount of electrolyte to overflow.
6. Replace the probe sensor guard.

MEMBRANE MAINTENANCE

Additional membrane changes will be required over time. The average replacement interval is 4 to 8 weeks, although they may last longer if kept clean. To clean the membrane, use a lint-free cloth, such as a Kimwipe, and rubbing alcohol to gently remove the contamination. In harsh environments, such as wastewater, membrane replacements may be required every 2 to 4 weeks.

DISSOLVED OXYGEN CALIBRATION

Dissolved oxygen calibration must be done in an environment with known oxygen content. The YSI 550A DO Instrument can be calibrated in either mg/L or % saturation. Sections below include instructions on how to calibrate in either mode.

BEFORE YOU CALIBRATE

To accurately calibrate the YSI 550A, you will need to know the following information:

- The approximate salinity of the water you will be analyzing. Fresh water has a salinity of approximately zero. Seawater has a salinity of approximately 35 parts per thousand (ppt). If you are uncertain what the salinity of the sample water is, use a YSI 30 Salinity-Conductivity-Temperature instrument to determine a salinity value.

- For calibration in % saturation mode, the approximate altitude (in feet) of the region where you are located is required. This information can be obtained over the internet or from a local airport or weather station. To convert from meters to feet, divide by 0.3048.

For best results:

- Check calibration with each use and recalibrate as necessary to prevent drift. Dissolved oxygen readings are only as good as the calibration.

CALIBRATION IN % SATURATION

1. Ensure that the sponge inside the instrument's calibration chamber is moist. Insert the probe into the calibration chamber.

2. Power the instrument on and allow readings to stabilize. This may take 5 to 15 minutes, depending on the age of the instrument and condition of the probe.

3. Press and release both the **UP ARROW** and **DOWN ARROW** keys at the same time to enter the calibration menu.

4. Press the **Mode** key until "%" is displayed on the right side of the screen for oxygen units. Press **ENTER**.

5. The LCD will prompt you to enter the local altitude in hundreds of feet. Use the arrow keys to increase or decrease the altitude. When the proper altitude appears on the LCD, press the **ENTER** key.

   EXAMPLE: Entering the number 12 here indicates 1200 feet.

6. **CAL** will now display in the lower left corner of the screen, the calibration value in the lower right corner and the current DO reading (before calibration) will be the main display. Once the current DO reading is stable, press the **ENTER** button.

7. The LCD will prompt you to enter the approximate salinity of the water you are about to analyze. You can enter any number from 0 to 70 parts per thousand (PPT) of salinity. Use the arrow keys to increase or decrease the salinity setting. When the correct salinity appears on the LCD, press the **ENTER** key. The instrument will return to normal operation.

CALIBRATION IN MG/L

1. Power the instrument on and allow readings to stabilize. This may take 5 to 15 minutes, depending on the age of the instrument and condition of the probe.

2. Place the probe in a solution with a known mg/L reading. Continuously stir or move the probe through the sample at a rate of at least 1/2 foot per second (16cm per second) during the entire calibration process.

3. Press and release both the **UP ARROW** and **DOWN ARROW** keys at the same time to enter the calibration menu.

4. Press the **Mode** key until “mg/L” is displayed on the right side of the screen for oxygen units. Press **ENTER**.

5. **CAL** will now display in the lower left corner of the screen and the current DO reading (before calibration) will be on the main display. Once the current DO reading is stable, use the up and down arrow keys to select the mg/L value of the known solution, then press the **ENTER** button.

6. The LCD will prompt you to enter the approximate salinity of the water you are about to analyze. Enter any number from 0 to 70 parts per thousand (PPT) of salinity. Use the arrow keys to increase or decrease the salinity setting. When the correct salinity appears on the, press the **ENTER** key. The instrument will return to normal operation.

SALINITY COMPENSATION CALIBRATION

1. Press the **Mode** key until salinity calibration is displayed on the screen.
2. Use the **UP ARROW** and **DOWN ARROW** keys to adjust the salinity value to that of the samples you will be measuring, 0-70 ppt.
3. Press the **ENTER** key to save the calibration.
4. Press **Mode** to return to dissolved oxygen measurement

PROBE OPERATION

NOTE: The YSI 550A DO Instrument should not be used in a purpose other than that specified by YSI Incorporated. See **Warranty** for details.

STIRRING

It is important to recognize that a very small amount of oxygen dissolved in the sample is consumed during probe operation. It is therefore essential that the sample be continuously stirred at the sensor tip. If stagnation occurs, measurements will appear artificially low.

Stirring may be accomplished by mechanically moving the sample around the probe tip, or by moving the probe through the sample. The YSI Model 550A has a flow dependence of <25%. The rate of stirring required is 1/2 foot per second (16cm per second).

MEASUREMENT PROCEDURE

1. Insert the probe into the sample to be measured.
2. Continuously stir or move the probe through the sample.
3. Allow temperature and dissolved oxygen readings to stabilize.
4. Observe/Record readings.
5. If possible, rinse the probe with clean water after each use.

PRECAUTIONS

1. Membranes last longer if properly installed and regularly maintained. Erratic readings can result from loose, wrinkled, damaged, or fouled membranes, large (more than 1/8" diameter) air bubbles in the electrolyte reservoir, or membrane coating by oxygen consuming (e.g. bacteria) or oxygen producing (e.g. algae) organisms. If unstable readings or membrane damage occurs, replace both the membrane cap and electrolyte solution.

2. Chlorine, sulfur dioxide, nitric oxide, and nitrous oxide can affect readings by behaving like oxygen at the probe.

3. Avoid substances such as acids, caustics, and strong solvents, which may damage probe materials. Probe materials include the PE membrane, acrylic plastic, EPR rubber, stainless steel, epoxy, polyetherimide and the PVC cable covering.

4. Always store the probe in the calibration/storage chamber with the moistened sponge.

PROBE ELECTRODE MAINTENANCE

SILVER ANODE

After extended use, a thick layer of AgCl builds up on the silver anode reducing the sensitivity of the sensor. The anode must be cleaned to remove this layer and restore proper performance. The cleaning can be chemical or mechanical:

- **Chemical cleaning:** Remove the membrane cap and rinse the electrodes deionized or distilled water. Soak the entire anode section in a 14% ammonium hydroxide solution for 2 to 3 minutes (or a 3% solution may be used and soaked overnight for 8-12 hours). Rinse heavily in cool tap water followed by a thorough rinsing with distilled or deionized water. The anode should then be thoroughly wiped with a wet paper towel to remove the residual layer from the anode.

  Warning: Chemical cleaning should be performed on an as-needed basis, and no more often than once a year (or once per six months in wastewater environments). When readings appear unstable or the instrument will not calibrate, first attempt a membrane change and recalibrate. If a new membrane does not resolve the problem, then proceed with the chemical cleaning.

- **Mechanical cleaning:** Sand off the dark layer from the silver anode with 400 grit wet/dry sandpaper. Wrap the wet sandpaper around the anode and twist the probe. Rinse the anode with clean water after sanding, and wipe thoroughly with a wet paper towel.

GOLD CATHODE

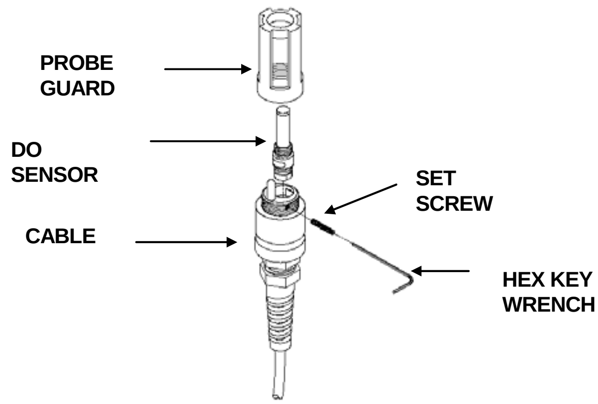
For correct probe operation, the gold cathode must be textured properly. It can become tarnished or plated with silver after extended use. The gold cathode can be cleaned by using the YSI 5238 Probe Reconditioning Kit or 400 grit wet/dry sandpaper. Never use chemicals or abrasives not recommended or supplied by YSI.

Using the sanding paper provided in the YSI 5238 Probe Reconditioning Kit, wet sand the gold with a twisting motion about 3 times or until all silver deposits are removed and the gold appears to have a matte finish. If the cathode remains tarnished, return the probe for service. Wipe the gold cathode thoroughly with a wet paper towel before putting on a new membrane cap.

REPLACEMENT OF THE DO ELECTRODES

Should replacement of the DO Electrodes be required, the user may purchase a YSI 559 Replaceable DO Module Kit. The kit includes an instruction sheet, DO sensor module, set screw, and hex key wrench.

1. Remove probe guard.
2. **IMPORTANT:** Thoroughly dry the sensor so that no water enters the probe port when the sensor is removed.
3. Insert the long end of the hex key wrench into the small hole in the side of the DO sensor. Turn the wrench counter clockwise until the sensor is released.
4. Pull the DO sensor out of the probe. The DO sensor is keyed, or has a flat side, so that it can not be removed or inserted improperly.



5. Make sure that the inside of the connector and the o-ring of the sensor are clean and dry, with no contaminants, such as grease, dirt, or hair. Insert the new sensor.
6. Use the hex key wrench to tighten the screw, making sure that the screw does not stick out on either side of the DO sensor module. Also, if the hex screw was removed completely, make sure that it is not cross-threaded when replaced.
7. The YSI 559 DO module is shipped with a dry, protective membrane. Before using for the first time, remove the protective cap and replace it with a new one following the instructions for **Membrane Cap Installation**.

ACCESSORIES/REPLACEMENT PARTS

The following parts and accessories are available from YSI or any YSI Authorized Dealer.

YSI Model Number	Description
5908	Membrane Kit, 1.25 mil PE, 6 caps and bottle of electrolyte solution
559	Replaceable DO Module
5238	Probe Reconditioning Kit, 10 sanding discs (400 grit) and sanding tool
5065	Form-Fitted Cover with Shoulder Strap
614	Ultra Clamp, C-Clamp Mount
4654	Tripod
5085	Hands Free Harness
5050	Small, Hard-sided Carrying Case, Foam-lined
5060	Small, Soft-sided Carrying Case, Precut Foam Interior
5080	Small, Hard-sided, Pelican Carrying Case, Precut Foam Interior

SPECIFICATIONS

Display	Resolution	Range	Accuracy
Dissolved O_2 mg/L	0.01 mg/L or 0.1 mg/L, user selectable	0 to 20 mg/L	± 0.3 mg/L or ± 2% of reading, whichever is greater
		20 to 50 mg/L	± 6% of reading
Dissolved O_2 %	0.1% or 1%, user selectable	0 to 200%	± 2% air sat or ± 2% of reading, whichever is greater
		200 to 500%	± 6% of reading
Temperature ºC	0.1 ºC	-5 to +45 ºC	± 0.3 ºC
Temperature ºF	0.1 ºF	23 to 113 ºF	± 0.6 ºF

Medium:	Fresh, sea or polluted water
Dissolved Oxygen Sensor:	Steady-state polarographic
Dissolved Oxygen Probe:	Field-replaceable module
Dissolved Oxygen Response Time:	95% of end value in 9 seconds
Temperature Units:	Celsius or Fahrenheit, user selectable
Parameter Compensation:	Automatic temperature compensation for dissolved oxygen Automatic salinity compensation (0-70 ppt) for dissolved oxygen Altitude compensation for dissolved oxygen percent calibration
Size:	4.7 in. width; 9 in. length (11.9 cm x 22.9 cm)
Weight with Batteries:	2 lb. (0.91 kg)
Power:	4 alkaline C-cells
Battery life:	Over 2000 hours at 25°C (77ºF)
Cables:	12, 25, 50, and 100-foot lengths (3.5, 7.5, 15, 30.5 meter lengths)
Other Features:	Waterproof to IP-67 High-impact resistance Push-button calibration Built-in calibration chamber Large back-lit display Low battery indicator on display Manual salinity input CE-compliance

TROUBLESHOOTING

NOTE: An error displayed briefly during the first few seconds after turning the instrument on does NOT indicate a problem.

SYMPTOM	POSSIBLE SOLUTION
1. Instrument will not turn on, LCD displays "LO BAT", or Main display flashes "OFF"	A. Low battery voltage, replace batteries B. Batteries installed incorrectly, check battery polarity C. Return system for service
2. Instrument will not calibrate.	A. Replace membrane and electrolyte B. Clean probe electrodes C. Return system for service
3. Instrument "locks up".	A. Remove batteries, wait 15 seconds for reset, replace batteries B. Replace batteries C. Return system for service
4. Instrument readings are inaccurate.	A. Verify calibration altitude and salinity settings are correct and recalibrate. B. Probe may not have been in 100% water saturated air during calibration procedure. Moisten sponge in calibration chamber and recalibrate. C. Replace membrane and electrolyte. Recalibrate. D. Clean probe electrodes. E. Return system for service.
5. Main display reads "Over" or "Undr".	A. Sample O_2 concentration is more than 60 mg/L or 500%, or less than –0.02 mg/L or -0.3%. B. Verify calibration altitude and salinity settings are correct and recalibrate. C. Replace membrane and electrolyte. Recalibrate. D. Clean probe electrodes. E. Return system for service.
6. Main display reads "Over" or "Undr" during calibration.	A. Replace membrane and electrolyte. Recalibrate. B. Clean probe electrodes. C. Return system for service.
7. Secondary display reads "Ovr" or "Undr".	A. Sample temperature is less than -5º C (23ºF) or more than +45°C (122°F). Increase or decrease the sample temperature to bring within the allowable range. B. Return system for service.

SYMPTOM	POSSIBLE SOLUTION
8. Main display reads “Err” and Secondary display reads “RO”, “RA”, or “AdC”.	A. Return system for service
9. Main display reads “Err” or burn” and Secondary display reads “EEP”	A. Return system for service

CONTACT INFORMATION

YSI offers a wide range of customer assistance and technical support functions to ensure that you have the information required to use our products. Contact YSI Environmental if you need assistance or have questions regarding any YSI Environmental Product. Business hours are Monday through Friday, 8AM to 5PM ET.

YSI Environmental Incorporated
1725 Brannum Lane
Yellow Springs, OH 45387
Toll Free: 800-897-4151
Phone: 937 767-7241
Fax: 937 767-1058
E-Mail: environmental@ysi.com
www.ysi.com/environmental

REQUIRED NOTICE

The Federal Communications Commission defines this product as a computing device and requires the following notice:

This equipment generates and uses radio frequency energy and if not installed and used properly, may cause interference to radio and television reception. There is no guarantee that interference will not occur in a particular installation. If this equipment does cause 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:

- re-orient the receiving antenna
- relocate the YSI Instrument with respect to the receiver
- move the YSI Instrument away from the receiver
- plug the YSI Instrument into a different outlet so that the computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet, prepared by the Federal Communications Commission, helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington, DC 20402, Stock No. 0004-000-00345-4.

Note: While testing to EN-61000-4-6, Conducted RF Immunity, per Table A.1 of EN61326, Electrical Equipment for Measurement, Control and Laboratory Use, the YSI 550A exhibited an ERROR 8 message from 8.6 MHz 22.8 MHz at induced RF voltages of 3-Volts to 1-Volt RMS on the 25-foot probe cable. If you observe this interference please relocate the probe-cable away from heavy industrial equipment power and control cables or communications equipment cables which may be causing the interference.

YSI Environmental

YSI 556 MPS

Multi Probe System

Operations Manual

Contents

1. Safety

1.1 General Information

Read all safety information in this manual carefully before using the YSI 556 Multi-Probe System (MPS). Reagents that are used to calibrate and check this instrument may be hazardous to your health. Take a moment to review Appendix D Health and Safety.

⚠ **WARNING**

Warnings are used in this manual when misuse of the instrument could result in death or serious injury to a person.

⚠ **CAUTION**

Cautions are used in this manual when misuse of the instrument could result in mild or serious injury to a person and/or damage to equipment.

⚠ **IMPORTANT SAFETY INSTRUCTIONS!**

⚠ **SAVE THESE INSTRUCTIONS!**

⚠ In essence, the most important safety rule for use of the YSI 556 MPS is to utilize the instrument ONLY for purposes documented in this manual. This is particularly true of the YSI 6117 rechargeable battery pack that contains nickel metal hydride (NiMH) batteries. The user should be certain to read all of the safety precautions outlined below before using the instrument.

⚠ Batteries

⚠This instrument is powered by alkaline or optional nickel-metal hydride batteries, which the user must remove and dispose of when the batteries no longer power the instrument. Disposal requirements vary by country and region, and users are expected to understand and follow the battery disposal requirements for their specific locale.

The circuit board in this instrument contains a manganese dioxide lithium "coin cell" battery that must be in place for continuity of power to memory devices on the board. This battery is not user serviceable or replaceable.

When appropriate, an authorized YSI service center will remove this battery and properly dispose of it, per service and repair policies.

⚠YSI Rechargeable Battery Pack Safety Information

⚠Restrictions on Usage

1. Never dispose of the battery pack in a fire.
2. Do not attempt to disassemble the YSI 6117 battery pack
3. Do not tamper with any of the electronic components or the batteries within the battery pack. Tampering with either the electronic circuitry or the batteries will result in the voiding of the warranty and the compromising of the system performance, but, more importantly, can cause safety hazards which result from overcharging such as overheating, venting of gas, and loss of corrosive electrolyte.
4. Do not charge the battery pack outside the 0–40°C temperature range.
5. Do not use or store the battery at high temperature, such as in strong direct sunlight, in cars during hot weather, or directly in front of heaters.
6. Do not expose the battery pack to water or allow the terminals to become damp.
7. Avoid striking or dropping the battery pack. If the pack appears to have sustained damage from these actions or malfunctions after an impact or drop, the user should not attempt to repair the unit. Instead, contact YSI Customer Service. Refer to *Appendix E Customer Service.*
8. If the battery pack is removed from the YSI 556 MPS, do not store it in pockets or packaging where metallic objects such as keys can short between the positive and negative terminals.

⚠Precautions for Users with Small Children.

Keep the battery pack out of reach of babies and small children.

⚠Danger Notifications – Misuse creates a STRONG possibility of death or serious injury.

FAILURE TO CAREFULLY OBSERVE THE FOLLOWING PROCEDURES AND PRECAUTIONS CAN RESULT IN LEAKAGE OF BATTERY FLUID, HEAT GENERATION, BURSTING, AND SERIOUS PERSONAL INJURY.

1. Never dispose of the battery pack in a fire or in heat.
2. Never allow the positive and negative terminals of the battery pack to become shorted or connected with electrically conductive materials. When the battery pack has been removed from the YSI 556 MPS, store it in a heavy plastic bag to prevent accidental shorting of the terminals.
3. Never disassemble the battery pack and do not tamper with any of the electronic components or the batteries within the battery pack. The battery pack is equipped with a variety of safety features. Accidental deactivation of any of these safety features can cause a serious hazard to the user.
4. The NiMH batteries in the battery pack contain a strong alkaline solution (electrolyte). The alkaline solution is extremely corrosive and will cause damage to skin or other tissues. If any fluid from the battery pack comes in contact with a user's eyes, immediately flush with clean water and consult a physician immediately. The alkaline solution can damage eyes and lead to permanent loss of eyesight.

⚠ Warning Notifications – Misuse creates a possibility of death or serious injury

1. Do not allow the battery pack to contact freshwater, seawater, or other oxidizing reagents that might cause rust and result in heat generation. If a battery becomes rusted, the gas release vent may no longer operate and this failure can result in bursting.
2. If electrolyte from the battery pack contacts the skin or clothing, thoroughly wash the area immediately with clean water. The battery fluid can irritate the skin.

⚠ Caution Notifications – Misuse creates a possibility of mild or serious injury or damage to the equipment.

1. Do not strike or drop the battery pack. If any impact damage to the battery pack is suspected, contact YSI Customer Service. Refer to *Appendix E Customer Service*.

2. Store the battery pack out of reach of babies and small children.
3. Store the battery pack between the temperatures of -20 and 30°C.
4. Before using the battery pack, be sure to read the operation manual and all precautions carefully. Then store this information carefully to use as a reference when the need arises.

⚠YSI 616 Cigarette Lighter Charger Safety Information

1. This section contains important safety and operating instructions for the YSI 556 MPS cigarette lighter battery charger (YSI 616; RadioShack Number 270-1533E). BE SURE TO SAVE THESE INSTRUCTIONS.
2. Before using the YSI 616 cigarette lighter charger, read all instructions and cautionary markings on battery charger, battery pack, and YSI 556 MPS.
3. Charge the YSI 6117 battery pack with the YSI 616 cigarette lighter charger ONLY when the YSI 6117 is installed in the YSI 556 MPS.
4. Do not expose charger to rain, moisture, or snow.
5. Use of an attachment not recommended or sold by the battery charger manufacturer may result in a risk of fire, electric shock, or injury to persons.
6. To reduce risk of damage to cigarette lighter and cord, pull by cigarette lighter rather than cord when disconnecting charger.
7. Make sure that the cord is located so that it will not be stepped on, tripped over, or otherwise subjected to damage or stress.
8. Do not operate charger with damaged cord or cigarette lighter connector – replace it immediately.
9. Do not operate charger if it has received a sharp blow, been dropped, or otherwise damaged in any way; contact YSI Customer Service. Refer to *Appendix E Customer Service*.
10. Do not disassemble charger other than to change the fuse as instructed. Replace the part or send it to YSI Product Service if repair is required (refer to *Appendix E Customer Service*). Incorrect reassembly may result in a risk of electric shock or fire.

11. To reduce risk of electric shock, unplug charger before attempting any maintenance or cleaning. Turning off controls will not reduce this risk.

⚠ YSI 556 MPS Water Leakage Safety Information

The YSI 556 MPS has been tested and shown to comply with IP67 criterion, i.e. submersion in 1 meter of water for 30 minutes with no leakage into either the battery compartment or the main case. However, if the instrument is submersed for periods of time in excess of 30 minutes, leakage may occur with subsequent damage to the batteries, the rechargeable battery pack circuitry, and/or the electronics in the main case.

If leakage into the battery compartment is observed when using alkaline C cells, remove batteries, dispose of batteries properly, and dry the battery compartment completely, ideally using compressed air. If corrosion is present on the battery terminals, contact YSI Customer Service for instructions. Refer to *Appendix E Customer Service*.

If leakage into the battery compartment is observed when using the YSI rechargeable battery pack, remove the battery assembly and set aside to dry. Return the battery pack to YSI Product Service for evaluation of possible damage. Finally dry the battery compartment completely, ideally using compressed air. If corrosion is present on the battery terminals, contact YSI Customer Service for instructions. Refer to *Appendix E Customer Service*.

⚠ **CAUTION:** If water has contacted the rechargeable battery pack, do not attempt to reuse it until it has been evaluated by YSI Product Service (refer to Appendix E Customer Service). Failure to follow this precaution can result in serious injury to the user.

If it is suspected that leakage into the main cavity of the case has occurred, remove the batteries immediately and return the instrument to YSI Product Service for damage assessment. Refer to *Appendix E Customer Service*.

⚠ **CAUTION:** Under no circumstances should the user attempt to open the main case.

2. General Information

2.1 Description

The rugged and reliable YSI 556 MPS (Multi-Probe System) combines the versatility of an easy-to-use, easy-to-read handheld unit with all the functionality of a multi-parameter system. Featuring a waterproof, impact-resistant case, the YSI 556 MPS simultaneously measures dissolved oxygen, conductivity, temperature, and optional pH and ORP. A simple cellular phone style keypad and large display make the instrument easy to use. The YSI 556 MPS is compatible with YSI EcoWatch™ for Windows™ software.

The YSI 556 MPS assists the user in conforming to Good Laboratory Practice (GLP) standards which help ensure that quality control/quality assurance methods are followed. Battery life is displayed with a fuel gauge, and the user can choose standard alkaline batteries or an optional rechargeable battery pack.

The 1.5 MB memory can store more than 49,000 data sets. Other options include a flow cell and barometer. The internal barometer can be user-calibrated and displayed along with other data, used in dissolved oxygen calibrations, and logged to memory for tracking changes in barometric pressure.

Features

- Waterproof -meets IP67 specifications
- Field-replaceable DO electrode module; pH and pH/ORP sensors
- Compatible with EcoWatch™ for Windows™ data analysis software
- Assists with Good Laboratory Practice Standards (GLP)
- Choice of DO membrane material for different applications
- Easy-to-use, screw-on cap DO membranes
- User-upgradeable software from YSI website
- Three-year warranty on the instrument; one-year on the probe modules
- Available with 4,10, and 20 m cable lengths
- Stores over 49,000 data sets, time and date stamped

- Auto temperature compensating display contrast
- Optional barometer
- Optional rechargeable battery pack or standard alkaline batteries

2.2 Unpacking the Instrument

1. Remove the instrument from the shipping box. Note that the probe module and sensors are shipped in a separate box and will be unpacked later in Section *3.2 Unpacking the Probe Module*

NOTE: Do not discard any parts of supplies.

2. Use the packing list to ensure all items are present.

3. Visually inspect all components for damage.

   NOTE: If any parts are missing or damaged, contact your YSI Service Center immediately. Refer to Appendix E Customer Service or www.ysi.com.

2.3 Features of the YSI 556 Multi-Probe System

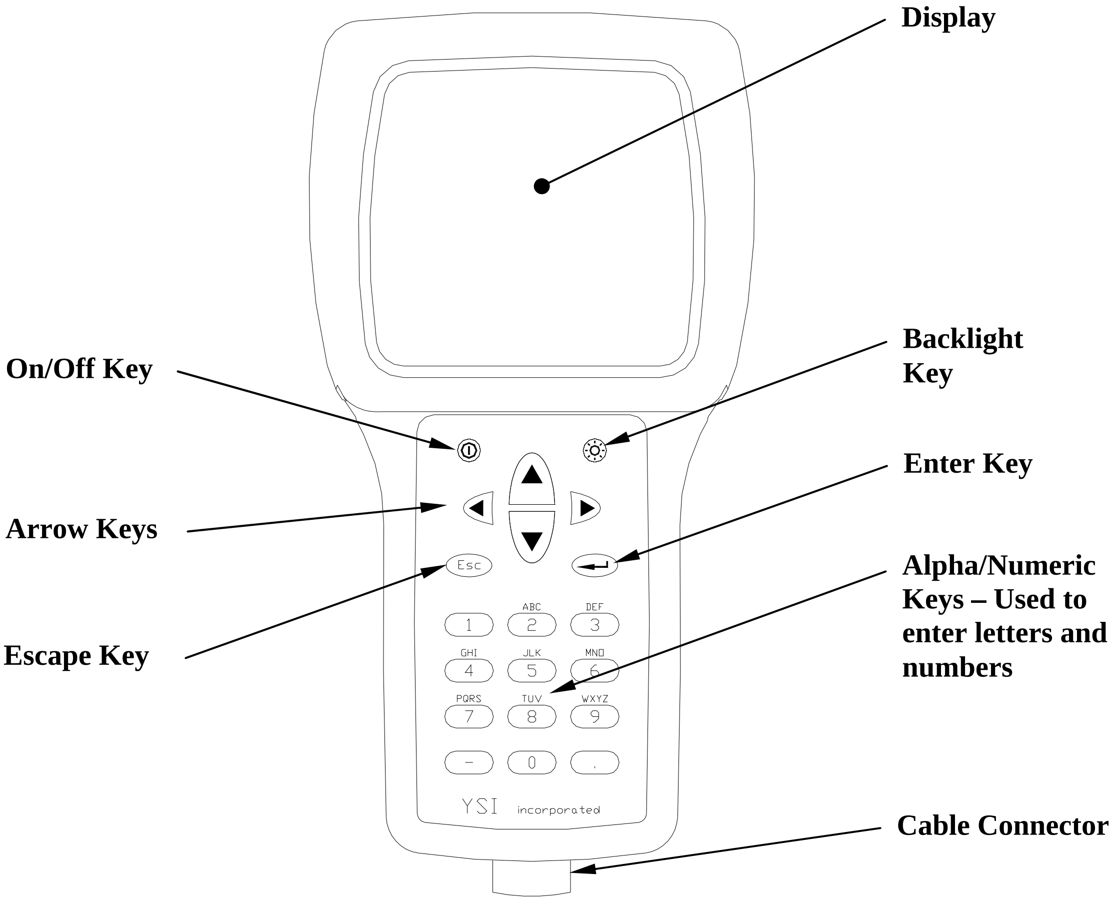


Figure 2.1 Front View of YSI 556 MPS

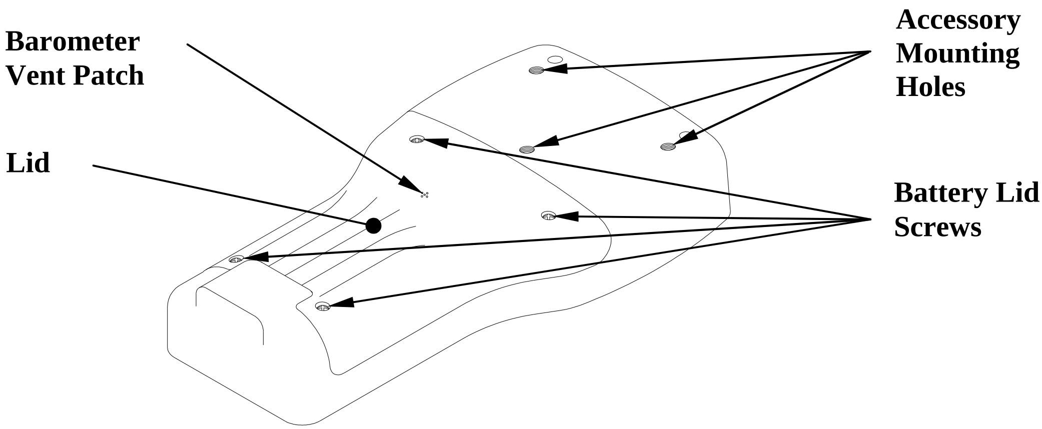


Figure 2.2 Back View of YSI 556 MPS

2.4 Batteries

2.4.1 Battery Life

Standard Alkaline Batteries

With the standard battery configuration of 4 alkaline C cells, the YSI 556 MPS will operate continuously for approximately 180 hours. Assuming a standard usage pattern when sampling of 3 hours of "on time" in a typical day, the alkaline cells will last approximately 60 days.

Optional Rechargeable Battery Pack

When fully charged, the optional rechargeable battery pack will provide approximately 50 hours of battery life.

2.4.2 Inserting 4 C Batteries

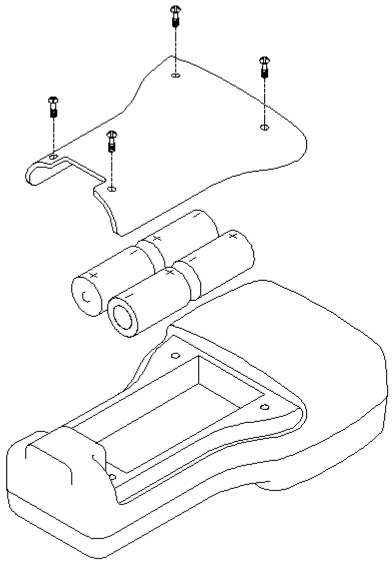


Figure 2.1 Inserting C Cells

⚠ **CAUTION: Install batteries properly to avoid damage to the instrument**.

1. Loosen the four screws in the battery lid on the back of the instrument using any screwdriver.

2. Remove the battery lid.

3. Insert four C batteries between the clips following the polarity (+ and -) labels on the bottom of the battery compartment.

4. Check gasket for proper placement on the battery lid.

5. Replace the battery lid and tighten the 4 screws securely and evenly.

NOTE: Do not over-tighten the screws.

2.4.3 Inserting Optional Rechargeable Battery Pack

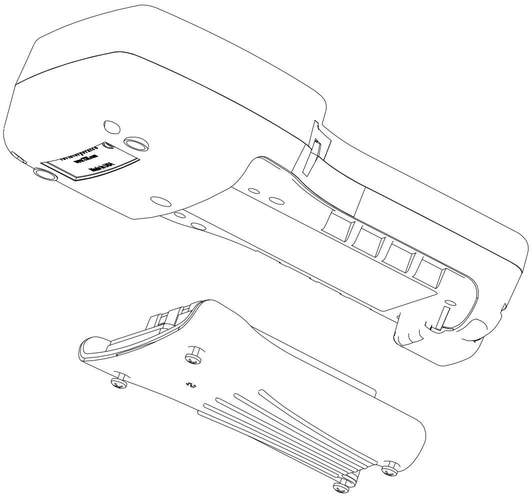


Figure 2.2 Inserting Battery Pack

⚠ **CAUTION: Read all cautions and warning that come with the battery pack before using the battery pack.**

1. Loosen the four screws in the battery lid on the back of the instrument using any screwdriver.

2. Remove the C battery lid and store for future use. Remove C batteries, if installed.

3. Install the rechargeable battery pack and lid and tighten the 4 screws securely and evenly.

NOTE: Do not over tighten the screws.

2.4.4 Charging the Optional Rechargeable Battery Pack

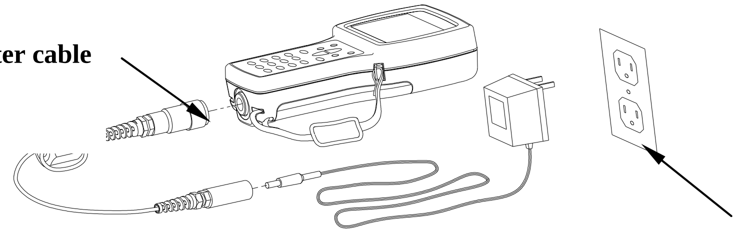


Figure 2.3 Charging the Battery Pack

⚠ **CAUTION: Do not use or store the battery pack at extreme temperatures such as in strong direct sunlight, in cars during hot weather or close to heaters.**

1. Install the rechargeable battery pack into the instrument as described in Section *2.4.3 Inserting Optional Rechargeable Battery Pack.*

2. Attach the charger adapter cable (YSI 6119) to the instrument.

NOTE: Wall power supplies for use in countries outside the US and Canada can be found in *Appendix B Instrument Accessories.*

3. Insert the barrel connector of the wall power supply into the barrel of the adapter cable.

⚠ **CAUTION: Do not charge the battery pack continuously for more than 48 hours.**

⚠ **CAUTION: Do not drop or expose to water.**

⚠ **CAUTION: Do no charge the battery pack at temperatures below 0°C or above 40°C.**

4. Plug the wall power supply into an AC power outlet for approximately 2 hours to obtain an 80% to 90% charge for 6 hours to get a full charge.

NOTE: The battery pack can be recharged whether the instrument is on or off.

2.4.5 Storing the Battery Pack

Remove the battery pack from the instrument when the instrument will not be used for extended periods of time to prevent over discharge of the battery pack.

Store the battery pack in a heavy plastic bag to prevent accidental shorting of the terminals. Store between –20 and 30°C.

2.4.6 Optional Cigarette Lighter Charger

⚠ **CAUTION: Read all warnings and cautions that come with the charger before using the charger.**

⚠ **CAUTION: Only use cigarette lighter charger when rechargeable battery pack is inserted into instrument.**

⚠ **CAUTION: Do not mishandle cigarette lighter charger. Do not expose to moisture.**

1. Plug the barrel connector of the cigarette lighter charger into the mating end of the YSI 6119 Charger Adapter Cable.

2. Attach the MS-19 end of the YSI 6119 Charger Adapter Cable to the instrument.

3. Make one of the following modifications to the other end of the charger:

Slide the adapter ring off the plug to use the device with an American or Japanese vehicle.

.

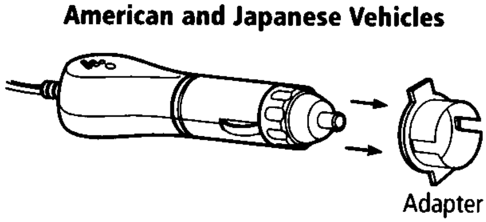


Figure 2.1 Charger Plug Adapter Use

Leave the adapter ring on the plug and position it so that the slots on the adapter ring line up with the plug's spring clips to use the device on a European vehicle.

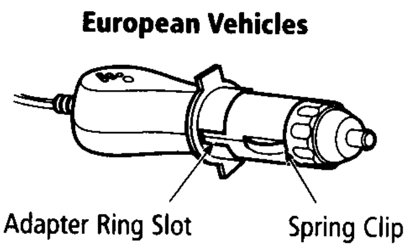


Figure 2.2 European Charger Plug Adapter Use

NOTE: If the charger stops working properly, refer to Section 13 *Troubleshooting.*

2.5 Power On

Press and release the on/off button in the upper left corner of the instrument keypad to turn the instrument on or off. See Figure2.1 Front View of YSI 556 MPS.

2.6 Setting Display Contrast

The display contrast automatically compensates for temperature changes. However, under extreme temperature conditions you may wish to optimize the display by manual adjustment as follows:

1. Press and *hold down* the backlight key in the upper right corner of the keypad and press the “up” arrow to increase (darken) the contrast.

2. Press and *hold down* the backlight key in the upper right corner of the keypad and press the “down” arrow to decrease (lighten) the contrast.

2.7 Backlight

Press and *release* the backlight key in the upper right corner of the keypad to turn the backlight on or off. See Figure 2.1 Front View of YSI 556 MPS.

NOTE: The backlight turns off automatically after two minutes of non-use.

2.8 General Screen Features

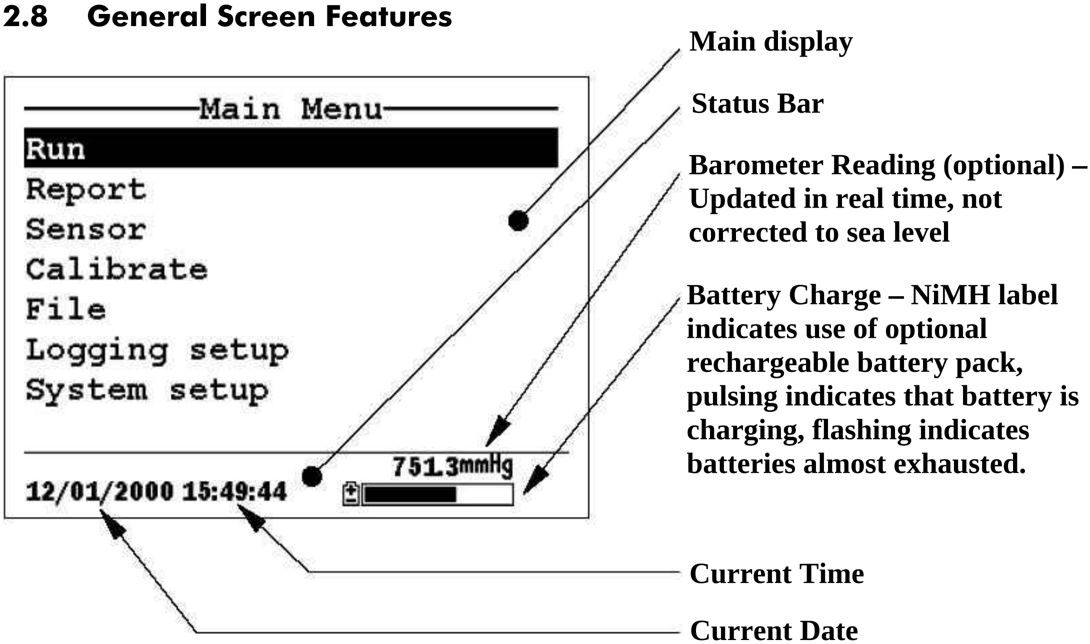


Figure 2.4 Main Screen Menu

2.9 Keypad Use

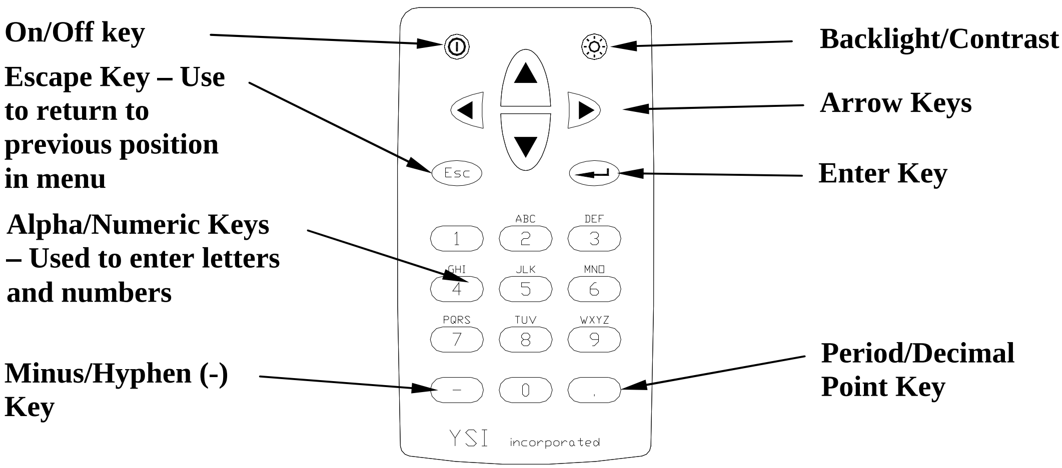


Figure 2.5 Keypad Features

KEY	LETTER/NUMBER
1	1
2	ABC2abc3
3	DEF3def3
4	GHI4ghi4
5	JKL5jkl5
6	MNO6mno6
7	PQRS7pqrs7
8	TUV8tuv8
9	WXYZ9wxyz9
0	0

Figure 2.6 Keypad Features

1. See Figure 2.10 Keypad Letters & Numbers and press the appropriate key repeatedly until letter or number desired appears in display.

NOTE: Press the key repeatedly in rapid succession to get to the desired letter or number. If you pause for more than a second, the cursor automatically scrolls to the right to prepare for the next input.

EXAMPLE 1: Press the **6** key *once* and *release* to display an uppercase “M”.

EXAMPLE 2: Press the **6** key *four times* and *release* to display the number “6”.

EXAMPLE 3: Press the **6** key *five times* and *stop* to display a lowercase “m”.

2. Press the left arrow key to go back and reenter a number or setter that needs to be changed.

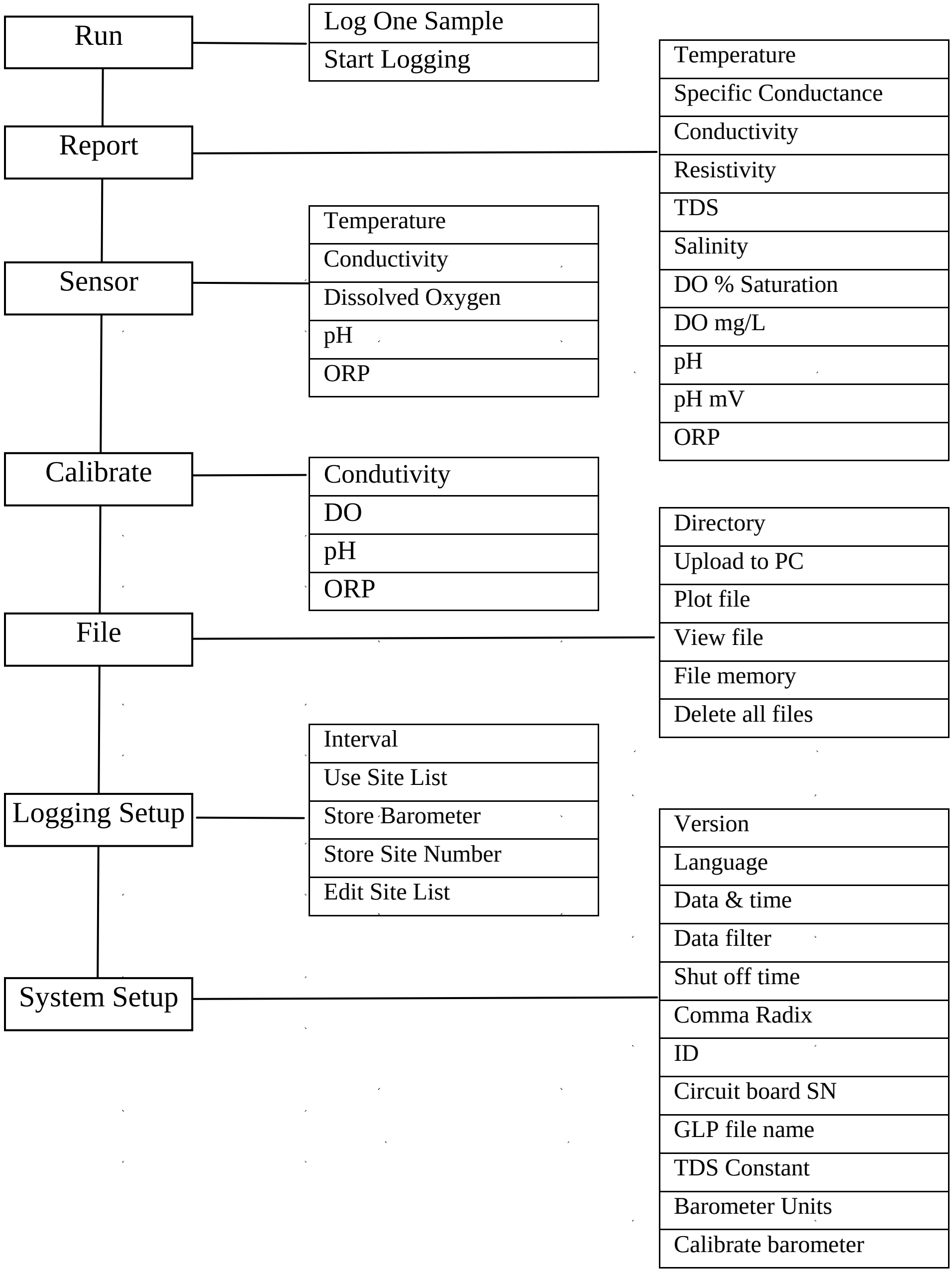
   Press the **Enter** key when your entry is complete.

   NOTE: The instrument software permits only numeric entries in many instances, such as when setting the clock or entering calibration parameters.

2.10 Instrument Reset

The YSI 556 MPS is characterized by sophisticated software that should provide trouble-free operation. However, as with all high-capability software packages, it is always possible that the user will encounter circumstances in which the instrument does not respond to keypad entry. If this occurs, the instrument function can easily be restored by removing and then reapplying battery power. Simply remove either your C-cells or rechargeable battery pack from the battery compartment, wait 30 seconds and then replace the batteries. See Section *2.4 Batteries* for battery removal/reinstallation instructions.

2.11 Menu Flowchart



3. Probe Module

3.1 Introduction

The YSI 5563 Probe module is used for measuring dissolved oxygen, temperature, conductivity, and optional pH and ORP. The probe module is rugged, with the sensors enclosed in a heavy duty probe sensor guard with attached sinking weight. A 4, 10 or 20 meter cable is directly connected to the probe module body making it waterproof. An MS-19 connector at the end of the cable makes the YSI 5563 fully compatible with the YSI 556 Multi-Probe System.

3.2 Unpacking the Probe Module

1. Remove the YSI 5563 Probe Module from the shipping boxes.

   NOTE: Do not discard any parts or supplies.

2. Use the packing list to ensure all items are present.

3. Visually inspect all components for damage.

NOTE: If any parts are missing or damaged, contact a YSI representative immediately. Refer to: *Appendix E Customer Service* o visit www.ysi.com.

3.3 Features of the YSI 5563 Probe Module

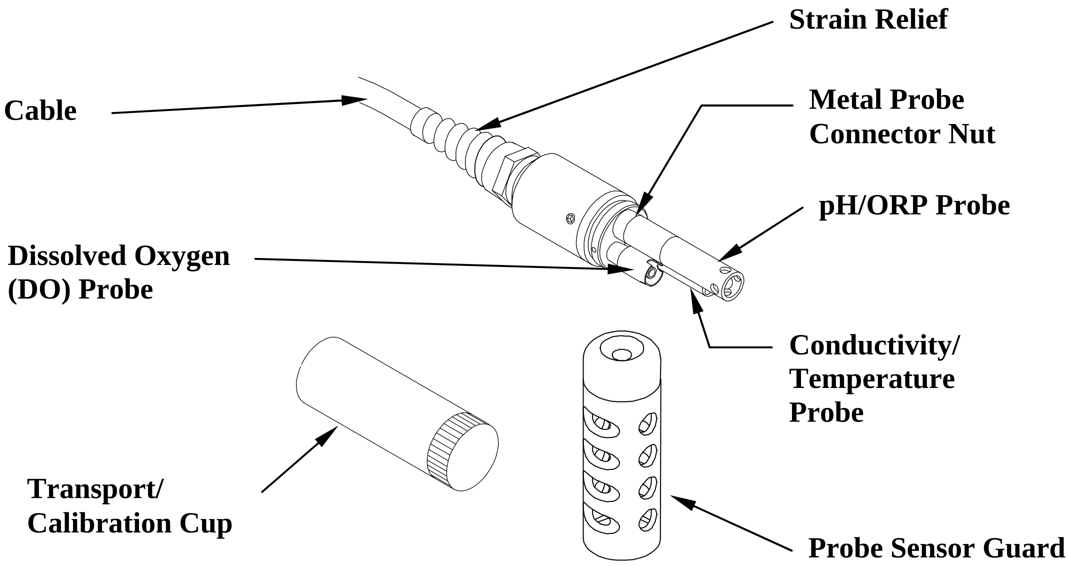


Figure 3.1 Probe Module

3.4 Preparing the Probe Module

To prepare the probe module for calibration and operation, you need to install the sensors into the connectors on the probe module bulkhead. In addition to sensor installation, you need to install a new DO membrane cap.

3.4.1 Sensor Installation

Whenever you install, remove or replace a sensor, it is extremely important that the entire probe module and all sensors be thoroughly dried prior to the removal of a sensor or a sensor port plug. This will prevent water from entering the port. Once you remove a sensor or plug, examine the connector inside the probe module sensor port. If any moisture is present, use compressed air to completely dry the connector. If the connector is corroded, return the probe module to your YSI Distributor or directly to YSI Customer Service. Refer to *Appendix E Customer Service*.

Conductivity/Temperature and pH, pH/ORP Sensor Installation

1. Unscrew and remove the probe sensor guard.

2. Using the sensor installation tool supplied in the YSI 5511 maintenance kit, unscrew and remove the sensor port plugs.

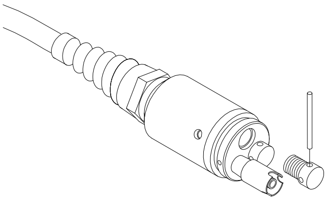


Figure 3.2 Port Plug Removal

3. Locate the port with the connector that corresponds to the sensor that is to be installed.

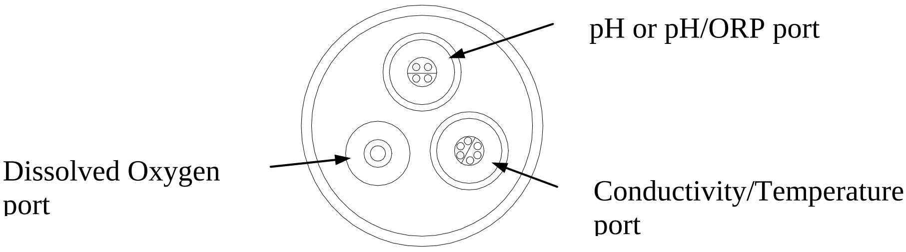


Figure 3.3 Sensor Port Identification

4. Apply a thin coat of o-ring lubricant (supplied in the YSI 5511 maintenance kit) to the o-rings on the connector side of the sensor (see Figure 3.4 O-ring Lubrication).

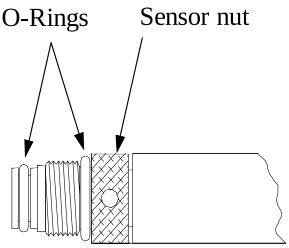


Figure 3.4 O-ring Lubrication

⚠ **CAUTION:** Make sure that there are NO contaminants between the o-ring and the sensor. Contaminants that are present under the o-ring may cause the o-ring to leak.

5. Be sure the probe module sensor port is free of moisture and then insert the sensor into the correct port. Gently rotate the sensor until the two connectors align.

6. With the connectors aligned, screw down the sensor nut using the sensor installation tool.

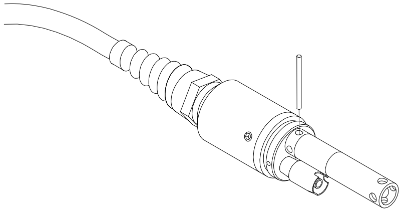


Figure 3.5 Sensor Installation

⚠ **CAUTION:** Do not cross thread the sensor nut. Tighten the nut until it is flush with the face of the probe module bulkhead. Do not over tighten.

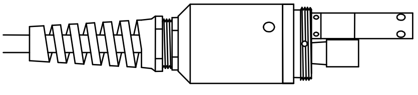


Figure 3.6 Bulkhead Seating

7. Repeat steps 3-6 for any other sensors.

8. Replace the probe sensor guard.

Dissolved Oxygen Sensor Installation

The YSI 5563 comes with the DO sensor already installed. Refer to Section *11.1.2 DO Sensor Replacement* for instructions on installing the YSI 559 Replaceable DO Module Kit.

3.4.2 Membrane Cap Selection

The YSI 5563 is shipped with a YSI 5909 kit that contains membrane caps made with 2 mil polyethylene (PE), a material which should be ideal for most field applications of the 556. However, YSI also offers membrane caps made with two other materials (1 mil polyethylene and 1 mil Teflon) which some users may also prefer. All membranes available for the 556/5563 system provide comparable accuracy if used properly. The difference between the two thicknesses of PE is found in the trade-off of flow dependence and response time as described below. Teflon is offered because some users may prefer to continue using the traditional membrane material used by YSI. To avoid confusion, the membrane caps are color coded as described below and can be ordered in kits as noted:

1 mil Teflon – Black Caps (Kit = YSI 5906)
1 mil Polyethylene (PE) – Yellow Caps (Kit = YSI 5908)
2 mil Polyethylene (PE) – Blue Caps (Kit = YSI 5909)

The 1 mil Teflon caps will offer traditional, reliable performance for most dissolved oxygen applications. The 1 mil PE caps will provide a significantly faster dissolved oxygen response (as long as your 556 Data Filter is set correctly as described below in Sections 10.2 and 10.3.1) while also giving readings which are significantly less flow dependent than the 1 mil Teflon caps. Finally, 2 mil PE caps will show a large reduction in flow dependence over 1 mil Teflon while not significantly increasing the response time. Generally, one of the PE caps is likely to provide better performance for your application.

IMPORTANT: No matter which type of membrane cap you select, you will have to confirm your selection in the 556 software from the Sensor menu as described in Section *4 Sensors*.

3.4.3 Membrane Cap Installation

NOTE: The YSI 5563 DO sensor (already installed in the probe module) was shipped dry. A shipping membrane was installed to protect the electrode. **A new membrane cap must be installed before the first use.**

1. Unscrew and remove the probe sensor guard.
2. Unscrew, remove, and discard the old membrane cap.
3. Thoroughly rinse the sensor tip with distilled water.
4. Prepare the electrolyte according to the directions on the electrolyte solution bottle.
5. Hold the new membrane cap and fill it at least ½ full with the electrolyte solution.
6. Screw the membrane cap onto the sensor moderately tight. A small amount of electrolyte should overflow.

⚠ **Caution:** Do not touch the membrane surface.

7. Screw the probe sensor guard on moderately tight.

3.5 Transport/Calibration Cup

The YSI 5563 Probe module has been supplied with a convenient transport/calibration cup. This cup is an ideal container for calibration of the different sensors, minimizing the amount of solution needed. Refer to Section *6 Calibrate*.

3.5.1 Transport/Calibration Cup Installation

1. Remove probe sensor guard, if already installed.

2. Ensure that an o-ring is installed in the o-ring groove on the threaded end of the probe module body.

3. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

   NOTE: Do not over tighten as this could cause damage to the threaded portions.

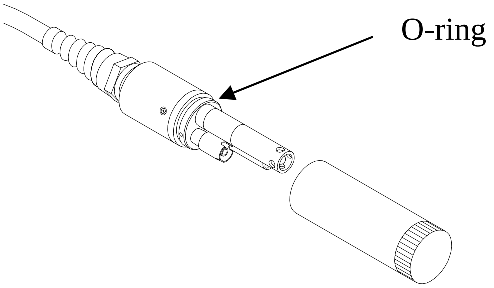


Figure 3.7 Transport/Calibration Cup Installation

3.6 Instrument/Cable Connection

Attach the cable to the instrument as follows:

1. Line up the pins and guides on the cable with the holes and indentations on the cable connector at the bottom of the YSI 556 instrument. See Figure 2.1 Front View of YSI 556 MPS.

2. Holding the cable firmly against the cable connector, turn the locking mechanism clockwise until it snaps into place.

Remove the cable from the instrument by turning the cable connector counterclockwise until the cable disengages from the instrument.

4. Sensors

The Sensors screen allows the user to enable or disable each of the sensors and select which membrane material will be used for the dissolved oxygen sensor. Disabled sensors will not be displayed on the screen in real time or logged to files.

1. Press the **On/off** key to display the run screen.

2. Press the **Escape** key to display the main menu screen.

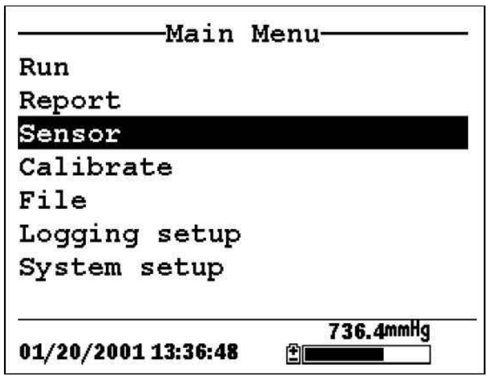


Figure 4.1 Main Menu Screen

3. Use the arrow keys to highlight the **Sensor** selection.

4. Press the **Enter** key to display the sensors enabled screen.

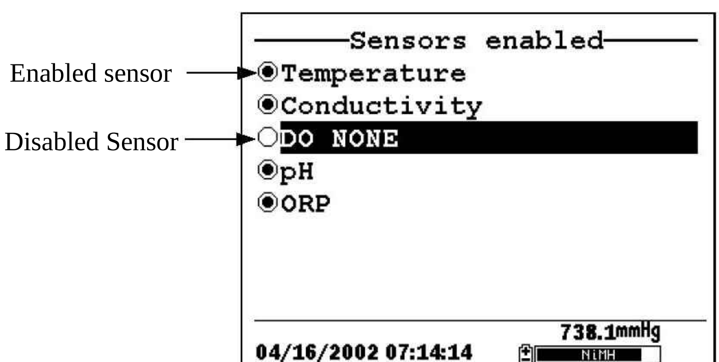


Figure 4.2 Sensors Enabled Screen Before DO Membrane Selection

A black dot to the left of a sensor indicates that sensor is enabled. Sensors with an empty circle are disabled.

Highlight the "DO None" entry as shown above and press **Enter** to display the membrane choice screen. Consult Section *3.4.2 Membrane Cap Selection* for information on the advantages of each type of membrane material. Blue membrane caps using 2 mil polyethylene (PE) were shipped with your YSI 5563 and are likely to be the best choice for most 556 field applications.

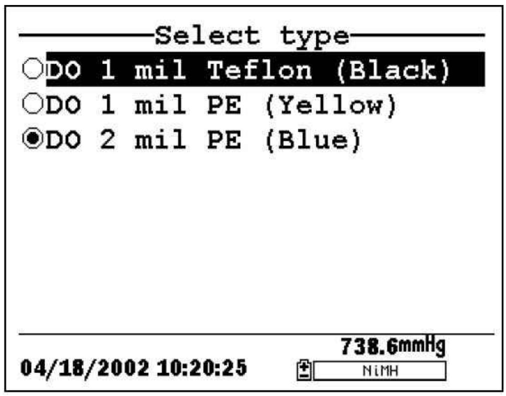


Figure 4.3 Membrane Selection Screen

Highlight the desired membrane choice – in this case, 2 mil PE - and press Enter to activate your selection with a dot to the left of the screen. Then press **Escape** to return to the Sensor menu that now shows your DO membrane selection.

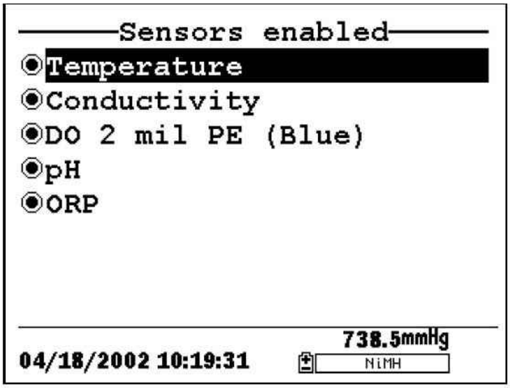


Figure 4.4 Sensors Enabled Screen After DO Membrane Selection

NOTE: The Temperature sensor cannot be disabled. Most other sensors require temperature compensation for accurate readings. In addition, the conductivity sensor must be activated in order to obtain accurate dissolved oxygen mg/L readings.

5. Use the arrow keys to highlight the sensor you want to change, then press the Enter key to enable or disable it.

6. Repeat step 5 for each sensor you want to change.

7. Press the Escape key to return to the main menu screen.

5. Report

The Report Setup screen allows the user to select which sample parameters and units the YSI 556 MPS will display on the screen. It does NOT determine which parameters are logged to memory. Refer to Section *4 Sensors.*

1. Press the **On/off** key to display the run screen.

2. Press the **Escape** key to display the main menu screen.

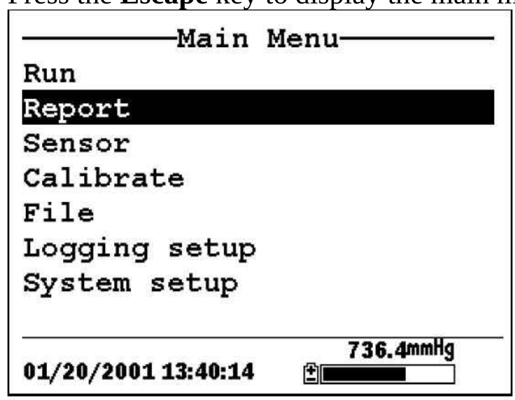


Figure 5.1 Main Menu

3. Use the arrow keys to highlight the **Report** selection.

4. Press the **Enter** key to display the report setup screen.

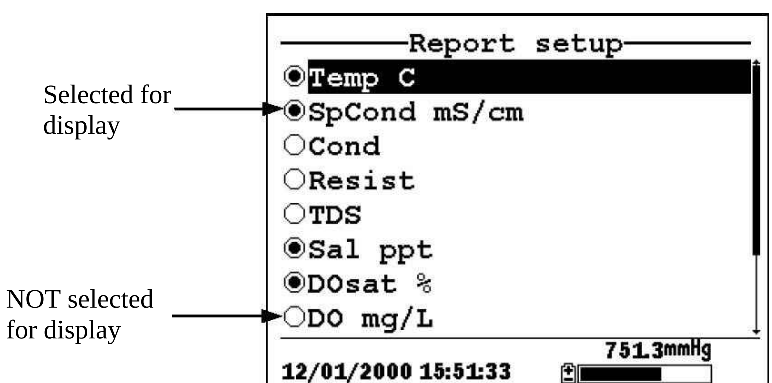


Figure 5.2 Report Setup Screen

NOTE: A black dot to the left of a parameter indicates that parameter is selected for display. Parameters with an empty circle will not be displayed.

NOTE: You may have to scroll down past the bottom of the screen to see all the parameters.

5. Use the arrow keys to highlight the parameter you want to change, then press the **Enter** key. If you can't find the parameter you want, even after scrolling down past the bottom of the screen, the sensor used for that parameter is disabled. Refer to Section *4 Sensors*.

6. If you selected Temperature, Specific Conductivity, Conductivity, Resistance or Total Dissolved Solids, the Units screen will appear.

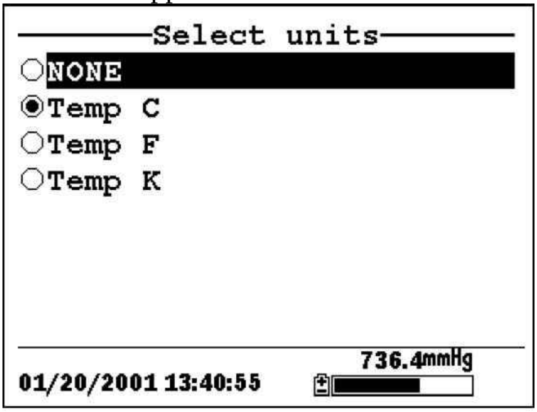


Figure 5.3 Units Screen

7. Use the arrow keys to select the units desired, then press the **Enter** key to return to the report setup screen.

8. Repeat steps 5 and 6 for each parameter you want to change.

NOTE: Specific Conductance (temperature compensated conductivity) is notated on the Run screen with a small 'c' after the units of measure.

All parameters may be enabled at the same time.

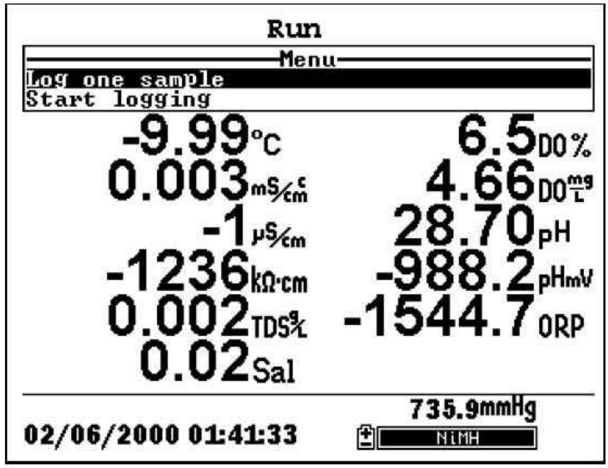


Figure 5.4 All Parameters Displayed

9. Press the **Escape** key to return to the Main menu screen.

6. Calibrate

All of the sensors, except temperature, require periodic calibration to assure high performance. You will find specific calibration procedures for all sensors that require calibration in the following sections. If a sensor listed is not installed in your probe module, skip that section and proceed to the next sensor until the calibration is complete.

⚠ **CAUTION:** Reagents that are used to calibrate and check this instrument may be hazardous to your health. Take a moment to review *Appendix D Health and Safety*. Some calibration standard solutions may require special handling.

6.1 Getting Ready to Calibrate

6.1.1 Containers Needed to Calibrate the Probe Module

The transport/calibration cup that comes with your probe module serves as a calibration chamber for all calibrations and minimizes the volume of calibration reagents required.

Instead of the transport/calibration cup, you may use laboratory glassware to perform calibrations. If you do not use the transport/calibration cup that is designed for the probe module, you are cautioned to do the following:

- ✓ Perform all calibrations with the Probe Sensor Guard installed. This protects the sensors from possible physical damage.
- ✓ Use a ring stand and clamp to secure the probe module body to prevent the module from falling over. Most laboratory glassware has convex bottoms.
- ✓ Ensure that all sensors are immersed in calibration solutions. Many of the calibrations factor in readings from other sensors (e.g., temperature sensor). The top vent hole of the conductivity sensor must also be immersed during some calibrations.

6.1.2 Calibration Tips

1. If you use the Transport/Calibration Cup for dissolved oxygen (DO) calibration, make certain to loosen the seal to allow pressure equilibration before calibration. The DO calibration is a water-saturated air calibration.

2. When calibrating pH, always calibrate with buffer 7 first, regardless if performing a 1, 2, or 3 point calibration

3. The key to successful calibration is to ensure that the sensors are completely submersed when calibration values are entered. Use recommended volumes when performing calibrations.

4. For maximum accuracy, use a small amount of previously used calibration solution to pre-rinse the probe module. You may wish to save old calibration standards for this purpose.

5. Fill a bucket with ambient temperature water to rinse the probe module between calibration solutions.

6. Have several clean, absorbent paper towels or cotton cloths available to dry the probe module between rinses and calibration solutions. Shake the excess rinse water off of the probe module, especially when the probe sensor guard is installed. Dry off the outside of the probe module and probe sensor guard. Making sure that the probe module is dry reduces carry-over contamination of calibrator solutions and increases the accuracy of the calibration.

7. If you are using laboratory glassware for calibration, you do not need to remove the probe sensor guard to rinse and dry the sensors between calibration solutions. The inaccuracy resulting from simply rinsing the sensor compartment and drying the outside of the guard is minimal.

8. If you are using laboratory glassware, remove the stainless steel weight from the bottom of the probe sensor guard by turning the weight counterclockwise. When the weight is removed, the calibration solutions have access to the sensors

without displacing a lot of fluid. This also reduces the amount of liquid that is carried between calibrations.

9. Make certain that port plugs are installed in all ports where sensors are not installed. It is extremely important to keep these electrical connectors dry.

6.1.3 Recommended Volumes

Follow these instructions to use the transport/calibration cup for calibration procedures.

- ✓ Ensure that an o-ring is installed in the o-ring groove of the transport/calibration cup bottom cap, and that the bottom cap is securely tightened.

  NOTE: Do not over-tighten as this could cause damage to the threaded portions.

- ✓ Remove the probe sensor guard, if it is installed.
- ✓ Remove the o-ring, if installed, from the probe module and inspect the installed o-ring on the probe module for obvious defects and, if necessary, replace it with the extra o-ring supplied.
- ✓ Some calibrations can be accomplished with the probe module upright or upside down. A separate clamp and stand, such as a ring stand, is required to support the probe module in the upside down position.
- ✓ To calibrate, follow the procedures in the next section, Calibration Procedures. The approximate volumes of the reagents are specified below for both the upright and upside down orientations.
- ✓ When using the Transport/Calibration Cup for dissolved oxygen % saturation calibration, make certain that the vessel is vented to the atmosphere by loosening the bottom cap or cup assembly and that approximately 1/8 inch (3 cm) of water is present in the cup.

Sensor to Calibrate	Upright	Upside Down
Conductivity	55ml	55ml
pH/ORP	30ml	60ml

Table 6.1 Calibration Volumes

6.2 Calibration Procedures

6.2.1 Accessing the Calibrate Screen

1. Press the **On/off** key to display the run screen.
2. Press the **Escape** key to display the main menu screen.
3. Use the arrow keys to highlight the **Calibrate** selection.

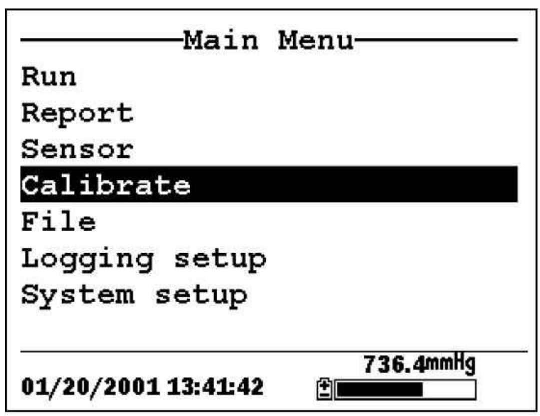


Figure 6.1 Main Menu

4. Press the **Enter** key. The Calibrate screen will be displayed.

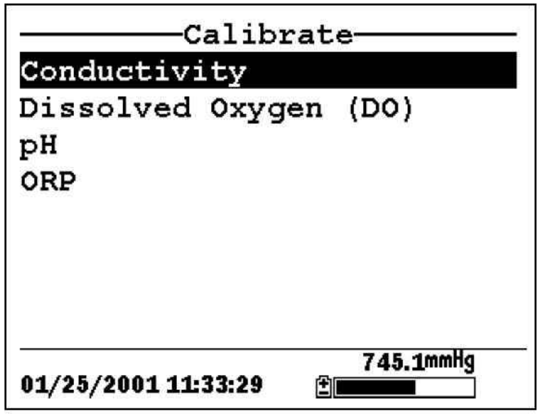


Figure 6.2 Calibrate Screen

6.2.2 Conductivity Calibration

This procedure calibrates specific conductance (recommended), conductivity and salinity. Calibrating any one option automatically calibrates the other two.

1. Go to the calibrate screen as described in Section *6.2.1Accessing the Calibrate Screen.*.

2. Use the arrow keys to highlight the **Conductivity** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter**. The Conductivity Calibration Screen is displayed.

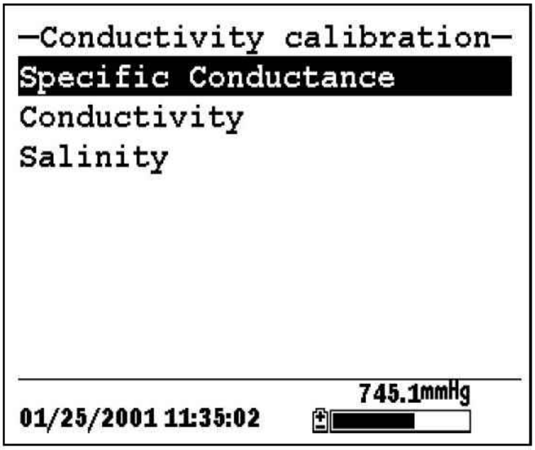


Figure 6.3 Conductivity Calibration Selection Screen

4. Use the arrow keys to highlight the Specific Conductance selection.

5. Press **Enter**. The Conductivity Calibration Entry Screen is displayed.

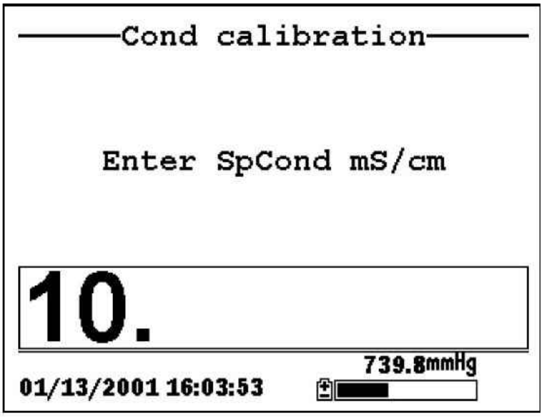


Figure 6.4 Conductivity Calibration Selection Screen

6. Place the correct amount of conductivity standard (see Table 6.1 Calibration Volumes) into a clean, dry or pre-rinsed transport/calibration cup.

⚠ **WARNING**: Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: For maximum accuracy, the conductivity standard you choose should be within the same conductivity range as the samples you are preparing to measure. However, we do not recommend using standards less than 1 mS/cm. For example:

- ✓ For fresh water use a 1 mS/cm conductivity standard.
- ✓ For brackish water use a 10 mS/cm conductivity standard.
- ✓ For seawater use a 50 mS/cm conductivity standard.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the conductivity sensor with a small amount of standard that can be discarded. Be certain that you avoid cross-contamination of solutions. Make certain that there are no salt deposits around the oxygen and pH/ORP sensors, particularly if you are employing standards of low conductivity.

7. Carefully immerse the sensor end of the probe module into the solution.

8. Gently rotate and/or move the probe module up and down to remove any bubbles from the conductivity cell.

NOTE: The sensor must be completely immersed past its vent hole. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the vent hole is covered.

9. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

NOTE: Do not over tighten as this could cause damage to the threaded portions.

10. Use the keypad to enter the calibration value of the standard you are using.

NOTE: Be sure to enter the value in **mS/cm at 25°C**.

11. Press **Enter**. The Conductivity Calibration Screen is displayed.

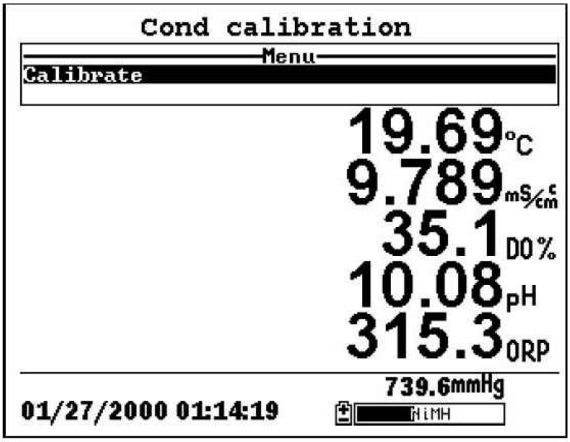


Figure 6.5 Conductivity Calibration Screen

12. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

13. Observe the reading under Specific Conductance. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

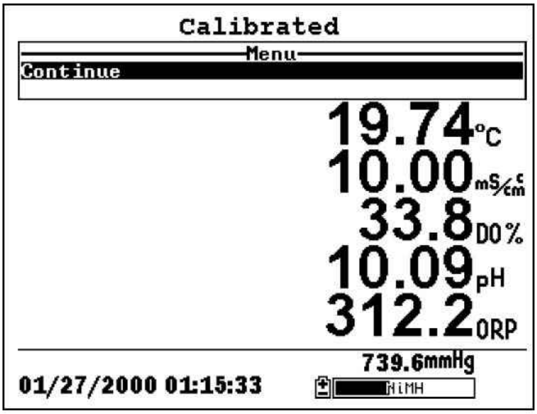


Figure 6.6 Calibrated

14. Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen, See Figure 6.3 Conductivity Calibration Selection Screen..

15. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen .

16. Rinse the probe module and sensors in tap or purified water and dry.

6.2.3 Dissolved Oxygen Calibration

This procedure calibrates dissolved oxygen. Calibrating any one option (% or mg/L) automatically calibrates the other.

1. Go to the calibrate screen as described in Section *6.2.1 Accessing the Calibrate Screen*.

NOTE: The instrument must be on for at least 10 - 15 minutes to polarize the DO sensor before calibrating.

2. Use the arrow keys to highlight the **Dissolved Oxygen** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter**. The dissolved oxygen calibration screen is displayed.

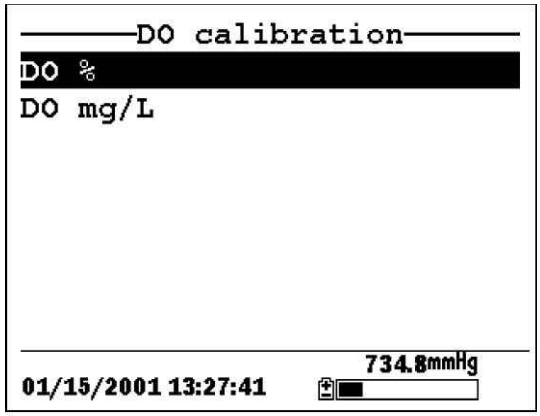


Figure 6.7 DO Calibration Screen

DO Calibration in % Saturation

1. Use the arrow keys to highlight the DO% selection.

2. Press **Enter**. The DO Barometric Pressure Entry Screen is displayed.

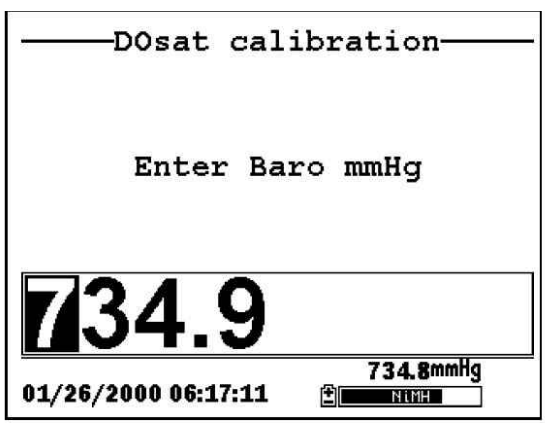


Figure 6.8 DO Barometric Pressure Entry Screen

3. Place approximately 3 mm (1/8 inch) of water in the bottom of the transport/calibration cup.

4. Place the probe module into the transport/calibration cup.

NOTE: Make sure that the DO and temperature sensors are **not** immersed in the water.

5. Engage only 1 or 2 threads of the transport/calibration cup to ensure the DO sensor is vented to the atmosphere.

6. Use the keypad to enter the current local barometric pressure.

NOTE: If the unit has the optional barometer, no entry is required.

NOTE: Barometer readings that appear in meteorological reports are generally corrected to sea level and must be uncorrected before use (refer to Section *10.10 Calibrate Barometer, Step 2*).

7. Press **Enter**. The DO% saturation calibration screen is displayed.

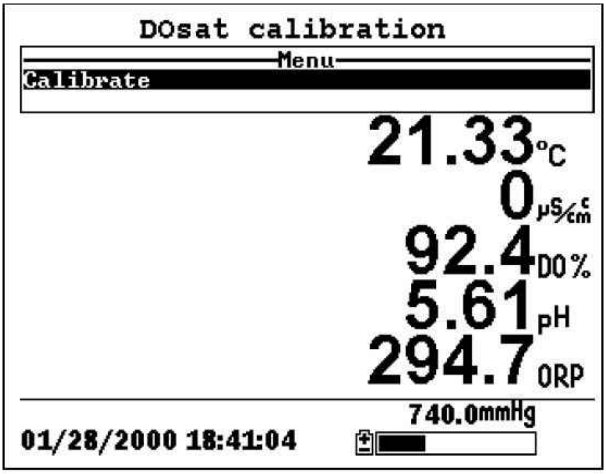


Figure 6.9 DO Sat Calibration Screen

8. Allow approximately ten minutes for the air in the transport/calibration cup to become water saturated and for the temperature to equilibrate before proceeding.

9. Observe the reading under DO %. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue. See Figure 6.6 Calibrated.

10. Press **Enter**. This returns you to the DO calibration screen, See Figure 6.7 DO Calibration Screen.

11. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

12. Rinse the probe module and sensors in tap or purified water and dry.

DO Calibration in mg/L

DO calibration in mg/L is carried out in a water sample which has a known concentration of dissolved oxygen (usually determined by a Winkler titration).

1. Go to the DO calibrate screen as described in Section *6.2.3 Dissolved Oxygen Calibration*, steps 1 through 3.

2. Use the arrow keys to highlight the **DO mg/L** selection.

3. Press **Enter**. The DO mg/L Entry Screen is displayed.

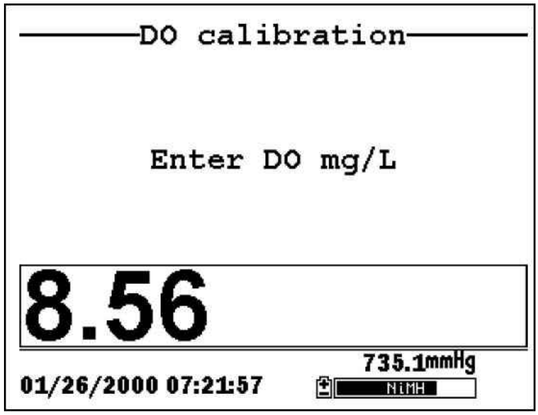


Figure 6.10 DO mg/L Entry Screen

4. Place the probe module in water with a known DO concentration.

NOTE: Be sure to completely immerse all the sensors.

5. Use the keypad to enter the known DO concentration of the water.

6. Press **Enter**. The Dissolved Oxygen mg/L Calibration Screen is displayed.

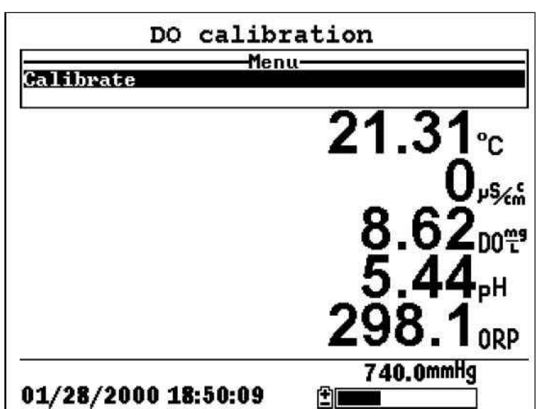


Figure 6.11 DO mg/L Calibration Screen

7. Stir the water with a stir bar, or by rapidly moving the probe module, to provide fresh sample to the DO sensor.

8. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

9. Observe the DO mg/L reading, when the reading is stable (shows no significant change for approximately 30 seconds), press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

10. Press **Enter**. This returns you to the DO calibration screen. See Figure 6.7 DO Calibration Screen.

11. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

12. Rinse the probe module and sensors in tap or purified water and dry.

6.2.4 pH Calibration

1. Go to the calibrate screen as described in *Section 6.2.1 Accessing the Calibrate Screen*.

2. Use the arrow keys to highlight the **pH** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter**. The pH calibration screen is displayed.

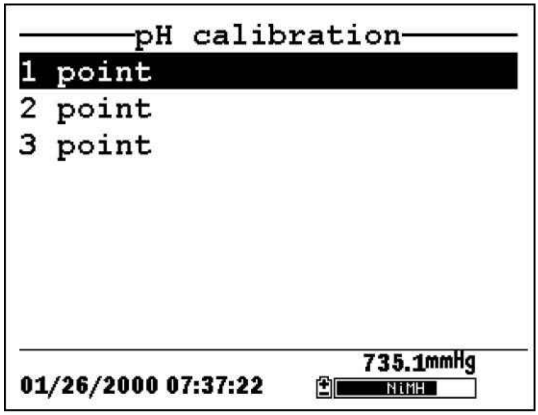


Figure 6.12 pH Calibration Screen

- Select the **1-point** option only if you are adjusting a previous calibration. If a 2-point or 3-point calibration has been performed previously, you can adjust the calibration by carrying out a one point calibration. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select only one pH buffer.
- Select the **2-point** option to calibrate the pH sensor using only two calibration standards. Use this option if the media being monitored is known to be either basic or acidic. For example, if the pH of a pond is known to vary between 5.5 and 7, a two-point calibration with pH 7 and pH 4 buffers is sufficient. A three point calibration with an additional pH 10 buffer will not increase the accuracy of this measurement since the pH is not within this higher range.
- Select the **3-point** option to calibrate the pH sensor using three calibration solutions. In this procedure, the pH sensor is calibrated with a pH 7 buffer and two additional buffers. The 3-point calibration method assures maximum accuracy when the pH of the media to be monitored cannot be anticipated. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select a third pH buffer.

4. Use the arrow keys to highlight the **2-point** selection.

5. Press **Enter**. The pH Entry Screen is displayed.

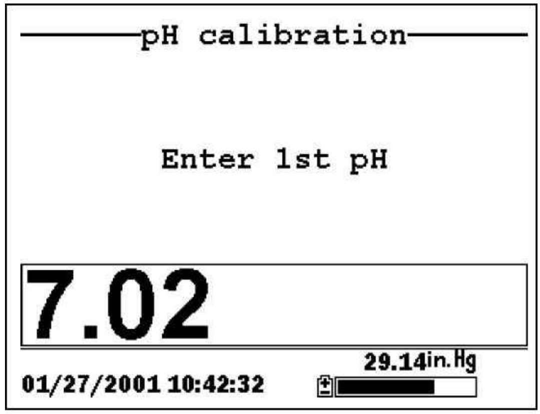


Figure 6.13 pH Entry Screen

6. Place the correct amount (see Table 6.1 Calibration Volumes) of pH buffer into a clean, dry or pre-rinsed transport/calibration cup.

NOTE: Always calibrate with buffer 7 first, regardless if performing a 1, 2, or 3 point calibration.

⚠ **WARNING**: Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: For maximum accuracy, the pH buffers you choose should be within the same pH range as the water you are preparing to sample.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the pH sensor with a small amount of buffer that can be discarded. Be certain that you avoid cross-contamination of buffers with other solutions.

7. Carefully immerse the sensor end of the probe module into the solution.

8. Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.

NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the sensor is covered.

9. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten

NOTE: Do not over tighten as this could cause damage to the threaded portions.

10. Use the keypad to enter the calibration value of the buffer you are using **at the current temperature**.

NOTE: pH vs. temperature values are printed on the labels of all YSI pH buffers.

11. Press **Enter**. The pH calibration screen is displayed.

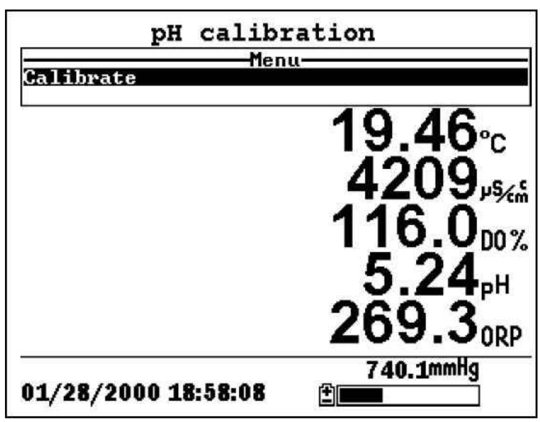


Figure 6.14 pH Calibration Screen

12. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

13. Observe the reading under pH, when the reading shows no significant change for approximately 30 seconds, press **Enter**.

The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

14. Press **Enter**. This returns you to the specified pH Calibration Screen, See Figure 6.13 pH Entry Screen.

15. Rinse the probe module, transport/calibration cup and sensors in tap or purified water and dry.

16. Repeat steps 6 through 13 above using a second pH buffer.

17. Press **Enter**. This returns you to the pH Calibration Screen, See Figure 6.12 pH Calibration Screen.

18. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

19. Rinse the probe module and sensors in tap or purified water and dry.

6.2.5 ORP Calibration

1. Go to the calibrate screen as described in Section *6.2.1 Accessing the Calibrate Screen*.

2. Use the arrow keys to highlight the **ORP** selection. See Figure 6.2 Calibrate Screen..

3. Press **Enter**. The ORP calibration screen is displayed.

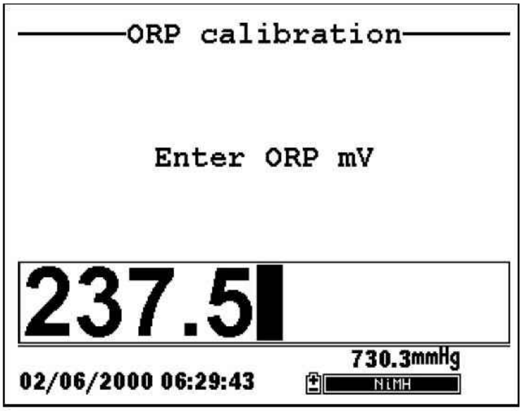


Figure 6.15 Specified ORP Calibration Screen

4. Place the correct amount (see Table 6.1 Calibration Volumes) of a known ORP solution (we recommend Zobell solution) into a clean, dry or pre-rinsed transport/calibration cup.

⚠ **WARNING**: Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the ORP sensor with a small amount of solution that can be discarded. Be certain that you avoid cross-contamination with other solutions.

5. Carefully immerse the sensor end of the probe module into the solution.

6. Gently rotate and/or move the probe module up and down to remove any bubbles from the ORP sensor.

NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes should ensure that the sensor is covered.

7. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

NOTE: Do not over tighten as this could cause damage to the threaded portions.

8. Use the keypad to enter the correct value of the calibration solution you are using at the current temperature. Refer to Table 6.2 Zobell Solution Values.

Temperature °C	Zobell Solution Value, mV
-5	270.0
0	263.5
5	257.0
10	250.5
15	244.0
20	237.5
25	231.0
30	224.5
35	218.0
40	211.5
45	205.0
50	198.5

Table 6.2 Zobell Solution Values

9. Press **Enter**. The ORP calibration screen is displayed.

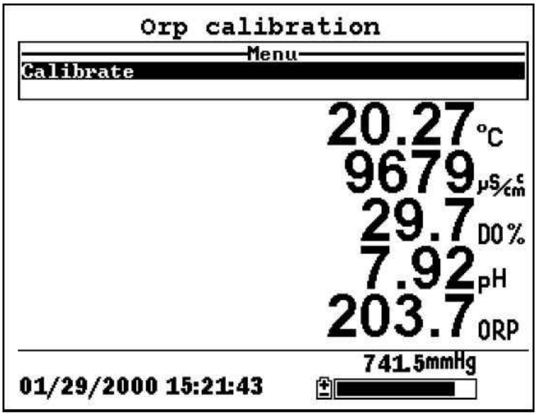


Figure 6.16 DO Cal Screen

10. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

NOTE: Verify that the temperature reading matches the value you used in Table 6.2 Zobell Solution Values.

11. Observe the reading under ORP, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

12. Press **Enter**. This returns you to the Calibrate Screen. See Figure 6.2 Calibrate Screen.

13. Rinse the probe module and sensors in tap or purified water and dry.

6.3 Return to Factory Settings.

1. Go to the calibrate screen as described in Section *6.2.1 Accessing the Calibrate Screen*.

2. Use the arrow keys to highlight the **Conductivity** selection. See Figure 6.2 Calibrate Screen.

   NOTE: We will use the Conductivity sensor as an example; however, this process will work for any sensor.

3. Press **Enter.** The Conductivity Calibration Selection Screen is displayed. See Figure 6.3 Conductivity Calibration Selection Screen.

4. Use the arrow keys to highlight the **Specific Conductance** selection.

5. Press **Enter.** The Conductivity Calibration Entry Screen is displayed. See Figure 6.4 Conductivity Calibration Entry Screen.

6. Press and hold the **Enter** key down and press the **Escape** key.

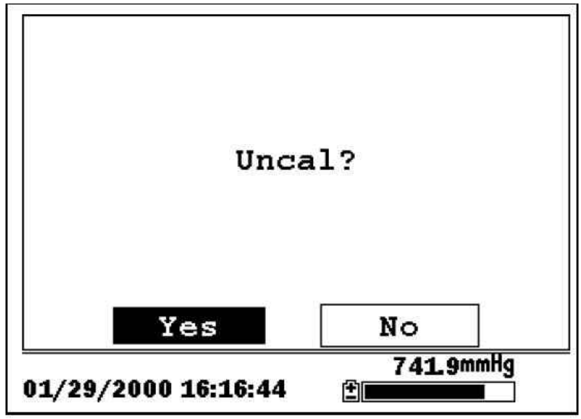


Figure 6.17 ORP Calibration Screen

7. Use the arrow keys to highlight the **YES** selection.

CAUTION: This returns a sensor to the factory settings. For example, in selecting to return specific conductance to the factory setting, salinity and conductivity will automatically return to their factory settings.

8. Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen, See Figure 6.3 Conductivity Calibration Selection Screen. .

9. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

7. Run

The Run screen displays data from the sensors in real-time and allows the user to log sample data to memory for later analysis. Refer to Section *9 Logging* for details on logging sample data.

7.1 Real-Time Data

NOTE: Before measuring samples you must prepare the probe module (refer to Section *3.4 Preparing the Probe Module*), attach the probe module to the instrument (refer to Section *3.6 Instrument/Cable Connection*) and calibrate the sensors (refer to Section *6 Calibrate*).

1. Press the On/off key.

OR select Run from the main menu to display the run screen.

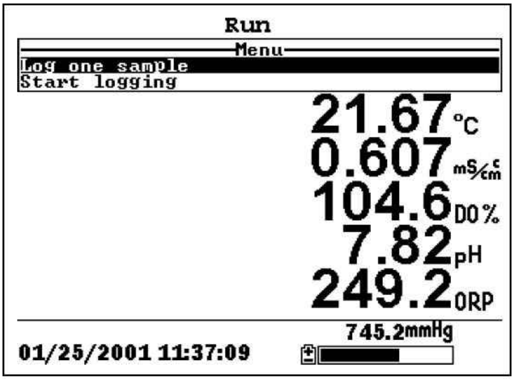


Figure 7.1 Run Screen

2. Make sure the probe sensor guard is installed.

3. Place the probe module in the sample. Be sure to completely immerse all the sensors.

4. Rapidly move the probe module through the sample to provide fresh sample to the DO sensor.

5. Watch the readings on the display until they are stable.

6. Refer to Section *9 Logging* for instructions on logging sample data.

8. File

The File menu allows the user to view, upload or delete sample data and calibration record files stored in the YSI 556 MPS.

8.1 Accessing the File Screen

1. Press the **On/off** key to display the run screen.

2. Press the **Escape** key to display the main menu screen.

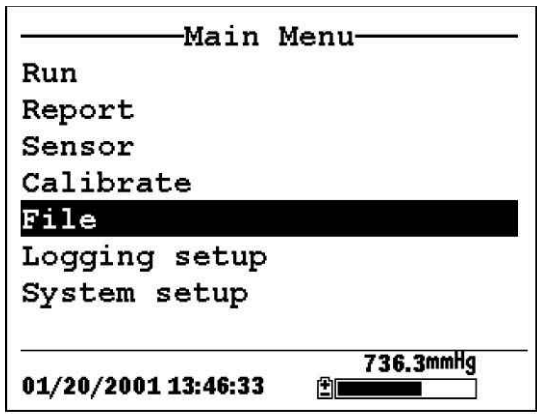


Figure 8.1 Main Menu Screen

3. Use the arrow keys to highlight the **File** selection.

4. Press the **Enter** key. The file screen is displayed.

Figure 8.2 File Screen

8.2 Directory

1. Go to the file screen as described in Section *8.1 Accessing the File Screen*.
2. Use the arrow keys to highlight the **Directory** selection. See Figure 8.2 File Screen.
3. Press the **Enter** key. The file list screen is displayed.

NOTE: Files are listed in the order in which they are logged to memory. Sample Data files have the file extension **.dat**, while Calibration Record files have the file extension **.glp**.

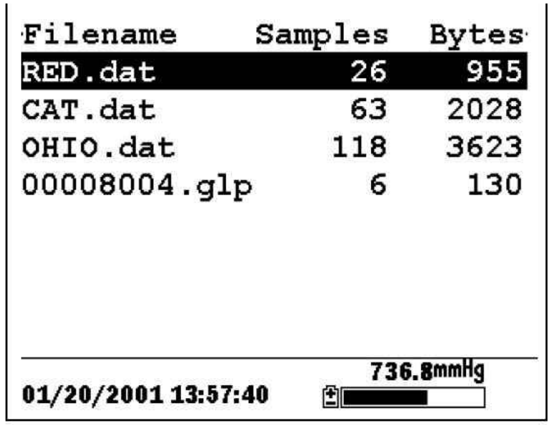


Figure 8.3 File List Screen

4. Use the arrow keys to highlight a file.

5. Press the **Enter** key. The file details screen is displayed.

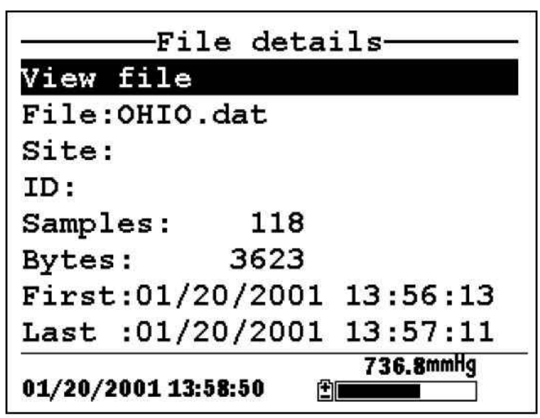


Figure 8.4 File Details Screen

6. Press the **Enter** key to view the file data. Refer to Section *8.3 View File* for details.

7. Press the **Escape** key repeatedly to return to the main menu screen.

8.3 View File

1. Go to the file screen as described in Section *8.1 Accessing the File Screen*. See Figure 8.2 File Screen.

2. Use the arrow keys to highlight the **View file** selection.

3. Press the **Enter** key. A list of files is displayed. See Figure 8.3 File List Screen.

4. Use the arrow keys to highlight an individual file.

   NOTE: You may have to scroll down to see all the files.

5. Press the **Enter** key. The file data is displayed with the file name at t8e top of the display.

   NOTE: If no file name was specified, the data is stored under the default name NONAME1.dat.

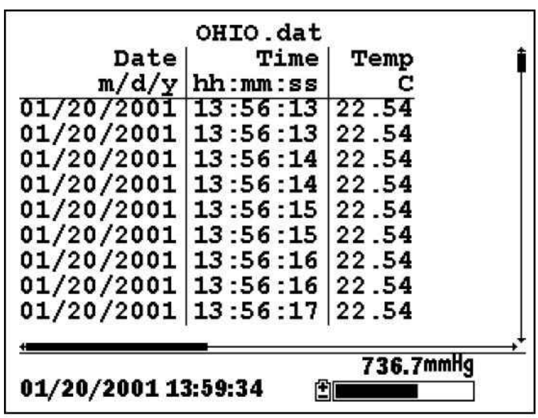


Figure 8.5 File Data Screen

6. Use the arrow keys to scroll horizontally and/or vertically to view all the data.

7. Press the **Escape** key repeatedly to return to the main menu screen.

8.4 Upload to PC

EcoWatch™ for Windows™ must be used as the PC software interface to the YSI 556 MPS. Refer to *Appendix G EcoWatch* for more information. EcoWatch for Windows® is available at no cost via a download from the YSI Web Site (www.ysi.com) or by contacting YSI Customer Support. Refer to *Appendix E Customer Service.*

8.4.1 Upload Setup

1. Disconnect the YSI 5563 Probe Module from the YSI 556 MPS instrument.

2. Connect the YSI 556 MPS to a serial (Comm) port of your computer via the 655173 PC Interface cable as shown in the following diagram:

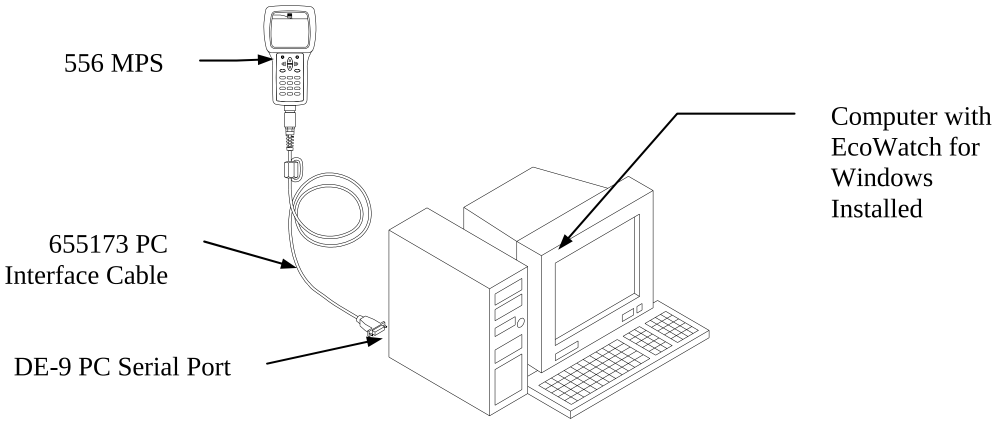


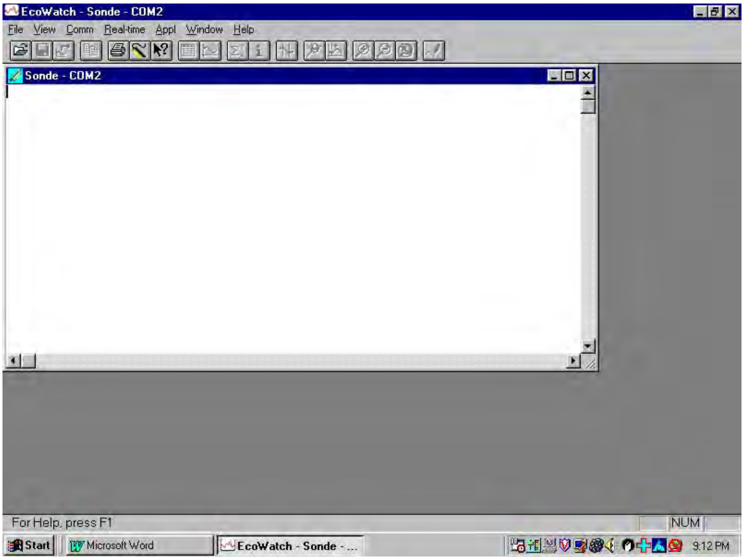
Figure 8.2 Computer/Instrument Interface

3. Open EcoWatch for Windows on your computer.

   NOTE: See *Appendix G EcoWatch* for installation instructions.

4. Click on the sonde/probe icon  in the upper toolbar.

5. Set the Comm port number to match the port the YSI 556 MPS is connected to. After this setup procedure, the following screen will be present on your PC monitor:



8.4.2 Uploading a .DAT File

1. Setup the instrument as described in Section *8.4.1 Upload Setup*.

2. Go to the YSI 556 MPS file screen as described in Section *8.1 Accessing the File Screen.*

3. Use the arrow keys to highlight the **Upload to PC** selection. See Figure 8.2 File Screen.

4. Press the **Enter** key. The file list screen is displayed. See Figure 8.3 File List Screen.

5. Use the arrow keys to highlight the DAT file that you wish to transfer and press **Enter**, both the YSI 556 MPS and PC displays show the progress of the file transfer.

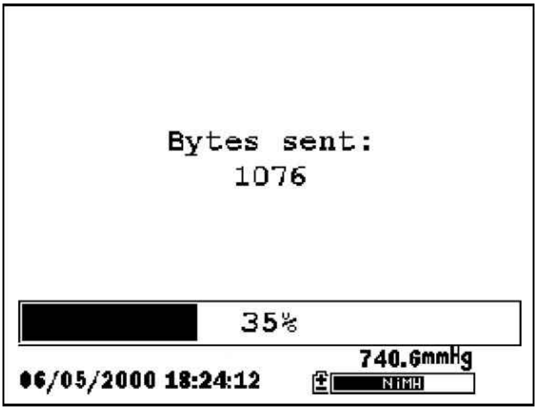
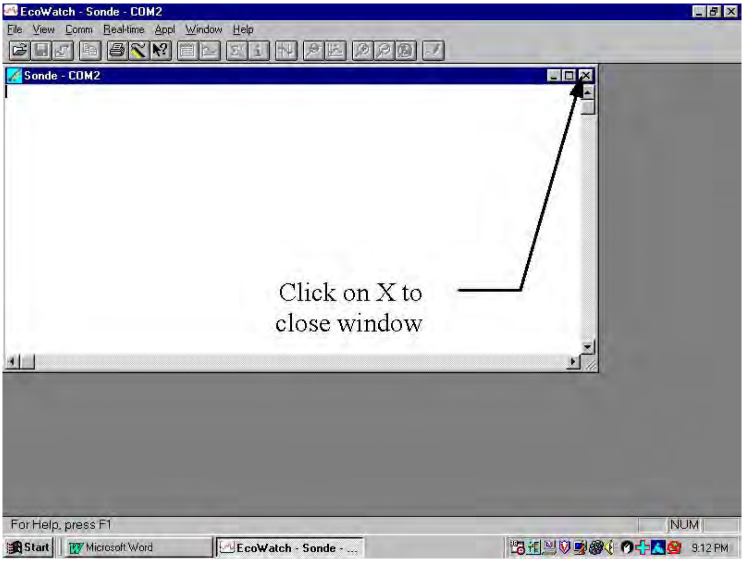


Figure 8.3 File Transfer Progress Screen

NOTE: After transfer, the file will be located in the C:\ECOWWIN\DATA folder of your PC, designated with a .DAT extension.

6. After the file transfer is complete, close the terminal window (small window on the PC) by clicking on the "X" at its upper right corner.



7. Press the **Escape** key on the YSI 556 MPS repeatedly to return

to the main menu screen.

8.4.3 Uploading a Calibration Record (.glp) File

For more information on the calibration record, refer to *Appendix H Calibration Record Information*.

1. Setup up the instrument as described in Section *8.4.1 Upload Setup*.

2. Go to the YSI 556 MPS file screen as described in Section

3. Use the arrow keys to highlight the Upload to PC selection. See Figure 8.2 File Screen.

4. Press the **Enter** key. The file list screen is displayed. See Figure 8.3 File List Screen.

5. Use the arrow keys to highlight the calibration record file that you wish to transfer and press **Enter.**

6. You will then be given a choice of uploading the file in three formats; **Binary, Comma & “” Delimited, and ASCII Text**.

   NOTE: The binary format is reserved for future YSI software packages.

7. Choose an option and press Enter, both the YSI 556 and PC displays show the progress of the file transfer.

   NOTE: After transfer, the file will be located in the C:\ECOWWIN\DATA folder of your PC, designated with the appropriate file extension.

   NOTE: To view the Calibration Record data after upload, simply open the .txt file in a general text editor such as Wordpad or Notepad.

8. After the file transfer is complete, close the terminal window (small window on the PC) by clicking on the “X” at its upper right corner.

9. Press the **Escape** key repeatedly to return to the main menu screen.

8.5 File Memory

1. Go to the file screen as described in Section *8.1 Accessing the File Screen*.

2. Use the arrow keys to highlight the **File memory** selection. See Figure 8.2 File Screen.

3. Press the **Enter** key. The file bytes used screen is displayed.

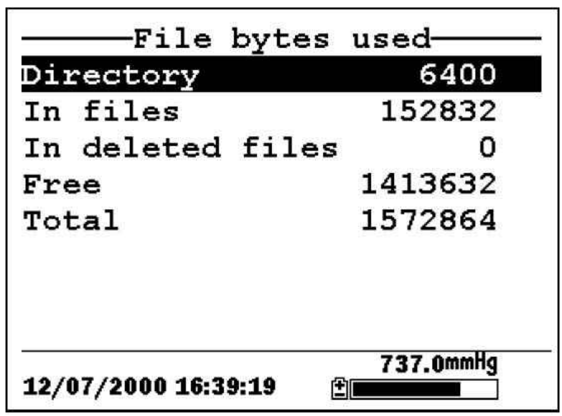


Figure 8.4 File Bytes Used Screen

4. The amount of free memory is listed in line 4 of the file bytes used screen.

   NOTE: If the amount of free memory is low, it may be time to delete all files (after first uploading all data to a PC). Refer to Section *8.6 Delete All Files*.

5. Press the **Escape** key repeatedly to return to the main menu screen.

8.6 Delete All Files

NOTE: It is not possible to delete individual files in order to free up memory. The only way to free up memory is to delete ALL files present. Take care to transfer all files to your computer (refer to Section 8.4 Upload to PC) before deleting them.

1. Go to the file screen as described in Section *8.1 Accessing the File Screen*.

2. Use the arrow keys to highlight the **Delete all files** selection. See Figure 8.2 File Screen.

3. Press the **Enter** key. The Delete all Files screen is displayed.

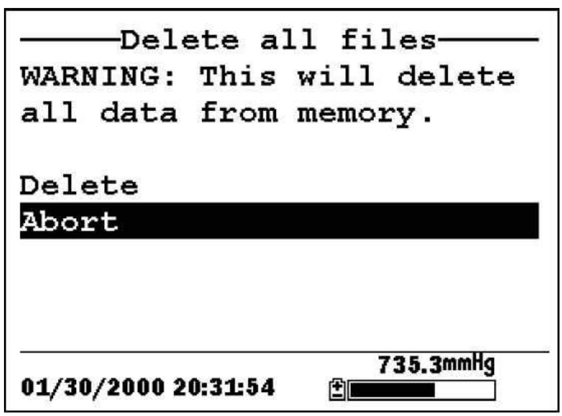


Figure 8.5 Delete All Files Screen

4. Use the arrow keys to highlight the **Delete** selection.

5. Press the **Enter** key.

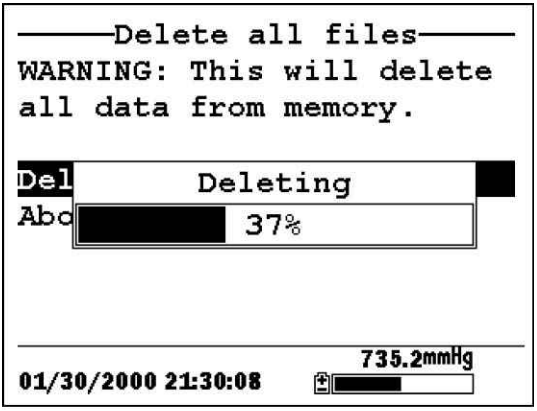


Figure 8.10 Deleting

The progress of file deletion is displayed in bar graph format.

NOTE: Deleting all files in the directory will not change any information in the site list.

6. Press the Escape key repeatedly to return to the main menu screen.

9. Logging

9.1 Accessing the Logging Setup Screen

1. Press the **On/off** key to display the run screen.

2. Press the **Escape** key to display the main menu screen.

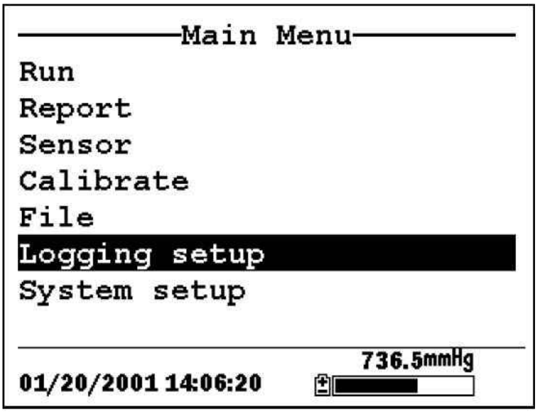


Figure 9.1 Main Menu

3. Use the arrow keys to highlight the **Logging setup** selection.

4. Press the **Enter** key. The logging setup screen is displayed.

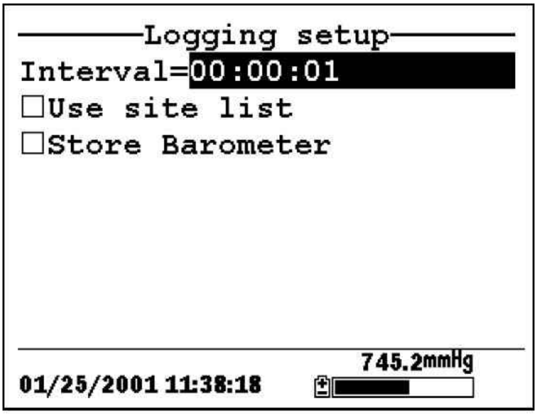


Figure 9.2 Setup Screen

9.2 Setting Logging Interval

Follow steps below to set the interval for logging a data stream.

NOTE: If you do not specify an interval, the instrument will use a default interval setting of 1 second.

NOTE: It is not necessary to set a logging interval when logging a single sample.

1. Go to the logging setup screen as described in Section *9.1 Accessing the Logging Setup Screen*.

2. Use the keypad to enter an interval between 1 second and 15 minutes. Refer to Section *2.9 Keypad Use*.

   NOTE: The interval field has hour, minute and second entry fields. Any entry over 1 hour will change automatically to a 15-minute setting.

3. Press the **Enter** key. The data stream interval is set.

4. Press the **Escape** key repeatedly to return to the main menu screen.

9.3 Storing Barometer Readings

NOTE: The **Store barometer** option is only available on instruments that are equipped with the optional barometer.

1. Go to the logging setup screen as described in Section *9.1 Accessing the Logging Setup Screen*.

2. Use the arrow keys to highlight the **Store barometer** selection. See Figure 9.2 Logging Setup Screen.

3. Press the **Enter** key until a check mark is entered in the box next to the store barometer selection if you want to log barometric readings.

OR press the **Enter** key until the box next to the barometer selection is empty if you do not want to log barometric readings.

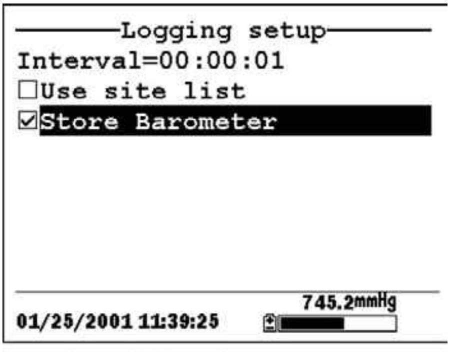


Figure 9.3 Store Barometer

4. Press the **Escape** key repeatedly to return to the main menu screen.

9.4 Creating a Site List

The site list option allows you to define file and site descriptions in the office or laboratory before moving to field logging studies. This is usually more convenient than entering the information at the site and is particularly valuable if you are visiting certain sites on a regular basis. The following section describes how to set up site lists which contain entries designated "Site Descriptions" that will be instantly available to the user in the field to facilitate the logging of data with pre-established naming of files and sites. There are two kinds of **Site Descriptions** available for use in Site lists:

• **Site Descriptions** associated with applications where data from a single site is always logged to a single file. This type is referred to as a "Single-Site Description" and is characterized by two parameters – a file name and a site name. Files logged to YSI 556 MPS memory under a **Single-Site Description** will be characterized primarily by the file name, but will also have the Site name attached, so that it is viewable in either the YSI 556 MPS **File directory** or in EcoWatch for Windows after upload to a PC

• **Site Descriptions** associated with applications where data from multiple sites are logged to a single file. This type is referred to as a "Multi-site Description" and is characterized by three parameters – a file name, a site name, and a site number. Files logged to YSI 556 MPS memory under a

Multi-site Description are characterized by a file name, but not a site name, since multiple sites are involved. However, each data point has a Site Number attached to it so that the user can easily determine the sampling site when viewing the data from the YSI 556 MPS **File** menu or processing the data in EcoWatch for Windows after upload to a PC.

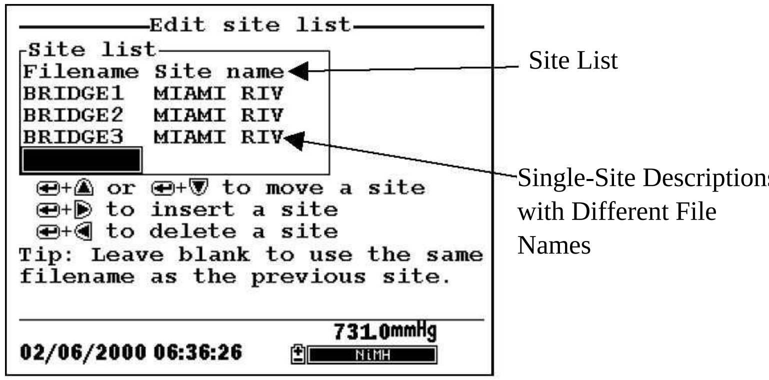


Figure 9.4 Single-Site Descriptions

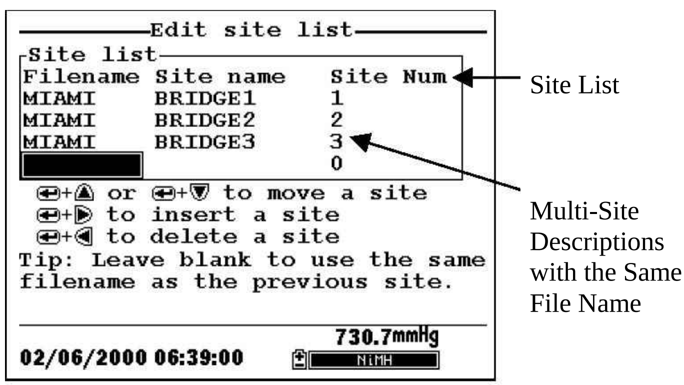


Figure 9.5 Multiple-Site Descriptions

NOTE: Site lists containing Single Site Descriptions are usually input with the designation **Store Site Number** INACTIVE in the YSI 556 MPS **Logging setup** menu. Thus, no site numbers appear in the first **Site list** example. Conversely, **Site lists** containing **Multi-Site Descriptions** MUST be input with the **Store Site Number** selection ACTIVE as shown in the second example.

To create a site list:

1. Go to the logging setup screen as described in Section *9.1 Accessing the Logging Setup Screen*.

2. Use the arrow keys to highlight the **Use site list** selection.

3. Press the **Enter** key. A check mark is entered in the box next to the use site list selection *and* two new entries appear on the logging setup screen. See Figure 9.6 Logging Setup Screen.

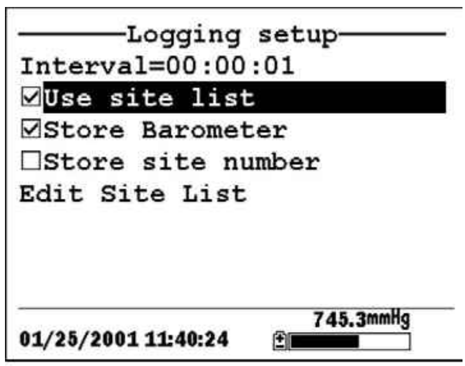


Figure 9.6 Logging Setup Screen

4. Use the arrow keys to highlight the **Store site number** selection.

5. If you are creating Multi-Site Descriptions (which require that the site **number** be stored in your data files), press the **Enter** key until a check mark appears in the box next to the store site number selection.

OR Press the **Enter** key until the box next to the store site number selection is empty, to create Single-Site Descriptions. The site **name** will be stored in the header of your data files.

6. Use the arrow keys to highlight the **Edit site list** selection.

7. Press the **Enter** key. The edit site list screen is displayed. See Figure 9.7 Edit Site List Screen. The **Filename** field is ready for input.

Figure 9.7 Edit Site List Screen

8. Use the keypad to enter a filename up to 8 characters in length. Refer to Section *2.9 Keypad Use*.

9. Press the **Enter** key. The cursor moves to the right for the entry of a **Site name**.

10. Use the keypad to enter a site name up to 11 characters in length. Refer to Section *2.9 Keypad Use*.

NOTE: If the store site number selection is *not* checked, skip to Step 13.

11. Press the **Enter** key. The cursor moves to the site number entry position.

12. Use the keypad to enter a site number up to 7 characters in length. Refer to Section *2.9 Keypad Use*.

13. Press **Enter**. The cursor moves to the next filename entry position.

14. Repeat Steps 8 to 13 until all filenames and sites have been entered.

15. Press **Escape** repeatedly to return to the main menu screen.

9.5 Editing a Site List

1. Go to the logging setup screen as described in Section *9.1 Accessing the Logging Setup Screen*.

2. Use the arrow keys to highlight the **Edit Site List** selection. See Figure 9.6 Logging Setup Screen.

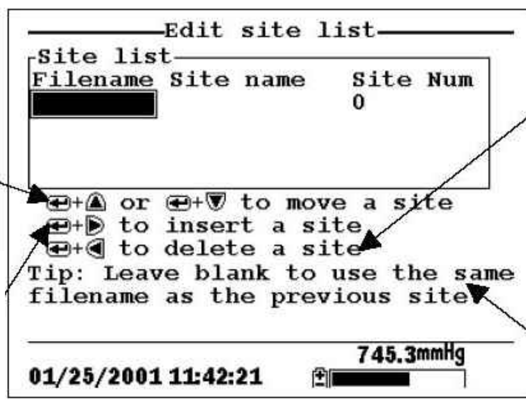
3. Press the **Enter** key. The edit site list screen is displayed.

4. Edit the site list using the keystrokes described below.

NOTE: Editing the site list will not have any effect on files stored in the instrument memory.

<u>To MOVE a site:</u>
Use the arrow keys to highlight a site. Press the Up or Down arrow key while holding down the Enter key.

<u>To INSERT a site above another site:</u>
Use the arrow keys to highlight the site. Press the Right arrow key while holding down the Enter key. Use keypad to input letters. Refer to Section 2.9 *Keypad Use.*



<u>To DELETE a site:</u>
Use the arrow keys to highlight a site. Press the Left arrow key while holding down the Enter key.

<u>To use the same file name as the previous site:</u> Leave the filename blank

Figure 9.1 Keystrokes for Editing Site List

9.6 Logging Data Without a Site List

1. Follow Steps 1 through 5 in Section 7.1 Real-Time Data.

2. Use the arrow keys to highlight the **Log one sample** selection on the run screen if only a single sample is being logged.

OR Use the arrow keys to highlight the **Start logging** selection on the run screen if a data stream is being logged.

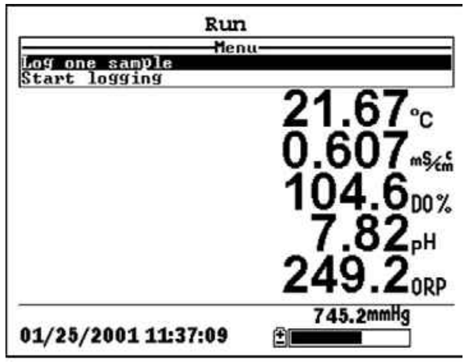


Figure 9.9 Run Screen

3. Press the **Enter** key. The Enter information screen is displayed.

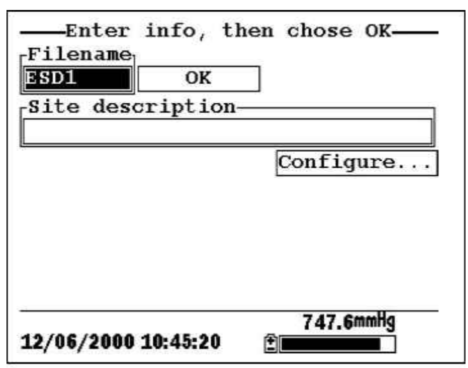


Figure 9.10 Enter Information Screen

NOTE: The last filename used will be displayed.

4. Use the keypad to enter a file name. Refer to Section *2.9 Keypad Use*.

   NOTE: The instrument will assign a default file name of NONAME if no file name is specified.

5. Press the **Enter** key to input the file name.

6. Use the arrow keys to highlight the **Site description** field in the enter information screen.

   NOTE: Entering a Site Description is optional. You may leave the Site Description blank and skip to Step 9.

7. Use the keypad to enter a site description name. Refer to Section *2.9 Keypad Use*.

8. Press the **Enter** key to input the site description.

   NOTE: If you want to change the logging setup, such as sampling interval or storing the barometer reading, use the arrow keys to highlight the **Configure** field, press the **Enter** key, then refer to Section *9.2 Setting Logging Interval* or *9.3 Storing Barometer Readings* for details.

9. Use the arrow keys to highlight the **OK** field in the center of the information screen.

10. Press the **Enter** key to start logging.

    NOTE: If the parameter mismatch screen is displayed, refer to Section *9.8 Adding Data to Existing Files*.

11. If a single point is being logged, the header on the run screen changes momentarily from **Menu** to **Sample logged** to confirm that the point was successfully logged. Skip to Step

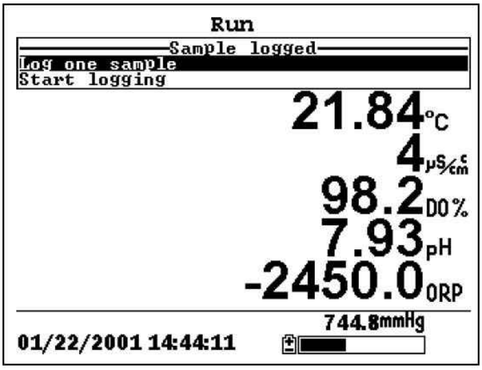


Figure 9.11 Sample Logged Screen

If a continuous stream of points is being logged, the start logging entry in the run screen changes from **Start logging** to **Stop logging**.

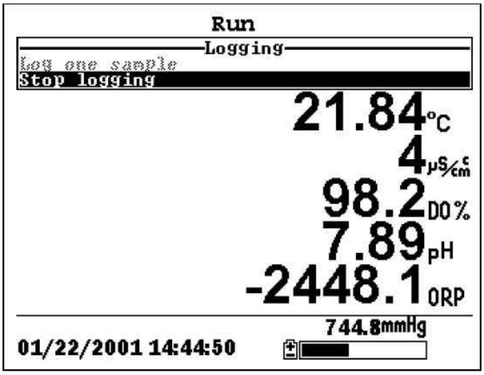


Figure 9.12 Logging Screen

12. At the end of the logging interval, press **Enter** to stop logging.

13. Refer to Section *8.3 View File* to view the data on the instrument display.

9.7 Logging Data with a Site List

1. If you have not already created a site list, refer to Section *9.4 Creating a Site List*.

2. Follow Steps 1 through 5 in Section 7.1 Real-Time Data.

3. Use the arrow keys to highlight the **Log one sample** selection on the run screen if only a single sample is being logged.

OR Use the arrow keys to highlight the **Start logging** selection on the run screen if a data stream is being logged. See Figure 9.9 Run Screen.

4. Press the **Enter** key. The Pick a site screen is displayed.

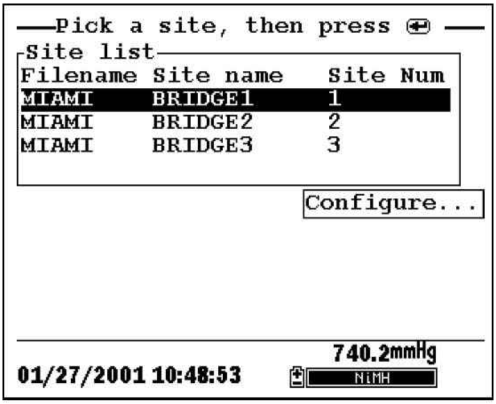


Figure 9.13 Pick a Site Screen

5. Use the arrow keys to highlight the **site** of your choice.

NOTE: If the site of your choice is grayed out in the site list, refer to Section *9.8 Adding Data to Existing Files*.

NOTE: Refer to Section *9.5 Editing a Site List* if you want to edit the site list.

6. Press the **Enter** key to start logging.

NOTE: If the parameter mismatch screen is displayed, refer to Section 9.8 Adding Data to Existing Files.

7. If a single point is being logged, the header on the run screen changes momentarily from **Menu** to **Sample logged** to confirm that the point was successfully logged. See Figure 9.11 Sample Logged Screen. Skip to Step 9.

If a continuous stream of points is being logged, the start logging entry in the run screen changes from **Start logging** to **Stop logging**. See Figure 9.12 Logging Screen.

8. At the end of the logging interval, press **Enter** to stop logging.

9. Refer to Section *8.3 View File* to view the data on the instrument display.

9.8 Adding Data to Existing Files

In order to add new data to an existing file, the current logging and sensor setup must be *exactly* the same as when the file was created. The following settings must be the same:

- **Sensors enabled** (refer to Section *4 Sensors*)
- **Store Barometer** (refer to Section *9.3 Storing Barometer Readings*)
- **Store Site Number** (refer to Section *9.4 Creating a Site List*)

If the current logging setup is not exactly the same as when the file was created, a parameter mismatch screen is displayed.

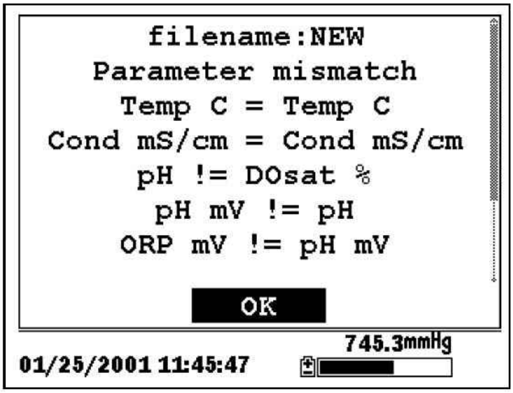


Figure 9.14 Parameter Mismatch Screen

NOTE: The right column shows parameters used when the file was created. The left column shows current parameters.

1. Press the **Down Arrow** key to scroll down and find the mismatch(es).

2. Use the following chart to resolve the mismatch(es).

Mismatch	**Action**	**Reference**
Sensor(s) missing from left column	Enable the missing sensor(s)	Section *4 Sensors*
Extra sensor(s) listed in left column	Disable the extra sensor(s)	Section *4 Sensors*
Barometer missing from left column, but present in right column	Enable the Store Barometer setting	Section *9.3 Storing Barometer Readings*
Barometer present in left column, but missing from right column	Disable the Store Barometer setting	Section *9.3 Storing Barometer Readings*
Store Site Number missing from left column, but present in right column	Enable the Store Site Number setting	Section *9.4 Creating a Site List*
Store Site Number present in left column, but missing from right column	Disable the Store Site Number setting	Section *9.4 Creating a Site List*

3. Return to Section *9.6 Logging Data without a Site List* or *9.7 Logging Data with a Site List*.

10. System Setup

The YSI 556 MPS has a number of features that are user-selectable or can be configured to meet the user's preferences. Most of these choices are found in the **System setup** menu.

10.1 Accessing the System Setup Screen

1. Press the **On/off** key to display the run screen. See Figure Front View of YSI 556 MPS.

2. Press the **Escape** key to display the main menu screen.

3. Use the arrow keys to highlight the **System setup** selection.

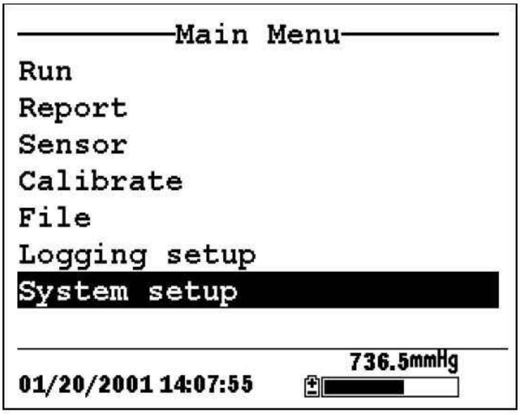


Figure 10.1 Main Menu

4. Press the **Enter** key. The system setup screen is displayed.

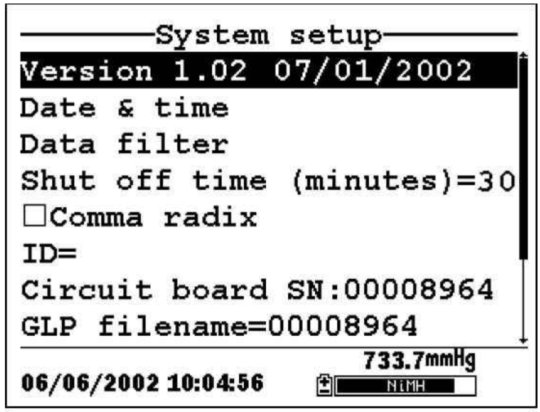


Figure 10.2 System Setup Screen

NOTE: The first line of the **System setup** menu shows the current software version of your YSI 556 MPS. As software enhancements are introduced, you will be able to upgrade your YSI 556 MPS from the YSI Web site. Refer to Section *11.2 Upgrading YSI 556 MPS* Software for details.

10.2 Language Setting

1. Go to the System Setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight **Language** on the System Setup screen. Press **Enter** to open the Language screen. .

3. Use the arrow keys to highlight your desired **Language**. Press **Enter**.

4. Press the Escape key repeatedly to return to the Main men

10.3 Date and Time Setup

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **Date & time** selection on the system setup screen. See Figure 10.2 System Setup Screen.

3. Press **Enter**. The date and time setup screen is displayed.

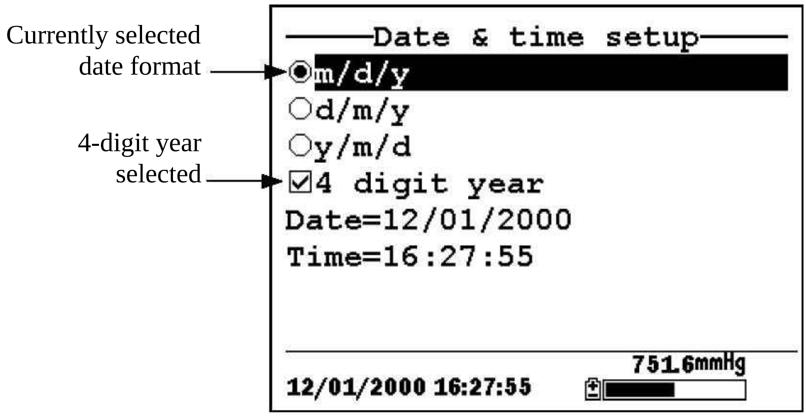


Figure 10.3 Date Setup Screen

NOTE: A black dot to the left of a date format indicates that format is selected.

4. Use the arrow keys to highlight your desired date format.

5. Press **Enter**.

6. Use the arrow keys to highlight the 4-digit year selection.

7. Press **Enter**. A check mark appears in the check box next to the 4-digit year selection.

NOTE: If unchecked, a 2-digit year is used.

8. Use the arrow keys to highlight the **Date** selection.

9. Press **Enter**. A cursor appears over the first number in the date.

10. Enter the proper number from the keypad for the highlighted date digit. The cursor moves automatically to the next date digit. Refer to Section *2.9 Keypad Use* for more keypad information.

11. Repeat Step 10 until all date digits are correct.

12. Press **Enter** to input the specified date.

13. Use the arrow keys to highlight the **Time** selection.

14. Press **Enter**. A cursor appears over the first number in the time selection.

15. Enter the proper number from the keypad for the highlighted time digit. The cursor moves automatically to the next time digit.

NOTE: Use military format when entering time. For example, 2:00 PM is entered as 14:00.

16. Repeat Step 15 until all time digits are correct.

17. Press **Enter** to input the correct time.

18. Press the **Escape** key repeatedly to return to the Main menu screen.

10.4 Data Filter

The Data Filter is a software filter that eliminates sensor noise and provides more stable readings.

NOTE: YSI recommends using the default values for the data filter for most field applications.

However, users who are primarily interested in a fast response from their dissolved oxygen sensor should consider a change of the default time constant setting of 8 seconds to one of 2 seconds. This change can be made according to the instructions in Section *10.3.1 Changing the Data Filter Settings* below. The disadvantage of lowering the time constant is that field pH readings may appear somewhat noisy if the cable is in motion.

10.4.1 Changing the Data Filter Settings

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **Data filter** selection. See Figure 10.1 Main Menu.

3. Press the **Enter** key. The Data filter setup screen is displayed.

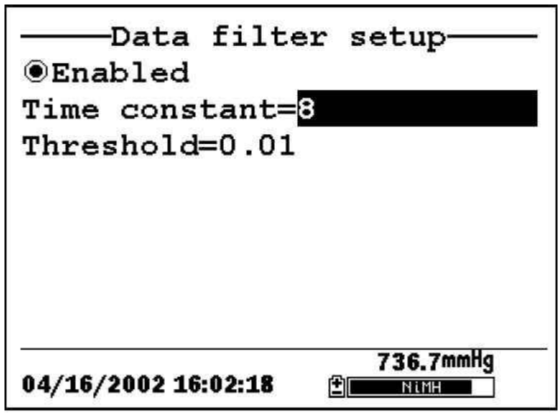


Figure 10.4 Data Filter Screen

4. With Enabled highlighted, press the **Enter** key to Enable or Disable the data filter. A black dot to the left of the selection indicates the data filter is enabled.

5. Use the arrow keys to highlight the **Time constant** field.

   NOTE: This value is the time constant in seconds for the software data filter. Increasing the time constant will result in greater filtering of the data, but will also slow down the apparent response of the sensors.

6. Use the keypad to enter a value. The default value is 8 and this value is ideal for most 556 field applications. As described in Section *10.3 Data Filter* above, users who wish to decrease the response time of the DO readings at the expense of some noise for the pH readings determined

concurrently, should change the Time Constant to a value of 2.

7. Press the **Enter** key to enter the time constant.

8. Use the arrow keys to highlight the **Threshold** field.

   NOTE: This value determines when the software data filter will engage/disengage, speeding the response to large changes in a reading. When the difference between two consecutive readings is larger than the threshold, then the reading is displayed unfiltered. When the difference between two consecutive readings drops below the threshold, readings will be filtered again.

9. Use the keypad to enter a value. The default value is 0.01.

10. Press the **Enter** key to enter the threshold.

11. Press the **Escape** key repeatedly to return to the Main menu screen.

10.5 Shutoff Time

The YSI 556 MPS shuts off automatically after 30 minutes of inactivity. The shut off time may be changed as described below.

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **Shutoff time** selection on the system setup screen. See Figure 10.2 System Setup Screen.

3. Use the keypad to enter a value from 0 to 60 minutes. The default value is 30.

   NOTE: To disable the automatic shutoff feature, enter a zero (0).

4. Press the **Enter** key to enter the correct shutoff time.

5. Press the **Escape** key repeatedly to return to the main menu screen.

10.6 Comma Radix

The user can toggle between a period (default) and comma for the radix mark by selecting this item and pressing the **Enter** key as follows:

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **Comma radix** selection on the system setup screen. See Figure 10.2 System Setup Screen.

3. Press the **Enter** key. A check mark appears in the check box next to the comma radix selection indicating that the radix mark is a comma.

10.7 ID

This selection allows you to enter an identification name/number for your YSI 556 MPS. This ID name/number is logged in the header of each file.

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **ID** selection. See Figure 10.1 Main Menu.

3. Use the keypad to enter an alphanumeric ID up to 15 characters in length. Refer to Section *2.9 Keypad Use*.

4. Press the **Enter** key to enter the ID.

5. Press the **Escape** key repeatedly to return to the main menu screen.

10.8 GLP Filename

This selection allows you to enter a different filename for the YSI 556 MPS Calibration Record file.

NOTE: The default filename is the “556 PC board Serial Number.glp.”

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **GLP Filename** selection. See Figure 10.1 Main Menu.

3. Use the keypad to enter a filename up to 8 characters in length. Refer to Section *2.9 Keypad Use*.

4. Press the **Enter** key to enter the new filename.

5. Press the **Escape** key repeatedly to return to the main menu screen.

10.9 TDS Constant

This selection allows you to set the constant used to calculate Total Dissolved Solids (TDS). TDS in g/L is calculated by multiplying this constant times the specific conductance in mS/cm.

10.9.1 Changing the TDS Constant

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **TDS Constant** selection. See Figure 10.1 Main Menu.

3. Use the keypad to enter a value. Refer to Section *2.9 Keypad Use*. The default value is 0.65.

4. Press the **Enter** key to enter the correct TDS constant.

5. Press the **Escape** key repeatedly to return to the main menu screen.

10.10 Barometer Units

The following information is only for instruments with the barometer option.

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **Barometer units** selection on the system setup screen. See Figure 10.2 System Setup Screen.

3. Press the **Enter** key. The Barometer units screen will appear.

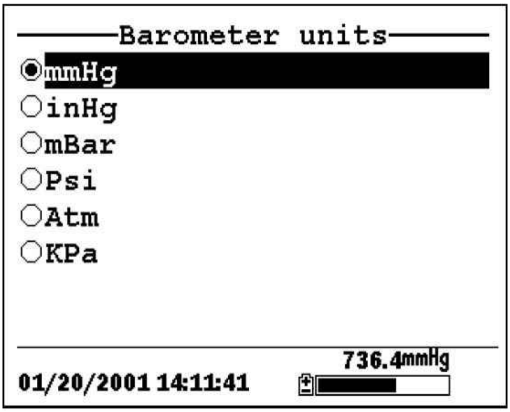


Figure 10.5 Data Filter Screen

A black dot indicates the currently selected units.

4. Use the arrow keys to highlight your desired barometric unit.

5. Press the **Enter** key to select your choice. A black dot will appear in the circle next to your selected units.

6. Press the **Escape** key repeatedly to return to the main menu screen.

10.11 Calibrate Barometer

The optional barometer has been factory calibrated to provide accurate readings. However, some sensor drift may occur over time, requiring occasional calibration by the user, as follows:

1. Determine your local barometric pressure from an independent laboratory barometer or from your local weather service.

2. If the barometric pressure (BP) reading is from your local weather station, reverse the equation that corrects it to sea level.

   NOTE: For this equation to be accurate, the barometric pressure units must be in mmHg.

   True BP = (Corrected BP) – [2.5 * (Local Altitude/100)]

3. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

4. Use the arrow keys to highlight the **Calibrate barometer** selection on the system setup screen. See Figure 10.2 System Setup Screen.

5. Press the **Enter** key. The Calibrate Barometer screen is displayed.

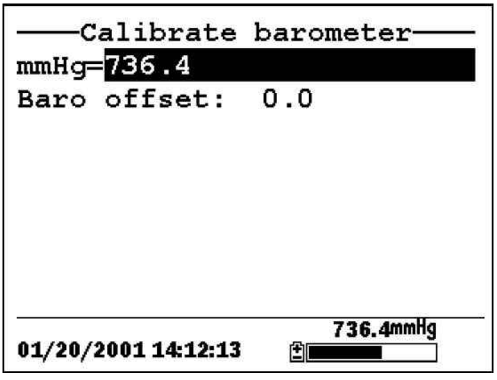


Figure 10.6 Barometer Calibration Screen

6. Use the keypad to input the known barometric pressure value as determined in Step 2.

7. Press the **Enter** key. The new barometer reading is displayed as well as the approximate offset from the factory reading.

NOTE: To return the sensor to the factory setting, subtract the offset amount from the current setting and repeat Steps 5 to 7.

8. Press the **Escape** key repeatedly to return to the main menu screen.

11. Maintenance

11.1 Sensor Care and Maintenance

Once the sensors have been properly installed, remember that periodic cleaning and DO membrane changes are required.

11.1.1 DO Sensor

For best results, we recommend that the KCl solution and the membrane cap be changed at least once every 30 days.

1. It is important to recognize that oxygen dissolved in the sample is consumed during sensor operation. It is therefore essential that the sample be continuously stirred at the sensor tip. If stagnation occurs, your readings will be artificially low. Stirring may be accomplished by mechanically moving the sample around the sensor tip, or by rapidly moving the sensor through the sample. The rate of stirring should be at least 1 foot per second.

2. Membrane life depends on usage. Membranes will last a long time if installed properly and treated with care. Erratic readings are a result of loose, wrinkled, damaged, or fouled membranes, or from large (more than 1/8" diameter) bubbles in the electrolyte reservoir. If erratic readings or evidence of membrane damage occurs, you should replace the membrane and the electrolyte solution. The average replacement interval is two to four weeks.

3. If the membrane is coated with oxygen consuming (e.g. bacteria) or oxygen producing organisms (e.g. algae), erroneous readings may occur.

4. Chlorine, sulfur dioxide, nitric oxide, and nitrous oxide can affect readings by behaving like oxygen at the sensor. If you suspect erroneous readings, it may be necessary to determine if these gases are the cause.

5. Avoid any environment that contains substances that may attack the probe module and sensor materials. Some of these substances are concentrated acids, caustics, and strong solvents. The sensor materials that come in contact

with the sample include FEP Teflon, acrylic plastic, EPR rubber, stainless steel, epoxy, polyetherimide and the PVC cable covering.

6. It is possible for the silver anode, which is the entire silver body of the sensor, to become contaminated. This will prevent successful calibration. To restore the anode, refer to Section *11.1.1 DO Sensor, Silver Anode Cleaning*.

7. For correct sensor operation, the gold cathode must always be bright. If it is tarnished (which can result from contact with certain gases), or plated with silver (which can result from extended use with a loose or wrinkled membrane), the gold surface must be restored. To restore the cathode, refer to Section *11.1.1 DO Sensor, Gold Cathode Cleaning.*

8. To keep the electrolyte from drying out, store the sensor in the transport/calibration cup with at least 1/8″ of water.

Silver Anode Cleaning

After extended use, a thick layer of AgCl builds up on the silver anode reducing the sensitivity of the sensor. The anode must be cleaned to remove this layer and restore proper performance. The cleaning can be chemical or mechanical:

Chemical Cleaning: Remove the membrane cap and soak the entire anode section in a 14% ammonium hydroxide solution for 2 to 3 minutes, followed by a thorough rinsing with distilled or deionized water. The anode should then be thoroughly wiped with a wet paper towel to remove the residual layer from the anode.

Mechanical Cleaning: Sand off the dark layer from the silver anode with 400 grit wet/dry sandpaper. Wrap the sandpaper around the anode and twist the sensor. Rinse the anode with clean water after sanding, followed by wiping thoroughly with a wet paper towel.

NOTE: After cleaning, a new membrane cap must be installed. Refer to Section *3.4.3 Membrane Cap Installation***.**

Turn the instrument on and allow the system to stabilize for at least 30 minutes. If, after several hours, you are still unable to calibrate, contact your dealer or YSI Customer Service. Refer to *Appendix E Customer Service*.

Gold Cathode Cleaning

For correct sensor operation, the gold cathode must be textured properly. It can become tarnished or plated with silver after extended use. The gold cathode can be cleaned by using the adhesive backed sanding disc and tool provided in the YSI 5238 Probe Reconditioning Kit.

Using the sanding paper provided in the YSI 5238 Probe Reconditioning Kit, wet sand the gold with a twisting motion about 3 times or until all silver deposits are removed and the gold appears to have a matte finish. Rinse the cathode with clean water after sanding, followed by wiping thoroughly with a wet paper towel. If the cathode remains tarnished, contact your dealer or YSI Customer Service. Refer to *Appendix E Customer Service*.

NOTE: After cleaning, a new membrane cap must be installed. Refer to Section *3.4.3 Membrane Cap Installation***.**

11.1.2 DO Sensor Replacement

1. Remove the probe sensor guard.

⚠ **CAUTION:** Thoroughly dry the sensor so that no water enters the probe module sensor port when the sensor is removed.

2. Insert the long end of the hex key wrench into the small hole in the side of the probe module bulkhead. Turn the wrench counterclockwise and remove the screw. (You do not have to remove the screw all the way to release the sensor.)

3. Pull the old DO sensor module straight out of the probe module body.

   NOTE: The DO sensor is not threaded, it is keyed, so it cannot be removed by twisting.

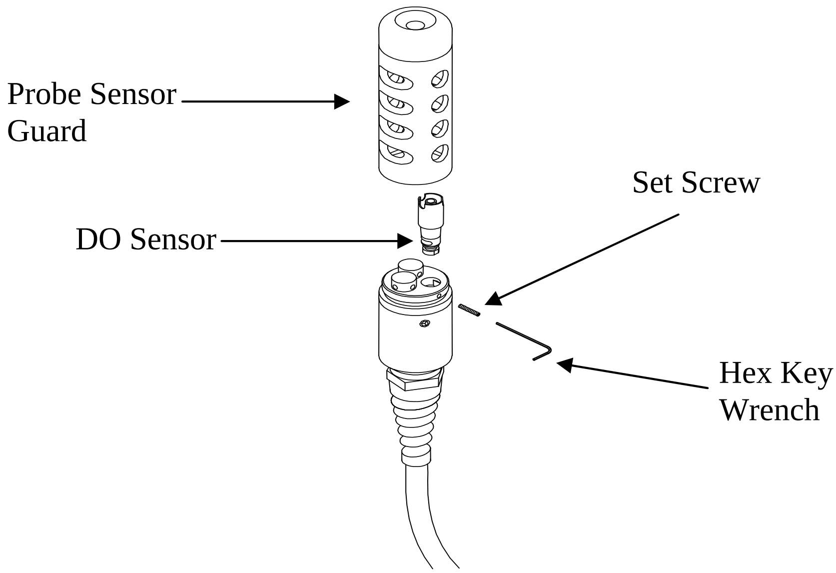


Figure 11.1 DO Sensor Replacement

4. Insert the new DO sensor module. Make sure that the inside of the probe module sensor port and the o-ring on the sensor are clean, with no contaminants, such as grease, dirt, or hair. The DO sensor is keyed, or has a flat side, so that it cannot be aligned improperly.

   NOTE: Make sure the DO sensor bottoms out before the set screw is inserted.

5. Insert the set screw into the small hole in the side of the probe module bulkhead, and turn clockwise to rethread.

⚠ **CAUTION**: Make sure that you do not cross-thread the set screw. Use the hex key wrench to tighten the screw in properly, making sure that the screw does not stick out of the side of the probe module bulkhead. The probe sensor guard will not thread on properly and damage may result if the screw is allowed to stick out.

NOTE: The YSI 5563 DO sensor is shipped dry. A shipping membrane was installed to protect the electrode. A new membrane cap must be installed before the first use. Refer to Section 3.4.1 Sensor Installation.

11.1.3 YSI 5564 pH and 5565 Combination pH/ORP Sensor Cleaning

Cleaning is required whenever deposits or contaminants appear on the glass and/or platinum surfaces of these sensors or when the response of the sensor becomes slow.

1. Remove the sensor from the probe module.

2. Initially, simply use clean water and a soft clean cloth, lens cleaning tissue, or cotton swab to remove all foreign material from the glass bulb (YSI 5564 and YSI 5565) and platinum button (YSI 5565). Then use a moistened cotton swab to carefully remove any material that may be blocking the reference electrode junction of the sensor.

⚠ **CAUTION:** When using a cotton swab with the YSI 5564 or YSI 5565, be careful NOT to wedge the swab tip between the guard and the glass sensor. If necessary, remove cotton from the swab tip, so that the cotton can reach all parts of the sensor tip without stress.

NOTE: If good pH and/or ORP response is not restored by the above procedure, perform the following additional procedure:

1. Soak the sensor for 10-15 minutes in clean water containing a few drops of commercial dishwashing liquid.

2. GENTLY clean the glass bulb and platinum button by rubbing with a cotton swab soaked in the cleaning solution.

3. Rinse the sensor in clean water, wipe with a cotton swab saturated with clean water, and then re-rinse with clean water.

   NOTE: If good pH and/or ORP response is still not restored by the above procedure, perform the following additional procedure:

1. Soak the sensor for 30-60 minutes in one molar (1 M) hydrochloric acid (HCl). This reagent can be purchased from most distributors. Be sure to follow the safety instructions included with the acid.

2. GENTLY clean the glass bulb and platinum button by rubbing with a cotton swab soaked in the acid.

3. Rinse the sensor in clean water, wipe with a cotton swab saturated with clean water, and then re-rinse with clean water. To be certain that all traces of the acid are removed from the sensor crevices, soak the sensor in clean water for about an hour with occasional stirring.

NOTE: If biological contamination of the reference junction is suspected or if good response is not restored by the above procedures, perform the following additional cleaning step:

1. Soak the sensor for approximately 1 hour in a 1 to 1 dilution of commercially available chlorine bleach.

2. Rinse the sensor with clean water and then soak for at least 1 hour in clean water with occasional stirring to remove residual bleach from the junction. (If possible, soak the sensor for period of time longer than 1 hour in order to be certain that all traces of chlorine bleach are removed.) Then re-rinse the sensor with clean water and retest.`

11.1.4 Temperature/Conductivity Sensor Cleaning

The single most important requirement for accurate and reproducible results in conductivity measurement is a clean cell. A dirty cell will change the conductivity of a solution by contaminating it. The small cleaning brush included in the YSI 5511 Maintenance Kit is ideal for this purpose.

To clean the conductivity cell:

1. Dip the brush in clean water and insert it into each hole 1520 times.

2. Rinse the cell thoroughly in deionized or clean tap water.

NOTE: In the event that deposits have formed on the electrodes, perform the following additional procedure:

1. Use a mild detergent solution in combination with the brush. Dip the brush in the solution and insert it into each hole 1520 times.

2. Rinse the cell thoroughly in deionized or clean tap water.

NOTE: After cleaning, check the response and accuracy of the conductivity cell with a calibration standard.

NOTE: If this procedure is unsuccessful, or if sensor performance is impaired, it may be necessary to return the sensor to a YSI authorized service center for service, Refer to *Appendix E Customer Service*.

The temperature portion of the sensor requires no maintenance.

11.2 Upgrading YSI 556 MPS Software

1. Access the YSI Environmental Software Downloads page as described in *Appendix G EcoWatch* Step 1 through 3.

2. Click on the **YSI Instruments Software Updates** link (or scroll down until you see YSI 556 MPS).

3. Click on the file icon to the right of the **YSI 556 MPS** listing and save the file to a temporary directory on your computer.

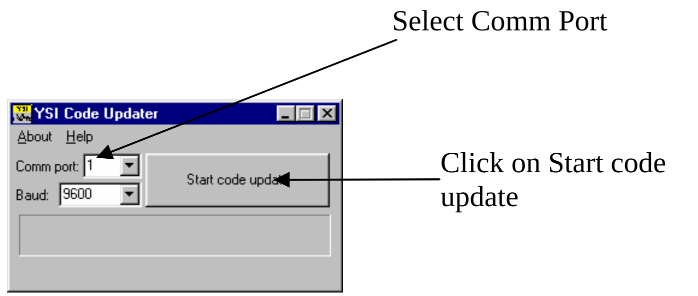
4. After the download is complete, run the file (that you just downloaded) and follow the on screen instructions to install the YSI Code Updater on your computer. If you encounter difficulties, contact YSI customer service for advice. Refer to *Appendix E Customer Service*.

5. If necessary, disconnect the YSI 5563 Probe Module from the YSI 556 MPS instrument.

6. Connect the YSI 556 MPS to a serial port of your computer via the 655173 PC interface cable. See Figure 8.6 Computer/Instrument Interface.

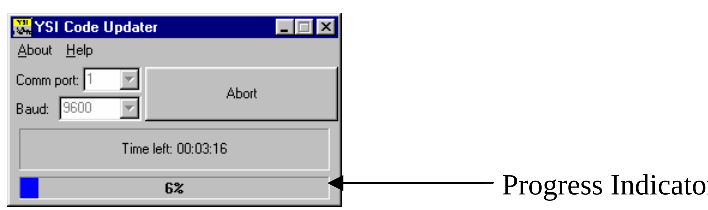
7. Press the **On/off** key on the YSI 556 MPS to display the run screen.

8. Run the YSI Code Updater software that you just installed on your computer. The following window will be displayed:

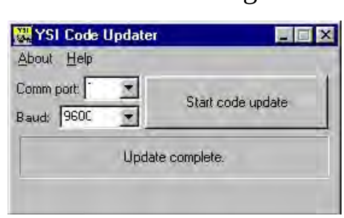


9. Set the Comm port number to match the port that you connected the 655173 PC Interface Cable to, then click on the Start Code Update button.

The YSI 556 MPS screen will blank out and a progress indicator will be displayed on the PC.



When the update is finished (indicated on the PC screen), the YSI 556 MPS will return to the Run screen. See Figure 7.1 Run Screen.



10. Close the YSI Code Updater window (on the PC) by clicking on the "X" in the upper right corner of the window.

11. Disconnect the YSI 556 MPS from the 655173 PC interface cable and reconnect it to the YSI 5563 Probe Module. Refer to Section *3.6 Instrument/Cable Connection*.

12. Storage

Proper storage between periods of usage will not only extend the life of the sensors, but will also ensure that the unit will be ready to use as quickly as possible in your next application.

12.1 General Recommendations for Short Term Storage

No matter what sensors are installed in the instrument, it is important to keep them moist without actually immersing them in liquid. Immersing them could cause some of them to drift or result in a shorter lifetime.

YSI recommends that short term storage of all multi-parameter instruments be done by placing approximately 1/2 inch of tap water in the transport/calibration cup that was supplied with the instrument, and by placing the probe module with all of the sensors installed into the cup. The use of a moist sponge instead of a 1/2 inch of tap water is also acceptable, as long as its presence does not compromise the attachment of the cup to the probe module. The transport/calibration cup should be sealed to prevent evaporation.

NOTE: Ensure that an o-ring is installed in the o-ring groove on the threaded end of the probe module body. See Figure 3.7 Transport/Calibration Cup Installation.

⚠ **CAUTION**: The water level has to be low enough so that none of the sensors are actually under water. Check the transport/calibration cup periodically to make certain that the water is still present or the sponge is still moist.

NOTE: If the storage water (tap water) is accidentally lost during field use, environmental water can be used.

12.2 General Recommendations for Long Term Storage

12.2.1 Probe Module Storage

1. Remove the pH or pH/ORP sensor from the probe module and store according to the individual sensor storage instructions found in Section *12.2.2 Sensor Storage*.

2. Seal the empty port with the provided port plug.

   NOTE: Leave the conductivity/temperature sensor and dissolved oxygen sensor, with membrane cap still on, in the probe module.

3. Place 1/2″ of water, deionized, distilled or tap, in the transport/calibration cup.

⚠ **CAUTION:** The water level has to be low enough so that none of the sensors are actually under water. Check the transport/calibration cup periodically to make certain that the water is still present or the sponge is still moist.

4. Insert the probe module into the cup.

   NOTE: Ensure that an o-ring is installed in the o-ring groove on the threaded end of the probe module body. See Figure 3.7 Transport/Calibration Cup Installation.

12.2.2 Sensor Storage

Temperature/Conductivity Sensor

No special precautions are required. Sensor can be stored dry or wet, as long as solutions in contact with the thermistor and conductivity electrodes are not corrosive (for example, chlorine bleach). However, it is recommended that the sensor be cleaned with the provided brush prior to long term storage. Refer to Section *11.1.4 Temperature/Conductivity Sensor Cleaning*.

pH and Combination pH/ORP Sensor

The key to sensor storage is to make certain that the reference electrode junction does not dry out. Junctions which have been allowed to dry out due to improper storage procedures can usually be rehydrated by soaking the sensor for several hours (overnight is recommended) in a solution which is 2 molar in potassium chloride. If potassium chloride solution is not available, soaking the sensor in tap water or commercial pH buffers may restore sensor function. However in some cases the sensor may have been irreparably damaged by the dehydration and will require replacement.

⚠ **CAUTION:** Do not store the sensor in distilled or deionized water as the glass sensor may be damaged by exposure to this medium.

1. Remove the pH or pH/ORP sensor from the probe module.

2. Seal the empty port with the provided port plug.

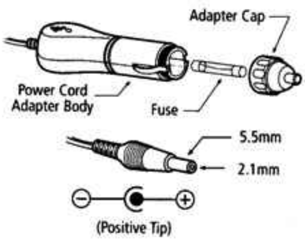
3. Place the sensor in the storage vessel (plastic boot or bottle) which was on the sensor at delivery. The vessel should contain a solution which is 2 molar in potassium chloride.

   NOTE: Make certain that the vessel is sealed to prevent evaporation of the storage solution.

13. Troubleshooting

The following sections describe problems you may encounter when using the YSI 556 MPS and provides suggestions to overcome the symptom.

PROBLEM	POSSIBLE SOLUTION
Display Problems	
No display is visible after pressing the on/off key.	If C cells are used, make certain that they are installed properly with regard to polarity and that good batteries are used. If a rechargeable battery pack is used, place the pack in the instrument and charge for 30 minutes.
Instrument software appears to be locked up as evidenced by no response to keypad entries or display not changing.	First, attempt to reset the instrument by simply turning off and then on again. If this fails, remove battery power from the instrument for 30 seconds and then reapply power. When using C cells, remove the battery lid and one of the batteries; when using the rechargeable battery pack, remove the pack completely from the instrument. After 30 seconds replace the battery or battery pack and check for instrument function.
The 556 display flashes and the instrument speaker makes a continuous clicking sound.	The battery voltage is low. Change to new C cells or recharge the 6117 battery pack.
Water Damage to Instrument	
Leakage detected in battery compartment when using C cells.	Dispose of batteries properly. Dry the battery compartment using compressed air if possible. If corrosion is present on battery terminals, contact YSI Customer Service.
Water has contacted rechargeable battery pack.	Remove battery pack immediately. Send battery pack to YSI Product Service for evaluation. **CAUTION**: DO NOT REUSE BATTERY PACK UNTIL YSI PRODUCT SERVICE HAS EVALUATED IT.
Leakage suspected into the main cavity of the instrument case.	Remove the batteries immediately. Return the instrument to YSI Product Service.

<table>
<tr><th>PROBLEM</th><th>POSSIBLE SOLUTIONS</th></tr>
<tr><td colspan="2">Optional Cigarette Lighten Charger</td></tr>
<tr><td>Power cord fuse blown.

</td><td>1. Unscrew adapter’s cap, remove tip and pull out fuse.
2. Replace fuse with a new 2-amp fast-blow fuse from an electronics store such as Radio Shack.
3. Reassemble the adapter and securely screw the cap back onto the adapter body.</td></tr>
<tr><td colspan="2">File Problems</td></tr>
<tr><td>Upload of files from YSI 556 MPS to PC fails</td><td>1. Make sure that cable is connected properly to both 556 and PC.
2. Make certain that the proper Comm port is selected in EcoWatch for Windows.</td></tr>
<tr><td>Barometer data is not stored with sensor data file.</td><td>Make sure Store barometer is active in the 556 Logging setup menu.</td></tr>
<tr><td>Site Descriptions in the Site List are “grayed-out” and not available for appending files with additional data.</td><td>There is a parameter mismatch between the current 556 setup and that initially used. Change the current logging and sensor setup to match the setup that was initially used to create the file.</td></tr>
<tr><td colspan="2">Sensor Problems</td></tr>
<tr><td rowspan="9">Dissolved Oxygen reading is unstable or inaccurate. Out of Range message appears during calibration.</td><td>Sensor not properly calibrated. Follow DO cal procedures.</td></tr>
<tr><td>Membrane not properly installed or may be punctured. Replace membrane cap.</td></tr>
<tr><td>DO sensor electrodes require cleaning. Follow DO cleaning procedure. Use 5511 Maintenance kit.</td></tr>
<tr><td>Water in sensor connector. Dry connector; reinstall sensor.</td></tr>
<tr><td>Algae or other contaminant clinging to DO sensor. Rinse DO sensor with clean water.</td></tr>
<tr><td>Barometric pressure entry is incorrect. Repeat DO cal procedure.</td></tr>
<tr><td>Calibrated at extreme temperature. Recalibrate at (or near) sample temperature.</td></tr>
<tr><td>DO sensor has been damaged. Replace sensor.</td></tr>
<tr><td>Internal failure. Return probe module for service.</td></tr>
</table>

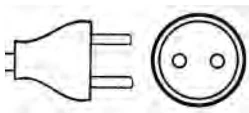
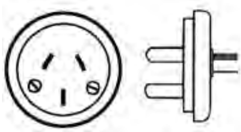
PROBLEM	POSSIBLE SOLUTIONS
Sensor Problems	
pH or ORP readings are unstable or inaccurate. Out of Range message appears during calibration.	Sensor requires cleaning. Follow sensor cleaning procedure.
	Sensor requires calibration. Follow cal procedures.
	pH sensor reference junction has dried out from improper storage. Soak sensor in tap water or buffer 4 until readings become stable.
	Water in sensor connector. Dry connector; reinstall sensor.
	Sensor has been damaged. Replace sensor.
	Calibration solutions out of spec or contaminated with other solution. Use new calibration solutions
	ORP fails Zobell check. Take into account temperature dependence of Zobell solution readings.
	Internal failure. Return probe module for service.
Conductivity unstable or inaccurate. Out of Range message appears during calibration	Conductivity improperly calibrated. Follow calibration procedure.
	Conductivity sensor requires cleaning. Follow cleaning procedure.
	Conductivity sensor damaged. Replace sensor.
	Calibration solution out of spec or contaminated. Use new calibration solution.
	Internal failure. Return probe module for service.
	Calibration solution or sample does not cover entire sensor. Immerse sensor fully.
Temperature, unstable or inaccurate	Water in connector. Dry connector; reinstall sensor.
	Sensor has been damaged. Replace the 5560 sensor.
Installed sensor has no reading	The sensor has been disabled. Enable sensor.
	Water in sensor connector. Dry connector; reinstall sensor.
	Sensor has been damaged. Replace sensor.
	Report output improperly set up. Set up report output.
	Internal failure. Return probe module for service.

If these guidelines and tips fail to correct your problem or if any other symptoms occur, contact YSI Customer Service for Advice. Refer to *Appendix E Customer Service*.

14. Appendix A YSI 556 MPS Specifications

For the most recent product specifications, please visit the YSI website: www.ysi.com

15. Appendix B Instrument Accessories

ITEM #	ACCESSORY
5563-4	4m Cable with DO/temp/conductivity
5563-10	10m Cable with DO/temp/conductivity
5563-20	20m Cable with DO/temp/conductivity
5564	pH Kit
5565	pH/ORP Kit
6118	Rechargeable Battery Pack Kit for use in US
5094	Rechargeable Battery Pack Kit with universal charger and three adapter cables for use in international applications   
5095	Rechargeable Battery Pack Kit with universal charger and two adapter cables for use in international applications  
5083	Flow Cell – probe module is secured in the flow cell and groundwater is pumped through it. Displaced volume approx. 475 ml
3059	Flow Cell, low volume. Displaced volume approx. 200 ml
116505	Battery Lid
616	Charger, Cigarette Lighter – used to power up the instrument from a car's cigarette lighter
4654	Tripod
614	Ultra Clamp, C Clamp –used to clamp the instrument to a table top or car dashboard
6081	Large Carrying Case, Hard-sided
5085	Hands-free Harness
5065	Carrying Case, Form-fitted, for use in the field – has a clear vinyl window, shoulder strap, belt loop strap and hand strap

16. Appendix C Required Federal Communications Notice

The Federal Communications Commission defines this product as a computing device and requires the following notice.

This equipment generates and uses radio frequency energy and if not installed and used properly, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class A or Class B computing device in accordance with the specification in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause 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 the receiving antenna
- Relocate the computer with respect to the receiver
- Move the computer away from the receiver
- Plug the computer into a different outlet so that the computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet, prepared by the Federal Communications Commission, helpful: "How to Identify and Resolve Radio-TV Interference Problems". This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No.0004-000-00345-4.

17. Appendix D Health Safety

YSI Conductivity Solutions: 3161, 3163, 3165, 3167, 3168, 3169

INGREDIENTS:
- Iodine
- Potassium Chloride
- Water

WARNING: INHALATION MAY BE FATAL

⚠ ***CAUTION:*** **AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR INGESTION. MAY EVOLVE TOXIC FUMES IN FIRE.**

Harmful if ingested or inhaled. Skin or eye contact may cause irritation. Has a corrosive effect on the gastro-intestinal tract, causing abdominal pain, vomiting, and diarrhea. Hyper-sensitivity may cause conjunctivitis, bronchitis, skin rashes etc. Evidence of reproductive effects.

FIRST AID:
INHALATION: Remove victim from exposure area. Keep warm and rest. In severe cases seek medical attention.
SKIN CONTACT: Remove contaminated cloth immediately. Wash affected area thoroughly with large amounts of water. In severe cases seek medical attention.
EYE CONTACT: Wash eyes immediately with large amounts of water, (approx. 10 minutes). Seek medical attention immediately.
INGESTION: Wash out mouth thoroughly with large amounts of water. Seek medical attention immediately.

YSI pH 4.00, 7.00, y 10.00: 3821, 3822, 3823

pH 4 INGREDIENTS:

- o Potassium Hydrogen Phthalate
- o Formaldehyde
- o Water

pH 7 INGREDIENTS:

- o Sodium Phosphate, Dibasic
- o Potassium Phosphate, Monobasic
- o Water

pH 10 INGREDIENTS:

- o Potassium Borate, Tetra
- o Potassium Carbonate
- o Potassium Hydroxide
- o Sodium (di) Ethylenediamine Tetraacetate
- o Water

⚠ **CAUTION -AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR INGESTION. MAY AFFECT MUCOUS MEMBRANES.**

Inhalation may cause severe irritation and be harmful. Skin contact may cause irritation; prolonged or repeated exposure may cause Dermatitis. Eye contact may cause irritation or conjunctivitis. Ingestion may cause nausea, vomiting and diarrhea.

FIRST AID:
INHALATION – Remove victim from exposure area to fresh air immediately. If breathing has stopped, give artificial respiration. Keep victim warm and at rest. Seek medical attention immediately.
SKIN CONTACT – Remove contaminated clothing immediately. Wash affected area with soap or mild detergent and large amounts of water (approx. 15-20 minutes). Seek medical attention immediately.
EYE CONTACT - Wash eyes immediately with large amounts of water (approx. 15-20 minutes), occasionally lifting upper and lower lids. Seek medical attention immediately.

INGESTION – If victim is conscious, immediately give 2 to 4 glasses of water and induce vomiting by touching finger to back of throat. Seek medical attention immediately.

YSI Zobell Solution: 3682

INGREDIENTS:

- Potassium Chloride
- Potassium Ferrocyanide Trihydrate
- Potassium Ferricyanide

⚠ **CAUTION -AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR INGESTION. MAY AFFECT MUCOUS MEMBRANES.**

May be harmful by inhalation, ingestion, or skin absorption. Causes eye and skin irritation. Material is irritating to mucous membranes and upper respiratory tract. The chemical, physical, and toxicological properties have not been thoroughly investigated.

Ingestion of large quantities can cause weakness, gastrointestinal irritation and circulatory disturbances.

FIRST AID:
INHALATION – Remove victim from exposure area to fresh air immediately. If breathing has stopped, give artificial respiration. Keep victim warm and at rest. Seek medical attention immediately.
SKIN CONTACT – Remove contaminated clothing immediately. Wash affected area with soap or mild detergent and large amounts of water (approx. 15-20 minutes). Seek medical attention immediately.
EYE CONTACT - Wash eyes immediately with large amounts of water (approx. 15-20 minutes), occasionally lifting upper and lower lids. Seek medical attention immediately.
INGESTION – If victim is conscious, immediately give 2 to 4 glasses of water and induce vomiting by touching finger to back of throat. Seek medical attention immediately.

18. Appendix E Customer Service

18.1 Ordering and Technical Support

Telephone:	800 897 4151 (US)
	+1 937 767 7241 (Globally)
	Monday through Friday, 8:00 AM to 5:00 ET
Fax:	+1 937 767 9353 (orders)
	+1 937 767 1058 (technical support)
Email:	environmental@ysi.com or proseries@ysi.com
Mail:	YSI Incorporated
	1725 Brannum Lane
	Yellow Springs, OH 45387 USA
Website:	www.ysi.com

18.2 YSI Authorized Service Centers

YSI has authorized service centers throughout the United States and Internationally. For the nearest service center information, please visit www.ysi.com and click 'Support' or contact YSI Technical Support directly at 800-897-4151.

When returning a product for service, include the Product Return form with cleaning certification. The form must be completely filled out for a YSI Service Center to accept the instrument for service. The form may be downloaded from www.ysi.com by clicking on the 'Support" tab, then the Product Return Form button.

18.3 Cleaning Instructions

Equipment exposed to biological, radioactive, or toxic materials must be cleaned and disinfected before being serviced. Biological contamination is presumed for any instrument, probe, or other device that has been used with body fluids or tissues, or with wastewater. Radioactive contamination is presumed for any instrument, probe or other device that has been used near any radioactive source.

If an instrument, probe, or other part is returned or presented for service without a Cleaning Certificate, and if in our opinion it represents a potential biological or radioactive hazard, our service personnel reserve the right to withhold service until appropriate cleaning, decontamination, and certification has been completed. We will contact the sender for instructions as to the disposition of the equipment. Disposition costs will be the responsibility of the sender.

When service is required, either at the user's facility or at a YSI Service Center, the following steps must be taken to ensure the safety of service personnel.

- In a manner appropriate to each device, decontaminate all exposed surfaces, including any containers. 70% isopropyl alcohol or a solution of 1/4-cup bleach to 1-gallon tap water is suitable for most disinfecting. Instruments used with wastewater may be disinfected with .5% Lysol if this is more convenient to the user.
- The user shall take normal precautions to prevent radioactive contamination and must use appropriate decontamination procedures should exposure occur.
- If exposure has occurred, the customer must certify that decontamination has been accomplished and that no radioactivity is detectable by survey equipment.
- Any product being returned to the YSI Repair Center should be packed securely to prevent damage.
- Cleaning must be completed and certified on any product before returning it to YSI.

18.4 Packing Procedure

- Clean and decontaminate items to ensure the safety of the handler.
- Complete and include the Cleaning Certificate.
- Place the product in a plastic bag to keep out dirt and packing material.
- Use a large carton, preferably the original, and surround the product completely with packing material.
- Insure for the replacement value of the product.

18.5 Warranty

The instrument is warranted for three years against defects in workmanship and materials when used for its intended purposes and maintained according to instructions. The probe module and cables are warranted for one year. The dissolved oxygen, temperature/conductivity, pH, and pH/ORP combination sensors are warranted for one year. Damage due to accidents, misuse, tampering, or failure to perform prescribed maintenance is not covered. The warranty period for chemicals and reagents is determined by the expiration date printed on their labels. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, write or call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

Limitation of Warranty

This Warranty does not apply to any YSI product damage or failure caused by (i) failure to install, operate or use the product in accordance with YSI's written instructions, (ii) abuse or misuse of the product, (iii) failure to maintain the product in accordance with YSI's written instructions or standard industry procedure, (iv) any improper repairs to the product, (v) use by you of defective or improper components or parts in servicing or repairing the product, or (vi) modification of the product in any way not expressly authorized by YSI.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI'S LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.

19. Appendix F Ferrite Bead Installation

⚠ **WARNING:** If you are using your YSI 556 in a European Community (CE) country or in Australia or New Zealand, you must attach a ferrite bead to the 655173 PC Interface Cable and the YSI 6117 Charger Adapter Cable in order to comply with the Residential, Commercial and Light Industrial Class B Limits for radio-frequency emissions specified in EN55011 (CISPR11) for Industrial, Scientific and Medical laboratory equipment. These ferrite assemblies are supplied as part of cable kits.

1. Make a small loop (approximately 5 cm in diameter) in the cable near the YSI 556 MS-19 connector.

2. Lay the open ferrite bead assembly under the loop with the cable cross-over position within the cylinder of the ferrite bead.

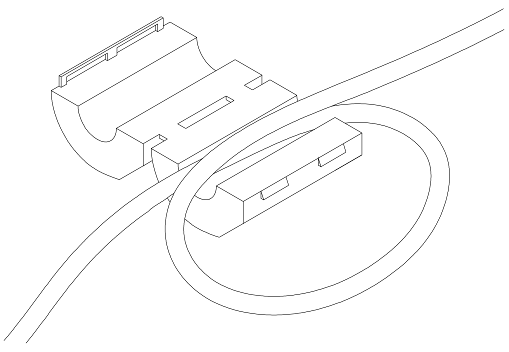


Figure 19.1 Ferrite Bead Installation

3. Snap the two pieces of the bead together making certain that the tabs lock securely.

4. When the installation is complete, the 655173 and 6117 cables should resemble the following drawings.

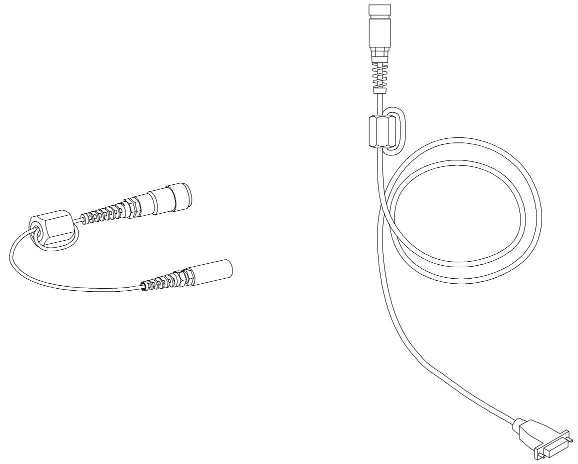


Figure 19.2 Cables with Ferrite Beads

20. Appendix G EcoWatch

EcoWatch™ for Windows™ must be used as the PC software interface to the YSI 556 MPS. EcoWatch is a powerful tool that can also be used with YSI 6-series sondes. Many features of the software will only be utilized by advanced users or are not relevant to the 556 MPS at all. This section is designed in tutorial format to familiarize you with the commonly used features of EcoWatch so that it will be possible to:

- Upload data from a 556 MPS to a PC
- Assemble plots and reports of your data
- Zoom in on certain segments of the plots of your data to facilitate analysis
- Show statistical data for your studies
- Export data in spreadsheet-compatible formats
- Print plots and reports

The advanced features of EcoWatch can be explored by downloading a 6-series manual from the YSI Web Site (www.ysi.com), purchasing a hard copy of the manual through YSI Customer Service (Item # 069300), or utilizing the on-line help feature of the software.

20.1 Installing EcoWatch for Windows

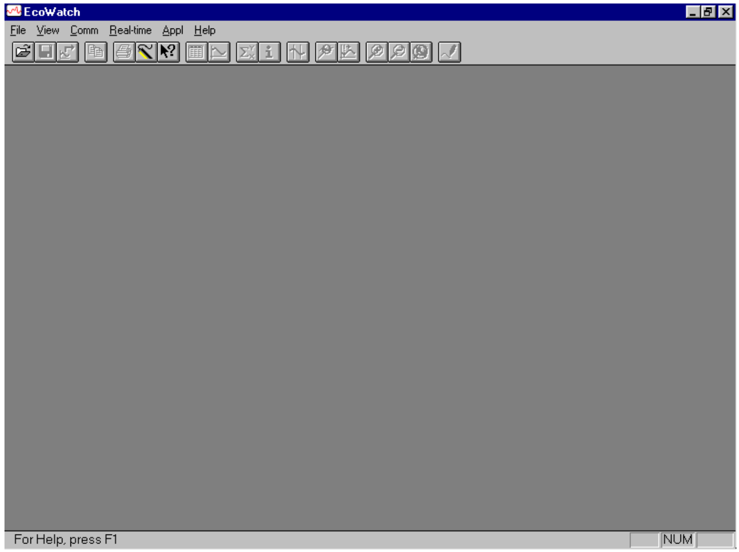
EcoWatch for Windows is available at no cost via a download from the YSI Web Site – www.ysi.com

20.2 EcoWatch Tutorial

This EcoWatch tutorial is designed to teach you the commonly used operations associated with the software when used with your 556 MPS.

After you have uploaded a file, Refer to Section 8.4 Upload to PC, you will see two files in the C:\ECOWWIN\DATA directory; the file you transferred and a file supplied by YSI designated SAMPLE.DAT. This SAMPLE.DAT file is referred to in the remainder of this tutorial section. After following the instructions below for the analysis of SAMPLE.DAT, you apply the same analysis to the data file which was uploaded from your 556 MPS to assure that you are familiar with the basic features and capabilities of EcoWatch for Windows.

To start the analysis of the SAMPLE.DAT file, note that a shortened menu bar is visible and many of the tools in the toolbar appear dimmed or "grayed out" before any file is opened (see below).

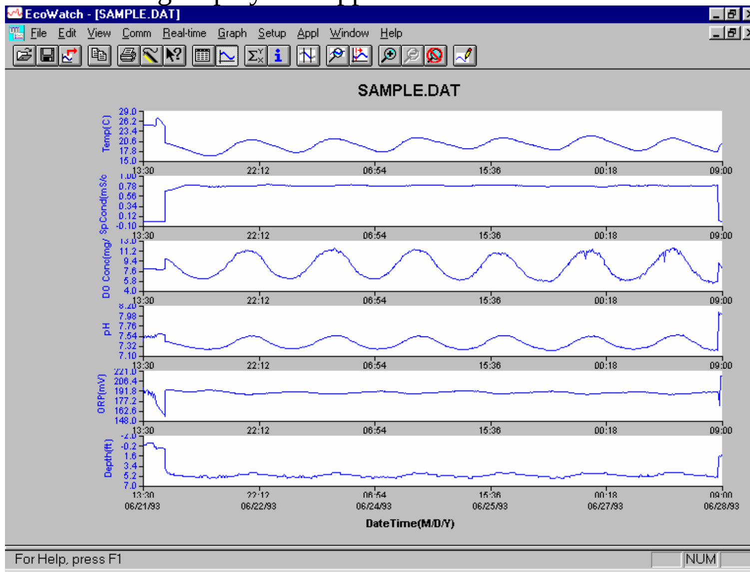


Full activation of EcoWatch features will be realized after a file is opened.

To open the sample data file:

1. Click the **File** menu  button in the toolbar.
2. Select the **SAMPLE.DAT** file.
3. Click **OK** to open the file.

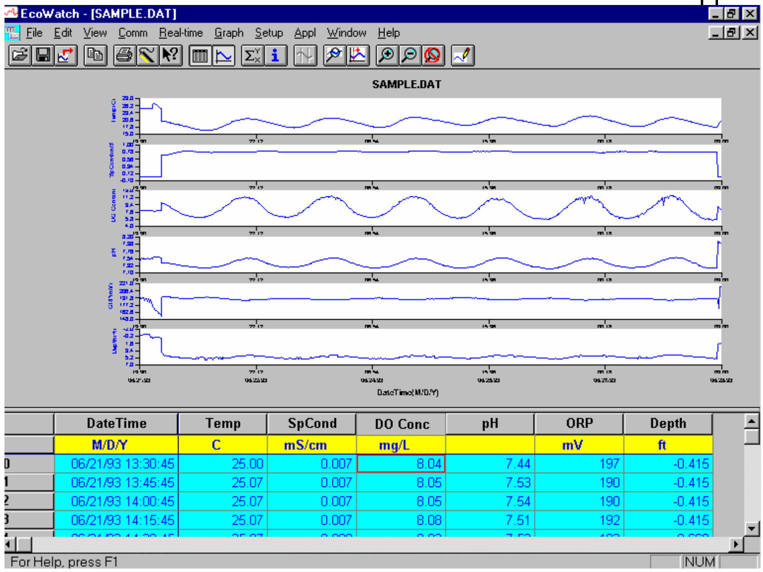
The following display will appear:



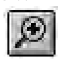
Note that the data in this file appears as a graph of temperature, specific conductance, dissolved oxygen, pH, ORP, and depth, all versus time. The graphs are scaled automatically so that all data fits comfortably on the computer screen. Note also that this data file was obtained with a 6-series sonde for which a depth sensor is available. Depth is NOT a current parameter for the 556 MPS.

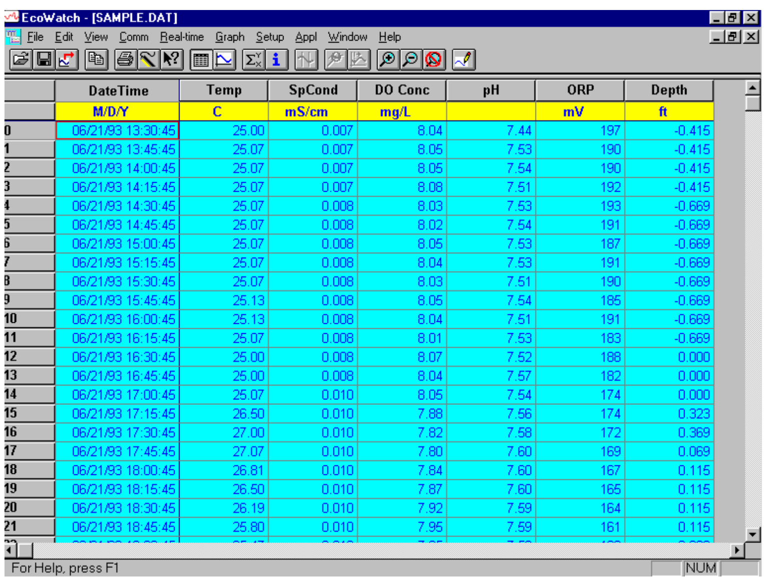
The **Table**  and **Graph**  buttons on the toolbar are on/off switches that are used to display or hide the graph and table pages respectively. When displaying a graph and a table at the same time, you can control the relative size of the two pages by placing the cursor over the small bar that separates them and

then dragging it to the desired location. Click the **Table**  button to generate the following dual display of data.

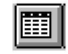
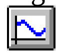


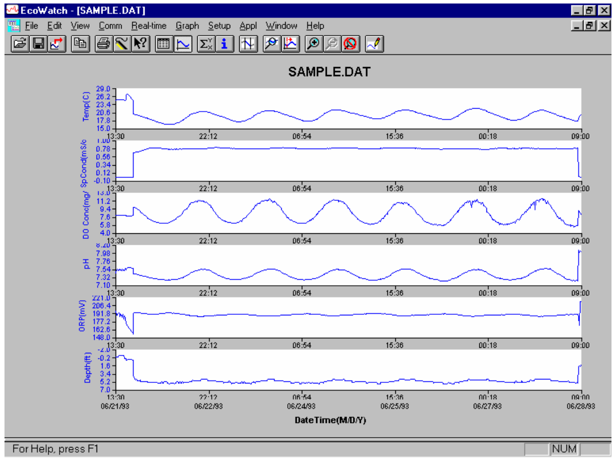
	DateTime	Temp	SpCond	DO Conc	pH	ORP	Depth
	M/D/Y	C	mS/cm	mg/L		mV	ft
0	06/21/93 13:30:45	25.00	0.007	8.04	7.44	197	-0.415
1	06/21/93 13:45:45	25.07	0.007	8.05	7.53	190	-0.415
2	06/21/93 14:00:45	25.07	0.007	8.05	7.54	190	-0.415
3	06/21/93 14:15:45	25.07	0.007	8.08	7.51	192	-0.415

Now click the **Graph**  button (turn it off) to display only a report of your data as shown below. Note that the size of the report can be varied by clicking on the  and  buttons in the Toolbar.

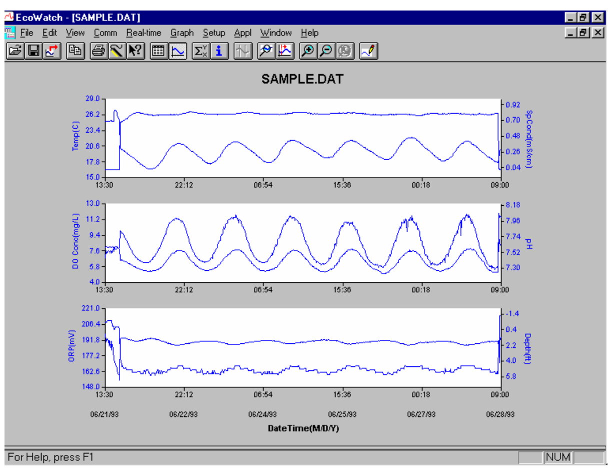


	DateTime	Temp	SpCond	DO Conc	pH	ORP	Depth
	M/D/Y	C	mS/cm	mg/L		mV	ft
0	06/21/93 13:30:45	25.00	0.007	8.04	7.44	197	-0.415
1	06/21/93 13:45:45	25.07	0.007	8.05	7.53	190	-0.415
2	06/21/93 14:00:45	25.07	0.007	8.05	7.54	190	-0.415
3	06/21/93 14:15:45	25.07	0.007	8.08	7.51	192	-0.415
4	06/21/93 14:30:45	25.07	0.008	8.03	7.53	193	-0.669
5	06/21/93 14:45:45	25.07	0.008	8.02	7.54	191	-0.669
6	06/21/93 15:00:45	25.07	0.008	8.05	7.53	187	-0.669
7	06/21/93 15:15:45	25.07	0.008	8.04	7.53	191	-0.669
8	06/21/93 15:30:45	25.07	0.008	8.03	7.51	190	-0.669
9	06/21/93 15:45:45	25.13	0.008	8.05	7.54	185	-0.669
10	06/21/93 16:00:45	25.13	0.008	8.04	7.51	191	-0.669
11	06/21/93 16:15:45	25.07	0.008	8.01	7.53	183	-0.669
12	06/21/93 16:30:45	25.00	0.008	8.07	7.52	188	0.000
13	06/21/93 16:45:45	25.00	0.008	8.04	7.57	182	0.000
14	06/21/93 17:00:45	25.07	0.010	8.05	7.54	174	0.000
15	06/21/93 17:15:45	26.50	0.010	7.88	7.56	174	0.323
16	06/21/93 17:30:45	27.00	0.010	7.82	7.58	172	0.369
17	06/21/93 17:45:45	27.07	0.010	7.80	7.60	169	0.069
18	06/21/93 18:00:45	26.81	0.010	7.84	7.60	167	0.115
19	06/21/93 18:15:45	26.50	0.010	7.87	7.60	165	0.115
20	06/21/93 18:30:45	26.19	0.010	7.92	7.59	164	0.115
21	06/21/93 18:45:45	25.80	0.010	7.95	7.59	161	0.115

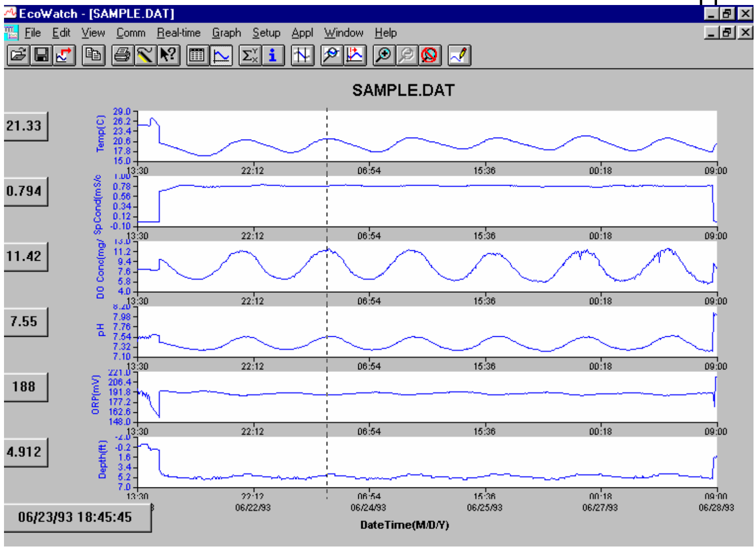
Now return to the original graphic display by toggling the **Table**  button "off" and **Graph**  button "on".



From the **Setup** menu, click **Graph**. Click **2 Traces per Graph** and notice that the parameters are now graphed in pairs for easy comparison of parameters.

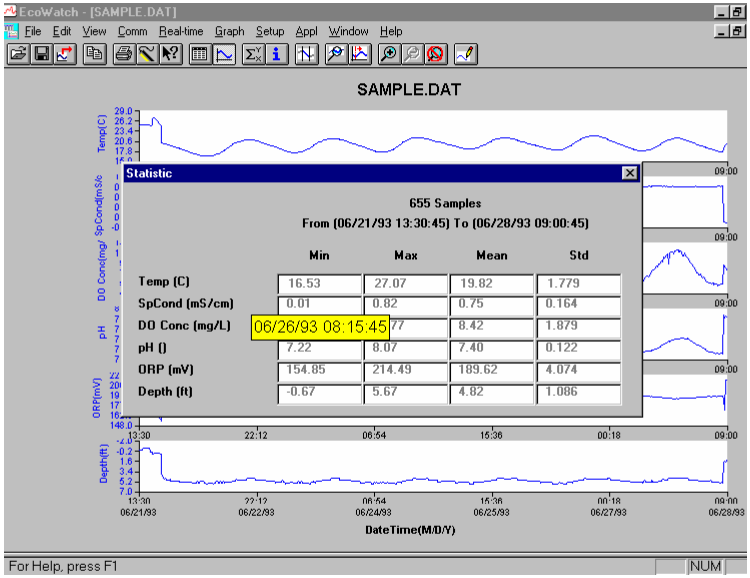


Click **1 Trace per Graph** to return the display to the original setting. Move the cursor to any position in the graph, then click and hold the right mouse button.

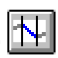


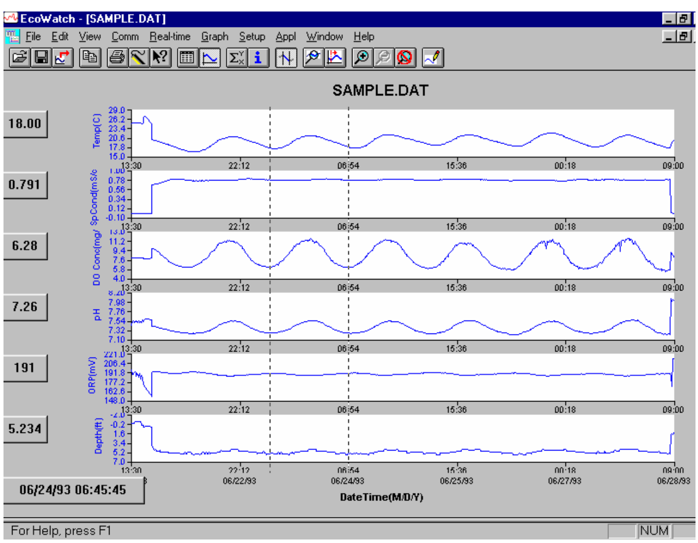
Note that the exact measurements for this point in time are displayed to the left of the graph. While holding down the right mouse button, move to another area on the graph. Notice how the measurements change as you move. When you release the mouse button, the display returns to normal.

To view statistical information for the study, click the **Statistics**  button on the toolbar. On the statistics window, click on any min or max value to display the time when it occurred.

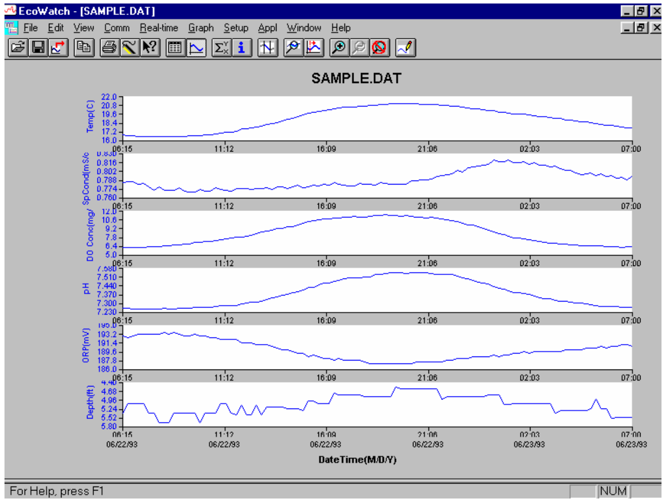


After viewing statistics, click the "x" at the upper right to close the window and return to the normal display.

Now click on the delimiter  icon in the toolbar and then move the displayed icon to the graph. Click at the two points shown by dotted lines in the display below, being sure that the first click is to the left of the second.

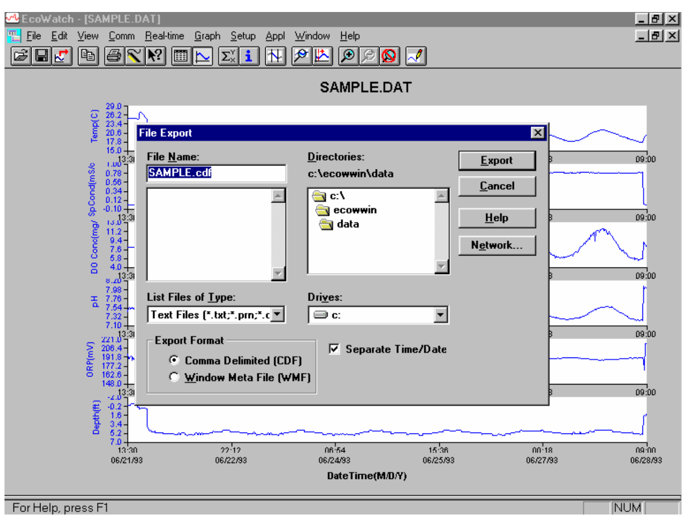


The data between the two selected points will then be graphed in higher resolution as shown below.

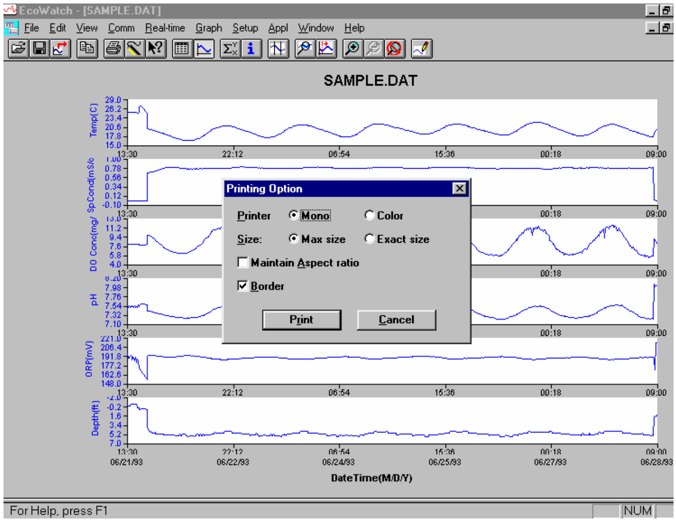


To return to the complete data set, select **Graph** from the toolbar and then click **Cancel Limits**.

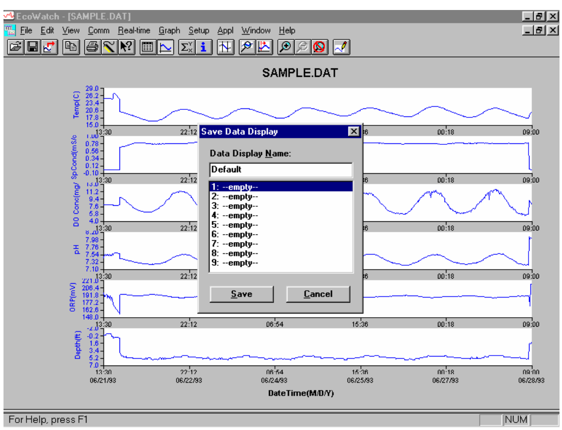
Now select the  icon from the Toolbar to create a new data file which will allow your data to be imported into spreadsheets. Select the default export settings for a Comma Delimited File (.CDF) and click OK. A new spreadsheet-importable file (SAMPLE.CDF) is now present in the same folder as the SAMPLE.DAT file.



Now select the  icon from the toolbar to print the plot. Accept the default settings and click OK to complete the printing operation.



Finally, end the tutorial by saving the **Data Display** in the format shown. From the File menu, click **Save Data Display**.

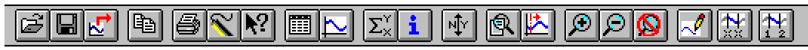


Then type "Default" for the file name and click **Save**. The parameters, colors, format, and x-axis time interval associated with the current display are now saved and can be accessed any time in the future. Nine different data displays may be saved for any data file. You can easily switch between various displays of the data. The data files can be accessed by clicking **Load Data Display** from the file menu and then selecting the desired presentation.

20.2.1 Summary of Toolbar Capability

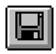
The EcoWatch toolbar includes buttons for some of the most common commands in EcoWatch, such as **File Open**. To display or hide the toolbar, open the **View** menu and click on the **Toolbar** command. A check mark appears next to the menu item when the toolbar is displayed.

The toolbar is displayed across the top of the application window, below the menu bar.

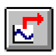


Click to:

Open an existing data file (.DAT). EcoWatch displays the **Open** dialog box, in which you can locate and open the desired file.



Save the working Data Display of the active data file. EcoWatch displays the **Save Data Display** dialog box in which you can overwrite existing Data Display or save to a new one.



Export data as a graph in Window Meta File (.WMF) format or as data in Comma Delimited (.CDF) format.

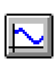
Copy the whole graph page or data from the selection on the table to the clipboard.

Print the active graph page or table page depending on which one is currently active.

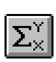
Open a new terminal window to communicate with the sonde.

Access context sensitive help (Shift+F1).

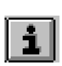
Toggle table window during file processing.



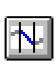
Toggle graph window during file processing.



Display study statistics.



Display study info.



Limit the data to be processed.

Enlarge a selective portion of graph.


Center the graph under the cursor.


Enlarge graph of table 20%.


Reduce graph of table 20%.


Return graph or table to its normal size (unzoom).


Redraw the graph.

20.2.2 Other capabilities

The above tutorial and function list for the toolbar provide basic information to allow you to view and analyze the field data which was stored in your 556 MPS. Some of the other commonly used capabilities of EcoWatch which the user may want to explore are listed below:

- Customize the units for each parameter, e.g., report uS/cm instead of mS/cm for conductivity.
- Customize the order of parameters in each plot or report.
- Customize the colors and fonts of each data display.
- Manually scale the y-axis sensitivity for each parameter.
- Merging of two or more data files with compatible parameter formats
- View information about the study such as number of points, instrument serial number, etc. which was stored in the 556 with the data.
- Print data reports in different statistical formats.
- Create plots of parameter vs. parameter rather than parameter vs. time.

These additional features of EcoWatch for Windows are explained in detail in the YSI 6-series manual (which can be downloaded at no cost from the YSI Web Site as described above) and the Help selection in the EcoWatch menu bar. To purchase a hard copy of the 6-series manual, contact YSI Customer Service using the contact information in *Appendix E Customer Service*.

21. Appendix H Calibration Record Information

When your YSI 556 MPS sensors are initially calibrated, relevant information about the sensors will be stored in a separate file in the YSI 556 MPS memory.

NOTE: This file, by default, will have the name "556 Circuit Board Serial Number.glp." The circuit board serial number is assigned at the factory and has a hexadecimal format such as 000080A4. Thus the default calibration record file would be designated 00080A4.glp. Refer to Section *10.7 GLP Filename* to change the filename.

The information in the calibration record will track the sensor performance of your instrument and should be particularly useful for programs operating under Good Laboratory Practices (GLP) protocols.

21.1 Viewing the Calibration Record (.glp) File

NOTE: Make certain that you have performed a calibration on at least one of the sensors associated with your YSI 556 MPS.

Follow the procedures outlined in Section *8.3 View File*.

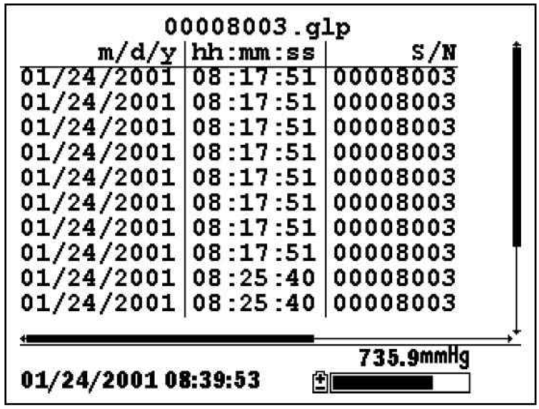
21.2 Uploading the Calibration Record (.glp) File

NOTE: Make certain that you have performed a calibration on at least one of the sensors associated with your YSI 556 MPS.

Follow the procedures outlined in Section *8.4 Upload to PC*.

21.3 Understanding the Calibration Record (.glp) File

1. Open a calibration record file. Refer to Section 8.3 View File.
2. Use the arrow keys to scroll horizontally and/or vertically to view all the data.

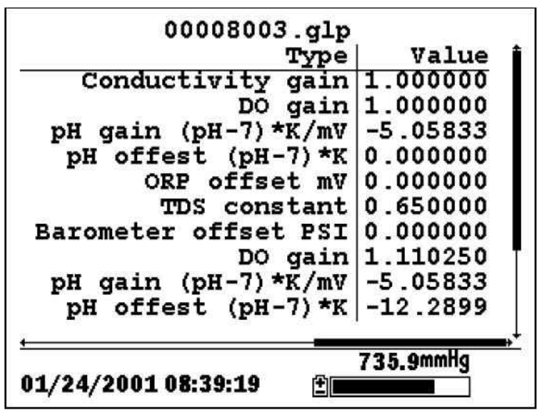


00008003.glp

m/d/y	hh:mm:ss	S/N
01/24/2001	08:17:51	00008003
01/24/2001	08:17:51	00008003
01/24/2001	08:17:51	00008003
01/24/2001	08:17:51	00008003
01/24/2001	08:17:51	00008003
01/24/2001	08:17:51	00008003
01/24/2001	08:17:51	00008003
01/24/2001	08:17:51	00008003
01/24/2001	08:25:40	00008003
01/24/2001	08:25:40	00008003

735.9mmHg
01/24/2001 08:39:53

Figure 21.1Calibration Record Screen 1



00008003.glp

Type	Value
Conductivity gain	1.000000
DO gain	1.000000
pH gain (pH-7)*K/mV	-5.05833
pH offest (pH-7)*K	0.000000
ORP offset mV	0.000000
TDS constant	0.650000
Barometer offset PSI	0.000000
DO gain	1.110250
pH gain (pH-7)*K/mV	-5.05833
pH offest (pH-7)*K	-12.2899

735.9mmHg
01/24/2001 08:39:19

Figure 21.2 Calibration Record Screen 2

NOTE: Each sensor (not parameter) is characterized by either 1 line (Conductivity, Dissolved Oxygen, ORP, TDS, or Barometer (Optional)) or 2 lines (pH) of calibration documentation.

The left hand portion of each calibration entry shows the date and time that a calibration of a particular sensor was performed. In addition, each calibration entry is characterized by the instrument serial number, as defined by YSI. See Figure 21.1 Calibration Record Screen 1. The right hand portion shows the YSI designation of the calibration constants and their values after their calibration has been performed. A more detailed description of the calibration constants is provided below:

- **Conductivity Gain** – A relative number which describes the sensitivity of the sensor. Basically, the value represents the calculated cell constant divided by the typical value of the cell constant (5 cm^{-1}).
- **DO Gain** – A relative number which describes the sensitivity of the sensor. Basically, the value represents the sensor current at the time of calibration divided by the typical value of the sensor current (15 uA).
- **pH Gain** – A number which basically represents the sensitivity of the pH sensor. To remove the effect of temperature on the slope of the relationship of probe output in mv versus pH, the value of pH/mv is multiplied by the temperature in degrees Kelvin (K).
- **pH Offset** – A number which basically represents the offset (or intercept) of the relationship of probe output in mv versus pH, the value of pH is multiplied by the temperature in degrees Kelvin (K).

Anytime you perform a calibration, information concerning the calibration constants will be logged to the Calibration Record file (.glp file). However, if the **Delete All Files** command is used, Refer to Section *8.6 Delete All Files*, the Calibration Record file will also be lost. It is critical that this file should be uploaded to your PC prior to issuing a **Delete All Files** command. Refer to Section *8.4 Upload to PC*.

YSI Environmental
1700/1725 Brannum Lane
Yellow Springs, OH
45387 USA
937.767.7241
937.767.9353 fax
environmental@YSI.com
www.YSI.com

Item # 655279
Rev D
Drawing # A655279
August 2009

USER MANUAL
DOCUMENT #626973-01REF

ProDSS

USER MANUAL

a xylem brand

This page left intentionally blank

Contents

Introduction

Thank you for purchasing the YSI Professional Digital Sampling System (ProDSS).

ProDSS features include:

- Digital smart probes that are automatically recognized by the instrument when connected
- Waterproof (IP-67) case
- Long-life rechargeable lithium-ion battery pack
- Color display and backlit keypad
- User-selectable cable options
- USB connectivity
- Global Positioning System (GPS) (optional)
- Depth sensor (optional)
- Large memory with extensive site list capabilities
- Rugged enclosure with rubber over-molded case and miltary-spec (MS) connectors

Safety information

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all precautionary statements. Failure to do so could result in serious injury to the operator or damage to the equipment. Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

NOTICE: The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Precautionary symbols

NOTE: *Information that requires special emphasis*

NOTICE: Indicates a situation which, if not avoided, may cause damage to the instrument

⚠ **CAUTION:** Indicates a potentially hazardous situation that may result in minor or moderate injury

⚠ **WARNING:** Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury

Product components

Carefully unpack the instrument and accessories and inspect for damage. If any parts or materials are damaged, contact YSI Customer Service at 800-897-4151 (+1 937 767-7241) or the authorized YSI distributor from whom the instrument was purchased.

Battery use and battery life

The ProDSS uses a rechargeable lithium-ion (Li-Ion) battery pack as a power source. The battery comes pre-installed in the ProDSS and does not need to be replaced until the battery charge capacity is deemed unacceptable by the user. The battery is shipped at ~50% full capacity and charging the battery is not required before first use.

Battery life depends on use, enabled parameters, LCD brightness, and GPS use. As with all lithium-ion batteries, battery life will decline over time and use. This decay is typical and should be expected.

A new ProDSS battery is expected to last for the following durations (25 °C (77 °F), auto sampling, GPS on, keypad backlight off):

- ProDSS instrument only - 48 hours
- ProDSS with fully loaded cable assembly and 25% (Default) LCD brightness - 20 hours
- ProDSS with fully loaded cable assembly and 100% LCD brightness - 14 hours

To increase battery life, enable manual sampling mode (Sampling on page 20). Manual sampling mode powers the sensor/s on to take a measurement and then powers down to conserve battery life. Battery life may also depend on the battery charging practices used. For maximum battery life, keep the battery 40% to 80% charged. Also, a larger discharge (e.g. to 50%) is better than a small discharge (e.g. to 90%) between recharges.

Charging the battery pack

A USB cable is included with the ProDSS to charge the instrument battery pack and connect the instrument to a PC. The instrument battery pack can be charged from the AC power adapter, directly from a computer USB connection or from an external, portable USB battery pack (sold separately, see ProDSS accessories on page 76).

Plug the USB connector into the AC power adapter, computer USB connector or external USB battery pack, then plug the micro USB connector into the ProDSS instrument (Figure 1).

NOTE: *The ProDSS internal charge controller only allows the battery pack to be charged if the temperature is between 0 and 45 °C (32 and 113 °F).*

⚠ **WARNING:** Charge the battery pack in an open area away from flammable materials, liquids, and surfaces. Read Rechargeable Lithium-Ion battery pack safety warnings and precautions on page 79.

The ProDSS will charge faster when plugged into an AC outlet for charging rather than a PC's USB port. For the instrument to recognize that it is using AC power, you must start charging the ProDSS while on. After the instrument recognizes it is being charged, it can be turned off to finish charging.

When using the AC adapter, it takes approximately 14 hours to charge the ProDSS battery when the instrument is turned off during the charge. The amount of time required to completely charge the battery pack when the ProDSS is initially turned on during the charge is approximately 9 hours.

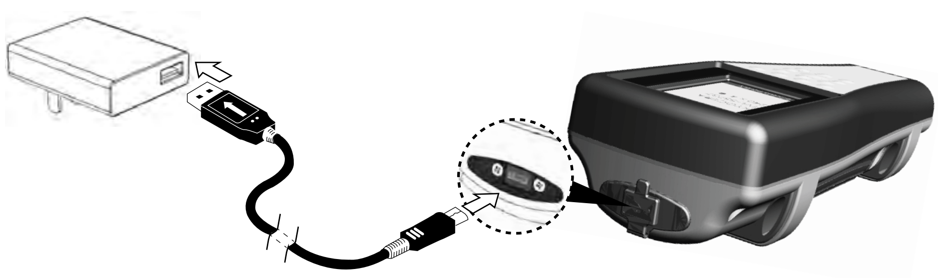


Figure 1 Connecting the ProDSS to AC power supply

Battery replacement

NOTE: *The battery pack is pre-installed in the ProDSS instrument.*

⚠ **WARNING:** Do not charge or handle a battery pack that is hot to the touch. Failure to follow the safety warnings and precautions can result in personal injury and/or instrument damage not covered under warranty. Read Rechargeable Lithium-Ion battery pack safety warnings and precautions on page 79.

1. Remove the battery pack cover by unscrewing (counter-clockwise) the four screws with a flat or Phillips head screwdriver (Figure 2 on page 7).

   NOTE: *The retaining screws are captured into the battery pack cover and are not removable.*

2. If replacing an existing battery pack, remove the Li-Ion battery pack and battery pack gasket/cradle. With two fingers, grasp the battery pack connector and pull the connector straight up to disconnect and remove.

   NOTE: *Properly dispose of the old battery pack (Battery Disposal on page 80).*

   NOTE: *A new gasket/cradle is included with a new battery pack to prevent water leaking into the instrument case. When replacing the battery pack, use the new battery pack gasket/cradle supplied with the replacement battery pack.*

3. Inspect the replacement battery pack and battery pack gasket/cradle for damage. Contact YSI customer service if the new battery pack and/or replacement gasket/cradle is damaged.
4. Correctly align and seat the battery pack gasket/cradle and battery pack into the instrument.
5. Align the battery pack connector wire terminals with the three instrument pins, then connect the battery pack to the instrument.

   NOTICE: Make sure that the three wire terminal connectors and three instrument pins are correctly aligned before connecting the battery pack connector. Incorrect installation can damage the battery pack connectors or instrument pins.

6. Install the battery pack cover, then tighten the cover screws. Make sure that the cover sealing surface is correctly aligned and free of any contamination or damage.

   NOTICE: Overtightening the cover screws can damage the battery cover.

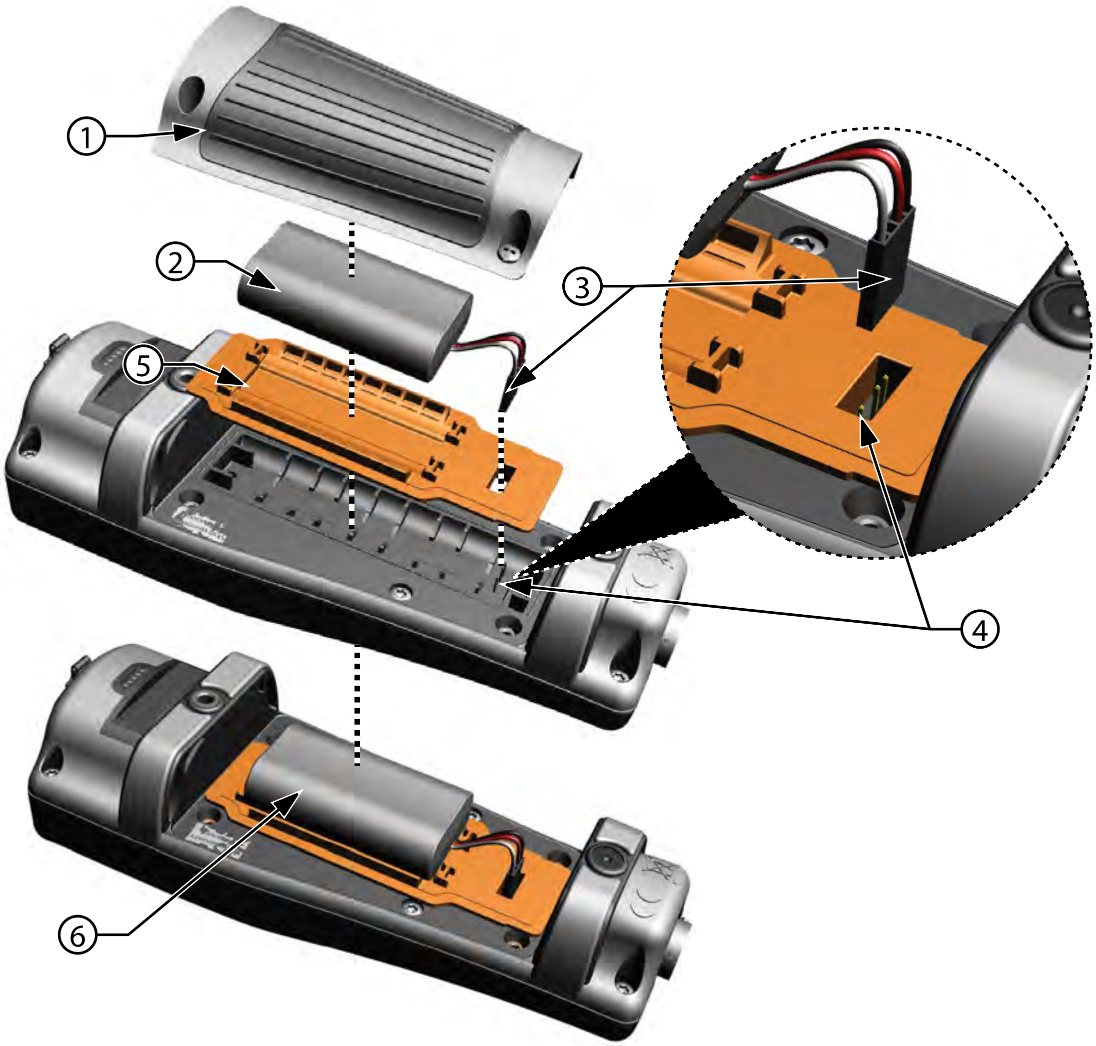


Figure 2 Battery replacement

1 Battery pack cover	**4** Instrument pin connectors
2 Battery pack	**5** Battery pack gasket/cradle*
3 Battery pack connector	**6** Battery pack gasket/cradle installed

*Color shown for reference

Connect the handheld to the cable assembly

The ProDSS cable connectors are keyed for positive mating and to prevent connector damage (Figure 3). The ProDSS instrument retains its IP-67 rating when the cable is disconnected. However, the connectors are not wet-mateable and should be clean and dry before connecting.

Align the keys on the cable assembly connector with the slots on the instrument connector. Push together firmly, then twist the outer ring clockwise until it locks into place.

Figure 3 Keyed connectors

1	Handheld female connector	**3**	Keyed area of connectors
2	Cable male connector		

ProDSS sensor installation/removal

NOTICE: The ProDSS bulkhead and sensor connectors are not wet-mateable. Make sure that the sensor and bulkhead connectors are clean and dry before sensor installation.

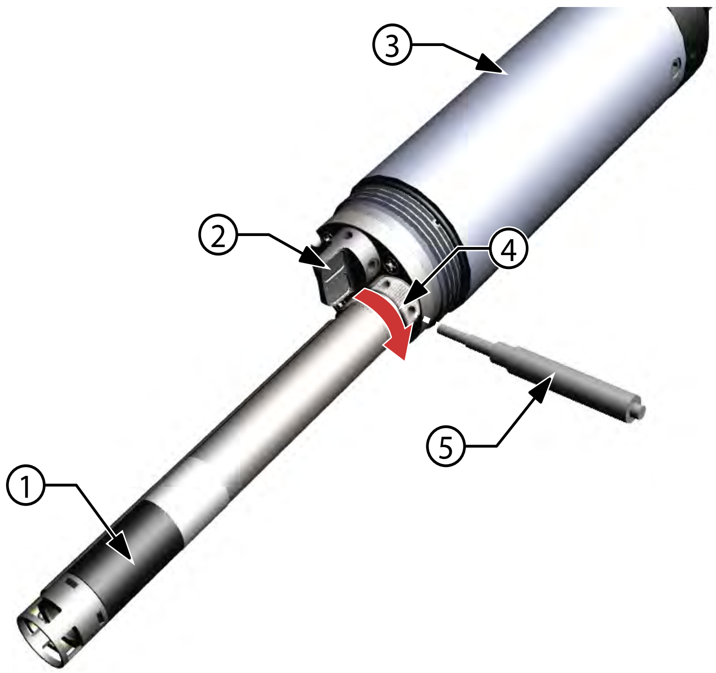


Figure 4 Sensor installation

1	Sensor	**4**	Sensor retaining nut
2	Port plug	**5**	Sensor installation/removal tool
3	Bulkhead		

Sensor installation

The ports on the ProDSS bulkhead are universal; therefore, you can install any sensor into any port. For highest accuracy, always install a conductivity/temperature sensor to compensate all measurement data for temperature and dissolved oxygen data for conductivity.

1. Remove and discard the dust plugs shipped with the instrument (Figure 5 on page 10).
2. Inspect the bulkhead port for contamination. If the port is wet, clean it with compressed air.
3. Apply a thin coat of Krytox o-ring lubricant to the sensor o-rings. Wipe off any excess o-ring grease with a lint-free cloth.
4. Carefully align the sensor and bulkhead connectors by inserting the sensor into the port then gently rotating the sensor until the connectors align. Once aligned, push the sensor toward the bulkhead until the sensor seats in the port.
5. Carefully finger-tighten the retaining nut clockwise.

   NOTICE: If any resistance is felt, loosen the retaining nut completely to prevent cross-threading. Incorrect installation may cause damage to the sensor or bulkhead that is not covered by the warranty.

6. Use the sensor installation/removal tool to tighten the retaining nut clockwise until snug, about a 1/4 to 1/2 additional turn of the retaining nut.

   NOTICE: Do not over-tighten the retaining nut. Over-tightening can cause damage to the sensor or bulkhead not covered by the warranty.

Sensor removal

To remove a sensor, insert the sensor installation/removal tool into the retaining nut, then rotate the retaining nut counterclockwise to loosen. After the retaining nut has been completely unscrewed from the bulkhead, pull the sensor straight out of the port and place it on a clean surface.

NOTICE: Install a port plug if not reinstalling a sensor in the exposed port. Exposure to water can cause damage or corrosion to the bulkhead connectors not covered by the warranty.

Port plugs

Figure 5 Port plugs

1 Shipping dust cover*	**2** Port plug

*Color shown for reference

To protect the bulkhead connectors from damage, install a port plug into any port without an installed sensor. Port plugs and a tube of o-ring lubricant are included in the maintenance kit that ships with all ProDSS cables. Refer to the accessories section if an additional maintenance kit is needed (Ordering on page 73).

NOTICE: The shipping dust covers installed on the bulkhead when purchased (not sensor installation/removal tool compatible) are not o-ring sealed and must be replaced with a port plug before field use.

NOTICE: Do not submerge the bulkhead without a sensor or port plug installed in all ports.

Installation

1. Apply a thin coat of Krytox o-ring lubricant to the o-rings on the plug port.
2. Remove any excess lubricant from the o-rings and port plug with a lint-free cloth.
3. Insert the port plug into the empty port and press until firmly seated.
4. Finger-tighten the port plug clockwise to install. If necessary, use the sensor installation tool to make sure that the plug is fully seated into the port.

NOTICE: The o-rings will not be visible if a port plug is correctly installed.

NOTICE: Do not over-tighten the port plug. Over-tightening can cause damage to the port plug or bulkhead not covered by the warranty.

Sensor guard and weight installation

1. Carefully slide the sensor guard over the bulkhead and attached sensors/port plugs. Push the sensor guard toward the bulkhead until the sensor guard threads align with the bulkhead threads.
2. Carefully finger-tighten the sensor guard clockwise.

NOTICE: If any resistance is felt, loosen the sensor guard completely to prevent cross-threading. Incorrect installation may cause damage to the sensor guard or bulkhead that is not covered by the warranty.

NOTICE: Do not submerge the bulkhead without a sensor or port plug installed in all ports.

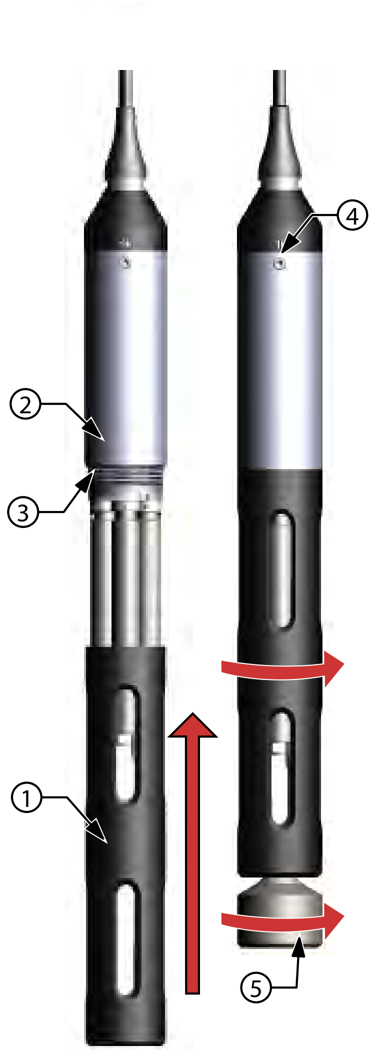


Figure 6 Sensor guard and weight installation

1	Sensor guard	**4**	Depth sensor (if equipped)
2	Bulkhead	**5**	Weight
3	Bulkhead threads		

Sensor guard weights

To help stabilize the sensors when profiling at deeper depths, a sensor guard weight is supplied with cables 10 meters and longer. To attach the weight, carefully hand-tighten it clockwise on to the bottom of the sensor guard (Figure 6 on page 11).

NOTICE: If any resistance is felt, loosen the sensor guard weight completely to prevent cross-threading. Incorrect installation may cause damage to the sensor guard.

The bottom of the weight is threaded so that additional weights can be added if needed. See ProDSS accessories on page 76.

NOTE: *Do not have any weights installed on the sensor guard when calibrating using the calibration cup.*

Operation

Keypad and navigation

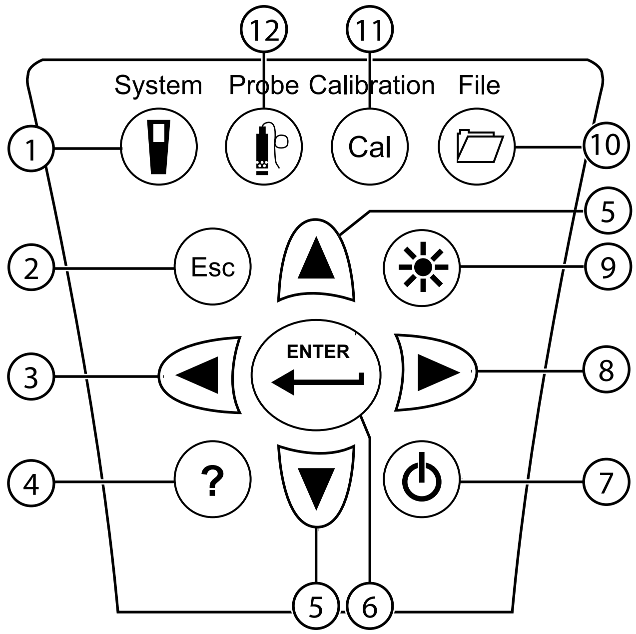


Figure 7 Keypad description

1 **System:** Opens the system menu. Use to adjust system settings	**7** **ON/OFF:** Turn on or turn off the instrument
2 **Exit/Escape key:** Exits to the Run screen. When in an alpha/numeric entry screen, returns to previous menu	**8** **Right arrow key:** Navigate right in an alpha/numeric entry screen. On the Run screen, push to show graphical representations of the displayed measurements. Push the right or left arrow to return to the Run screen. In the View Data screen, push to view additional parameters in the data set
3 **Left arrow key:** Navigate left in an alpha/numeric entry screen. Push to return to previous menu in all screens except alpha/numeric entry. On the Run screen, push to show graphical representations of the displayed measurements. Push the right or left arrow to return to the Run screen	**9** **Backlight:** Turns the keypad backlight on or off for use in low light conditions
4 **Help:** Shows context sensitive help	**10** **File:** Opens the file menu. Use to view logged data and GLP files, backup data to a USB stick, and delete data
5 **Up/down arrow keys:** Scroll through menus or enter numbers and letters	**11** **Calibrate:** Opens the calibration menu. Use to calibrate all parameters except temperature
6 **Enter key:** Push to confirm selections. On the Run screen, push to log a single data point or start continuous data logging	**12** **Probe:** Opens the sensor menu. Use to setup sensors, change the measurements shown on the run screen, and turn on/off Auto Stable and GPS

Operation

Startup

Push the ⏻ key to turn on the handheld. If the handheld does not turn on, make sure that the battery pack is correctly installed and charged. Push and hold the ⏻ key for 1.5 seconds to turn the handheld off.

Navigation

The ProDSS contains menus to change user-defined options, functions, and parameters. Use the arrow keys (▲ and ▼) to highlight different options within menus and sub-menus, then push the ENTER key to select the option. Push the ◀ key to return to the previous menu.

> ***NOTE:*** *When in an alpha/numeric screen, the ◀ key is for alpha/numeric navigation only. Push the Esc key to return to the previous menu.*

Push the Esc key to return to the Run screen. To enable or disable an option, highlight the option, then push the ENTER key. Enabled functions appear as a circle with a dot ⦿ or a box with a check mark ☑. Disabled functions appear as a circle only ○ or an empty box ☐.

Alpha/numeric entry

When required, an alpha or alpha/numeric entry screen will be shown. When finished entering information, highlight **ENTER**, then push the ENTER key to save the entry (Figure 8).

> ***NOTE:*** *When in an alpha/numeric screen, the ◀ key is for alpha/numeric navigation only. Push the Esc key to return to the previous menu.*

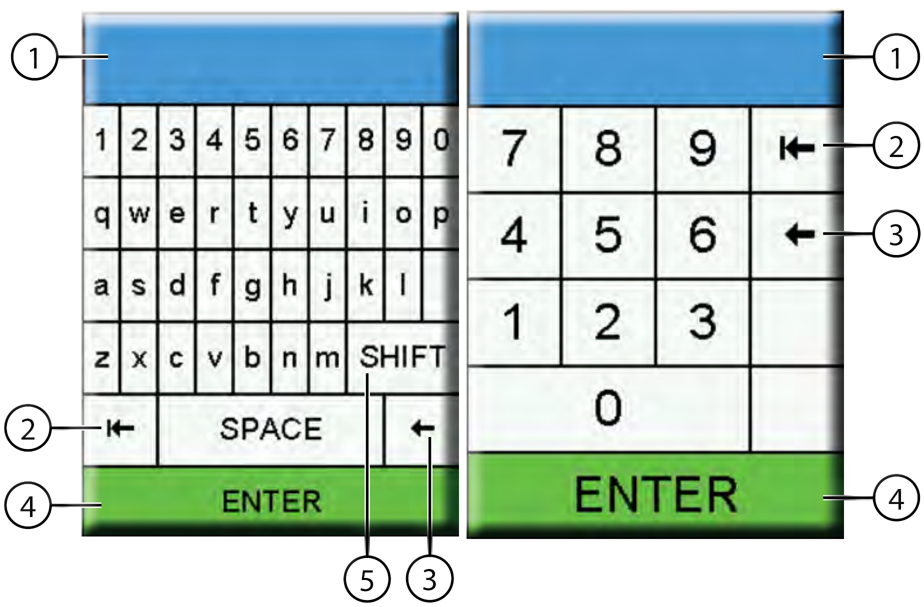


Figure 8 Alpha/numeric and numeric entry screens

1	User entry field	**4**	Enter selection
2	Delete entire entry	**5**	Upper/lowercase
3	Backspace		

Main display description

The main display (Run screen) shows the current measurements as defined in the Sensor Display menu (Sensor Display on page 25). If more measurements are selected than can be displayed on the Run screen, a scroll bar will be shown. Use the ▲ and ▼ arrow keys to view the additional measurements (Figure 9).

The message area shows status messages, error messages, and information about selected functions.

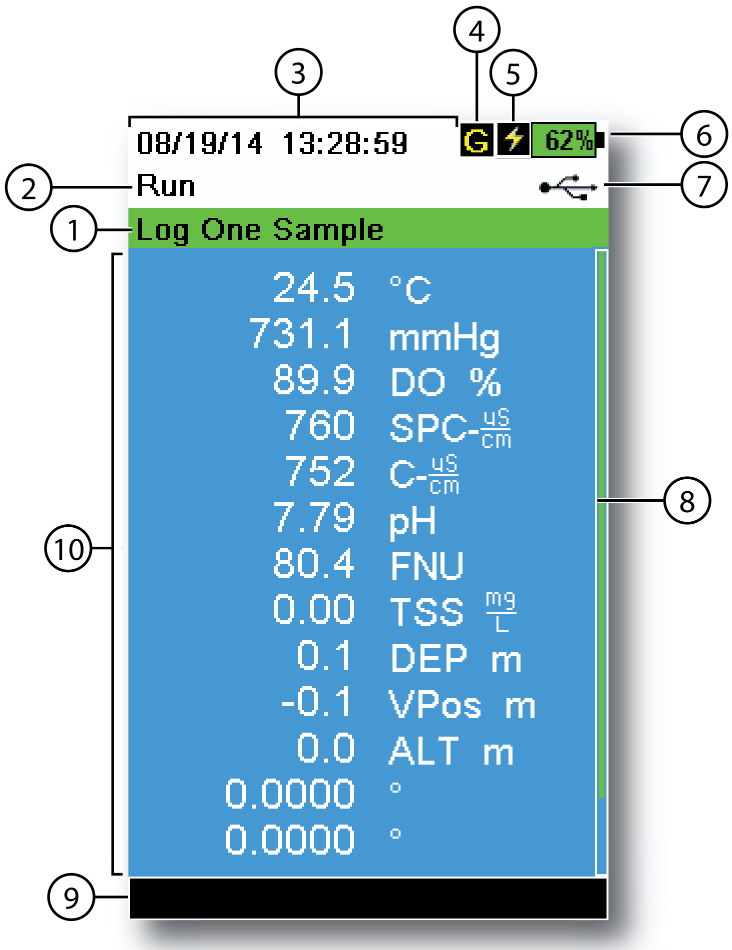


Figure 9 Main display example

1	Log or sampling (update measurements) prompt on Run screen (single or continuous)	**6**	Battery charge %
2	Current screen/menu	**7**	USB/PC connection indicator
3	Date/Time	**8**	Scroll bar
4	GPS signal indicator	**9**	Message area
5	Battery charging indicator	**10**	Displayed measurements

System menu

Push the System key to view and adjust instrument settings. Highlight a sub-menu then push the key to view the sub-menu options (Figure 10).

Pre-defined or user-selected options are noted within brackets (**[ ]**). See Alpha/numeric entry on page 14.

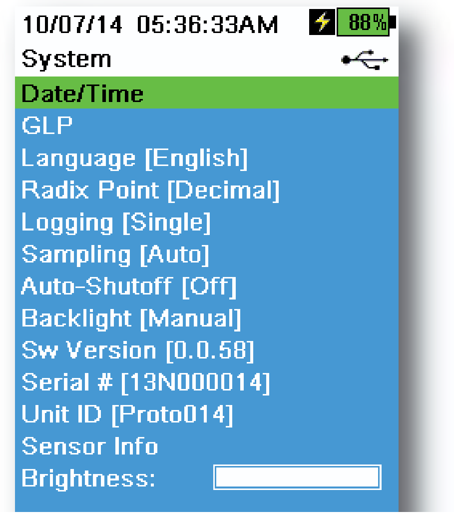


Figure 10 System menu

Use the System menu to:

- Set the date and time (Date/Time on page 17)
- Change the user-defined Good Laboratory Practices (GLP) options (GLP menu on page 17)
- Change the instrument language setting (Language on page 19)
- Change the radix point (Radix Point on page 19)
- Change logging options (Logging on page 19)
- Change sampling options (Sampling on page 20)
- Set the handheld auto-shutoff time (Auto-Shutoff on page 20)
- Set the backlight mode (Backlight on page 21)
- View the software version (Alpha/numeric entry on page 14)
- View the handheld serial number (Serial # on page 21)
- View and adjust the Unit ID (Unit ID on page 21)
- View the sensor specific information (Sensor info on page 22)
- Adjust the display brightness (Brightness on page 22)

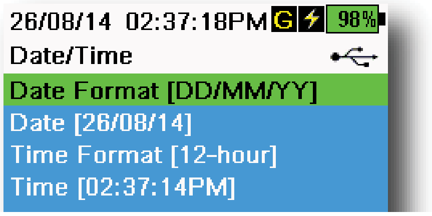


Figure 11 Date/Time

Date/Time

→ **Date/Time**

For accurate logging and GLP data, correctly set the date and time options (Figure 11). Select any of the following options to set the Date/Time in the ProDSS.

Date/Time options:

- Set YY/MM/DD, MM/DD/YY, DD/MM/YY or YY/DD/MM date format
- Set the correct date
- Select 12 or 24 hour time format
- Set the correct time

GLP menu

Detailed sensor calibration information is stored in the Good Laboratory Practice (GLP) file for later review.

One GLP file is used to store all calibration records. The instrument's internal memory can save up to 400 individual calibration records. After 400 records, the instrument will overwrite previously stored calibration records, starting with the oldest.

To prevent the permanent loss of GLP records, periodically download the GLP file to a computer using the KorDSS software.

> ***NOTE:*** *GLP files uploaded to the PC will overwrite a previously downloaded GLP file if it has the same file name. To prevent data loss, move or rename previously downloaded GLP files before downloading the GLP file.*

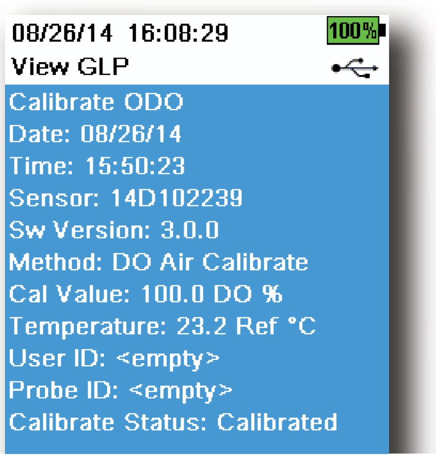


Figure 12 GLP record example (single point % DO calibration)

GLP saved information

See Figure 12.

- Sensor calibrated
- Date/time stamp
- Sensor ID
- Sensor software version
- Calibration method (Conductivity and ODO calibrations)
- Calibration value
- Temperature
- User ID (optional)
- Probe ID (optional)
- User fields #1 and #2 (optional)
- Calibration status

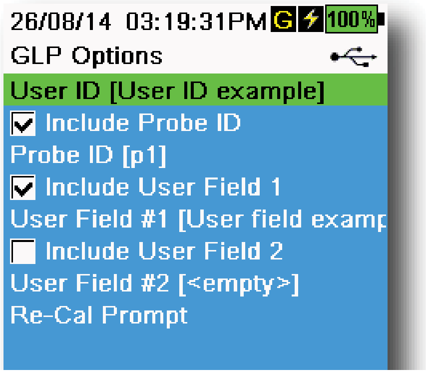


Figure 13 GLP Options

GLP Options

→ **GLP** → **Options**

User ID, Probe ID, or User Field #1 or 2 can be user-defined for positive GLP file identification of:

- The person calibrating the instrument.
- The sensor/cable serial number used during calibration (or other, user-defined Probe ID).
- Other user-specific identification (User Field #1 and #2) (Figure 13).

NOTE: *User Field can be used to describe the condition of the probe. For example, new sensor or new ODO cap.*

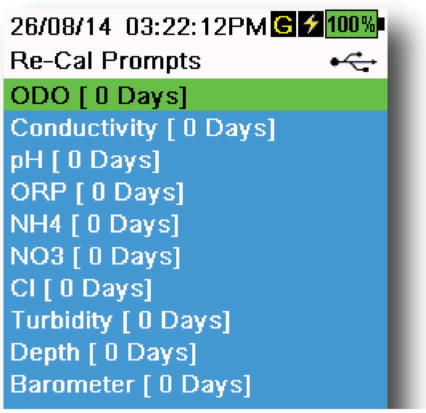


Figure 14 Re-Cal Prompts

Re-Cal Prompts

→ **GLP** → **Options** → **Re-Cal Prompts**

Re-Cal Prompts provide a reminder to recalibrate a probe in the user-defined number of days (Figure 14).

The Re-Cal prompt will be displayed in the message area of the main display when the set time has elapsed (Figure 9 on page 15).

Select the desired sensor Re-Cal prompt, then enter the desired number of days before the Re-Cal prompt occurs.

Set the sensor value to zero (0) days (default) to turn off Re-Cal prompts.

NOTE: *When enabled and the set amount of time since the last calibration has passed, the Re-Cal prompt will be shown when the instrument is turned on.*

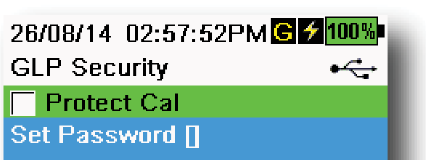


Figure 15 GLP Security

GLP Security

→ **GLP** → **Security**

The Calibration menu can be password protected to prevent accidental or unauthorized sensor calibration (Figure 15).

1. From the GLP menu, select **Security**, then enter the default password "ysi123".
2. Select **Set Password []** and change the default password.
3. Select the **Protect Cal** check box to password protect the Calibration menu.

NOTE: *Write down and keep the password in a safe place. Contact YSI Technical Support if you lose the password (*Technical support on page 81*).*

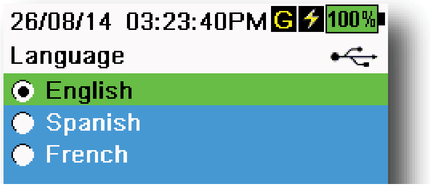


Figure 16 Language

Language

→ **Language**

The ProDSS is shipped with English enabled. If a different language is desired and selected, the ProDSS will take approximately 10 to 20 seconds to enable the new language (during the first installation only).

Optional languages:
- French
- German
- Italian
- Japanese
- Norwegian
- Portuguese
- Simplified Chinese
- Spanish
- Traditional Chinese

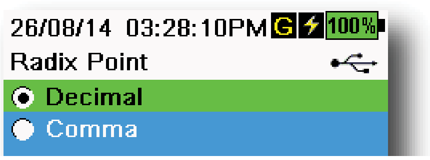


Figure 17 Radix Point

Radix Point

→ **Radix Point**

The radix point can be changed to display a comma or a decimal in numeric displays (e.g. 1.00 becomes 1,00 when Comma is selected) (Figure 17).

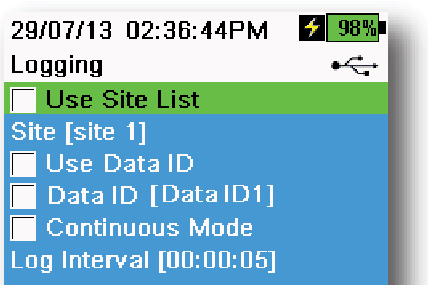


Figure 18 Logging

Logging

→ **Logging**

The Logging menu allows user-defined site and Data ID lists to be added to the logged data. Add a Site or Data ID, then select the applicable check box to log data to that site and/or Data ID (Figure 18).

Continuous Mode (Interval logging): Select the Continuous Mode check box and enter the user-defined Log Interval (in HH:MM:SS - hours:minutes:seconds) to log samples continuously at the specified time interval. The Run screen will display **Start Logging...** when in Continuous Mode.

One sample logging: Clear the Continuous Mode check box. The Run screen will display **Log One Sample**. A sample will be logged each time the ENTER key is pushed when in the Run screen.

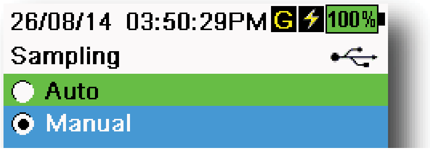


Figure 19 Sampling

Sampling

→ **Sampling**

Auto sampling mode continuously updates measurements on the display (Figure 19).

Manual mode helps conserve battery power. The user-defined Sample Period determines the measurement time limit.

When in Manual mode, the instrument will take measurements for the duration of the Sample Period then "lock" or hold the readings on the display (sample period default 50 seconds, user-defined between 15 to 60 seconds).

Once the measurements are locked, push the ENTER key to log the held data, or the Esc key and then the ENTER key to take a new measurement.

Enter the desired Sample Period time.

> ***NOTE:*** *When both Continuous Logging Mode and Manual Sampling mode are enabled, the ProDSS will power the sensors on and take measurements for 15 seconds before logging a data set.*

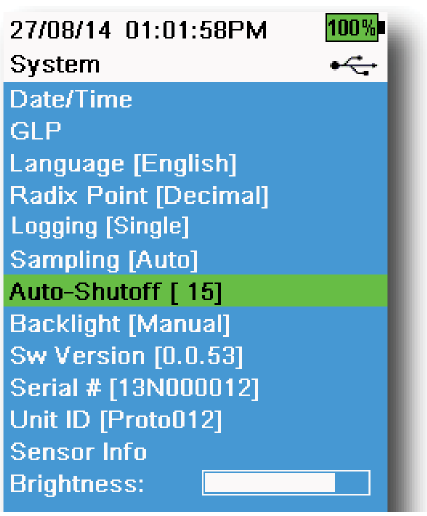


Figure 20 Auto-Shutoff

Auto-Shutoff

→ **Auto-Shutoff**

To conserve battery power, auto-shutoff powers off the instrument after a user-defined time period (in minutes) (Figure 20). Set to 0 (zero) to disable Auto-Shutoff.

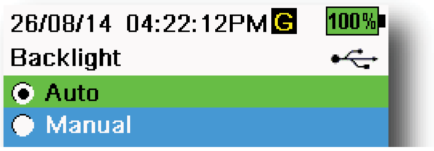


Figure 21 Backlight

Backlight

→ **Backlight**

In Automatic mode, the instrument display will dim 60 seconds after the last key was pushed. Once any key is pushed, the instrument display will return to the user-defined brightness setting and the keypad backlight will turn on. The screen will dim and the keypad backlight will turn off after another 60 seconds of inactivity.

In manual mode, the instrument display remains at the user-defined brightness until manually changed and the keypad backlight is turned on and off by the Backlight key (Figure 21).

NOTE: *In bright conditions, set the backlight to Manual mode.*

Software (Sw) Version

→ **Sw Version**

Sw Version (System menu on page 16)

Sw Version shows the ProDSS software version number. The latest instrument software version is available at ysi.com. Instrument software can be updated through the KorDSS PC software program when connected to the internet or if the firmware file has been transferred to the PC. See the KorDSS help section for more information.

Serial

→ **Serial #** (System menu on page 16)

Serial # shows the serial number of the ProDSS handheld instrument. Note the serial number when contacting YSI support.

Unit ID

→ **Unit ID** (System menu on page 16)

Unit ID identifies the instrument in the KorDSS PC software program that was included with the instrument.

Select **Unit ID** to change the default ID.

Sensor info

→ **Sensor info** (System menu on page 16)

Sensor info shows measurement data, and hardware/software information for each component of the system: instrument, sensor, and bulkhead. Use the ▲ and ▼ arrow keys to scroll through the components.

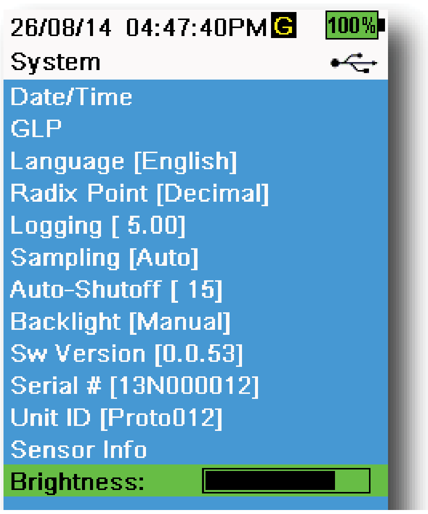


Figure 22 Display Brightness

Brightness

→ **Brightness**

The screen brightness can be adjusted to accommodate lighting conditions and to conserve battery power (Figure 22).

Select **Brightness** then use the ◀ and ▶ arrow keys to adjust the screen brightness.

> ***NOTE:*** *In bright conditions, set the screen brightness to 75% or greater.*

Sensor menu

Use the Probe key to access the Sensor menu and change sensor settings (if applicable), enable the measurement units displayed on the Run screen, set Auto Stable parameters, and if equipped, turn on/off GPS.

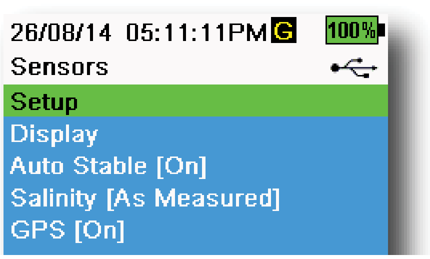


Figure 23 Probe (Sensor) menu

Push the key to access the sensor menu (Figure 23). Highlight a sub-menu then push the ENTER key to view sub-menu options.

Pre-defined or user-selected sensor settings are noted within brackets (**[]**).

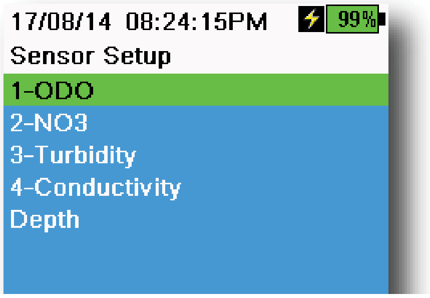


Figure 24 Sensor Setup

Sensor Setup

→ **Setup**

The Sensor Setup menu will show all sensors installed on the bulkhead (Figure 24). If a sensor is installed on the bulkhead and is not listed on the Sensor Setup menu (**<None>** displayed), check the sensor and cable connections (ProDSS sensor installation/removal on page 9).

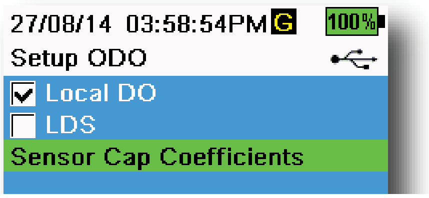


Figure 25 Setup ODO

Setup ODO

→ **Setup** → **ODO**

Local DO: Enable or disable localized DO% measurements. When enabled, the calibration value is set to 100% regardless of altitude or barometric pressure. When enabled, an L will be shown next to DO% on the run screen. DO mg/L measurements are unaffected when Local DO is enabled (Figure 25).

LDS: Last Digit Supression (LDS) rounds the DO value to the nearest tenth, e.g. 8.27 mg/L becomes 8.3 mg/L.

Sensor Cap Coefficients: The sensor cap coefficients must be updated after sensor cap replacement. Update the sensor cap coefficients using the KorDSS software and the coefficient sheet provided with the new sensor cap.

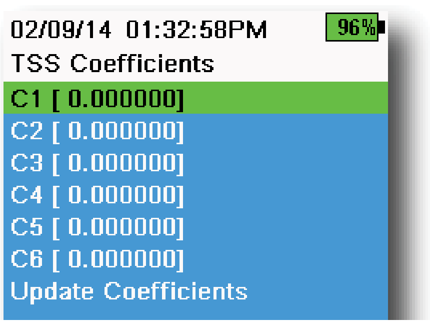


Figure 26 TSS coefficients

Setup Turbidity

→ **Setup** → **Turbidity**

TSS Coefficients: The Total Suspended Solids (TSS) coefficients are calculated in KorDSS by entering turbidity and TSS correlation data.

Measure turbidity and take a grab sample for laboratory analysis of TSS to obtain a value pair for the correlation. At least two and up to six value pairs can be entered into KorDSS.

The TSS coefficients can be entered manually or updated through the KorDSS software (Figure 26).

For highest accuracy, obtain 6 values pairs and calculate new coefficients for each unique sampling site.

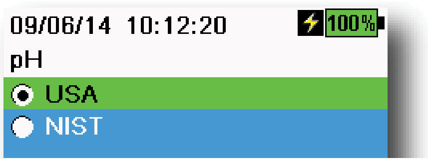


Figure 27 Setup pH

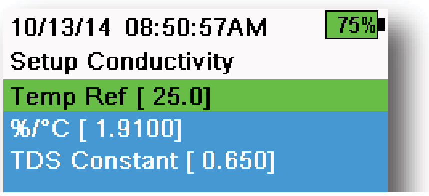
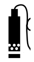


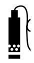
Figure 28 Setup Conductivity

Setup pH

 → **Setup** → **pH**

Select USA auto-buffer recognition (4.01, 7.00, and 10.00) or NIST auto-buffer recognition (4.01, 6.86, and 9.18) (Figure 27).

Setup Conductivity

 → **Setup** → **Conductivity**

Temp Ref (Temperature reference): Reference temperature used to calculate temperature compensated specific conductance. All specific conductance values are compensated to the Temp Ref temperature. The default value is 25 °C (77 °C) (Figure 28). Enter a new value between 15.00 °C (59 °F) and 25.00 °C (77 °F).

%/°C (Percent per degree Celsius): Temperature coefficient used to calculate temperature compensated specific conductance. The default is 1.91% based on KCl standards. Enter a new value between 0 and 4%.

TDS Constant: Multiplier used to calculate an estimated Total Dissolved Solids (TDS) value from conductivity. The multiplier is used to convert specific conductance in mS/cm to TDS in g/L. The default value is 0.65. Enter a new value between 0 and 0.99.

This multiplier is highly dependent on the nature of the ionic species present in the water sample. To be assured of moderate accuracy for the conversion, you must determine a multiplier for the water at your sampling site. Use the following procedure to determine the multiplier for a specific sample:

1. Determine the specific conductance of a water sample from the site.
2. Filter a portion of water from the site.
3. Carefully measure a volume of the filtered water. Completely evaporate to yield a dry solid.
4. Accurately weight the remaining solid.
5. Divide the weight of the solid (in grams) by the volume of water used (in liters) to yield the TDS value in g/L for the site.
6. Divide the TDS value in g/L by the specific conductance of the water in mS/cm to yield the conversion multiplier.

   NOTE: *Make sure to use the correct units.*

   NOTE: *If the nature of the ionic species at the site changes between sampling studies, the TDS values will be in error. TDS cannot be calculated accurately from specific conductance unless the make-up of the chemical species in the water remains constant.*

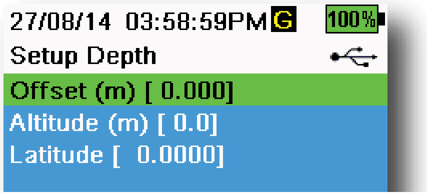


Figure 29 Setup Depth

Setup Depth

→ **Setup** → **Depth**

For ProDSS bulkheads with the depth sensor:

The ProDSS cable assemblies with a depth sensor in the bulkhead can measure virtual vented depth (Figure 6 on page 11). The virtual vented depth measurement allows for real time compensation for atmospheric pressure using the instrument's barometer.

Depth offset: Depth offset can be used if referencing water elevation against a known datum. If a depth offset is entered (in meters), the output value will shift by the value of the offset (Figure 29).

Altitude/Latitude: To compensate for atmospheric pressure based on elevation and gravitational pull, enter the local altitude in meters relative to sea level and latitude in degrees where the ProDSS is sampling.

Latitude effect: Varying latitudes cause a 200 mm change in depth from equator to pole.

Altitude effect: Varying altitudes cause approximately 90 mm change from sea level to 8000 m. A 100 m change causes 1.08 mm of change to the readings.

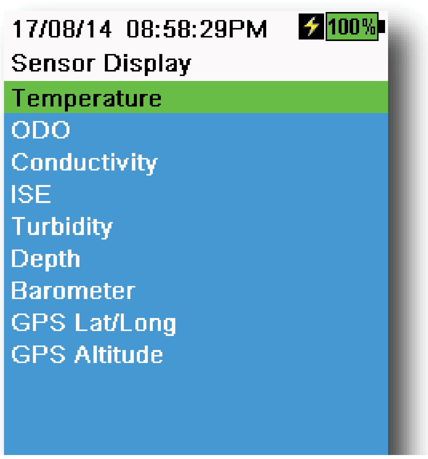


Figure 30 Sensor Display

Sensor Display

→ **Display** (Figure 30)

The Sensor display menu determines the measurements that are shown on the Run screen (Figure 3 Main display example on page 28). The Run screen will only show measurements for sensors that are attached to the cable bulkhead.

If more measurements are selected than can be displayed on one screen, a scroll bar will be shown. Use the ▲ and ▼ keys to scroll through the measurements.

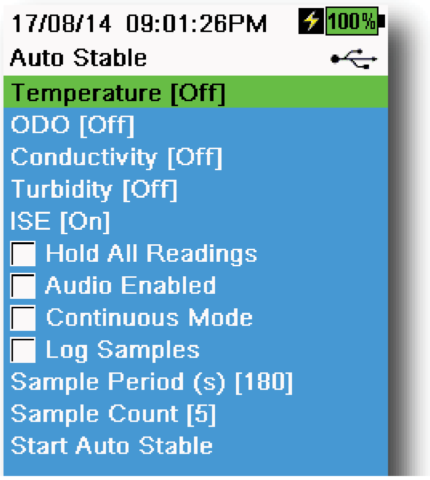


Figure 31 Auto Stable

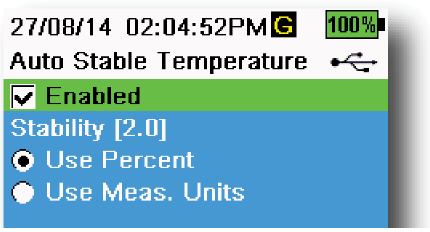


Figure 32 Auto Stable stability threshold

Auto Stable

→ **Auto Stable**

Auto Stable indicates when a measurement is stable. Sensors with Auto Stable enabled will have $\overset{\text{A}}{\text{s}}$ flash beside the measurement on the Run screen.

$\overset{\text{A}}{\text{s}}$ will flash green when the measurement is stable.

Select a sensor to enable or disable Auto Stable. Set the stability threshold parameters (Figure 31).

The Auto Stable stability threshold can be set by percent of measurement or in the units of measurement selected in the Sensor Display menu.

Enter the stability value, then select **Use Percent** or **Use Meas. Units** (Figure 32).

This threshold is used to compare the last reading with the previous. The smaller the number entered in % or units, the longer it will take for the instrument to reach the auto stable criteria.

Example: For temperature in °C, if unit threshold is set to 0.2 and the temperature reading changes by more than 0.2 degrees, $\overset{\text{A}}{\text{s}}$ will continue to be red until the reading does not change by more than 0.2 °C over the defined sample period and sample count.

Hold All Readings: After all sensors have reached their stability criteria, the measurements will be held or 'locked' on the display. If disabled, the sensor measurements will continue to change in real time.

Audio Enabled: An audio alert will sound when stability is reached.

Continuous Mode: The ProDSS will continuously check sensor values against the stability criteria even after the sample period and sample count have been met.

Log Samples: Logs the sample/s defined by the Sample Period to memory.

Sample Period: Time interval between the sensor measurements (sample) that are used to determine stability. Set the interval in seconds (1 to 900).

Sample Count: Number of consecutive samples required for stability (1 to 10).

Select **Start Auto Stable** to enable.

Salinity

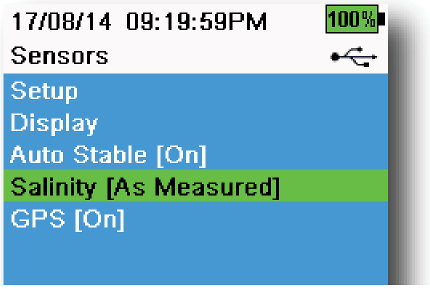


Figure 33 Salinity

→ **Salinity** (Figure 33)

Salinity is determined by calculations derived from the conductivity and temperature sensors.

Because salinity is an important factor in determining dissolved oxygen, YSI does not recommend calibrating or taking dissolved oxygen measurements without the conductivity/temperature sensor installed in the bulkhead.

GPS (optional)

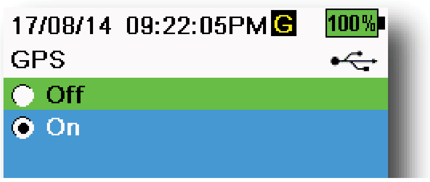


Figure 34 GPS

→ **GPS**

GPS turns the ProDSS Global Positioning System On or Off. The G symbol is shown when a GPS signal is received (Figure 34).

When enabled, the GPS coordinates will be saved with the GLP file and logged data.

Calibration menu

Push the Cal key to access the Calibration menu (Figure 35). Highlight a sub-menu then push the ENTER key to view sub-menu options.

Pre-defined or user-selected parameters are noted within brackets (**[]**). See Alpha/numeric entry on page 14.

Refer to the Calibration section for sensor specific calibration procedures (Calibration on page 33).

NOTE: *Attached sensors are listed according to the bulkhead port in which they are installed.*

NOTE: *User ID, Probe ID, and User Field #1 and #2 must be enabled in the GLP menu to appear in the Calibration menu* (GLP Options on page 18).

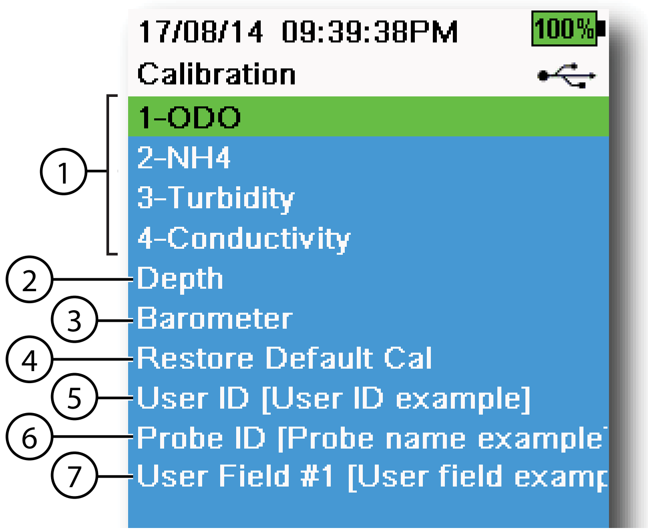


Figure 35 Calibration menu

1	Sensors connected to bulkhead	**5**	User ID
2	Optional Depth sensor calibration	**6**	Probe ID
3	Barometer calibration	**7**	User Field #1
4	Restore Default Calibration - restores all calibrations to factory default		

Files menu

Push the key to access the Files menu (Figure 36). Highlight a sub-menu then push the key to view sub-menu options.

Use the Files menu to view, delete or backup logged data or the GLP file. Data can be filtered by a specific date and time range and by user-created site and Data ID lists (Logging on page 29).

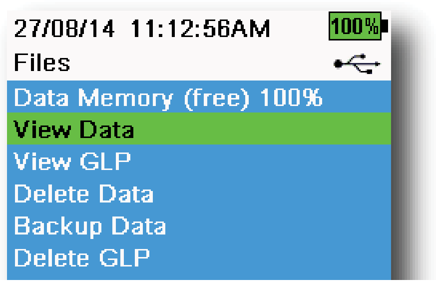


Figure 36 Files menu

Data Memory (free) % shows the remaining memory available. Download or delete data to free available internal memory.

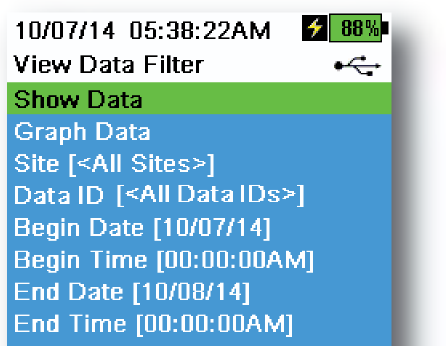


Figure 37 View Data Filter

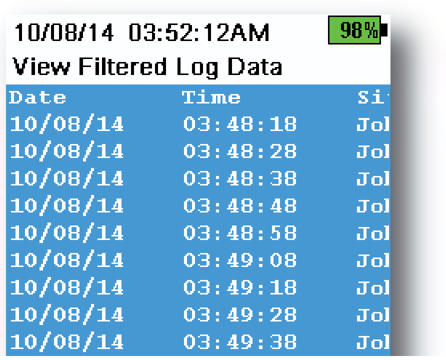


Figure 38 View Filtered Log Data

View Data Filter

→ **View Data**

Enter the desired filter criteria, then select **Show Data** or **Graph Data** to view the tabular or graphical data. If necessary, use the ▲ and ▼ arrow keys to scroll through the data (Figure 37 and Figure 38).

Site: View data from one site or all sites.

Data ID: View data from one ID or all IDs.

Begin/End: View data within specific date and time ranges.

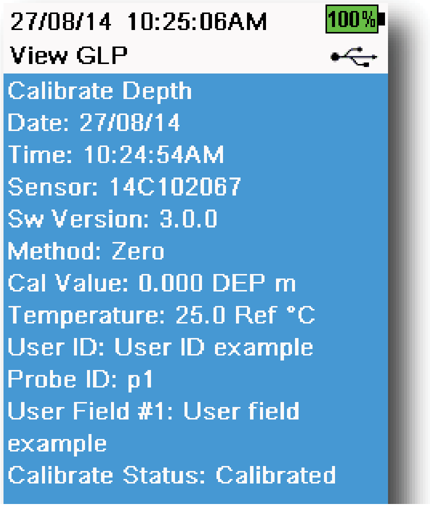


Figure 39 View GLP

View GLP

→ **View GLP**

Select **View GLP** to show the stored sensor calibrations (Figure 39).

Use the arrow keys to scroll through the GLP file data.

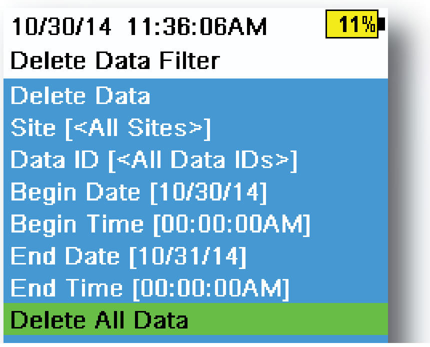


Figure 40 Delete Data Filter

Delete Data

→ **Delete Data**

Enter the desired filter criteria, then select **Delete Data** to _permanently_ delete the data (Figure 40).

> ***NOTE:*** *If filter criteria are not selected, all logged data will be permanently deleted.*

Select **Delete All Data** to _permanently_ delete _all_ logged data from the ProDSS.

Backup Data

→ **Backup Data**

A USB female to micro USB male adapter is included to directly backup files from the handheld to a standard USB storage device. The data is exported as a CSV file.

Enter the desired filter criteria then connect the handheld to the USB storage device using the supplied adapter. Select **Backup Data** to export the data to an USB storage device (Figure 41 and Figure 42).

NOTE: *The USB storage device must be formatted as FAT32, not NTFS or exFAT. The handheld will only support FAT32.*

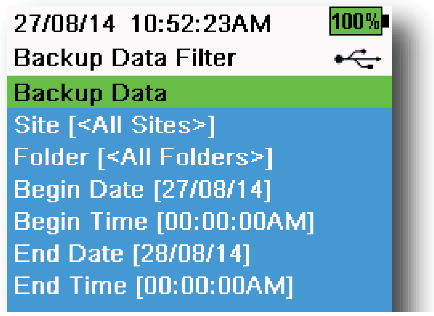


Figure 41 Backup Data

Figure 42 Micro USB female connector

Delete GLP

→ **Delete GLP**

To permanently delete the GLP file from the instrument, select **Yes**, then push the ENTER key (Figure 43).

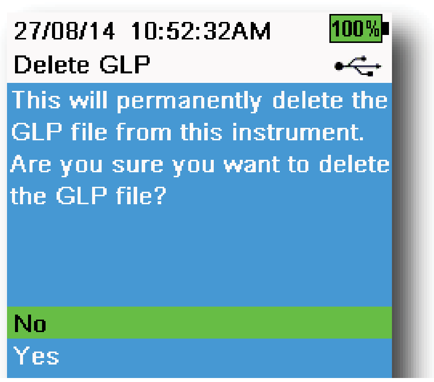


Figure 43 Delete GLP

Taking measurements

For the highest accuracy, calibrate the instrument before taking measurements (Calibration on page 33).

1. Create site and Data ID lists for logged data (if applicable) (Logging on page 19).
2. Set the logging method (single or interval) (Logging on page 19).
3. Set the Auto Stable parameters (if applicable) (Auto Stable on page 26).
4. Verify that the sensors and/or port plugs are correctly installed in all bulkhead ports (on page 8).
5. Install the sensor guard (Figure 6 on page 11).
6. Insert the sensors into the sample.

   NOTE: *Make sure to submerge the sensors completely. If using a depth sensor, submerge to where the cable assembly attaches to the bulkhead.*

7. Move the bulkhead in the sample to release any air bubbles and to provide a fresh sample to the sensors.
8. Wait for the sensor/s to stabilize in the sample.
9. If logging, select **Log One Sample** or **Start Logging** (Logging on page 19).

Calibration

ProDSS sensors (except temperature) require periodic calibration to maintain accurate measurements. Calibration procedures follow the same basic steps with variations for specific parameters.

Before calibration

- Enter GLP user-defined data if applicable to user requirements (User ID, Probe ID, User Field #1/2) (GLP menu on page 17).
- Setup sensor options, settings, and coefficients as applicable (Probe menu on page 37).

NOTICE: Install a gray port plug in all exposed ports. Exposure to water can cause damage or corrosion to the bulkhead connectors not covered by the warranty.

Calibration setup (pH, ORP, ISE, conductivity, turbidity)

NOTE: *Make sure the calibration cup, sensor guard, and all sensors are clean.*

NOTE: *If using the calibration cup, make sure to install the sensor guard before placing the sensors into the calibration cup.*

NOTE: *The sensor guard and calibration cup should be used for the turbidity and DO calibration. All other calibrations can be performed in other laboratory glassware.*

NOTE: *Make sure to use a clean probe guard during calibration to prevent contamination of the calibration environment.*

1. Install a clean, dry sensor and sensor guard (if used) onto the bulkhead (Figure 4 on page 9).

   NOTICE: Install a gray port plug in any exposed port. All sensors must have either a sensor or port plug installed.

2. Fill the calibration cup with a moderate amount of water and tighten the calibration cup onto the bulkhead. Use the water to rinse the cup and the sensor to be calibrated. Discard the rinse.
3. Thoroughly rinse the calibration cup with a small amount of the calibration standard for the sensor to be calibrated. Discard the standard.
4. Refill the calibration cup with fresh calibration standard to approximately the first line for pH, ORP, and turbidity calibration. Fill to the second line for conductivity calibration (Figure 44 on page 34).

   NOTE: *Volumes will vary. Make sure that the temperature sensor and the sensor to be calibrated are submerged in calibration solution, except when performing a DO% saturation calibration.*

   NOTE: *Be careful to avoid cross-contamination with other standards.*

   NOTE: *These rinsing recommendations are only suggested guidelines for highest data accuracy. Make sure to follow your organization Standard Operating Procedures (SOPs) for instrument calibration and operation.*

5. Immerse the sensor(s) in the standard and tighten the calibration cup onto the bulkhead.
6. Calibrate the sensor(s).

Calibration

Alternately, pH, ORP, and conductivity calibrations can be completed in a beaker or other container using the same basic procedure described above. Make sure that the temperature sensor and the sensor to be calibrated are completely submerged. When submerging the conductivity sensor, make sure that the calibration solution covers the vent hole on the side of the conductivity sensor and there is at least 25.4 mm (1 in) distance between the sides and bottom of the calibration container and the conductivity probe.

Calibration cup installation

1. Make sure the calibration cup gasket is correctly seated (Figure 44). Loosely install the retaining nut on the calibration cup.
2. Slide the calibration cup over the sensors and sensor guard.
3. Tighten the retaining nut.

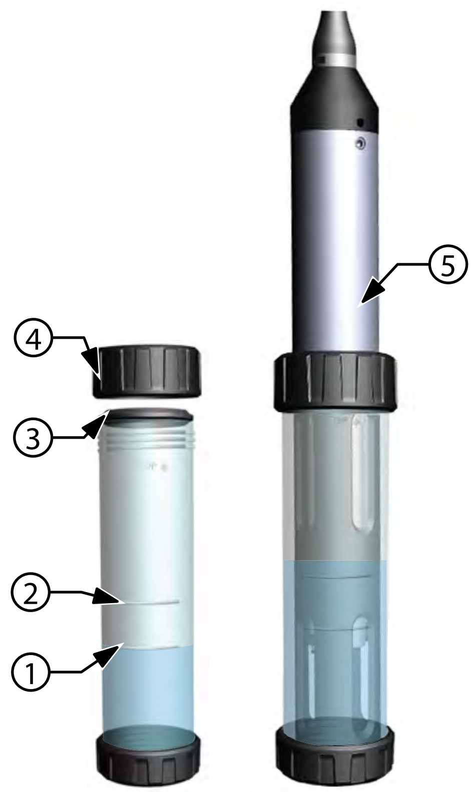


Figure 44 Calibration cup standard volume

1	Fill line one (used for Turbidity, pH, and ORP calibration solution)	**4**	Retaining nut
2	Fill line two (used for conductivity calibration solution)	**5**	Calibration cup installed
3	Gasket		

Conductivity

A conductivity/temperature sensor must be installed on the bulkhead for accurate temperature compensation and measurements of all other parameters (Figure 4 on page 9). Temperature calibration is not available or required for accurate temperature measurements.

The conductivity/temperature sensor can measure and calculate conductivity, specific conductance (temperature compensated conductivity), salinity, non-linear function (nLF) conductivity, TDS, resistivity, and density. Calibration is only available for specific conductance, conductivity, and salinity. Calibrating one of these options automatically calibrates the other conductivity/temperature parameters listed above. For both ease of use and accuracy, YSI recommends calibrating specific conductance.

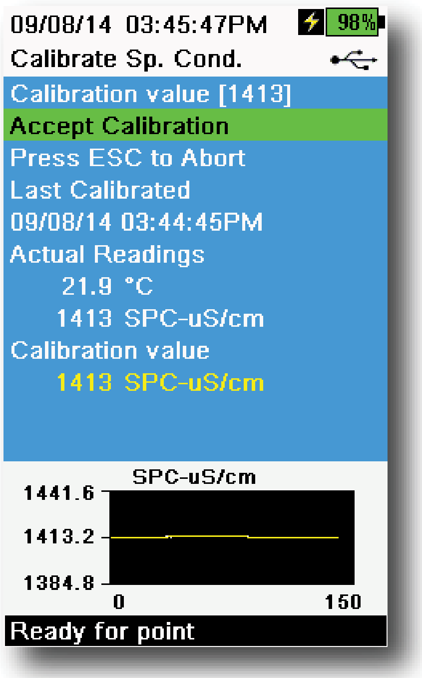


Figure 45 Calibrate specific conductance

Conductivity calibration

1. If necessary, clean the conductivity cell with the supplied soft brush. See Conductivity/temperature sensor maintenance on page 56.
2. Perform the Calibration setup (pH, ORP, ISE, conductivity, turbidity) on page 33.
3. Place the correct amount of conductivity standard (225 mL if using the calibration cup) into a clean and dry or pre-rinsed calibration cup.

   NOTE: *Select the appropriate calibration standard for the conductivity of the sampling environment. Standards greater than 1 mS/cm (1000 µs/cm) are recommended for the greatest stability. For fresh water applications, calibrate to 1,000 or 10,000 uS. For salt water applications, calibrate to 50,000 uS.*

4. Carefully immerse the sensors into the solution. Make sure the solution is above the vent holes on the side of the conductivity sensor.
5. Gently rotate and/or move the sensor up and down to remove any bubbles from the conductivity cell. Allow at least one minute for temperature equilibration before proceeding.
6. Push the Cal key, select **Conductivity**, then select **Specific Conductance**.

   NOTE: *Calibrating any conductivity calibration option will automatically calibrate the other options. Specific conductance is recommended for both ease of use and accuracy.*

7. Select **Calibration value** then enter the calibration value of the standard used. Note the measurement units the instrument is reporting and calibrating and be sure to enter in the correct calibration value for the units being used. For example, 10,000 uS = 10 mS. Make sure that the units are correct and match the units displayed on the handheld.
8. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 45). "Calibration successful!" will be displayed in the message area.

NOTE: *If the data is not stabilized after 40 seconds, gently rotate the sensor or remove/reinstall the calibration cup to make sure that no air bubbles are in the conductivity cell.*

NOTE: *If the actual measurement data is about 1/2 if the expected calibration value, the conductivity sensor is not completely submerged. Add more calibration standard to the calibration cup.*

NOTE: *If you get calibration error messages, check for proper sensor immersion, verify the calibration solutions is fresh, the correct value has been entered into the ProDSS, and/or try cleaning the sensor.*

9. Rinse the bulkhead and sensors in clean water then dry.

Barometer

The barometer is factory calibrated and should rarely need to be recalibrated. The barometer is used for DO calibration, %Local measurements, and for virtual depth measurements. Verify that the barometer is accurately reading "true" barometric pressure and recalibrate as necessary.

Laboratory barometer readings are usually "true" (uncorrected) values of air pressure and can be used "as is" for barometer calibration. Weather service readings are usually not "true", i.e. they are corrected to sea level and cannot be used until they are "uncorrected". Use this approximate formula:

True BP in mmHg=[Corrected BP in mmHg] - [2.5* (Local altitude in ft. above sea level/100)]

Example:

Corrected BP = 759 mmHg

Local altitude above sea level = 978 ft

True BP = 759 mmHg - [2.5*(978ft/100)] = 734.55 mmHg

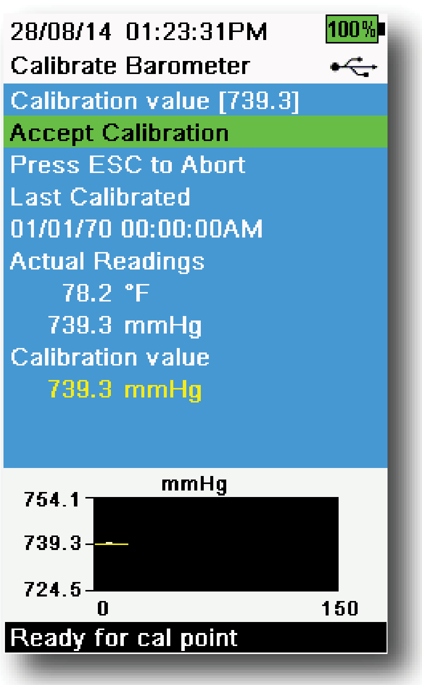


Figure 46 Calibrate Barometer

Barometer calibration

1. Push the Cal key, then select **Barometer**.

2. Select **Calibration value** then enter the correct "true" barometric pressure.

NOTE: *The measurement units during calibration are dictated by what is enabled in the sensor setup menu. Be sure to enter in the correct units.*

- BP in mmHg=25.4 x BP inHg
- BP in mmHg=0.750062 x BP mb
- BP in mmHg=51.7149 x BP psi
- BP in mmHg=7.50062 x BP kPa
- BP in mmHg=760 x BP atm

3. Select **Accept Calibration** (Figure 46). "Calibration successful!" will be displayed in the message area.

Dissolved oxygen

ODO calibration requires the current "true" barometric pressure. Make sure that the barometer is reading accurately and recalibrate the barometer as necessary.

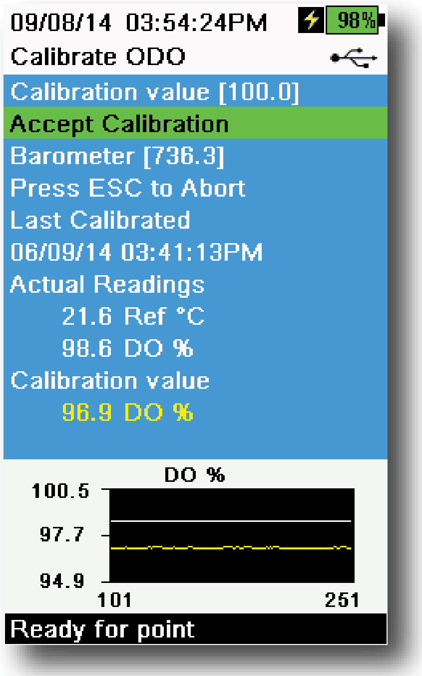


Figure 47 Calibrate ODO %

ODO% and ODO% local - water saturated air calibration

NOTE: *This method calibrates the instrument's DO% measurement or DO% Local measurement if DO% local is enabled in the sensor setup menu.*

NOTE: *Calibrating in DO% or DO% local automatically calibrates the mg/L and ppm measurement. There is no reason to calibrate both parameters. For both ease of use and accuracy, we recommend that you calibrate DO% or DO% Local and not mg/L.*

1. Place a small amount of clean water (1/8 inch) into the calibration cup.
2. Make sure there are no water droplets on the ODO sensor cap or temperature sensor.
3. Attach the sensor guard to the bulkhead and carefully place the guard/sensor into the calibration cup. Partially tighten the calibration cup to the bulkhead.

NOTE: *Do not fully tighten the calibration cup to the bulkhead. Atmospheric venting is required for accurate calibration.*

NOTE: *Make sure the ODO and temperature sensors are not immersed in water.*

4. Turn the instrument on and wait approximately 5 to 15 minutes for the air in the storage container to be completely saturated with water.
5. Push the Cal key, then select **ODO**. Select **DO%**. This will calibrate the instrument's DO% measurement or DO% Local measurement if DO% Local is enabled in the sensor setup menu.
6. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 47). "Calibration successful!" will be isplayed in the message area.

NOTE: *If you see a calibration error message, verify the barometer reading and inspect the sensor cap. Clean and/or replace the sensor cap as needed.*

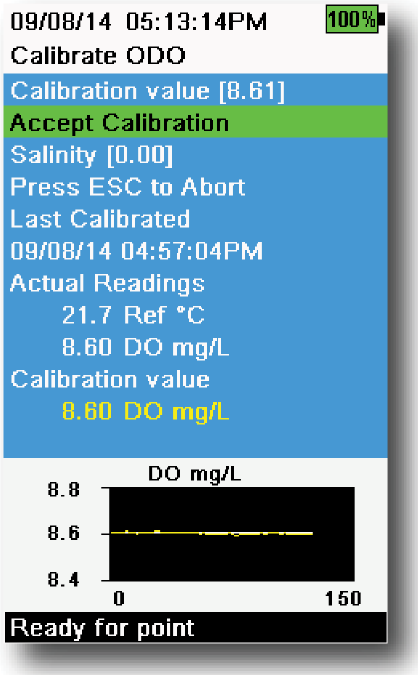


Figure 48 Calibrate ODO mg/L

ODO mg/L calibration

1. Place the ODO and conductivity/temperature sensor into a water sample that has been titrated by the Winkler method to determine the dissolved oxygen concentration in mg/L.
2. Push the Cal key, then select **ODO**. Select **DO mg/L**.
3. Select **Calibration value**.
4. Enter the dissolved oxygen concentration of the sample in mg/L.
5. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 48). "Calibration successful!" will be displayed in the message area.
6. Rinse the bulkhead and sensors in clean water then dry.

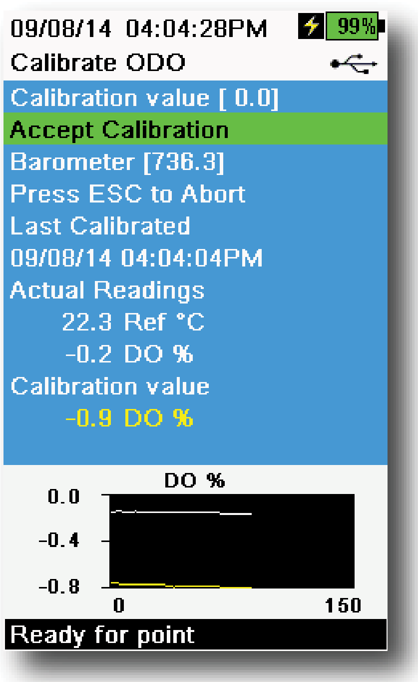


Figure 49 Calibrate ODO zero point

ODO zero point calibration

1. Place the ODO and Conductivity/Temperature sensors in a solution of zero DO.

   NOTE: *A zero DO solution can be made by dissolving approximately 8-10 grams of sodium sulfite into 500 mL of tap water. Mix the solution thoroughly. It may take the solution 60 minutes to be oxygen-free.*

2. Push the Cal key, then select **ODO**. Select **Zero**.
3. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 49). "Calibration successful!" will be displayed in the message area.
4. Thoroughly rinse the bulkhead and sensors in clean water then dry.
5. Perform a ODO % water-saturated air calibration after performing a zero point calibration.

pH/ORP

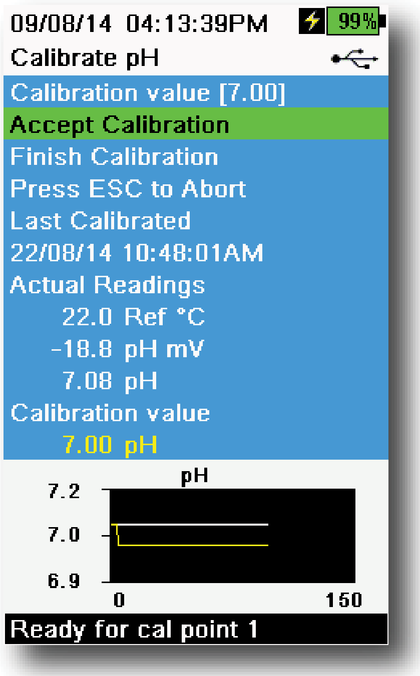


Figure 50 Calibrate pH 1-point

pH calibration 1-point

NOTE: *If performing a 1-point calibration, use buffer 7 (6.86) as your calibration point for highest accuracy.*

NOTE: *Observe the pH mV readings during calibration to understand the condition and response of the pH sensor. In buffer 7, pH mVs should be between -50 and +50. In buffer 4, the mVs should be a +165 to 185 away from the pH 7 mV value or a 59 mV per decade slope. In buffer 10, the mVs should be a -165 to -185 away from the pH 7 mV value or a -59 mV per decade slope.*

1. Perform the Calibration setup (pH, ORP, ISE, conductivity, turbidity) on page 33.
2. Fill the calibration cup to the appropriate level (170 mL) with pH 7 buffer solution (or 6.86 if using NIST buffers).
3. Carefully immerse the probe end of the sensors into the buffer solution.
4. Push the Cal key, then select **pH** or **pH/ORP**.

   NOTE: *If using a pH/ORP sensor, select* **pH/ORP***, then* **pH**.
5. Allow at least one minute for temperature stabilization, then select **Calibration value**.
6. Enter the pH buffer value that corresponds to the measured temperature reading (example: the value of pH 7 buffer solution @ 20 °C (68 °F) is 7.02 - this value can be found on the bottle of most pH buffers).
7. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 50). “Ready for cal point 2” will be displayed in the message area.
8. Select **Finish Calibration** for a 1-point calibration or continue on to the 2-3 point calibration procedure (Calibration cup installation on page 34).

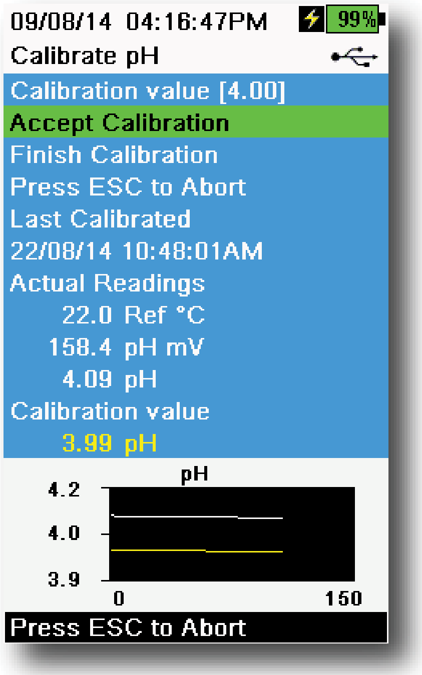


Figure 51 Calibrate pH 2- or 3-point

pH calibration 2- or 3-point

NOTE: *If performing a 2- or 3-point calibration, one point should be in buffer 7; however, the calibration points can be in any order.*

1. Perform steps 1-7 of the pH calibration 1-point procedure (pH calibration 1-point on page 39).
2. Rinse the sensor 2-3 times with a small amount of pH 4 or pH 10 buffer solution.
3. Rinse, then fill the calibration cup to the appropriate level with the buffer solution (approximately 170 mLs) that is the same value (pH 4 or pH 10) used to rinse the sensor.
4. Carefully immerse the sensors into the solution.
5. Allow at least one minute for temperature stabilization, then select **Calibration value**.
6. Enter the pH buffer value that corresponds to the buffer temperature reading (value may be located on pH buffer bottle).
7. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 51). “Ready for cal point 3” will be displayed in the message area.
8. Select **Finish Calibration** for a 2-point calibration or repeat the 2- or 3-point calibration procedure with the third buffer solution.

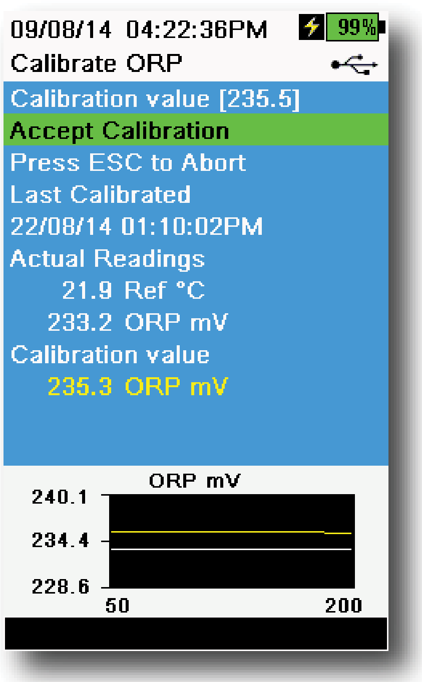


Figure 52 Calibrate ORP

ORP calibration

1. Obtain/prepare a standard with a known oxidation reduction potential (ORP) value.

   NOTE: *YSI recommends Zobell solution.*

2. Fill the solution to fill line 1 on the calibration cup (approximately 170 mLs).
3. Carefully immerse the sensors into the solution.
4. Push the Cal key, then select **pH/ORP**, then **ORP**.
5. Allow the temperature of the standard to stabilize then select **Calibration value**.
6. Enter the ORP calibration value that corresponds to the measured temperature reading (example: the value of YSI Zobell @ 20 ˚C is 237.5)
7. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 52). “Calibration successful!” will be displayed in the message area.

Depth

NOTE: *This calibration option is available only if your bulkhead is equipped with a depth sensor. The depth sensor is located where the cable connects to the bulkhead* (Figure 59 on page 54).

For the calibration, make sure that the depth sensor is clean and in air, not immersed in any solution. For highest accuracy, keep the bulkhead still and in one position while calibrating.

NOTE: *Cables 10 m and longer are supplied with a weight that can be attached to the sensor guard for sampling at water depths 10 m and greater.*

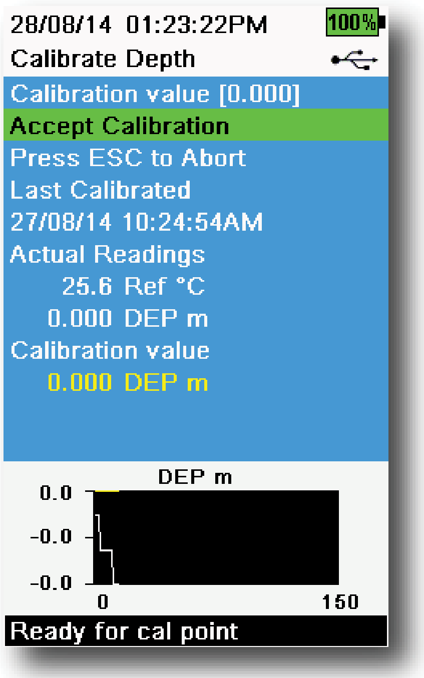


Figure 53 Calibrate Depth

Depth calibration

1. If applicable, enter the depth offset, altitude, and latitude (Figure 29 Setup Depth on page 25).

   NOTE: *Depth offset allows you to set the depth measurement to something other than zero. If the depth offset is used, the depth measurement will be adjusted by the offset after calibration. Enter the altitude and latitude of your sampling location to increase the accuracy of your depth measurement.*

2. Push the Cal key, then select **Depth**.
3. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 53). “Calibration successful!” will be displayed in the message area.

Turbidity

Before performing the calibration, review “Calibration setup (pH, ORP, ISE, conductivity, turbidity)” on page 33.

For proper calibration, you must use standards that have been prepared according to details in Standard Methods for the Treatment of Water and Wastewater (Section 2130 B).

Acceptable standards include:

- AMCO-AEPA standards prepared specifically for the ProDSS turbidity sensor manufactured by YSI (YSI turbidity standards)
- Formazin prepared according to Standard Methods, especially for calibration points greater than 1010
- Dilutions of 4000 FNU (NTU) formazin concentrate purchased from Hach
- Hach StablCal™ standards in various FNU (NTU) denominations

The use of standards other than those mentioned above will result in calibration errors and inaccurate field readings. It is important to use the same type of standard for all calibration points. (i.e. do not mix formazine and AMCO-AEPA standard for different points in a multi-point calibration).

Calibration limits

Because of the non-linear response of the turbidity sensor, calibration ranges may be limited. A 1-, 2- or 3-point calibration can be completed using the following limits:

1-point	2-point	3-point
0-1 FNU (NTU)	5-200 FNU (NTU)	400-4200 FNU (NTU)

Calibration standards

The following standards are available for the ProDSS turbidity sensor:

608000	0 (all turbidity sensors); 1 gallon
607200	12.4 FNU (NTU) (ProDSS); 1 gallon
607300	124 FNU (NTU) (ProDSS); 1 gallon
607400	1010 FNU (NTU) (ProDSS); 1 gallon

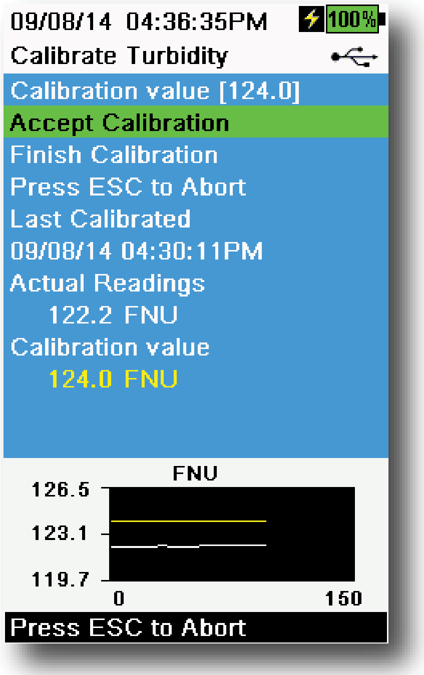


Figure 54 Calibrate turbidity

Turbidity calibration 1-, 2- or 3-point

NOTE: *The sensor guard must be installed for the turbidity sensor calibration.*

NOTE: *When performing a turbidity calibration, the first point must be zero.* Select **Calibration Value** and enter 0.00.

1. Perform the Calibration setup (pH, ORP, ISE, conductivity, turbidity) on page 33. Rinse the sensor 2-3 times with a small amount of 0 FNU (NTU) standard.
2. Fill the calibration cup to fill line one of the calibration cup (approximately 170 mLs) with 0 FNU (NTU) standard (clear deionized or distilled water is suitable). Immerse the sensors into the water.
3. Push the Cal key, then select **Turbidity**.
4. Select **Calibration Value** and enter 0.00.
5. Observe the data points readings for stability with the 0 FNU (NTU) standard (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration**. "Ready for cal point 2" will be displayed in the message area.
6. Select **Finish Calibration** to complete a 1-point calibration or continue for the 2- or 3-point calibration.
7. Rinse the sensors, calibration cup, and sensor guard 2-3 times with a small amount of standard #2. Discard the standard after each rinse.
8. Fill the calibration cup to fill line 1 with standard #2. Immerse the sensors in the second calibration standard.
9. Select **Calibration Value** and enter the value of the second calibration standard.
10. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 54). "Ready for cal point 3" will be displayed in the message area.
11. Select **Finish Calibration** to complete a 2-point calibration or continue for the 3-point calibration.
12. Rinse the sensors, calibration cup, and sensor guard 2-3 times with a small amount of standard #3. Discard the standard after each rinse.
13. Fill the calibration cup to fill line 1 with standard #3. Immerse the sensors in the third calibration standard.
14. Select **Calibration Value** and enter the value of the third calibration standard.
15. Observe the data points readings for stability, then select **Finish Calibration**. "Calibration successful!" will be displayed in the message area.
16. Rinse the sensors in clean water then dry.

ISEs: Ammonium, Nitrate, & Chloride

Before performing the calibration, review Calibration setup (pH, ORP, ISE, conductivity, turbidity) on page 33.

The ISE sensors can be calibrated to one, two or three points. A 2-point calibration without chilling a third calibration solution is extremely accurate and is the preferred method. However, if there is a large temperature variation during sampling, a chilled third calibration point is recommended.

Higher calibration accuracy can be obtained if the standards used have a least one order of magnitude difference between them. For example, 1 mg/L and 10 mg/L or 10 mg/L and 100 mg/L.

mV information for the ISE calibration

Ammonium mV values

- NH_4 1 mg/L = 0 mV +/- 20 mV (new sensor only)
- NH_4 100 mg/L = 90 to 130 mV > 1 mg/L mV value
- The mV span between 1 mg/L and 100 mg/L values should be ≈ 90 to 130 mV. The slope should be 45 to 65 mV per decade.

Nitrate mV values

- NO_3 1 mg/L = 200 mV +/- 20 mV (new sensor only)
- NO_3 100 mg/L = 90 to 130 mV < 1 mg/L mV value
- The mV span between 1 mg/L and 100 mg/L values should be ≈ 90 to 130 mV. The slope should be -45 to -65 mV per decade.

Chlroide mV values

- Cl 10 mg/L = 225 mV +/- 20 mV (new sensor only)
- Cl 1,000 mg/L = 80 to 130 mV < 10 mg/L mV value
- The mV span between 10 mg/L and 1000 mg/L values should be ≈ 80 to 130 mV. The slope should be -40 to -65 mV per decade.

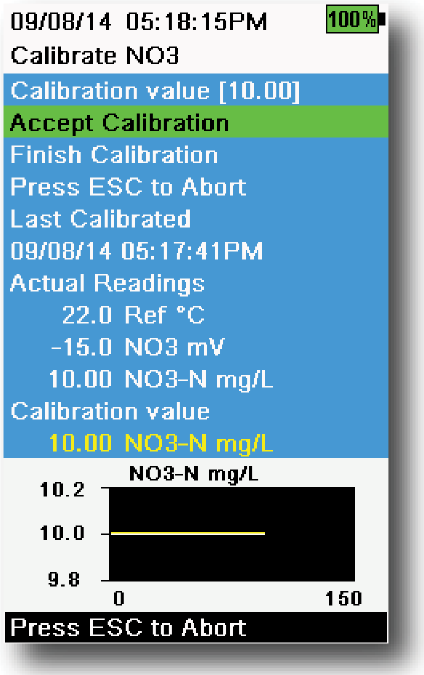


Figure 55 Calibrate ISE

ISE calibration 3-point

1. Perform the Calibration setup (pH, ORP, ISE, conductivity, turbidity) on page 33.
2. Fill the calibration cup to fill line one with standard #1 (approximately 170 mLs).
3. Push the Cal key, then select the applicable ISE sensor.
4. Carefully immerse the sensors into the standard solution.
5. Allow the temperature of the standard to stabilize, then select **Calibration value**. Enter the calibration value that corresponds to standard #1.
6. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 55). “Ready for cal point 2” will be displayed in the message area.
7. Rinse the sensor 2-3 times with a small amount of standard #2.
8. Rinse, then fill the calibration cup to fill line one with standard #2 (approximately 170 mLs).
9. Carefully immerse the sensors into the solution.
10. Allow the temperature of the solution to stabilize then select **Calibration value**. Enter the calibration value that corresponds to standard #2.
11. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 55). “Ready for cal point 3” will be displayed in the message area.
12. Rinse, then fill the calibration cup to fill line 1 with standard #3 (approximately 170 mLs).

    NOTE: *To calibrate with a chilled third standard, see* Chilled third calibration point on page 46.

13. Carefully immerse the sensor into the solution. Allow the temperature of the solution to stabilize then select **Calibration value**. Enter the calibration value that corresponds to standard #3.
14. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Finish Calibration**. “Calibration successful!” will be displayed in the message area.

Chilled third calibration point

The 3-point calibration method assures maximum accuracy when the temperature of the media to be monitored cannot be anticipated. If you must perform a chilled 3-point calibration, the following procedure requires one portion of the high concentration calibration solution and two portions of the low concentration calibration solution.

The high concentration solution and one of the low concentration solutions should be at ambient temperature. The other low concentration solution should be chilled to less than 10 °C (50 °F) to prior calibration point.

See ISE calibration 3-point on page 45.

1. When “Ready for cal point 3” is displayed in the message area during ISE calibration, place the proper amount of chilled 1 mg/L standard (10 mg/L for the chloride) into a clean, dry or pre-rinsed calibration cup.
2. Carefully immerse the sensor into the solution. Allow for temperature equilibration. If necessary, select **Calibration value** to manually enter the standard #3 value.
3. Once the readings are stable, select **Accept Calibration**. “Calibration successful!” will be displayed in the message area.

Preparing chloride standards

The following recipes are provided for preparation of 10 and 1000 mg/L chloride reagents. Nitrate and Ammonium standards can be purchased from YSI or other laboratory supply companies.

⚠ **WARNING:** Some of the chemicals required for these solutions could be hazardous under some conditions. It is the responsibility of the user to obtain and study the MSDS for each chemical and to follow the required instructions with regard to handling and disposal of these chemicals.

You will need:

- Solid sodium chloride or a certified 1000 mg/L chloride solution from a supplier
- Magnesium sulfate
- High-purity water
- A good quality analytical balance
- 1000 mL volumetric flask
- An accurate 10 mL measuring devices
- And 1000 mL glass or plastic storage vessels.

1000 mg/L Standard

1. Accurately weigh 1.655 grams of anhydrous sodium chloride and transfer into a 1000 mL volumetric flask.
2. Add 0.5 grams of anhydrous magnesium sulfate to the flask.
3. Add 500 mL of water to the flask, swirl to dissolve all of the reagents, then dilute to the volumetric mark with water.
4. Mix well by repeated inversion, then transfer the 1000 mg/L standard to a storage bottle.
5. Rinse the flask extensively with water prior to its use in the preparation of the 10 mg/L standard. Alternatively, simply add 0.5 grams of magnesium sulfate to a liter of a 1000 mg/L chloride standard from a certified supplier.

10 mg/L Standard

1. Accurately measure 10 mL of the above 1000 mg/L standard solution into a 1000 mL volumetric flask.
2. Add 0.5 grams of anhydrous magnesium sulfate to the flask.
3. Add 500 mL of water, swirl to dissolve the solid reagents, then dilute to the volumetric mark with water.
4. Mix well by repeated inversion, then transfer the 10 mg/L standard to a storage bottle.

Preparing nitrate standards

We recommend using YSI calibration solutions whenever possible. However, qualified users can save cost by following these recipes for 1 and 100 mg/L nitrate standards. Other concentrations can be made by altering the amount of potassium nitrate. All other concentrations should remain unchanged.

⚠ **CAUTION:** Some of these chemicals are hazardous and therefore, the standards should only be prepared by qualified chemists in laboratories where proper safety precautions are possible. It is the responsibility of the user to obtain and study the MSDS for each chemical and to follow the required instructions with regard to handling and disposal of these materials.

You will need:

- Solid potassium nitrate or a certified 1000 mg/l NO_3-N from a supplier
- Magnesium sulfate, high purity water
- A good quality analytical balance
- 1000 mL volumetric flask
- Accurate volumetric measuring devices for 100 mL, 10 mL and 1 mL of solution
- And 1000 mL glass or plastic storage vessels.
-

100 mg/L standard

1. Accurately weigh 0.7222 g of anhydrous potassium nitrate and transfer quantitatively into a 1000 mL volumetric flask. Add 1.0 g of anhydrous magnesium sulfate to the flask.
2. Add approximately 500 mL of water to the flask. Swirl to dissolve all of the reagents, and then dilute to the volumetric mark with distilled or deionized water.
3. Mix well by repeated inversion and then transfer the 100 mg/L standard to a storage bottle.
4. Rinse the flask extensively with water prior to its use in the preparation of the 1 mg/l standard. Alternatively, 100 mL of certified 1000 mg/L NO_3-N standard can be used in place of the solid potassium nitrate.

1 mg/L standard

1. Accurately measure 10.0 mL of the above 100 mg/L standard solution into a 1000 mL volumetric flask. Add 1.0 g of anhydrous magnesium sulfate to the flask.
2. Add approximately 500 mL of distilled or deionized water. Swirl to dissolve the solid reagents, and then dilute to the volumetric mark with water.
3. Mix well by repeated inversion and then transfer the 1 mg/L standard to a storage bottle.

NOTE: *Recipes are given for 1 and 100 mg/L. Other concentrations can be made by altering the amount of potassium nitrate. All other concentrations should remain unchanged.*

Preparing ammonium standards

We recommend using YSI calibration solutions whenever possible. However, qualified users can save cost by following these recipes for 1 and 100 mg/L standards. Other concentrations can be made by altering the amount of ammonium chloride. All other ingredient concentrations should remain unchanged.

⚠ **CAUTION:** Some of these chemicals are hazardous and therefore, the standards should only be prepared by qualified chemists in laboratories where proper safety precautions are possible. It is the responsibility of the user to obtain and study the MSDS for each chemical and to follow the required instructions with regard to handling and disposal of these materials.

You will need:

- Solid ammonium chloride or a certified 100 mg/L NH_4^+-N from a supplier
- Lithium acetate dihydrate
- Concentrated hydrochloric acid
- High purity water
- A good quality analytical balance
- A 1000 mL volumetric flask
- Accurate volumetric measuring devices for 100 mL and 10 mL of solution
- And a 1000 mL glass or plastic storage vessels.

⚠ **CAUTION:** Hydrochloric acid is highly corrosive and toxic and should therefore be handled with extreme care in a well-ventilated fume hood. The user could also add the equivalent amount of a less-hazardous, more dilute sample of the acid if preferred.)

100 mg/L Standard

1. Accurately weigh 0.3817 g of ammonium chloride and transfer quantitatively into a 1000 mL volumetric flask. Add 2.6 g of lithium acetate dihydrate to the flask.
2. Add approximately 500 mL of distilled or deionized water to the flask. Swirl to dissolve all of the reagents and then dilute to the volumetric mark with distilled or deionized water.
3. Mix well by repeated inversion and then transfer the 100 mg/L standard to a storage bottle.
4. Add 3 drops of concentrated hydrochloric acid to the bottle, then seal and agitate to assure homogeneity. Alternatively, 100 mL of certified 100 mg/L NH4+-N standard can be used in place of the solid ammonium chloride.

1 mg/L Standard

1. Accurately measure 10.0 mL of the above 100 mg/L standard solution into a 1000 mL volumetric flask. Add 2.6 g of lithium acetate dihydrate to the flask.
2. Add approximately 500 mL of distilled or deionized water. Swirl to dissolve the solid reagents and then dilute to the volumetric mark with water.
3. Mix well by repeated inversion and then transfer the 1 mg/L standard to a storage bottle.
4. Add 3 drops of concentrated hydrochloric acid to the bottle, then seal and agitate to assure homogeneity.

This page left intentionally blank

Maintenance and storage

Follow all maintenance and storage procedures in this section.

> **NOTICE:** Incorrect or unapproved maintenance and/or storage can cause handheld, sensor or cable damage not covered by the warranty.

Unless otherwise specified, storage terms are defined as follows:

Short-term storage (less than 4 weeks): Storage when the ProDSS will be used at regular intervals (daily, weekly, biweekly, etc.)

Long-term storage: Storage when the ProDSS will have long periods of inactivity (over winter, end of monitoring season, etc.)

> **NOTICE:** Perform sensor maintenance before long-term storage.

> **NOTICE:** To prevent damage, do not store sensors in corrosive solutions.

ProDSS handheld instrument

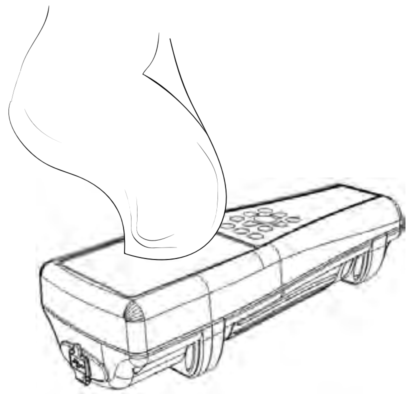


Figure 56 Handheld cleaning

Handheld instrument maintenance

Wipe the keypad, screen, and case with a cloth dampened with a mild solution of clean water and dish soap (Figure 56).

Handheld storage temperature

Optimal storage temperature of the handheld instrument:

- With battery pack installed: 0-45 °C (32-113 °F)
- Without battery pack installed: 0-60 °C (32-140 °F)

NOTICE: The battery pack permanently loses capacity at a faster rate when above 45 °C (113 °F).

Handheld short-term storage (less than 4 weeks)

Power off the handheld and store in a secure location (Startup on page 14).

Handheld long-term storage

1. Clean the handheld instrument.
2. Remove the battery pack to prevent possible battery leaks (on page 3). Reinstall the battery cover.
3. Install the protective covers on the USB and cable connectors.
4. Store the handheld and removed battery pack in a secure location. See Rechargeable Lithium-Ion battery pack safety warnings and precautions on page 79.

Cable, bulkhead, and connectors

Figure 57 Cable, bulkhead, connector maintenance

Cable, bulkhead, and connector maintenance

Wipe the bulkhead cable with a cloth dampened with a mild solution of clean water and dish soap.

NOTICE: Install sensors or port plugs so that the bulkhead ports do not get wet when cleaning. Exposure to water can cause damage or corrosion to the bulkhead connectors not covered by the warranty.

Inspect the bulkhead ports and cable connectors for contamination. If dirty or wet, clean it with compressed air (Figure 57).

Cable, bulkhead, and connector storage

Clean the connectors and bulkhead cable. Install the connector covers and the bulkhead port plugs when not in use (Port plugs on page 10).

Sensor guard

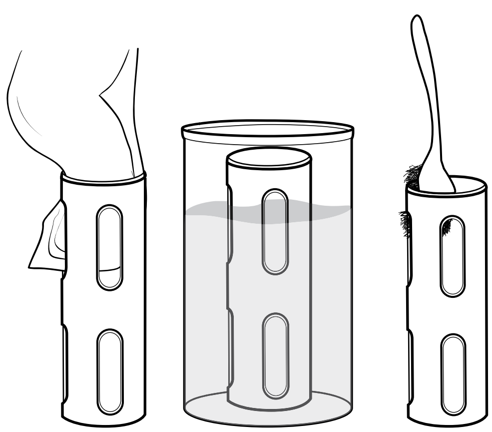


Figure 58 Sensor guard maintenance

Sensor guard maintenance

Remove minimal bio-fouling with a cloth soaked in a mild solution of clean water and dish soap (Figure 58).

Remove heavy bio-fouling by soaking the guard in a with a solution of clean water and dish soap. Soak in vinegar to remove hard growth and deposits.

Use a plastic scrub brush to remove any remaining bio-fouling. Rinse the sensor guard with clean water.

NOTICE: Do not sand or polish the guard. Removal of the guard coating can affect turbidity readings.

Depth sensor maintenance and storage

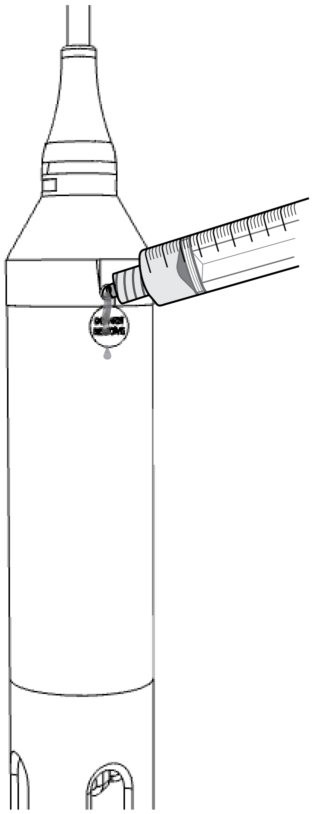


Figure 59 Depth sensor flush

Depth sensor storage

The ProDSS optional depth sensor accesses water through ports located in the bulkhead (Figure 59). Although not directly accessible, correct maintenance and storage is necessary for reliable operation.

The depth sensor can be stored dry, in water-saturated air or submerged in water.

NOTICE: To prevent damage to the sensor's strain gauge, do not store the sensor in corrosive solutions.

Depth sensor maintenance

Periodically clean the depth ports with the syringe included in the ProDSS maintenance kit (626990). Fill the syringe with clean water and gently force water into one of the ports. Flush until clean water flows from the opposite depth port.

NOTICE: Do not insert objects into the depth ports. Damage to the depth transducer from incorrect cleaning is not covered by the warranty.

Turbidity sensor

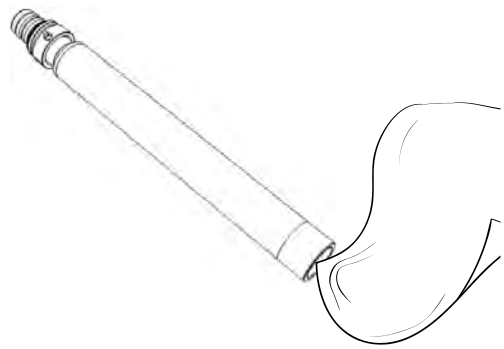


Figure 60 Turbidity sensor window

Turbidity sensor maintenance

Clean the sensing window with a non-abrasive, lint-free cloth (Figure 60).

NOTICE: Clean the window carefully to prevent scratches. If necessary, use mild soapy water.

Figure 61 Turbidity sensor storage

Turbidity sensor short-term storage (less than 4 weeks)

When in regular field use, the turbidity sensor can remain installed on the bulkhead in an environment of water-saturated air (Figure 61).

NOTE: *The turbidity sensor can be stored dry if stored separate from other sensors.*

Place approximately 0.5 in (1 cm) of any water (tap or environmental) in calibration cup.

Install the calibration cup on the bulkhead and firmly tighten to prevent evaporation.

Turbidity sensor long-term storage

Store the turbidity sensor in dry air. The turbidity sensor can be left on the bulkhead or removed for storage.

If removed from the bulkhead, install the shipping cap on the sensor to prevent scratches or damage to the optical sensing window.

NOTICE: Install a port plug into the empty port on the bulkhead.

Conductivity/temperature sensor

NOTICE: Use care when handling the conductivity/temperature sensor to prevent any impact on the exposed thermistor.

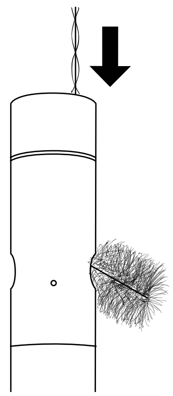


Figure 62 Channel brush

Conductivity/temperature sensor maintenance

1. Dip the sensor's cleaning brush (included with the maintenance kit) in clean water.
2. Insert the brush at the top of the channels, and sweep the channels 15 to 20 times (Figure 62).

   NOTICE: If deposits have formed on the electrodes, use a mild solution of dish soap and water to brush the channels. For heavy deposits, soak the sensor in white vinegar to assist cleaning, then scrub with the cleaning brush after soaking.

3. Rinse the channels with clean water following the sweepings or soak.

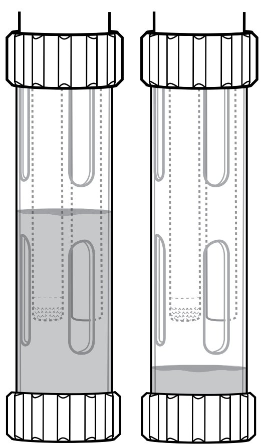


Figure 63 Conductivity/Temperature Short-term storage

Conductivity/temperature sensor short-term storage (less than 4 weeks)

When in regular field use, the conductivity/temperature sensor should remain installed on the bulkhead in a dry or water-saturated air environment.

Place approximately 0.5 in (1 cm) of any water (deionized, distilled or environmental) in calibration cup.

Install the calibration cup on the bulkhead and firmly tighten to prevent evaporation (Figure 63).

Conductivity/temperature sensor long-term storage

The Conductivity/Temperature sensor can be stored dry or wet, installed on the bulkhead or detached (Figure 64).

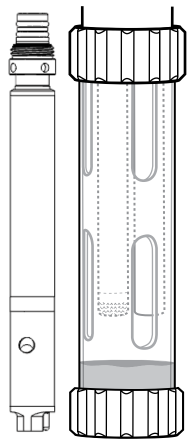


Figure 64 Conductivity/Temperature Long-term storage

Dissolved oxygen sensor

ODO sensor caps are warranted for 1 year but have a typical working life of 18 to 24 months. As the ODO sensor caps ages, large scratches in the paint/dye layer and changes in the dye layer can reduce measurement stability and response time.

Periodically inspect the sensor cap for damage and large scratches in the paint/dye layer. Replace the cap when readings become unstable and cleaning the cap and DO recalibration do not remedy the symptoms.

Cleaning the sensor cap

The sensor cap should be kept clean since some types of fouling may consume oxygen which could affect the dissolved oxygen measurements. To clean the sensor cap, gently wipe away any fouling with a lens cleaning tissue that has been moistened with water.

NOTICE: Do not use organic solvents to clean the sensor cap. Using an organic solvent to clean the sensor cap may cause permanent damage to the cap. For example, alcohol will dissolve the outer paint layer and other organic solvents will likely dissolve the dye in the cap.

ODO sensor cap replacement

The sensor cap should be replaced about once per year but may last longer. It should also be replaced if it is cracked or damaged. The instruction sheet shipped with the replacement ODO sensor cap includes the calibration coefficients specific to your sensor cap.

***NOTE:** Make sure to save the ODO sensor cap instruction sheet in case you need to reload the calibration coefficients.*

***NOTE:** The replacement ODO sensor cap is shipped in a humidified container and the package should not be opened until immediately before sensor cap replacement.*

Once the sensor cap has been installed on the ODO sensor, it is important to keep the sensor in a 100% humid environment. If the sensor dries out, refer to the rehydration procedure (ODO sensor rehydration on page 60).

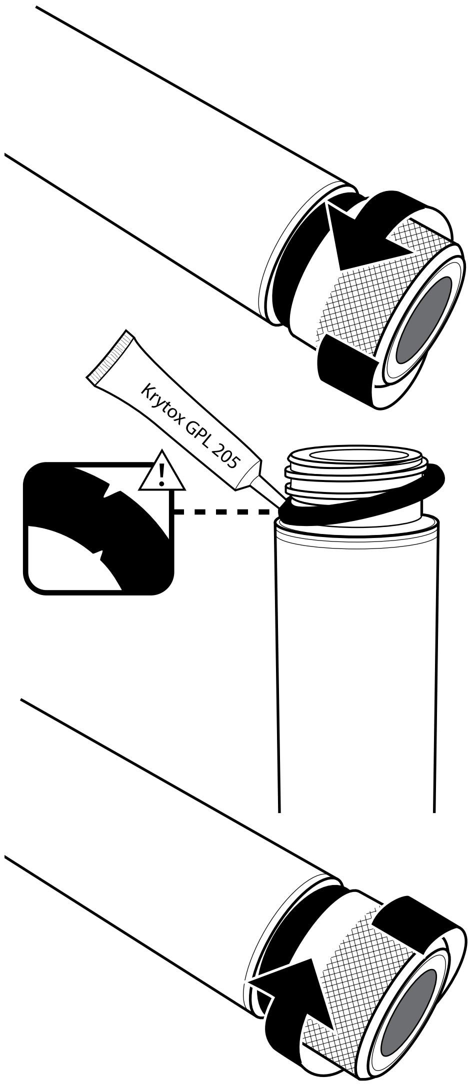


Figure 65 ODO cap replacement

ODO sensor cap replacement (continued)

1. Turn the used sensor cap counterclockwise to remove it from the sensor.

   NOTE: If possible, do not use a tool to remove the cap from the sensor. If necessary, carefully turn the cap counterclockwise with pliers until it breaks loose. Do not use the pliers on the sensor body. Make sure to not damage the sensor cap threads.

2. Without using tools, remove the used o-ring from the sensor body (pinch the o-ring out, then roll it upward over the threads), then discard it.
3. Clean the sensor threads with a clean, lint-free cloth.
4. Visually inspect the new o-ring for nicks, tears, contaminants or particles. Discard damaged o-rings.
5. Without twisting it, carefully install the new o-ring over the threads and into the o-ring groove.
6. Apply a thin coat of Krytox to the o-ring only. Wipe any excess from the threads and sensor body.
7. Clean the sensor window with a clean, lint-free cloth.
8. Make sure the new sensor cap cavity is completely dry, then carefully finger-tighten the cap clockwise onto the sensor. The o-ring should be compressed between the sensor cap and body, not pinched.

   NOTICE: Do not over-tighten the sensor cap. Do not use tools.

9. Store the ODO sensor in a moist environment.

   NOTE: If the o-ring is pinched, remove and discard it. Repeat steps 3 to 8.

Updating the ODO sensor cap coefficients

After installing a new sensor cap, connect the bulkhead cable assembly to the ProDSS instrument and turn the instrument on. Locate the Calibration Code Label on the ODO sensor cap instruction sheet and note the six numbers which are listed as K1 through K5 and KC. These six numbers contain the calibration code for this particular sensor cap.

Follow the procedures below to enter the new calibration coefficients into the instrument.

1. Push the Probe key to access the Sensor menu, then select **Setup**, then **ODO**.
2. Select **Sensor Cap Coefficients**.
3. Highlight each coefficient in turn (K1 through KC) and use the numeric entry screen to enter the corresponding new coefficient from the Calibration Code Label. Push the ENTER key after each entry and then proceed to the next K selection.
4. After all the new coefficients have been entered, select **Update Sensor Cap Coefficients**.
5. A message will appear warning that you will be overwriting the current sensor cap coefficients and you should confirm that you wish to carry out this action. Select **Yes** to confirm the new coefficients.

After updating the Coefficients, the Serial # in the Sensor Cap menu will be updated automatically based on your entries. If errors are made in entering the Sensor Cap Coefficients, the instrument will block the update and an error message will appear on the display.

If you see this error message, re-enter the coefficients and check them carefully for correct transcription from the Calibration Code Label prior to selecting Update Sensor Cap Coefficients. If you receive an error message after several entry attempts, contact YSI Technical Support for assistance.

After entering the new Sensor Cap coefficients, perform a 1-point DO calibration (ODO% and ODO% local - water saturated air calibration on page 37).

ODO sensor maintenance

Clean the sensing window with a non-abrasive, lint-free cloth (Figure 66).

NOTICE: Clean the window carefully to prevent scratches. Do not use organic solvents to clean the ODO sensor or sensor cap.

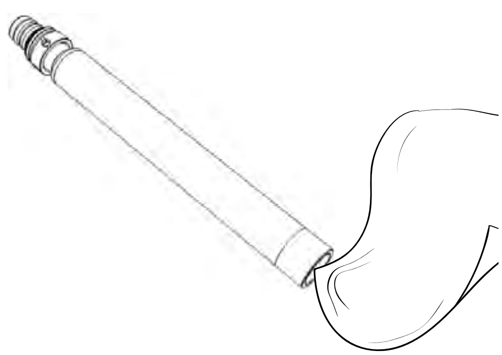


Figure 66 ODO sensor window

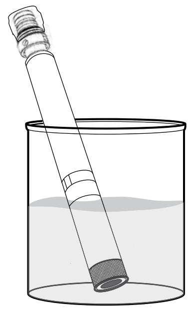


Figure 67 ODO rehydration

ODO sensor rehydration

To prevent sensor drift, always store the ODO sensor in a wet or water-saturated air environment. If the ODO sensor has accidentally been left dry for longer than 8 hours, it must be rehydrated.

If rehydration is necessary, soak the ODO sensor cap in warm (room temperature) tap water for approximately 24 hours. After the soak, calibrate the sensor (Figure 67).

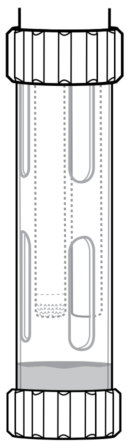


Figure 68 ODO short-term storage

ODO sensor short-term storage (less than 4 weeks)

When in regular field use, the ODO sensor should remain installed on the bulkhead. Place approximately 0.5 in (1 cm) of any water (tap or environmental) in the calibration cup (Figure 68).

Install the calibration cup onto the bulkhead and firmly tighten to prevent evaporation.

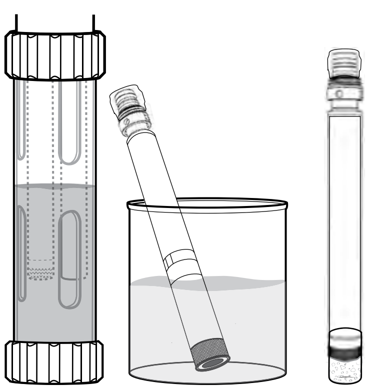


Figure 69 ODO long-term storage

ODO sensor long-term storage

The ODO sensor can be left on the bulkhead or removed for long-term storage (Figure 69).

Installed on bulkhead

Fill the calibration cup with clean water (use distilled or deionized water if a pH sensor is not installed). Submerge the sensor in the calibration cup then firmly tighten to prevent evaporation.

Removed from bulkhead

Remove the sensor from the bulkhead (Sensor removal on page 10).

Method 1 : Cover the sensor connector end with the plastic storage cap. Submerge the sensing end of the sensor in a container of clean water (use distilled or deionized water if a pH sensor is not installed). Periodically check the level of the water to make sure that it does not evaporate.

Method 2: Wet the sponge located in the cap originally included with the ODO sensor, then install on sensing end of the ODO sensor. Replace the sponge if it becomes dirty.

pH - pH/ORP sensors

NOTE: *pH and pH/ORP sensors require periodic maintenance to clear contamination from the sensing elements. These contaminants can slow sensor response time. Clean the sensors when deposits, bio-fouling or other contamination appears on the glass or when the sensor response time is noticeably slow.*

NOTICE: Do not physically scrub or swab the glass bulb. The bulbs are fragile and will break if pressed with sufficient force.

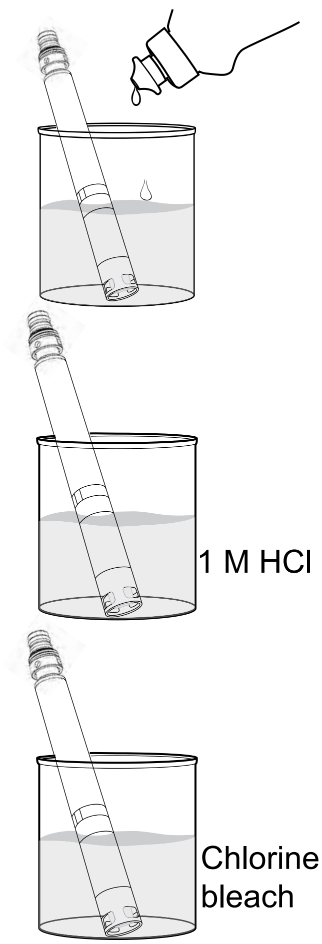


Figure 70 pH and pH/ORP sensor maintenance

pH - pH/ORP sensor maintenance

1. Remove the sensor from the bulkhead and soak for 10 to 15 minutes in a mild solution of clean water and dish soap (Figure 70).
2. Rinse the sensor with clean tap water and inspect.
3. If contaminants are removed, attach the sensor to the bulkhead and test the response time (ProDSS sensor installation/removal on page 9).

   OR
   If contaminants remain or response time does not improve, continue to the hydrochloric acid (HCl) soak in step 4.

4. Soak the sensor for 30 to 60 minutes in one molar (1 M) HCl.

   NOTE: *HCl reagent can be purchased from most chemical or laboratory distributors. If HCl is not available, soak in white vinegar.*

⚠ **CAUTION:** To prevent injury, carefully follow the HCl manufacturer's instructions.

5. Rinse the sensor in clean tap water.
6. Soak the sensor in clean tap water for 60 minutes, stirring occasionally. Repeat the clean tap water rinse.
7. Attach the sensor to the bulkhead and test the response time. If response time does not improve or biological contamination of the reference junction is suspected, continue to the chlorine bleach soak in step 8.
8. Soak the sensor for approximately one hour in a 1:1 dilution of chlorine bleach and tap water.
9. Rinse the sensor with clean tap water.
10. Soak the sensor in clean tap water for one hour or longer. Repeat the clean tap water rinse.

Maintenance and storage

pH - pH/ORP sensor storage

The pH - pH/ORP sensors are shipped with their tips in a storage bottle containing KCl. Store the pH - pH/ORP sensors in the shipping container when not in use.

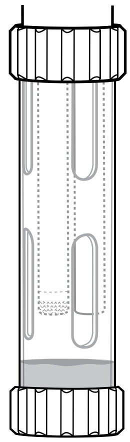


Figure 71 pH - pH/ORP short-term storage

pH - pH/ORP sensor short-term storage (less than 4 weeks)

When in regular field use, the pH-pH/ORP sensors should remain installed on the bulkhead. Place approximately 0.5 in (1 cm) of any water (tap or environmental) in the calibration cup (Figure 71).

Install the calibration cup onto the bulkhead and firmly tighten to prevent evaporation.

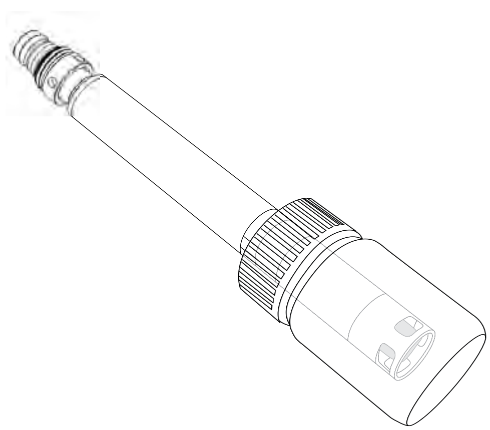


Figure 72 pH - pH/ORP long-term storage

pH - pH/ORP sensor long-term storage

Remove the sensor from the bulkhead and insert the sensing end into the shipping bottle. Install the bottle o-ring and tighten (Figure 72).

The shipping bottle contains a 2 molar solution of pH 4 buffer. If this solution is not available, store the sensor in tap water.

NOTICE: To prevent damage, do not store the pH - pH/ORP sensors in Zobell solution or DI water.

ISE sensors

Do not let the ISE sensor reference electrode junctions dry out. Clean the sensors when deposits, bio-fouling or other contamination appears on the membrane.

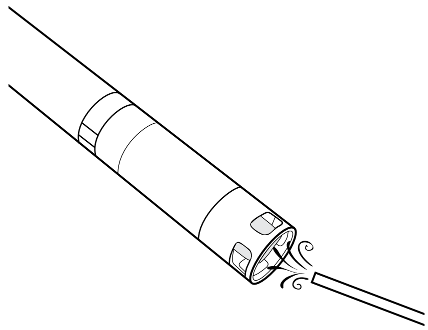


Figure 73 Ammonium and nitrate maintenance

Ammonium and nitrate sensor maintenance

1. Carefully clean the ammonium or nitrate sensor by using a fine jet of DI water or rinsing in alcohol followed by soaking in the high standard calibration solution (Figure 73).
2. Carefully dab the sensor dry with a clean, lint-free cloth.

   NOTICE: The ion-selective membranes are very fragile. Do not use coarse material (e.g. paper towels) to clean the membranes or permanent damage to the sensor can occur. The only exception is fine emery cloth on the chloride sensor.

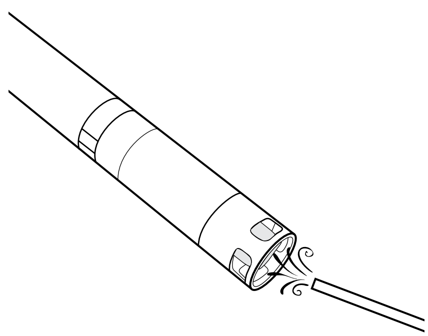


Figure 74 Chloride maintenance

Chloride sensor maintenance

Carefully clean the chloride sensor by rinsing with alcohol and/or carefully polishing with fine emery paper in a circular motion to remove deposits or discoloration (Figure 74).

Carefully rinse with DI water to remove any debris.

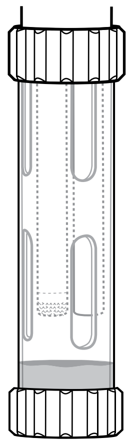


Figure 75 ISE short-term storage

ISE sensor short-term storage (less than 4 weeks)

When in regular field use, the ISE sensors should remain installed on the bulkhead in an environment of water-saturated air. Place approximately 0.5 in (1 cm) of any water (deionized, distilled or environmental) in the calibration cup (Figure 75).

Install the calibration cup onto the bulkhead and firmly tighten to prevent evaporation.

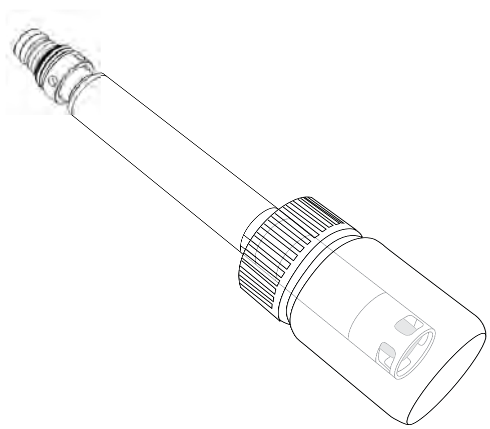


Figure 76 ISE long-term storage

ISE sensor long-term storage

NOTICE: Do not let the ISE junctions dry out. Junctions that have been allowed to dry out by improper storage may be irreparably damaged by dehydration and will require replacement.

1. Place a small amount of high-calibration solution or tap water in the storage bottle originally included with the sensor.
2. Remove the sensor from the bulkhead and insert the sensing end into the shipping bottle.
3. Install the bottle o-ring and tighten (Figure 76).

NOTICE: The sensors should not be immersed in water.

NOTICE: Do not store the ISE sensors in conductivity standard, pH buffer or salt water.

Rehydrating the reference junction

If an ISE sensor has been allowed to dry, soak the sensor for several hours (preferably overnight) in the sensor's high-calibration solution. If the sensor is irreparably damaged, the sensor module must be replaced.

ProDSS sensor module replacement

ProDSS pH, pH/ORP, ammonium, chloride and nitrate sensors feature replaceable sensor modules. These modules can be replaced by the user as needed. Typical working life of a pH or pH/ORP sensor module is 18 to 24 months. Typical working life of ammonium, chloride and nitrate sensor modules is 4 to 8 months.

Perform the pH - pH/ORP and ISE sensor module replacement in a clean, dry laboratory environment.

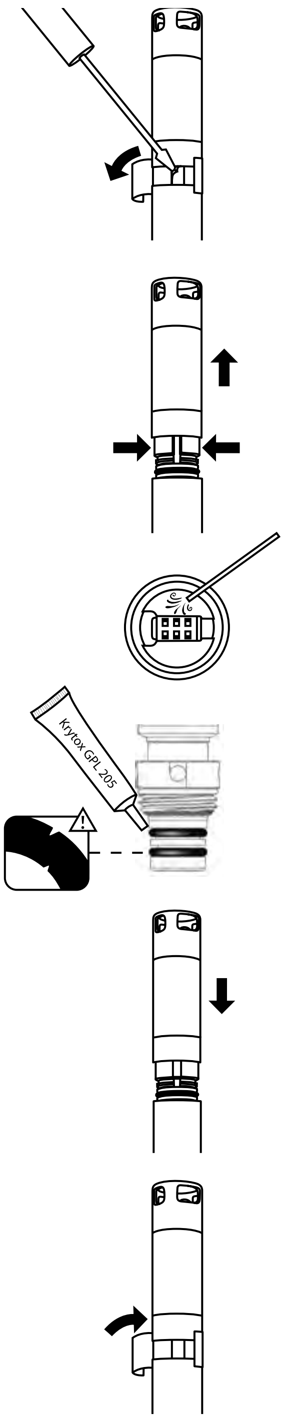


Figure 77 pH - pH/ORP sensor module replacement

Module replacement

1. Peel off and discard the sticker that covers the junction of the sensor body and the module (Figure 77).
2. With a small, flat-blade screwdriver, carefully remove the small rubber plug from the gap in the hard plastic ring at the base of the sensor module.
3. Using two fingers, squeeze the sensor module’s hard plastic ring so that it compresses the gap left by the rubber plug.
4. Steadily pull the sensor module straight from the sensor body, rocking slightly if necessary.

   NOTICE: The o-ring is unusable after removal from the sensor body. Do not reinstall the removed sensor module or o-ring after removal. Dispose of the module according to you organization’s guidelines or return it to YSI for recycling (Service information on page 81).

5. Inspect the sensor connector port for debris or moisture. If detected, remove it with lint-free cloth or a light blast of compressed air.
6. Visually inspect the two new o-rings for nicks, tears, contaminants or particles. Discard damaged o-rings.
7. Without twisting, carefully install the new o-rings over the threads and into the o-ring grooves.
8. Apply a thin coat of Krytox to the o-rings only. Wipe any excess from the threads and sensor module.

   NOTICE: If a sensor module is removed for any reason, the o-rings must be replaced.

9. Align the prongs on the base of the sensor module with the slots in the sensor body. The sensor module is keyed to insert in only one orientation.
10. Push the sensor module firmly into position until it clicks. Wipe any excess Krytox from the assembled components.
11. Wrap the junction of the sensor module and sensor body with the new sticker included in the sensor module kit. The sticker helps keep the sensor module junction clean and retain the rubber plug throughout deployment.
12. Write the replacement date on the sticker.
13. Calibrate the sensor (pH/ORP on page 39 or ISE calibration 3-point on page 45).

This page left intentionally blank

KorDSS software installation

NOTE: YSI recommends that you have administrative privileges on the PC in which KorDSS will be installed.

Follow these steps to complete the KorDSS installation process:

1. Install the KorDSS software from the USB flash drive included with the instrument.
2. Install the ProDSS instrument driver.
3. Start KorDSS for the first time and complete the KorDSS Startup Wizard.

System requirements

Supported 32 bit (x86) Microsoft Operating Systems:

- Microsoft Windows XP Home SP3
- Microsoft Windows XP Professional SP3
- Microsoft Windows 7 Home Basic SP1
- Microsoft Windows 7 Home Premium SP1
- Microsoft Windows 7 Professional SP1
- Microsoft Windows 7 Enterprise SP1
- Microsoft Windows 7 Ultimate SP1
- Microsoft Windows 8/8.1
- Microsoft Windows 8/8.1 Professional
- Microsoft Windows 8/8.1 Enterprise

Supported 64 bit (x64) Microsoft Operating Systems:

- Microsoft Windows 7 Home Basic SP1
- Microsoft Windows 7 Home Premium SP1
- Microsoft Windows 7 Professional SP1
- Microsoft Windows 7 Enterprise SP1
- Microsoft Windows 7 Ultimate SP1
- Microsoft Windows 8/8.1
- Microsoft Windows 8/8.1 Professional
- Microsoft Windows 8/8.1 Enterprise

Ram Memory Requirement:

- Minimum of 2 GB of RAM installed

Hard Disk Free Space:

- Minimum of 500 MB of free hard drive space

Internet Access Required to Support:

- Software and device updates, software licensing, and maps

KorDSS software installation

Install the KorDSS software

1. Insert the supplied USB flash drive into a USB port on your computer.
2. Depending on the PC operating system and system settings, the KorDSS Installer Guide may appear. If it does not appear, double-click **Start.exe** to start the installer guide (Figure 78).

NOTE: *If desired, view the ProDSS User Manual or the end-user license agreement.*

Figure 78 KorDSS Installer Guide

3. Click **Install** on the KorDSS Installer Guide.
4. Check the license agreement box. Click **Install** (Figure 79).

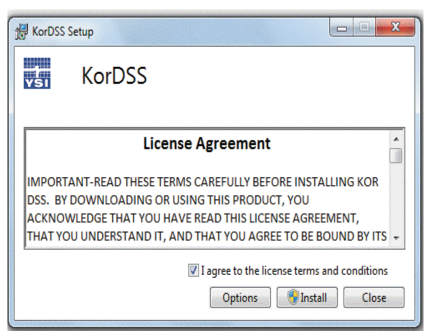


Figure 79 KorDSS license agreement

5. You may be asked if you want to allow a program from an unknown publisher to make changes on the computer. If so, select **Yes**.

KorDSS is now installed. Before using KorDSS to manage data, you must install the driver for the ProDSS instrument on your PC.

ProDSS driver installation

NOTE: *The ProDSS driver installation procedure allows the KorDSS software to recognize the instrument. To connect more than one ProDSS instrument to KorDSS, perform the driver installation procedure for each additional instrument.*

The driver installation procedure is different for each operating system. Follow the applicable installation procedure carefully.

Windows XP ProDSS driver on page 70
Windows 8 and 8.1 ProDSS driver on page 71

Windows 7 ProDSS driver

1. Turn the instrument on and connect it to the PC with the included USB cable.

If a message appears indicating successful download of the driver, proceed to the KorDSS Startup Wizard (page 72).

If you do not see a message indicating the successful download of the driver or if you see a message indicating unsuccessful download of the driver, continue this driver installation procedure.

2. Open the Device Manager. To access: Click the **Start** button, click **Control Panel**, click **System and Security**, and then, under **System**, click **Device Manager**.
3. Under **Other devices**, right click on **smxUSBD Serial Emulator** and select **Update Driver Software** (Figure 80).

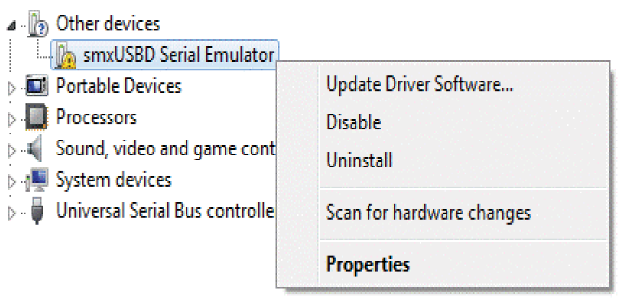


Figure 80 Device Manager Windows 7

4. Click **Browse my computer for driver software**.
5. Click **Browse**, then navigate to the file location: **C:\Program Files (x86)\YSI\KorDSS** for 64 bit systems or **C:\Program Files\YSI\KorDSS** for 32 bit systems. Click **Next**.
6. A warning will appear indicating that Windows can't verify the publisher of the driver software. Select **Install this driver software anyway**.
7. After driver installation, proceed to the KorDSS Startup Wizard (page 72).

Windows XP ProDSS driver

1. Turn the instrument on and connect it to the PC with the included USB cable.
2. On the **Found New Hardware Wizard** window, select **No, not at this time** when asked if Windows can connect to Windows Update. Click **Next**.
3. Select **Install from a list or specific location**, then click **Next**.
4. Select **Search for the best driver in these locations**, then **Include this location in the search:**. Click **Browse**, then navigate to the file location: **C:\Program Files (x86)\YSI\KorDSS** for 64 bit systems or **C:\Program Files\YSI\KorDSS** for 32 bit systems (Figure 81). Click **Next**.

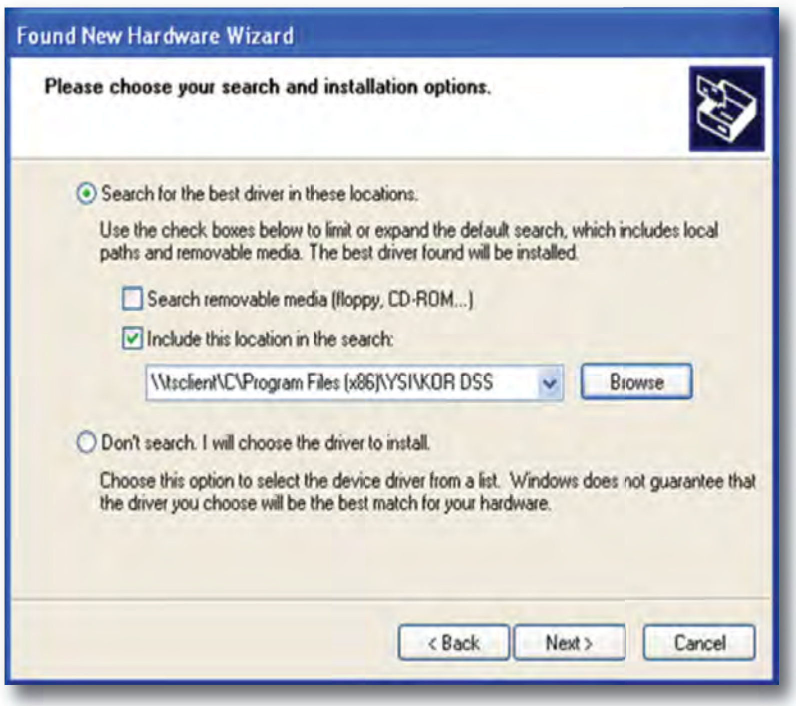


Figure 81 Found New Hardware Wizard file location

5. Select **Continue Anyway** when warned that the software has not passed Windows Logo testing.
6. Click **Finish** to close the New Hardware Wizard.
7. After driver installation, proceed to the KorDSS Startup Wizard (page 72).

Windows 8 and 8.1 ProDSS driver

1. Save any open files and close all programs. Your computer will restart during this process.
2. Open **Settings** by moving the computer mouse to the bottom right corner of the computer screen. If using a touch screen, swipe the screen from the right to reveal the Settings charm. Alternately, settings can be opened by pressing the Windows key + I.
3. Complete the following navigation steps under Settings:

- For Windows 8.1: **Change PC Settings** → **Update and Recovery** → **Advanced Setup** → **Restart now**
- For Windows 8: **Change PC Settings** → **General** → **Advanced Setup** → **Restart now**

4. When the **Choose an option** appears, select **Troubleshoot**, then **Advanced Options**.
5. Select **Startup Settings**, then **Restart**.
6. After the computer reboots, the **Startup Settings** screen will be shown. Use the **F7** or **7** key to select **Disable driver signature enforcement**.
7. Connect the ProDSS to the PC with the included USB cable. After connection, turn the instrument on.
8. Open Device Manager by pressing the Windows Key + X to open the Start Menu, then selecting **Device Manager**. Alternately, search for **devmgmt**, then select **Device Manager**.
9. Under **Other devices**, right click on **smxUSBD Serial Emulator** and select **Update Driver Software** (Figure 82).

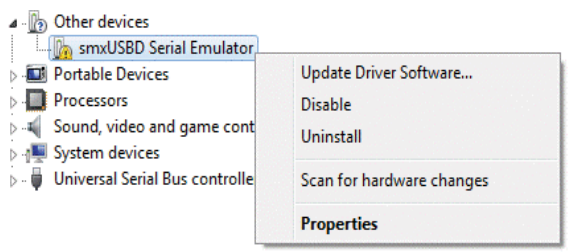


Figure 82 Device Manager Windows 8/8.1

10. Click **Browse my computer for driver software**.
11. Click **Browse**, then navigate to the file location: **C:\Program Files (x86)\YSI\KorDSS** for 64 bit systems or **C:\Program Files\YSI\KorDSS** for 32 bit systems (Figure 83). Click **Next**.

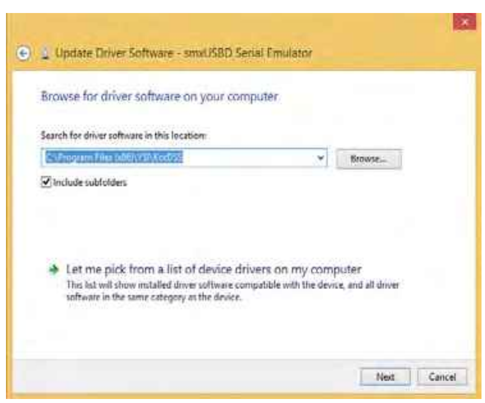


Figure 83 Driver location Windows 8/8.1

12. A warning will appear indicating that Windows can't verify the publisher of the driver software. Select **Install this driver software anyway**.
13. After driver installation, reboot the computer, then proceed to the KorDSS Startup Wizard (page 72).

KorDSS startup wizard

1. After Windows has successfully updated the driver software, start KorDSS and set the language preference (Figure 84). Click **Next**.

Figure 84 KorDSS language preference

2. On the Software Licensing Mode screen, select **Premium Mode** if you would like to view sampling locations on a map (internet connection required) (Figure 85). To upgrade to Premium Mode for free, follow the link, register your ProDSS, then use the code sent to you via email to upgrade to the Premium Mode. You can upgrade to Premium Mode at any time by going to the File tab in KorDSS.

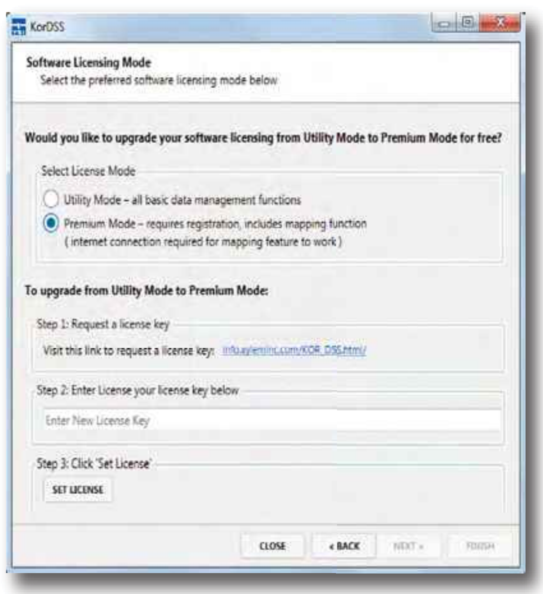


Figure 85 Software licensing mode screen

3. Select your ProDSS and KorDSS update preference to finish the installation process. Consult the HTML help file, found under the File tab of the KorDSS software, for a complete description of all KorDSS features.

Accessories

Ordering

Telephone: 800 897 4151 (USA)

+1 937 767 7241 (Globally) Monday through Friday, 8:00 AM to 5:00 ET

Fax: +1 937 767 9353 (orders)

Email: info@ysi.com

Mail: YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA

Internet: ysi.com

When placing an order please have the following available:

1. YSI account number (if available)
2. Name and phone number
3. Purchase Order or Credit Card number
4. Model Number or brief description
5. Billing and shipping addresses
6. Quantity

ProDSS handhelds

YSI Item #	Description
626870-1	ProDSS handheld, no GPS
626870-2	ProDSS handheld with GPS

ProDSS cable assemblies (No sensors included)

YSI Item #	Description
626909-1	DSS-1 meter 4 port cable assembly, no depth
626909-4	DSS-4 meter 4 port cable assembly, no depth
626909-10	DSS-10 meter 4 port cable assembly, no depth
626909-20	DSS-20 meter 4 port cable assembly, no depth
626909-30	DSS-30 meter 4 port cable assembly, no depth
626909-40	DSS-40 meter 4 port cable assembly, no depth
626909-50	DSS-50 meter 4 port cable assembly, no depth
626909-60	DSS-60 meter 4 port cable assembly, no depth
626909-70	DSS-70 meter 4 port cable assembly, no depth
626909-80	DSS-80 meter 4 port cable assembly, no depth
626909-90	DSS-90 meter 4 port cable assembly, no depth
626909-100	DSS-100 meter 4 port cable assembly, no depth
626910-1	DSS-1 meter 4 port cable assembly, with depth
626910-4	DSS-4 meter 4 port cable assembly, with depth
626910-10	DSS-10 meter 4 port cable assembly, with depth
626911-20	DSS-20 meter 4 port cable assembly, with depth
626911-30	DSS-30 meter 4 port cable assembly, with depth
626911-40	DSS-40 meter 4 port cable assembly, with depth
626911-50	DSS-50 meter 4 port cable assembly, with depth
626911-60	DSS-60 meter 4 port cable assembly, with depth
626911-70	DSS-70 meter 4 port cable assembly, with depth
626911-80	DSS-80 meter 4 port cable assembly, with depth
626911-90	DSS-90 meter 4 port cable assembly, with depth
626911-100	DSS-100 meter 4 port cable assembly, with depth

ODO/OBOD sensor and cable assemblies - DO/Temp only

NOTE: *ODO/OBOD cable assemblies feature non-replaceable temperature and optical DO sensors* with replaceable DO sensor caps (626320 for ODO cable assemblies; 626482 for OBOD cable assemblies). There is no depth option with ODO/OBOD cables.

YSI Item #	Description
626250-1	ODO-1 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-4	ODO-4 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-10	ODO-10 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-20	ODO-20 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-30	ODO-30 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-40	ODO-40 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-50	ODO-50 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-60	ODO-60 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-100	ODO-100 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626400	ProOBOD BOD probe/cable assembly, lab probe; U.S./Japanese version with power supply
626401	ProOBOD BOD probe/cable assembly, lab probe; International version with power supply

ProDSS smart sensors

YSI Item #	Description
626900	ProDSS Optical Dissolved Oxygen sensor
626902	ProDSS conductivity and temperature sensor
626901	ProDSS turbidity sensor
626903	ProDSS pH sensor with module
626904	ProDSS pH/ORP sensor with module
626906	ProDSS ammonium sensor with module
626905	ProDSS nitrate sensor with module
626907	ProDSS chloride sensor with module

Replacement sensor modules and ODO sensor caps

YSI Item #	Description
626890	Replacement ProDSS Optical Dissolved Oxygen sensor cap (for 626900 smart sensor)
626320	Replacement ODO Optical Dissolved Oxygen sensor cap (for 626250 probe/cable assemblies)
626482	Replacement OBOD Optical Dissolved Oxygen sensor cap (for 626400 or 626401 lab probes)
626963	Replacement ProDSS pH sensor module
626964	Replacement ProDSS pH/ORP sensor module
626966	Replacement ProDSS Ammonium sensor module
626965	Replacement ProDSS Nitrate sensor module
626967	Replacement ProDSS Chloride sensor module

ProDSS accessories

YSI Item #	Description
626946	Large, hard-sided carrying case
603075	Large, soft-sided carrying case
626945	Small, hard-sided carrying case (fits 1- and 4-meter cables)
599080	Flow cell
603056	Flow cell mounting spike
063507	Tripod (screws into back of meter)
063517	Ultra clamp (screws into back of meter)
603070	Shoulder strap
603069	Belt clip (screws into back of meter)
626942	USB car charger
626943	Small external Li-Ion rechargeable battery pack (Typical performance: will charge a completely discharged ProDSS battery to about 50%)
626944	Large external Li-Ion rechargeable battery pack (Typical performance: will charge a completely discharged ProDSS battery to full charge, plus have power to charge a second battery to 20%)
626940	AC charger (USA). Includes power supply and USB cable (included with ProDSS handheld)
626941	AC charger (international). Includes power supply, USB cable and outlet adapters (included with ProDSS handheld)
626846	Replacement Lithium-ion battery pack
626969	ProDSS USB flash drive (included with ProDSS handheld)
626991	Cable for charging and PC connection (included as part of 626940 and 626941)
626992	Cable for connection to USB drive (included with ProDSS handheld)
626990	ProDSS maintenance kit (included with all ProDSS cables): • 3 port plugs • 1 Krytox tube • 1 brush • 1 syringe • 1 sensor installation/removal tool • O-rings (6)
626919	Sensor guard for 4 port ProDSS cable assembly (included with all ProDSS cables)
599786	Calibration/storage cup for 4 port ProDSS cable assembly (included with all ProDSS cables)
603062	Cable management kit (included with any ProDSS cable 10, 20, or 30-meters long; included with any ODO cable 4, 10, 20, or 30-meters long)
626918	1 lb weight (included with any ProDSS cable 10-meters and longer)
605978	4.9 oz weight

Calibration standards

YSI Item #	Description
065270	Conductivity standard, 1000 µmhos/cm (quart, glass); ideal for fresh water
065272	Conductivity standard, 10000 µmhos/cm (quart, glass); ideal for brackish water
065274	Conductivity standard, 100000 µmhos/cm (quart, glass); ideal for supersaturated sea water
060907	Conductivity standard, 1000 µmhos/cm (box of 8 individual pints, plastic); ideal for fresh water
060906	Conductivity standard, 1413 µmhos/cm, ±1%, 0.01 M KCl (box of 8 individual pints, plastic)
060911	Conductivity standard, 10000 µmhos/cm (box of 8 individual pints, plastic); ideal for brackish water
060660	Conductivity standard, 50000 µmhos/cm (box of 8 individual pints, plastic); ideal for sea water
061320	ORP (mV) standard, Zobell solution, powder - needs hydrated (125 mL bottle, plastic)
003821	pH 4 buffer (box of 6 individual pints, plastic); ideal for storage solution for pH sensor
003822	pH 7 buffer (box of 6 individual pints, plastic)
003823	pH 10 buffer (box of 6 individual pints, plastic)
603824	Assorted case of pH 4, 7, and 10 buffers (2 individual pints of each buffer, plastic)
005580	Confidence solution to verify conductivity, pH and ORP system (box of 6 individual 475 mL bottles, plastic). ***Note:*** *Not for calibration*
003841	Ammonium standard, 1 mg/L (500 mL, plastic)
003842	Ammonium standard, 10 mg/L (500 mL, plastic)
003843	Ammonium standard, 100 mg/L (500 mL, plastic)
003885	Nitrate standard, 1 mg/L (500 mL, plastic)
003886	Nitrate standard, 10 mg/L (500 mL, plastic)
003887	Nitrate standard, 100 mg/L (500 mL, plastic)
608000	Turbidity standard, 0 FNU (1 gallon, plastic)
607200	Turbidity standard, 12.4 FNU (1 gallon, plastic)
607300	Turbidity standard, 124 FNU (1 gallon, plastic)
607400	Turbidity standard, 1010 FNU (1 gallon, plastic)

This page left intentionally blank

Safety and support

Rechargeable Lithium-Ion battery pack safety warnings and precautions

⚠ **CAUTION:** Failure to follow the safety warnings and precautions can result in fire, personal injury and/or equipment damage not covered under warranty.

⚠ **CAUTION:** If the internal battery fluid comes into contact with skin, wash the affected area(s) with soap and water immediately. If it comes into contact with your eye(s), flush them with generous amounts of water for 15 minutes and seek immediate medical attention.

⚠ **CAUTION:** Always keep batteries away from children.

⚠ **WARNING:** In the unlikely event a lithium-ion battery catches fire, **DO NOT** attempt to put the fire out with water, use a Class A, B or C fire extinguisher.

Do:

- Store the battery pack in a cool, dry, ventilated area.
- Store the battery pack in a non-conductive and fireproof container.
- Store the battery pack at approximately 50% of the capacity.
- Disconnect the battery pack when not in use and for long-term storage.
- Follow applicable laws and regulations for transporting and shipping of batteries.
- *Immediately discontinue* use of the battery pack if, while using, charging or storing the battery pack:
    - Emits an unusual smell
    - Feel hot
    - Changes color
    - Changes shape
    - Appears abnormal in any other way.

Battery pack general precautions:

- **DO NOT** put the battery in fire or heat the battery.
- **DO NOT** connect the positive and the negative terminal of the battery to each other with any metal object (e.g. wire).
- **DO NOT** carry or store the battery pack with neckaces, hairpins or other metal objects.
- **DO NOT** carry or store the battery pack with hazardous or combustible materials.
- **DO NOT** pierce the battery pack with nails, strike with a hammer, step on or otherwise subject the battery pack to strong impacts or shocks.
- **DO NOT** solder directly onto the battery pack.
- **DO NOT** expose the battery pack to water or salt water or allow it to get wet.
- **DO NOT** disassemble or modify the battery pack. The battery contains safety and protection devices that, if damaged, can cause the battery to generate heat, rupture or ignite.
- **DO NOT** place the battery pack on or near fires, stoves or other high-temperature locations.
- **DO NOT** place the battery pack in direct sunlight or extreme temperatures for extended periods of time or store the battery pack inside cars in hot weather. Doing so may cause the battery pack to generate heat, rupture or ignite. Using the battery pack in this manner may also result in a loss of performance and a shortened life expectancy.
- **DO NOT** place the battery pack in microwave ovens, high-pressure containers or on induction cookware.
- **DO NOT** ship damaged or potentially defective batteries to YSI or any of our authorized service centers unless instructed otherwise. All federal and international shipping laws should be consulted prior to shipping lithium-ion batteries.

Charging/discharging/handling the battery pack

⚠ **WARNING:** Failure to follow the battery pack charging/discharging instructions can cause the battery to become hot, rupture or ignite and cause serious injury and/or equipment damage.

⚠ **WARNING:** Only charge the battery using charging devices designed specifically for the ProDSS by YSI. Use of unapproved chargers can result in battery failure and potentially serious injury to the user.

If at any time the battery pack becomes damaged, hot or begins to balloon or swell, discontinue charging (or discharging) immediately. Quickly and safely disconnect the charger. Then place the battery pack and/or charger in a safe, open area way from flammable materials. After one hour of observation, remove the battery pack from service. **DO NOT** continue to handle, attempt to use or ship the battery.

Damaged or swollen batteries can be unstable and very hot. **DO NOT** touch batteries until they have cooled. In the event of a fire use a Class A, B, or C fire extinguisher. **DO NOT** use water.

- **DO NOT** attach the battery pack to a power supply plug or directly to a car's cigarette lighter.
- **DO NOT** place the battery pack in or near fire or into direct extended exposure to sunlight. When the battery pack becomes hot, the built-in safety equipment is activated, preventing the battery pack from charging further. Heating the battery pack can destroy the safety equipment and cause additional heating, breaking or ignition.
- **DO NOT** leave the battery pack unattended while charging.

NOTICE: The ambient temperature range over which the battery pack can be discharged is -20°C to 60°C (-4°F to 140°F). Use of the battery pack outside of this temperature range may damage the performance of the battery pack or may reduce its life expectancy.

- **DO NOT** discharge the battery pack using any device except for the ProDSS handheld. When the battery pack is used in other devices it may damage the performance of the battery or reduce its life expectancy. Use of a non-approved device to discharge the battery pack can cause an abnormal current to flow, resulting in the battery pack to become hot, rupture or ignite and cause serious injury.
- **DO NOT** leave the battery pack unattended while discharging.

Battery Disposal

When the battery pack is worn out, insulate the terminals with adhesive tape or similar materials before disposal. Dispose of the battery pack in the manner required by your city, county, state or country. For details on recycling lithium-ion batteries, please contact a government recycling agency, your waste-disposal service or visit reputable online recycling sources such as www.batteryrecycling.com.

This product must not be disposed of with other waste. Instead, it is the user's responsibility to dispose of their waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment.

For more information about where you can drop off your waste equipment for recycling, please contact your local city office, or your local waste disposal service. **DO NOT** ship batteries to YSI unless instructed to do otherwise.

Contact YSI Technical Support at (937) 767-7241 if you have additional questions.

Service information

YSI has authorized service centers throughout the United States and Internationally. For the nearest service center information, please visit ysi.com and click ‘Support’ or contact YSI Technical Support directly at 800-897-4151 (+1 937-767-7241).

When returning a product for service, include the Product Return form with cleaning certification. The form must be completely filled out for a YSI Service Center to accept the instrument for service. The form may be downloaded from ysi.com.

Technical support

Telephone: 800 897 4151 (USA)

+1 937 767 7241 (Globally) Monday through Friday, 8:00 AM to 5:00 ET

Fax: +1 937 767 9353 (orders)

Email: info@ysi.com

Mail: YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA

Internet: ysi.com

Declaration of Conformity

The undersigned hereby declares on behalf of the named manufacturer under our sole responsibility that the listed product conforms to the requirements for the listed European Council Directive(s) and carries the CE mark accordingly.

Manufacturer:	YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA
Product Name:	ProDSS
Conforms to the following:	
Directives:	EMC 2004/108/EC RoHS 2011/65/EU WEEE 2012/19/EU
Harmonized Standards:	EN61326-1:2013 (IEC 61326-1:2012) IEC 61000-3-2:2005 +A1:2008+A2:2009 IEC 61000-3-3:2008
Supplementary Information:	All performance met the operation criteria as follows: 1. ESD, IEC 61000-4-2:2008 2. Radiated Immunity, IEC 61000-4-3:2006 +A1:2007+A2:2010 3. Electrical Fast Transient (EFT), IEC 61000-4-4:2004 +A1:2010 4. Immunity to Surge, IEC 61000-4-5:2005 5. Radio Frequency, Continuous Conducted Immunity, IEC61000-4-6:2008 6. IEC 61000-4-8:2009 7. IEC 61000-4-11:2004
Authorized EU Representative	Xylem Analytics UK Ltd Unit 2 Focal Point, Lacerta Court, Works Road Letchworth, Hertfordshire, SG6 1FJ UK

Signed: Lisa M. Abel
Title: Director of Quality

Date: September 24 2014

The undersigned hereby declares on behalf of the named manufacturer under our sole responsibility that the listed product conforms to the requirements for electrical equipment under US FCC Part 15 and ICES-003 for unintentional radiators.

Manufacturer:	YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA
Product Name:	Professional Digital Sampling System Instrument
Model Numbers	
Instrument/Accessory:	ProDSS non-GPS (626870-1) / ProDSS GPS (626870-2)
Probe/Cable Assemblies:	626909-1, 626909-4, 626909-10, 626909-20, 626909-30, 626909-40, 626909-50, 626909-60, 626909-70, 626909-80, 626909-90, 626909-100, 626910-1, 626910-4, 626910-10, 626911-20, 626911-30, 626911-40, 626911-50, 626911-60, 626911-70, 626911-80, 626911-90, 626911-100
Sensors:	626900, 626902, 626901, 626903, 626904, 626906, 626905, 626907
Conforms to the following:	
Standards:	• FCC 47 CFR Part 15-2008, Subpart B, Class B, Radio Frequency Devices • ICES-003:2004, Digital Apparatus
Supplementary Information:	Tested using ANSI C63.4-2003 (excluding sections 4.1, 5.2, 5.7, 9, and 14)

Signed: Lisa M. Abel
Title: Director of Quality

Date: September 24 2014

Warranty

The YSI Professional Digital Sampling System (ProDSS) is warranted for three (3) years from date of purchase by the end user against defects in materials and workmanship. The ProDSS bulkhead, sensors and cable assemblies are warranted for two (2) years from date of purchase by the end user against defects in material and workmanship. ProDSS pH and pH/ORP sensor modules, optical ODO sensor caps, and Li-Ion battery pack are warranted for one (1) year from date of purchase by the end user against defects in material and workmanship (6 months for ammonium, nitrate, chloride sensor modules). ProDSS systems (instrument, cables & sensors) are warranted for 1 year (excluding sensor modules) from date of purchase by the end user against defects in material and workmanship when purchased by rental agencies for rental purposes. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio at +1 937 767-7241, 800-897-4151 or visit www.YSI.com (Support tab) for a Product Return Form. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

LIMITATION OF WARRANTY

This Warranty does not apply to any YSI product damage or failure caused by:

1. Failure to install, operate or use the product in accordance with YSI's written instructions;
2. Abuse or misuse of the product;
3. Failure to maintain the product in accordance with YSI's written instructions or standard industry procedure;
4. Any improper repairs to the product;
5. Use by you of defective or improper components or parts in servicing or repairing the product;
6. Modification of the product in any way not expressly authorized by YSI.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI's LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.

Appendix A - DO% calibration values

Calibration Value	**Pressure**			
D.O. %	**in Hg**	**mmHg**	**kPa**	**mbar**
101%	30.22	767.6	102.34	1023.38
100%	29.92	760.0	101.33	1013.25
99%	29.62	752.4	100.31	1003.12
98%	29.32	744.8	99.30	992.99
97%	29.02	737.2	98.29	982.85
96%	28.72	729.6	97.27	972.72
95%	28.43	722.0	96.26	962.59
94%	28.13	714.4	95.25	952.46
93%	27.83	706.8	94.23	942.32
92%	27.53	699.2	93.22	932.19
91%	27.23	691.6	92.21	922.06
90%	26.93	684.0	91.19	911.93
89%	26.63	676.4	90.18	901.79
88%	26.33	668.8	89.17	891.66
87%	26.03	661.2	88.15	881.53
86%	25.73	653.6	87.14	871.40
85%	25.43	646.0	86.13	861.26
84%	25.13	638.4	85.11	851.13
83%	24.83	630.8	84.10	841.00
82%	24.54	623.2	83.09	830.87
81%	24.24	615.6	82.07	820.73
80%	23.94	608.0	81.06	810.60
79%	23.64	600.4	80.05	800.47
78%	23.34	592.8	79.03	790.34
77%	23.04	585.2	78.02	780.20
76%	22.74	577.6	77.01	770.07
75%	22.44	570.0	75.99	759.94
74%	22.14	562.4	74.98	749.81
73%	21.84	554.8	73.97	739.67
72%	21.54	547.2	72.95	729.54

This page left intentionally blank

Appendix B - oxygen solubility table

Solubility of oxygen in mg/L in water exposed to water-xaturated air at 760 mm Hg pressure.

Salinity = Measure of quantity of dissolved salts in water.

Chlorinity = Measure of chloride content, by mass, of water.

S(0/00) = 1.80655 x Chlorinity (0/00)

Temp °C	Chlorinity : 0 Salinity: 0	5.0 ppt 9.0 ppt	10.0 ppt 18.1 ppt	15.0 ppt 27.1 ppt	20.0 ppt 36.1 ppt	25.0 ppt 45.2 ppt
0.0	14.62	13.73	12.89	12.10	11.36	10.66
1.0	14.22	13.36	12.55	11.78	11.07	10.39
2.0	13.83	13.00	12.22	11.48	10.79	10.14
3.0	13.46	12.66	11.91	11.20	10.53	9.90
4.0	13.11	12.34	11.61	10.92	10.27	9.66
5.0	12.77	12.02	11.32	10.66	10.03	9.44
6.0	12.45	11.73	11.05	10.40	9.80	9.23
7.0	12.14	11.44	10.78	10.16	9.58	9.02
8.0	11.84	11.17	10.53	9.93	9.36	8.83
9.0	11.56	10.91	10.29	9.71	9.16	8.64
10.0	11.29	10.66	10.06	9.49	8.96	8.45
11.0	11.03	10.42	9.84	9.29	8.77	8.28
12.0	10.78	10.18	9.62	9.09	8.59	8.11
13.0	10.54	9.96	9.42	8.90	8.41	7.95
14.0	10.31	9.75	9.22	8.72	8.24	7.79
15.0	10.08	9.54	9.03	8.54	8.08	7.64
16.0	9.87	9.34	8.84	8.37	7.92	7.50
17.0	9.67	9.15	8.67	8.21	7.77	7.36
18.0	9.47	8.97	8.50	8.05	7.62	7.22
19.0	9.28	8.79	8.33	7.90	7.48	7.09
20.0	9.09	8.62	8.17	7.75	7.35	6.96
21.0	8.92	8.46	8.02	7.61	7.21	6.84
22.0	8.74	8.30	7.87	7.47	7.09	6.72
23.0	8.58	8.14	7.73	7.34	6.96	6.61
24.0	8.42	7.99	7.59	7.21	6.84	6.50
25.0	8.26	7.85	7.46	7.08	6.72	6.39
26.0	8.11	7.71	7.33	6.96	6.62	6.28
27.0	7.97	7.58	7.20	6.85	6.51	6.18
28.0	7.83	7.44	7.08	6.73	6.40	6.09
29.0	7.69	7.32	6.93	6.62	6.30	5.99
30.0	7.56	7.19	6.85	6.51	6.20	5.90
31.0	7.43	7.07	6.73	6.41	6.10	5.81
32.0	7.31	6.96	6.62	6.31	6.01	5.72

Appendix B - oxygen solubility table

Temp °C	Chlorinity : 0 Salinity: 0	5.0 ppt 9.0 ppt	10.0 ppt 18.1 ppt	15.0 ppt 27.1 ppt	20.0 ppt 36.1 ppt	25.0 ppt 45.2 ppt
33.0	7.18	6.84	6.52	6.21	5.91	5.63
34.0	7.07	6.73	6.42	6.11	5.82	5.55
35.0	6.95	6.62	6.31	6.02	5.73	5.46
36.0	6.84	6.52	6.22	5.93	5.65	5.38
37.0	6.73	6.42	6.12	5.84	5.56	5.31
38.0	6.62	6.32	6.03	5.75	5.48	5.23
39.0	6.52	6.22	5.98	5.66	5.40	5.15
40.0	6.41	6.12	5.84	5.58	5.32	5.08
41.0	6.31	6.03	5.75	5.49	5.24	5.01
42.0	6.21	5.93	5.67	5.41	5.17	4.93
43.0	6.12	5.84	5.58	5.33	5.09	4.86
44.0	6.02	5.75	5.50	5.25	5.02	4.79
45.0	5.93	5.67	5.41	5.17	4.94	4.72

Item #626973-01REF
Rev B
November, 2014

APPENDIX C

Field Forms

Indoor Air/Ambient Air Sample Collection Log

Sample ID:	
Client:	
Project:	
Location:	
Project #:	
Samplers:	
Sample Point Location:	
Outdoor/Indoor:	
Sample Intake Height:	
Tubing Information:	
Miscellaneous Equipment:	
Time On/Off:	
Subcontractor:	

Instrument Readings:

Date	Time	Canister Vacuum (a, b) (inches of Hg)	Temperature (°F)	Relative Humidity (%)	Air Speed (mph)	Barometric Pressure (inches of Hg)	PID (ppb)

(a) Record canister information at a minimum at the beginning and end of sampling
(b) Canister should be closed at end of sample duration or when vacuum reaches -5 inches of Hg, whichever comes first

Canister Information:

Size (circle one):	**1 L** **6 L**
Canister ID:	
Flow Controller ID:	
Notes:	

Heating, Ventilation, and Air Conditioning System Information (Indoor Air Samples Only):

HVAC Fan On?	Start: Yes / No End: Yes / No
Heat On?	Start: Yes / No End: Yes / No
Temperature Setting:	Start: End:
Flow Rate:	Start: End:

General Observations/Notes:

ARCADIS Design & Consultancy for natural and built assets		Soil Vapor Sample Collection Log	
		Sample ID:	
Client:		**Boring Equipment:**	
Project:		**Sealant:**	
Location:		**Tubing Information:**	
Project #:		**Miscellaneous Equipment:**	
Samplers:		**Subcontractor:**	
Sample Point Location:		**Moisture Content of Sampling Zone:**	
Sampling Depth:		**Purge Method:**	
Time and Date of Collection:		**Approximate Purge Volume:**	

Instrument Readings:

Date	Time	Canister Vacuum (a) (inches of Hg)	Temperature (°F)	Relative Humidity (%)	Air Speed (mph)	Barometric Pressure (inches of Hg)	PID (ppb)

(a) Record canister information at a minimum at the beginning and end of sampling

Canister Information:

Size (circle one):	**1 L** **6 L**
Canister ID:	
Flow Controller ID:	
Notes:	

General Observations/Notes:

Sample/Core Log

ARCADIS Design & Consultancy for natural and built assets

Boring/Well ________ Project/No. ________ Page ____ of ____

Site Location ________ Drilling Started ________ Drilling Completed ________

Total Depth Drilled ____ Feet Hole Diameter ____ inches Type of Sample/ Coring Device ________

Length and Diameter of Coring Device ________ Sampling Interval ____ feet

Land-Surface Elev. ____ feet ☐ Surveyed ☐ Estimated Datum ________

Drilling Fluid Used ________ Drilling Method ________

Drilling Contractor ________ Driller ________ Helper ________

Prepared By ________ Hammer Weight ________ Hammer Drop ____ ins.

Sample/Core Depth (feet below land surface) From	To	Core Recovery (inches)	PID Reading (ppm)	Sample/Core Description

Sample/Core Log (Cont.d)

Boring/Well ____________________ Page _____ of _____

Prepared by ____________________

Sample/Core Depth (feet below land surface) From	To	Core Recovery (inches)	PID Reading (ppm)	Sample/Core Description

Lab Address

Chain of Custody Record

Client Information	Sampler:	Lab PM:	Carrier Tracking No(s):	COC No: 480-122228-28042.1
Client Contact:	Phone:	E-Mail:		Page: Page __ of __
Company: ARCADIS US			Analysis Requested	Job #:

Address:	Due Date Requested:
City:	TAT Requested (days):
State, Zip:	
Phone:	PO #:
Email:	WO #:
Project Name:	Project #: 48019304
Site:	SSOW#:

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)														Total Number of containers	Special Instructions/Note:
			Preservation Code:																		

Possible Hazard Identification

☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For __________ Months*

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
		Arcadis			
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

WELL DEVELOPMENT/ PURGING LOG

WELL NUMBER: ____________________ DATE: ________________________________

PROJECT NAME: ____

PROJECT NUMBER: ____

SAMPLERS: ____

A: Total Casing and Screen Length: ______________

B: Casing Internal Diameter: ______________

C: Water Level Below Top of Casing: ______________

D: Volume of Water in Casing: ______________

Well I.D.	Vol. Gal./ft.
1"	**0.04**
2"	**0.17**
3"	**0.38**
4"	**0.66**
5"	**1.04**
6"	**1.50**
8"	**2.60**

$v = 0.0408\ (B)^2 \times (A-C) = D$

$v = 0.0408\ (\qquad)^2 \times (\qquad - \qquad) =$ ______________ gal.

PARAMETER	ACCUMULATED VOLUME PURGED												
Time													
Gallons													
Depth to Water													
Temperature (^{o}C)													
pH													
Redox (mV)													
Conductivity (mohm/cm													
Turbidity (ntu)													
Dissolved Oxygen (mg/l)													
TDS													
Salinity													

Notes: ____

____

____

____

GROUNDWATER MONITORING WELL INSPECTION

SITE/PROJECT NAME: ______________________ PROJECT NUMBER: ____________________________

DATE OF INSPECTION: ______________________ INSPECTOR: ____________________________

WELL DESIGNATION: ____

WELL LOCATION: ____

Outward Appearance

Flushmount Diameter	______ inches	N/A [ ]		
Approximate Stickup Height	______ feet	N/A [ ]		
Integrity of Protective Casing	Describe: ____________________			
Protective Casing Material	Steel [ ]	Stainless Steel [ ]	Other ________________	
Protective Casing Width or Dia.	______ inches			
Weep Hole in Protective Casing	Yes [ ]	No [ ]		
Surface Seal/Apron Material	Cement [ ]	Bentonite [ ]	Not apparent [ ]	Other ________
Integrity of Surface Seal/Apron	Describe: ____________________			
	Away from Wellhead [ ]	Toward Wellhead [ ]		
Bollards Present?	Yes [ ]	No [ ]	Describe: ____________________	
Well ID. Visible?	Yes [ ]	No [ ]	Describe: ____________________	
Lock Present and Functional?	Yes [ ]	No [ ]	Describe: ____________________	
Photograph Taken? Photo #	Yes [ ]	No [ ]	Describe: ____________________	

Inner Appearance

Integrity of Well Casing	Describe: ____________________			
Integrity of Cap Seal	Describe: ____________________			
Surface Water in Casing?	Yes [ ]	No [ ]	Describe: ____________________	
Well Casing Diameter	______ inches			
Well Casing Material	PVC [ ]	Steel [ ]	Stainless Steel [ ]	
Inner Cap	Threaded [ ]	Slip [ ]	Expansion Plug [ ]	None [ ]
Reference/Measuring Point	Groove [ ]	Indelible Mark [ ]	None [ ]	
Evidence of Double Casing?	Yes [ ]	No [ ]	Describe: ____________________	

Downhole

Odor	Yes [ ]	No [ ]	Describe: ____________________	
Depth to Water (to top of casing)	______ feet (nearest 0.01)	Depth to LNAPL	_____ feet (nearest 0.01)	N/A [ ]
Total Well Depth (to top of casing)	______ feet (nearest 0.1)			
Sediment (Hard/Soft Bottom)	Describe: ____________________			

Additional Comments:

____

____

____

____

____

____

Test Pit Log

DATE STARTED: ______________________ DATE FINISHED: ________ TEST PIT NUMBER: _______

SITE/PROJECT/CLIENT NAME: ____ PROJECT NUMBER: _______

PHOTOGRAPH NUMBER(S): ______________________ FIELD LOGGER: __________________________________

SURFACE CONDITIONS: ______________________ WEATHER & TEMP: __________________________________

EQUIPMENT MAKE/MODEL: ______________________ CONTRACTOR: __________________________________

TEST PIT LOCATION: ____

APPROXIMATE LENGTH _____________FEET, WIDTH _____________ FEET, AND DEPTH _____________ FEET

DEPTH	DESCRIPTION (COLOR, TEXTURE, CONSISTENCY, MOISTURE)	SAMPLE #	PID	ODOR

MAP/SITE/TEST PIT LOCATION SKETCH:

N

TEST PIT CROSS SECTION(S):

___ ft.

___ ft.

TEST PIT LOG

DATE STARTED FINISHED: ______________________ TEST PIT NUMBER: ______________________

SITE/PROJECT/CLIENT NAME: ______________________ PROJECT NUMBER: ______________________

PHOTOGRAPH NUMBER: ______________________ FIELD SUPERVISOR: ______________________

SURFACE CONDITIONS: ______________________ WEATHER: ______________________

EQUIPMENT MAKE/MODEL: ______________________ CONTRACTOR: ______________________

TEST PIT LOCATION: ______________________

DEPTH	DESCRIPTION (COLOR, TEXTURE, CONSISTENCY, MOISTURE)	SAMPLE #	PID	ODOR

TEST PIT LOG

TEST PIT NUMBER: ______________________

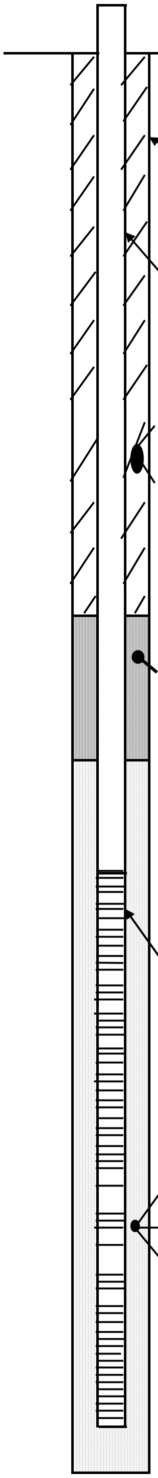
SITE/PROJECT/CLIENT NAME: ______________________ PROJECT NUMBER: ______________________

Map/Site Sketch:

Test Pit Cross Section(s):

Additional Comments:

Well Construction Log



ft
LAND SURFACE

______ inch diameter
drilled hole

Well casing,
______ inch diameter,
______

☐ Backfill
☐ Grout ______

______ ft*

Bentonite ☐ slurry
______ ft* ☐ pellets

______ ft*

Well Screen.
______ inch diameter
______ , ____ slot

☐ Gravel Pack
☐ Sand Pack
☐ Formation Collapse

______ ft*
______ ft*

Measuring Point is
Top of Well Casing
Unless Otherwise Noted.

* Depth Below Land Surface

Project ______ Well ______

Town/City ______

County ______ State ______

Permit No. ______

Land-Surface Elevation and Datum:

______ feet ☐ Surveyed
☐ Estimated

Installation Date(s) ______

Drilling Method ______

Drilling Contractor ______

Drilling Fluid ______

______

Development Technique(s) and Date(s)

______

______

Fluid Loss During Drilling ______ gallons

Water Removed During Development ______ gallons

Static Depth to Water ______ feet below M.P.

Pumping Depth to Water ______ feet below M.P.

Pumping Duration ______ hours

Yield ______ gpm Date ______

Specific Capacity ______ gpm/ft

Well Purpose ______

______

______

Remarks ______

______

______

______

______

Prepared by ______

Arcadis of New York, Inc.

855 Route 146

Suite 210

Clifton Park, New York 12065

Tel 518 250 7300

Fax 518 371 2757

www.arcadis.com

Appendix B

Generic Quality Assurance Project Plan for Work Conducted under NYSDEC State Superfund Standby Engineering Contract No. D00980

New York State Department of Environmental Conservation

GENERIC QUALITY ASSURANCE PROJECT PLAN FOR WORK ASSIGNMENTS

Standby Contract for Engineering Services

(No. D009804)

February 2021

GENERIC QUALITY ASSURANCE PROJECT PLAN FOR WORK ASSIGNMENTS

Standby Contract for Engineering Services (No. D009804)

Prepared for:

New York State Department of Environmental Conservation

625 Broadway

Albany, New York, 12233-7011

Prepared by:

Arcadis of New York, Inc.

855 Route 146

Suite 210

Clifton Park

New York 12065

Tel 518 250 7300

Fax 518 371 2757

Date:

February 2021

CONTENTS

ACRONYMS AND ABBREVIATIONS

DUSR	Data Usability Summary Report
DQO	Data Quality Objective
EDD	Electronic Data Deliverable
EDP	EQuIS Data Processor
EIMS	Environmental Information Management System
ELAP	Environmental Laboratory Approval Program
FAP	Field Activities Plan
GPS	Global Positioning System
HASP	Site Specific Health and Safety Plan
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MS	Matrix spikes
MSD	Matrix spike duplicate
ng/kg	nanograms per kilogram
ng/L	nanograms per liter
NYCRR	New York State Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
PCB	Polychlorinated Biphenyls
PFAS	Broad group of perfluoroalkyl and polyfluoroalkyl substances
ppb	parts per billion
ppt	parts per trillion
RPD	Relative percent difference
SCG	Standards, Criteria, and Guidance Values
SOP	Standard Operating Procedure
SVOCs	Semi-volatile organic compounds
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
VOCs	Volatile Organic Compounds
QA	Quality Assurance
QAO	Quality Assurance Officer
QC	Quality Control
QAPP	Quality Assurance Project Plan
USEPA or EPA	United States Environmental Protection Agency
UV	ultraviolet
WA	Work Assignment

1 PURPOSE AND OBJECTIVES

1.1 Purpose

This Generic Quality Assurance Project Plan (QAPP) has been prepared to guide work associated with Work Assignments (WAs) issued under the New York State Department of Environmental Conservation (NYSDEC) Standby Contract D009804. The purpose of this document is to provide quality assurance/quality control (QA/QC) methods, procedures, and protocols for the collection, analysis, and evaluation of data collected during the WAs. Deviations from, or additions to, the procedures and protocols provided in this Generic QAPP will be noted in the Schedule 1 – Scope of Work for each WA.

1.2 Generic QAPP Objectives

The objective of this Generic QAPP is to guide WA projects so that the data collected are of suitable quality and quantity to meet the project objectives. To meet this objective, the following topics are presented and discussed in this Generic QAPP:

- Project organization and responsibilities
- Data quality objectives, including field measurement quality assurance objectives and laboratory quality assurance objectives
- Analytical method requirements
- Data validation requirements
- Preventative maintenance
- Quality assurance procedures
- Corrective actions
- Quality assurance reports

This Generic QAPP addresses laboratory sample analysis and evaluation of the laboratory sample results. In addition, this Generic QAPP addresses components that influence these processes and provides a detailed plan to verify that decisions being made from the analytical data are valid, accurate, and defensible in support of subsequent recommendations. Field investigation procedures such as field measurement collection, equipment calibration, sample collection and sample integrity are discussed in the Generic Field Activities Plan (FAP) for WAs.

In addition to the procedures described in this document, quality assurance procedures for Work Assignments issued under NYSDEC standby engineering services contract D009804 will be conducted in general in accordance with "DER-10 Technical Guidance for Site Investigation and Remediation" (NYSDEC 2010).

2 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 Project Organization

Arcadis of New York, Inc. (Arcadis) will provide program oversight, coordination, health and safety, and field support. Arcadis will also evaluate analytical test results, which will be submitted to NYSDEC.

2.2 Analytical Laboratories

Analytical laboratories subcontracted by Arcadis or NYSDEC will perform analysis of samples collected during the WAs. Laboratories subcontracted by Arcadis or NYSDEC under the NYSDEC Standby Contract will be approved under United States Environmental Protection Agency (USEPA) and New York State Department of Health (NYSDOH) protocols. These laboratories will maintain their certification for the specific analyses to be performed by the NYSDOH Environmental Laboratory Approval Program (ELAP).

Each laboratory has their own provisions for performing internal QA/QC review of the data prior to transmittal to Arcadis. If required by the WA Schedule 1 – Scope of Work, laboratory data will be reviewed by an Arcadis data validator, or sent to a third-party data validation service, to review the methods and protocols performed by the laboratory to validate the analytical results. A summary of the data validation results will be provided in a Data Usability Summary Report (DUSR) (Section 7.2.2) if required.

3 DATA MEASUREMENT QA/QC OBJECTIVES

This section defines the QA/QC objectives for environmental sampling and analysis, including the data quality objectives (DQOs) for measurement data and the criteria for measuring performance within these objectives. Data collected during the WAs may include both field measurements and analytical samples. This section discusses the various types of data anticipated and provides QA/QC objectives for data collected during the WAs.

3.1 Data Quality Objectives

DQOs are qualitative and quantitative statements that specify the quality of the data to support decisions, and are developed to address specific procedures for collecting, analyzing, and evaluating results to meet overall project objectives. DQOs are developed and implemented to verify that the quality of the data is such that the data is legally and scientifically defensible and is applicable for its anticipated use. DQOs developed for specific sites, measurement, and media assume project objectives, data objectives, and data collection methods.

Site-specific DQOs have been developed based on the factors presented above and are presented below. These include the specific DQOs for planned data collection task, which identifies the particular sampling protocols, analysis methods, and laboratory deliverables to be provided for the data type anticipated.

Unless approved by NYSDEC DER, laboratory deliverables must be defined as either Category A or Category B data deliverables, as described in "DER-10 Technical Guidance for Site Investigation and Remediation" (NYSDEC 2010).

Category B Deliverables

A Category B deliverable is required to develop a Data Usability Summary Report (DUSR) and must be submitted for the following types of samples:

1. Samples representing the final delineation of the nature and extent of contamination for a Site Characterization or Remedial Investigation
2. Correlation samples
3. Confirmation and documentation samples
4. Samples to determine closure of a system

Category B deliverables include:

- A Sample Delivery Group Narrative
- Contract Lab Sample Information sheets
- DEC Data Package Summary Forms
- Chain-of-custody forms
- Test analyses results
- Calibration standards
- Surrogate recoveries

- Blank results
- Spike recoveries
- Duplicate results
- Confirmation (lab check/QC) samples
- Internal standard area and retention time summary
- Chromatograms
- Raw data files

Category A Deliverables

Category A deliverables are required when a DUSR is not needed. Category A deliverables include:

- A Sample Delivery Group Narrative
- Contract Lab Sample Information sheets
- DEC Data Package Summary Forms
- Chain-of-custody forms
- Test analyses results

3.1.1 DQOs for Air and Soil Vapor

The objective of a soil vapor intrusion study is to evaluate the nature and extent of volatile organic compounds (VOCs) in indoor air at concentrations exceeding the NYSDOH air guideline values and to determine where the analytical results fall on the applicable NYSDOH soil vapor/indoor air matrix found in “Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York” (NYSDOH 2006) and subsequent updates. To be useful in meeting this objective, the data from the air and soil vapor samples must be of known quality. To support the DQOs for air and soil vapor, NYSDOH-approved analytical methodologies with NYSDEC DER-10 Category A or B deliverables (depending on the data validation needs – refer to Section 3.1) have been chosen for air and soil vapor analyses. These procedures and deliverables are capable of producing high quality data characterized by rigorous QA/QC protocols and documentation. Site-specific air and soil vapor sample analyses are summarized in WAs. Air and soil vapor samples will be critical samples for the evaluation of potential risks to human health and the environment.

3.1.2 DQOs for Soil and Sediment

The objective of the soil sampling program is to evaluate the nature and extent of soil with contaminant concentrations exceeding the applicable 6 NYCRR Subpart 375-6 Remedial Program cleanup objectives in surface and subsurface soil. Sediment samples will be collected to evaluate the nature and extent of contaminants at concentrations greater than the applicable 6 NYCRR Subpart 375-6 Remedial Program soil cleanup objectives, the NYSDEC sediment guidance value in the “Screening and Assessment of Contaminated Sediment” (NYSDEC 2014) guidance, or site-specific standards. To meet these objectives, the data from the soil and sediment samples must be of known quality. To support the DQOs for soil and sediment, NYSDOH-approved analytical methodologies with NYSDEC Category A or B deliverables (depending on the data validation needs – refer to Section 3.1) have been chosen for soil and sediment analyses. These procedures and deliverables are capable of producing high quality data characterized by rigorous QA/QC protocols and documentation. Site-specific soil and sediment sample analyses are summarized in WAs. Soil and sediment samples will be critical samples for the evaluation of potential risks to human health and the environment.

3.1.3 DQOs for Groundwater

Groundwater will be sampled and analyzed to evaluate the nature and extent of groundwater contamination at the site. Field instrumentation will be used during sampling activities to collect representative samples. As such, data from the field instrumentation must be of sufficient quality to measure groundwater conditions prior to sampling. Analytical data will be used to identify the location of groundwater contamination, to aid in evaluating contaminant source locations, and to assess if standards, criteria, and guidance values (SCGs) have been exceeded. SCGs for groundwater include NYSDEC Class GA groundwater standards defined in “Division of Water Technical and Operation Guidance Series 1.1.1 - Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations” (NYSDEC 1998). In order to meet these objectives, the data from the groundwater samples must be of known quality. Therefore, NYSDOH-approved analytical methodologies with NYSDEC Category A or B deliverables (depending on the data validation needs – refer to Section 3.1) have been selected for groundwater analyses. These deliverables are characterized by rigorous QA/QC protocols and documentation, which historically have provided high quality data able to meet the DQOs for this media. Site-specific groundwater sample analyses are summarized in WAs. Groundwater samples will be critical samples for the evaluation of potential risks to human health and the environment.

3.1.4 DQOs for Surface Water

Surface water will be sampled and analyzed to evaluate the nature and extent of surface water contamination at the site. Field instrumentation will be used during sampling activities to collect representative samples. Analytical data will be used to evaluate the presence of contamination and to assess if SCGs have been exceeded. SCGs for surface water are defined in “Division of Water Technical and Operation Guidance Series 1.1.1 - Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations” (NYSDEC 1998). To meet these objectives, the data from the surface water samples must be of known quality. Therefore, USEPA SW-846 analytical methodologies with NYSDEC Category A or B deliverables (depending on the data validation needs – refer to Section 3.1) have been chosen for surface water analyses. These deliverables are characterized by rigorous QA/QC protocols and documentation, which historically have provided high quality data able to meet the DQOs for this media. Site-specific surface water sample analyses are summarized in WAs. The surface water sample will be a critical sample for the evaluation of potential risks to human health and the environment.

3.2 Field Measurement Quality Assurance Objectives

Tasks requiring field measurements include field screening of samples, evaluating the progress of monitoring well development, monitoring well sample collection, collection of soil conductivity data, in-situ measurements, surveying sampling locations, and field analysis of samples using other field screening technologies. To verify the accuracy and quality of the data provided by field measurements, the Generic

FAP provides procedures for recording field measurements during site investigations, including the following:

- Water Quality Parameters
- Field Screening of Soil Samples Using Ionization Detectors
- Other Field Screening Techniques
- Data Collection Using GPS and Data Point Surveys
-
- Radiological Screening

The DQOs developed for each method will verify that the data is appropriate and reliable for the extent they will be used in the investigation. A summary of field measurement methods, documentation, DQOs, and QA/QC protocols is provided in the Generic FAP. Specific field measurements anticipated for data collection task are detailed in the WA.

3.3 Laboratory Quality Assurance Objectives

Laboratory generated data are used to identify and quantify compounds of interest, while the field generated data are used in conjunction with the laboratory data for further evaluation of the nature and extent of contamination. Both laboratory and field internal QC programs include steps to assure the data are reliable for the extent they will be used in the investigation. In general, laboratory QC programs are more rigorous than field QC programs owing to the critical requirements of analytical instrumentation and the ability to precisely control the laboratory environment.

The scope and description of QC samples and QC methods are detailed in the applicable USEPA methodologies for the particular analyses. The methodologies for organic and inorganic analyses describe the type of QC samples and required QC methods, and the required frequency of analysis. QC limits have been established for standards, blanks, duplicates, matrix spikes (MS), and surrogates, and are contained in the methodologies.

Laboratory QC data will be reviewed by Arcadis personnel and by a subcontracted third-party data validation service to assess the validity of the data and determine if the DQOs have been met. This objective will be met by implementing the following:

- Evaluation of Laboratory Method Performance – QC criteria for method performance will be reviewed and assessed for target analyses. Analysis methods will be performed based on documented procedures by certified laboratories.
- Sample Matrix Effects – QC samples will be collected and analyzed to determine measurement bias because of to the sample matrix. If criteria are not met, matrix interferences will be confirmed by reanalysis or inspection of laboratory control samples to verify laboratory method performance is in control.
- Planning and Management – Laboratories will perform preventive maintenance and routine calibration of equipment. A managed program of internal and external QC checks will be followed to validate data quality.
- Corrective Actions – If QC issues are detected during QA audits or QC checks, corrective actions will be taken to stop work and modify procedures to validate data quality.

4 FIELD INVESTIGATION PROCEDURES

Field investigation procedures are provided in the Generic FAP.

5 CALIBRATION PROCEDURES

Calibration procedures are provided in the Generic FAP.

6 ANALYTICAL PROCEDURES

Groundwater, surface water, soil, sediment, and samples collected for laboratory analysis will be analyzed by a NYSDOH ELAP-certified laboratory for various analytes, including volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, PFAS, and 1,4 - Dioxane using NYSDOH/NYSDEC approved analytical methodologies accompanied by NYSDEC Category A or B deliverables (depending on if the data will be validated – Refer to Section 3.1). The analytical procedures and methods that will be utilized for the site will be presented in the WA Schedule 1 – Scope of Work.

The analytical methods utilized for each WA must be sufficient to meet the project specific DQOs.. The methods and procedures used for the analyses will include:

- Instruments will have the calibrations checked at a minimum at the start of the day before measurements are made.
- The calibration and calibration checks will indicate that the sensitivity of the instrument (practical detection limit) is adequate to meet project needs and that the instrument is accurate over the working range.
- Calibration information will be recorded in the laboratory logbook. This includes date and time, technician signature, calibration procedure, calibration results, calibration problems, recalibration and maintenance, and instrument serial numbers.

7 DATA REDUCTION, VALIDATION, AND REPORTING

The purpose of this section is to verify that the data produced by the laboratory are presented in a clear and useable format. Reduction, validation, and reporting specifications for these analyses are detailed below.

7.1 Data Reduction

Data reduction is the process by which raw analytical data generated from the analytical instrument systems is converted into useable concentrations. The raw data, which consists of area counts or instrument responses, is processed by the laboratory and converted into concentrations expressed in milligrams per kilogram (mg/kg), milligrams per liter (mg/L), micrograms per kilogram (µg/kg), micrograms per liter (µg/L), nanograms per kilogram (ng/kg), nanograms per liter (ng/L), parts per million (ppm), parts per billion (ppb), parts per trillion (ppt) or micrograms per cubic meter (µg/m3). These concentrations are the standard method for expressing the level of contamination present in environmental samples.

The process used to convert the instrument output into useable concentrations is defined in the NYSDOH approved methodologies. The resulting concentrations are comparable to other environmental samples in general and will be comparable to data previously collected for the site.

7.2 Data Validation

The data validation process evaluates the uncertainty of the data through comparison of the laboratory analytical results to the measurement quality objective and resultant application of data validation qualifiers. The output of data validation is qualitative or quantitative statements of data quality which can be used to evaluate the usability of the data with respect to the overall goals of the project. Once the quality of individual measurements is known, a compilation of data points into a cohesive statement can be made. The confidence associated with a statement incorporates both the confidence in individual measurements as well as in the decision. The laboratory will be responsible for reviewing data to determine if analytical problems exist prior to reporting of results. Specifically, the laboratory will develop a case narrative describing how closely the data meet the DQOs presented in this QAPP. If data validation is required by the WA scope, subsequent review of the data will be performed by a qualified Arcadis employee, who is independent from any direct involvement with the project, or third-party subcontractor in accordance with the sections below.

7.2.1 Data Review

The data review process consists of a contractual review that includes an evaluation of the analysis and specific requirements of the published method in addition to the laboratory SOP.

Data will be declared invalid whenever documented evidence exists demonstrating that a sample was not collected under representative conditions, such as an air sampling canister leaking to ambient pressure during shipment.

The laboratory will provide a data reporting package. One copy of the Category B data packages will be delivered to Arcadis and/or a third-party data validation subcontractor for data assessment. The data packages will include the case narrative. A Data Usability Summary Report (DUSR) will be submitted to the NYSDEC. This package will include sampling analysis and summary forms.

Data validation will be performed using the latest USEPA/ NYSDEC guidance for the applicable analytes.

The QA/QC Task Leader will coordinate the validation of the data set based on information from the field team and information supplied from the laboratory on the analysis. The Validator will review the submitted data package to determine compliance with those portions of the QAPP and site documents that pertain to the production of laboratory data. Compliance is defined by the following criteria:

1. The data package is complete.
2. The data has been produced and reported in a manner consistent with the data requirements of the project and the laboratory subcontract.
3. Protocol required QA/QC criteria have been met.
4. Instrument tune and calibration requirements have been met for the time frame during which the analyses were completed.
5. Protocol required initial and continuing calibration data is present and documented.
6. Data reporting forms are complete for samples submitted. This will include sample dilution/concentration factors and pre-measurement sample cleanup procedures.
7. Problems encountered during the analytical process have been reported in the case narrative along with and actions taken by the laboratory to correct these problems.

The data validation task requires that the Data Validator conduct a detailed comparison of the reported data with the raw data submitted as part of the supporting documentation package.

7.2.2 Data Usability Summary Report (DUSR)

Data validation results will be provided in a DUSR, which will include the following:

- A general assessment of the data package.
- Detailed descriptions of deviations from the required protocols. (These descriptions must include references to the portions of the protocols involved in the alleged deviations).
- Failures in the Validator's attempt to reconcile the reported data with the raw data from which it was derived. (Again, specific references must be included).
- A detailed assessment by the Validator of the degree to which the data has been compromised by deviations from protocol, QA/QC breakdowns, lack of analytical control, etc., that occurred during the analytical process.
- The report will include, as an attachment, a copy of the laboratory's case narrative including the NYSDEC required sample and analysis summary sheets.

- The report will include an overall appraisal of the data package.

The validation report will include a chart presented in a spreadsheet format, consisting of site name, sample numbers, data submitted to laboratory, analytical protocol used, matrix, fractions analyzed, e.g., volatiles, semi-volatiles, metals, cyanide, PCBs.

7.3 Reconciliation with Data Quality Objectives

Calculations and determinations for data precision, accuracy and completeness will be performed in accordance with the procedures presented in Section 7.4 upon the receipt of the validated analytical data. Results will be compared to the project specifications discussed in the WA and site documents. If the results do not meet the project specifications, the data will be flagged as questionable and the cause of the failure (i.e., analytical methods, equipment failure, or sampling error) will be evaluated. The Project Manager and Quality Assurance Officer (QAO) will be responsible for decisions regarding use of questionable data. Potential outcomes of this evaluation will include limitations on the use of the data, rejection of the data, and/or re-sampling. Limitations on the use of the data will be detailed in site reports. Corrective action procedures are discussed further in Section 10.

7.4 Data Reporting

The laboratory will report analytical data consistent with NYSDOH reporting requirements. The QA reporting will include the following accuracy and precision protocols as performed on the appropriate QA samples.

If the data quality measures indicate performance outside the desired objective, the data associated with that result are not considered useless. The burden is on the project team to determine the extent to which a quality issue affects the related data, and ultimately how the issue impacts the fitness for use of the data.

Often a single case in which a performance objective is not met does mean the data is useless, but slightly reduces the confidence that the measurement is reliable and indicates that increased quality control measures are needed. Potential limitations of the data set will be identified and communicated. The project team will present known or potential limitations on the data in the final report.

Data quality is measured by how well the data meet the QA/QC goals for the project. QC elements include precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS):

- Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed conditions. Precision measures the random error component of the data collection process. Precision is determined by measuring the agreement among individual measurements of the same property, under similar conditions. The degree of agreement, expressed as the Relative Percent Difference (RPD), is calculated using the formula below.

$$\mathrm{RPD} = \frac{(V_1 - V_2)}{\frac{(V_1 + V_2)}{2}} \times 100$$

where: V_1 = *value 1*

V_2 = *value 2*

Analytical precision is assessed by analyzing MS/MSD pairs and laboratory duplicate samples. Field precision is assessed by measurement of field duplicate samples. The objective for precision is to equal or exceed the precision demonstrated for similar samples and should be with the established control limits for the methods. Precision control limits and QC RPD limits are noted within the laboratory SOP.

- Accuracy is the degree of agreement of a measurement with an accepted reference or true value. Accuracy measures the bias or systematic error of the entire data collection process. Sources of these errors include the sampling process, field and laboratory contamination, sample preservation and handling, sample matrix interferences, sample preparation methods, and calibration and analytical procedures. To determine accuracy, a reference material of known concentration is analyzed or a sample which has been spiked with a known concentration is reanalyzed. Accuracy is expressed as a percent recovery.

$$Percent\ Recovery = 100 * (\frac{Measured\ Concentration}{Known\ Concentration})$$

- Completeness is calculated as follows:

$$\% \rightleftarrows \text{ Completeness} = \ 100 \ \times \frac{V}{n}$$

where: V = *number of measurements judged valid*

n = *total number of measurements*

The objective is to generate a sufficient database with which to make informed decisions. To help meet the completeness objective, every effort must be made to avoid sample loss through accidents or inadvertence. The completeness goal is 100%.

- Comparability expresses the confidence with which one data set can be compared to another.

Sensitivity is the capability of a method or instrument to discriminate between small differences in analyte concentration.

7.5 Electronic Data Deliverables

The NYSDEC has implemented an Environmental Information Management System (EIMS). The EIMS uses the database software application EQuIS™ from EarthSoft® Inc. In April 2011, NYSDEC issued a directive stating that "all data submitted to the DER must be in the DEC-approved Electronic Data Deliverable (EDD)…The Department will not approve a report or submission unless the data for the site has been submitted in the EDD format and approved. Moreover, new data must be submitted on a continuous basis immediately after data validation occurs but in no event more than 90 days after the data has been submitted to the remedial party or its consultant(s). In other words, data is not to be held and submitted with the related reports." The types of data that can be reported electronically include geological, process control, analytical chemistry, and field data routinely collected from a variety of media and site tasks.

Current data submission format information can be found at the following website: http://www.dec.ny.gov/chemical/62440.html. A Quickstart Guide and EDD Manual can also be found at this location.

According to the NYSDEC, data providers "must download and install the EQuIS Data Processor (EDP) to check their properly formatted file. When the EDD has cleared the EDP checker, a properly named and formatted .ZIP file is produced. The zipped file should then be emailed to NYENVDATA@dec.ny.gov and the DER Project Manager. Data providers should confer with their NYSDEC Project Manager at the project planning and budgeting phase prior to submitting an EQuIS EDD to determine what data (and tables) will be required for their project needs."

8 PREVENTATIVE MAINTENANCE

The preventative maintenance program validates that the sampling, field testing, and analytical equipment perform properly, avoiding erroneous results and minimizing equipment downtime. The preventative maintenance program also ensures instrument maintenance is documented and future maintenance is scheduled. This section describes the equipment maintenance program for field instruments and those responsible for implementation of the program at the Site. Specific field equipment maintenance procedures are given in the manufacturer specifications and operating manuals provided in the Generic FAP. The laboratory preventative maintenance program is the responsibility of the laboratory and only the minimum requirements are mentioned here.

8.1 Responsibilities

Responsibilities of key project personnel are described below:

Personnel	Responsibilities
Field Team Leader	• Develop and implement maintenance program. • Keep maintenance records.
Equipment Manager	• Maintain storage of equipment within the Arcadis equipment inventory. • Carry out maintenance according to schedule. • Inform field team members of specific maintenance requirements. • Keep records of maintenance performed under their care. • Send out equipment for service/repair. • Maintain adequate supply of spare parts.
Field Personnel	• Maintenance of equipment located on-site on a regular basis and after use. • Keep supply of spare parts on-hand.

8.2 Preventative Maintenance Program

The preventative maintenance program consists of three parts, normal upkeep, service and repair, and formal recordkeeping. Normal upkeep consists of daily procedures that include cleaning, lubrication and checking the batteries of the equipment. The following is a partial list of normal upkeep procedures and a partial list of important spare parts:

- Normal upkeep for environmental monitoring equipment performed daily or after use:

    - Cleaning.
    - Lubrication of moving parts.
    - Checking/charging battery.
    - Inspecting for damage.
    - Checking for operation problems.
    - Inspecting hoses and lines.
- Partial list of important spare parts for environmental monitoring instruments frequently used:
    - Fuses.
    - PID-UV lamp.
    - Spare battery.

The normal upkeep is performed daily after each use and includes inspecting for damage, signs of problems, and charging the batteries if necessary. Specific equipment upkeep procedures are described in the manufacturer specifications and operation manuals for instruments provided in the Generic FAP.

Minor service and repair will be performed by the Equipment Manager who is experienced in the service and repair of field instruments. Equipment in need of major or more complex repair and service will be sent to the manufacturer.

Maintenance, servicing, and repair of equipment will be recorded and kept on file. Field personnel will record maintenance and instrument problems in the field instrument logbooks. These will ultimately be kept on file by the Field Team Leader. The Equipment Manager will keep a record of equipment released to the field and a record of maintenance and service on file.

8.3 Laboratory Instrument Maintenance

Preventative maintenance procedures will be clearly defined and written for the measurement systems. Maintenance activity, preventative or repair, will be documented on standard forms, which are maintained in logbooks. Written procedures will include maintenance schedules, problem identification procedures, space for describing problems and repair notes, and failure analysis protocols. Service contracts and regularly scheduled in-house maintenance will be included, along with a list of critical spare parts. Laboratory instrument maintenance and calibration and corrective action procedures are incorporated in the laboratory SOPs.

8.4 Rental Equipment

Rental equipment will be obtained only from known, reputable rental suppliers. The equipment will require documentation to verify operation, maintenance, and upkeep of the equipment.

9 QUALITY ASSURANCE PROCEDURES

To monitor the quality of the analytical data generated for the WA, an appropriate type and number of QC methods will be employed for field and laboratory measurement systems. QC methods are used to validate the analytical methods and measure the suitability of the methods to meet the DQOs prior to the beginning of measurement or analysis. Once the measurements and analysis have begun, the QC methods are used to monitor the system output for quality. The QC results presented with the environmental sample data allow the data to be assessed for quality, and for evaluation of how well the data has met the DQOs.

Laboratory generated data is used to accurately identify and quantify hazardous substances, while the field generated data is used in conjunction with the laboratory data for further investigation of contamination at the site. Both laboratory and field internal QC programs include steps to assure the data are reliable for the extent they will be used in the focused investigation. In general, laboratory QC programs are more rigorous than field QC programs.

9.1 Field Quality Control

The intended data uses have been identified and the DQOs established for field measurement activities in Section 3 of this QAPP and in the Generic FAP. The Generic FAP contains SOPs, which describe the use and calibration of field instruments. QC methods will be used to demonstrate that the instruments are capable of producing reliable data. The QC checks employed for field instruments are as follows:

QC METHOD	PURPOSE	FREQUENCY
Calibration Check	o Checks proper working order of instrument. o Measures instrument accuracy and sensitivity.	Daily
Background Sample	o Provides measure of instrument reliability.	Daily
Duplicate Sample	o Measures instrument precision	One per every 20 environmental samples per media.
Field Duplicates	o Evaluates field sampling precision	One per every 20 environmental samples per media.
Trip Blanks	o Measures potential contamination from sample transport, the environment and/or shipping.	Minimum of one per cooler of samples for VOC analysis.
Field Blanks	o Measures potential contamination due to poor sampling device decontamination procedures	One per every 20 environmental samples per media.

Background Sample	o Provides measure of instrument reliability.	Daily

The calibration checks will occur daily, and duplicate samples will be analyzed at a minimum frequency of five percent. The calibration check verifies that the instrument is capable of accurately identifying and quantifying contaminants of concern. The duplicates provide a quantitative measurement of the precision of the instrument. Background samples are similar to blanks and provide information regarding instrument reliability. The information is recorded in field logbooks. The field technician uses the results from these QC methods to monitor the instrument at the time of the analysis. If QC results indicate a problem with the instrument, corrective action will be taken and, if necessary, the samples will be reanalyzed. Because field measurements are generally easy to repeat, measurements should be repeated, as necessary, so the data are as complete as possible. The QC results are used as an indication of data quality and reliability when the data are being reviewed.

9.2 Laboratory Quality Control

The scope and description of QC samples and QC methods are well detailed in the applicable USEPA SW-846 methodologies for the particular analysis. The methodologies for organic and inorganic analyses describe the type of QC samples and required QC methods, and the required frequency of analysis. QC limits have been established for standards, blanks, duplicates, matrix spikes, and surrogates, and are contained in the methodologies. QC data will be reviewed by Arcadis personnel to assess the validity of the data and determine if the DQOs have been met.

10 CORRECTIVE ACTIONS

10.1 Non-conformance Reports

Corrective action will be taken when a non-conforming condition is identified. A non-conforming condition occurs when QA objectives for precision, accuracy, completeness, representativeness, or comparability are not met, or when procedural practices or other conditions are not acceptable.

A non-conformance report will be prepared by the site QAO and approved by the Project Manager. The non-conformance report will describe the unacceptable condition and the nature of corrective measures recommended and will include a discussion of specific data involved, the impact to data quality, and ultimate data usability. A schedule for compliance will also be provided.

10.2 Corrective Actions

The non-conformance report will be transmitted to a responsible officer of the laboratory, the NYSDEC and the Project Manager. The non-conformance report will specify, in writing, the corrective action recommended including measures to prevent a recurrence of the original deficiency. Appropriate documentation of corrective action will also be prepared. The site QAO will monitor implementation of the corrective action and provide written record as to whether the original problem has been resolved.

10.3 Stop-Work Orders

If Arcadis' personnel become aware of a situation which they perceive jeopardizes or could jeopardize health and safety at a site, they will stop the relevant work as soon as possible. This work will remain stopped until the conditions causing the potential risk are altered, the perceived risk is reassessed, and the conditions are determined to be acceptable to resume the relevant work. If Arcadis is involved in a situation which requires the stopping of relevant work, the Arcadis Project Manager will be notified.

The conditions and need for a Stop-Work Order will be documented in sufficient detail to permit evaluation of the deficiency and determination of proper corrective action. Pertinent communications will be attached to the Stop-Work Order and referenced in the appropriate spaces. Such communications include discussions, correspondences, or telephone conversations that pertain to evaluation of the problem and potential solutions, and implementation of the preferred solution. For work to resume following a Stop-Work Order, the Project Manager must provide confirmation the Stop-Work Order is rescinded.

10.4 Course and Action to Prevent Recurrence

The site QAO tracks non-conforming conditions, evaluates the effectiveness of corrective measures, and assures that steps have been taken to prevent recurrence of the original problem.

10.5 Field Changes

The Project Manager is responsible for site activities. In this capacity the Project Manager will at times be required to modify site programs in response to changing site conditions. At such times, the responsible Field Team Leader will notify the Project Manager of the anticipated change and obtain the approval of the Project Manager and implement the necessary changes. The Project Manager will notify in writing the site QAO and the NYSDEC Representative. A copy of the notification will be attached to the file copy of the affected document. If an unapproved action has been taken during a period of deviation, the action will be evaluated to determine the significance of departure from established procedures.

11 QUALITY ASSURANCE REPORTS

Arcadis field staff will promptly report difficulties to the Project Manager. The laboratory will provide a written description on quality assurance, problems to Arcadis with submission of the analytical data packages.

Following quality assurance audits, the site QAO will submit a Quality Assurance report to the Project Manager describing the performance of the quality assurance program. Problems or issues that arise independent of audits, may be identified to project management at any time.

12 REFERENCES

NYSDEC, 2010. "DER-10 Technical Guidance for Site Investigation and Remediation." New York State Department of Environmental Conservation, Division of Environmental Remediation.

NYSDEC, 2014. “Screening and Assessment of Contaminated Sediment.” New York State Department of Environmental Conservation, Division of Fish, Wildlife and Marine Resources.

NYSDEC, 1998. “Division of Water Technical and Operational Guidance Series 1.1.1 – Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations.” New York State Department of Environmental Conservation, Division of Water.

NYSDOH, 2006. “Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York”. New York State Department of Health Center for Environmental Health, Bureau of Environmental Exposure Investigation.

6 NYCRR Subpart 375-6 Remedial Program Soil Cleanup Objectives

USEPA, “Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW 846”

USEPA, 2014, Region II Validating Volatile Organic Analysis of Ambient Air in canister by Method TO-15, SOP ID: HW-31, Revision 6.

Arcadis of New York, Inc.

855 Route 146

Suite 210

Clifton Park, New York 12065

Tel 518 250 7300

Fax 518 371 2757

www.arcadis.com

Appendix C

Site Specific Community Air Monitoring Plan

New York State Department of Environmental Conservation

Community Air Monitoring Plan

Former Commander Oil Terminal – Off-Site

Oyster Bay, New York

NYSDEC Site No. C130244A

Work Assignment # D009804-31

September 2024

Community Air Monitoring Plan

Former Commander Oil Terminal – Off-Site
Oyster Bay, New York
NYSDEC Site No. C130244A

Work Assignment # D009804-31

September 2024

Prepared By:
Arcadis of New York, Inc.
855 Route 146, Suite 210
Clifton Park
New York 12065
Phone: 518 250 7300
Fax: 518 371 2757

Prepared For:
NYSDEC
Division of Environmental Remediation
625 Broadway, 12th Floor
Albany, NY 12233

Our Ref:
30218263

Contents

Table (in text)

Attachment

1 Introduction

This Community Air Monitoring Plan (CAMP) has been prepared on behalf of the New York State Department of Environmental Conservation (NYSDEC) in support of investigation activities at the Flowers Property adjacent to the Former Commander Oil Terminal – Off-Site Site (ID #C130244A) in Oyster Bay, Nassau County, New York. Investigation activities are detailed in the Site Characterization Work Plan and Executive Summary (Arcadis 2024).

The purpose of this CAMP is to describe the monitoring activities that will be conducted by Arcadis to monitor for potential airborne releases of constituents of concern (COCs) during intrusive drilling and monitoring well installation. This CAMP specifies the air emission action levels, air monitoring procedures, monitoring schedule, data collection and reporting to be performed during the implementation of the field activities.

Arcadis is responsible for providing all labor, materials, and equipment necessary to implement the community air monitoring program specified herein. Arcadis's contractor (contractor) is ultimately responsible for confirming that all corrective measures associated with the community air monitoring program (including the control of dust, vapors, and odors) are conducted in accordance with this CAMP.

1.1 Site Location and Description

The Site consists of the adjacent off-site areas (C130244A) associated with the Brownfield Cleanup Program (BCP) Former Commander Oil Terminal site No. C130244. The Site is located in a mixed area of industrial, commercial, and residential properties surrounding the Former Commander Oil Terminal at One Commander Square, Oyster Bay, New York. The Site properties consist of commercial properties to the North of the Former Commander Oil terminal, Whites Creek to the South, and Oyster Bay Harbor to the East. The nearest residential property is approximately 100 feet south of the Former Commander Oil Terminal (NYSDEC, 2024).

The Former Commander Oil Terminal has been in use since at least the late 1800s. Initially the property was a sawmill, coal yard, ice plant, and residence. After the 1930s the Oil Terminal property was used for major oil storage and associated activities through May 2022, after which MOSF operations ceased, the large capacity storage tanks and piping were emptied but still remain in place as decommissioning in ongoing in anticipation for site redevelopment. The Oil Terminal property has been shown to have volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals in the soil beneath it as well as soil vapor impacted with VOCs. The groundwater beneath the Oil Terminal has also been shown to have VOCs, SVOCs, metals, and Per- and Polyfluoroalkyl Substances (PFAS). The contamination at the Oil Terminal property appears to extend off-site and includes potential impacts from the operation of a vapor recovery unit (VRU) in the northern part of the property which utilized trichloroethylene (TCE) as a refrigerant (NYSDEC, 2024).

The commercial property to the north of the Oil Terminal operates as a commercial oyster harvesting and processing facility with areas sub-leased for storage. Whites Creek to the south is a stream which empties eastward into Oyster Bay (NYSDEC, 2024).

1.2 Summary of Activities

In general, the anticipated intrusive site investigation activities include the installation of four cluster overburden monitoring wells, four soil borings, two sediment sampling locations, and two soil vapor points. Impacted soil and groundwater may be encountered at these investigation locations. Additional details regarding the field activities are provided in the Site Characterization Work Plan and Executive Summary (Arcadis 2024).

2 Odor, Vapor, and Dust Control

As defined in the New York State Department of Health (NYSDOH) Generic CAMP (included as Attachment 1), intrusive remedial activities to be performed at the site have the potential to generate localized impacts to air quality. Field activities that have the potential to generate air emissions include, but may not be limited to, the following:

- Overburden and bedrock drilling;
- Installation of monitoring wells;
- Installation of sub-slab soil vapor points;
- Saw-cutting of pavement or concrete;
- Material handling (e.g., offloading of materials, and loading of materials for transport to an off-site disposal facility); and
- Other ancillary intrusive activities.

Odor, vapor, and dust emissions resulting from these activities will be controlled using a combination of the following:

- Water spray during saw cutting and sub-slab vapor point installation;
- Drilling with water; and
- Polyethylene sheeting (for covering well construction materials).

Odor, vapor, and dust controls will be proactively utilized by the contractor during the work to:

- Prevent exceedances of the total volatile organic compounds (VOCs) and Particulate Matter of 10 microns in diameter or smaller (PM10) action levels specified Section 3.4 of this CAMP; and
- Mitigate odor emissions to the extent practicable and to the satisfaction of Arcadis, NYSDEC, and NYSDOH.

3 Air Monitoring Procedures

The community air monitoring program is intended to be a discrete program that will be operated in conjunction with the exclusion zone (i.e., work zone) air monitoring program. Arcadis will conduct real-time community air monitoring throughout the remedial construction. Monitoring will be conducted at representative locations at the perimeter of the work zone for VOCs and PM_{10}. However, particulate monitoring will not be performed during precipitation events.

Additional information regarding the monitoring locations, equipment, and action levels is presented below.

3.1 Monitoring Location Selection and Deployment

A full set of monitoring stations (i.e., one upwind and one downwind station) will be required at the perimeter of the work zone. Monitoring station locations will be determined daily based the nature of the anticipated investigation activities. An upwind location for both VOC and PM_{10} monitoring will be selected at the start of each workday and one downwind location (based on predominant wind direction) for both VOC and PM_{10} monitoring will also be selected. The VOC and PM_{10} monitoring stations will be deployed each day before the start of work activities. If wind direction shifts radically during the workday and for an extended period of time, such that the upwind location and downwind locations no longer fall within acceptable guidelines (±60-degree compass change from the original wind direction), the monitoring stations will be relocated so that the upwind and downwind locations are maintained. Air monitoring location changes will be documented in a field logbook.

3.2 Volatile Organic Compound Monitoring

Real-time monitoring for VOCs will be conducted at the site during field activities. As required by the NYSDOH Generic CAMP (Attachment 1), VOCs will be monitored continuously during intrusive and/or potential dust-generating activities (e.g., drilling, monitoring well installation, and saw cutting or coring) using instrumentation equipped with electronic data-logging capabilities. A real-time VOC monitor equipped with a photoionization detector and calibrated per manufacturer's specifications, will be used to monitor for VOCs. All time-weighted average (TWA) concentrations (calculated for continuous 15-minute increments [e.g., 08:00 to 08:15, 08:15 to 08:30]) and any instantaneous readings taken to facilitate activity decisions will be recorded using an electronic data logger and/or in the field logbook.

3.3 Total Suspended Particulate Monitoring

Real-time monitoring for PM_{10} will be conducted during investigative activities at the site. As required by the NYSDOH Generic CAMP and requirements for Fugitive Dust and Particulate Monitoring (Attachment 1), real-time airborne PM_{10} monitoring will be conducted continuously during intrusive and/or potential dust-generating activities (e.g., drilling, monitoring well installation, and saw cutting or coring) using instrumentation equipped with electronic data-logging capabilities. A real-time PM_{10} monitor will be used for PM_{10} monitoring. All TWA concentrations (calculated for continuous 15-minute increments [e.g., 08:00 to 08:15, 08:15 to 08:30]) and any instantaneous readings taken to assess an appropriate course of action will be recorded using an electronic data logger and/or in the field logbook.

Fugitive dust migration will be visually assessed during all work activities, and reasonable dust-suppression techniques will be used during any site activities that may generate fugitive dust (as discussed in Section 2).

3.4 Alert and Action Levels

Alert and action levels for VOCs and ambient air PM_{10} concentrations are provided below. Alert and action levels are to be used to initiate corrective actions, if necessary, based on real-time monitoring. Each piece of monitoring equipment will have alarm capabilities (audible and/or visual) to indicate exceedances of the alert levels. Table 1 summarizes the alert and action levels for total VOCs and PM_{10}. Additional details are provided in the following subsections.

Table 1. Community Air Monitoring Alert and Action Levels

Parameter	Basis of Measurement	Alert Level	Action Level
Total VOCs	15-Minute TWA Concentration	2.5 ppm	5.0 ppm
PM_{10}	15-Minute TWA Concentration	100 µg/m^3	150 µg/m^3

Notes:
1. ppm – parts per million
2. µg/m3 – micrograms per cubic meter
3. TWA – time weighted average

3.4.1 Alert and Action Levels for VOCs

As outlined in the NYSDOH Generic CAMP (Attachment 1) if the ambient air concentration for VOCs exceeds 2.5 parts per million (ppm) above background (i.e., upwind location) for the 15-minute TWA, work may continue. The contractor will attempt to identify the potential source of the exceedance and employ additional vapor, and/or dust controls, as necessary, to abate emissions.

If the ambient air concentrations for VOCs persist at levels in excess of 5 ppm but less than 25 ppm above background, all work activities will be halted, NYSDEC will be immediately notified, the source of the elevated VOC concentrations identified, corrective actions to reduce or abate the emissions will be completed or modify construction techniques, as necessary, and continue air monitoring. Work activities may resume provided that the 15-minute average VOC concentration remains below the alert levels.

If the ambient air concentrations for VOCs exceed 25 ppm above background, work shall not resume until authorized by NYSDEC.

PID action screening levels for the classification of a soil as contaminated is 5 ppm.

3.4.2 Alert and Action Levels for PM10

As outlined in the NYSDOH Generic CAMP (Attachment 1), if the ambient air concentration for PM_{10} exceeds 100 micrograms per cubic meter (µg/m^3) above average background (i.e., upwind location) for the 15-minute TWA, or visible dust is observed leaving the work area, work may continue if dust suppression techniques are implemented. The contractor will attempt to identify the potential source of the exceedance and shall employ additional dust controls, or modify construction techniques, to abate emissions.

If the ambient air concentration for PM_{10} exceeds 150 µg/m^3 above average background for the 15-minute TWA, or visible dust is observed leaving the work area, the contractor shall stop all work activities, immediately notify NYSDEC, identify the source of elevated PM_{10} concentrations, complete corrective actions to reduce or abate the emissions or modify construction techniques, as necessary, and continue air monitoring. Work activities may resume provided that the 15-minute TWA concentration remains below the action levels.

3.5 Odor Monitoring

During working hours, Arcadis will conduct periodic walks around the perimeter of the work area(s) to monitor for odors originating from the intrusive activities. These perimeter checks will be performed more frequently, as necessary, depending on the work being performed and meteorological factors such as change in wind direction. Meteorological factors that can influence odor generation and dissemination generally include temperature, humidity, precipitation, atmospheric pressure, wind direction, and wind speed. These factors can work synergistically with a positive or negative impact on odor generation and transport/dispersion. For example, odors generally tend to be less prevalent with lower temperatures, precipitation, or high humidity. Additionally, odor dissemination is greatly influenced by wind direction and wind speed. Meteorological factors, including wind direction, will be monitored during the intrusive activities.

If odors are noticed along the perimeter of the work area, work will continue and odor-, vapor-, and dust-suppression techniques employed to abate emissions. Additionally, drilling techniques will be evaluated and modified, if necessary and appropriate, and more frequent checks of the work area perimeter for odors will be performed.

Odor complaints (if any) will be directed to Arcadis. The legitimacy of the complaint will be verified based on the work activities being performed, the predominant wind direction, and other meteorological factors. In response to verified odor complaints, perimeter monitoring will continue, and additional odor, vapor, and dust controls will be employed to abate emissions. Additionally, construction techniques will be evaluated and modified, if necessary and appropriate.

If odors continue to be noticed at the perimeter of the work area, work will be stopped while activities are reevaluated. The source or cause of the odors will be identified and additional modifications of construction techniques or additional methods to abate emissions will be implemented. Work will resume provided the measures are successful at abating the odors noticed along the work area perimeter. If the odor complaint cannot be resolved through implementation of the stated controls, NYSDEC will then investigate the complaint further.

3.6 Instrument Calibration

Arcadis shall calibrate air monitoring equipment daily (at a minimum), or other frequency recommended by the manufacturer. All instrument readings, field reference checks, and calibrations will be recorded in the field logbook.

4 Monitoring Schedule and Reporting

The following subsections identify the monitoring schedule and data collection/reporting requirements.

4.1 Monitoring Schedule

Air monitoring will be conducted prior to initiation of the field activities/intrusive work to establish adequate baseline data and until such time that significant material handling activities are complete (i.e., removal of stockpiled materials for off-site transportation and disposal). As previously indicated, real-time VOC and PM_{10} monitoring will be performed during intrusive and/or potential dust-generating activities (e.g., drilling, monitoring well installation, and saw cutting or coring).

The frequency of air monitoring will be relative to the level of site work activities being conducted and may be adjusted as the work proceeds and in consideration of the monitoring results. Air monitoring for VOCs and PM_{10} may be discontinued during periods of heavy precipitation that would otherwise result in unreliable data or damage to the monitoring equipment.

4.2 Reporting

Arcadis will prepare and submit a daily summary of the 15-minute average community air monitoring results (for VOCs and PM_{10}) for NYSDEC and NYSDOH PM review within 24 hours. The summary will also include, but not be limited to, locations of stations, a description of community air monitoring exceedances (if any), work activities associated with the exceedances, and corrective actions implemented to address the exceedances. In addition, any exceedances or corrective actions taken will be reported immediately to NYSDEC and NYSDOH PMs. The time and outcome of each odor perimeter check will be documented in a daily log, specifically noting the presence or absence of odors and identifying the general location(s) along the perimeter where odors (if any) are noticed. These daily logs, as well as documentation of any odor complaints received from the public, will be included in the aforementioned daily CAMP reports.

Attachment A-1

NYSDOH Generic Community Air Monitoring Plan

Appendix 1A
New York State Department of Health
Generic Community Air Monitoring Plan

Overview

A Community Air Monitoring Plan (CAMP) requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

The generic CAMP presented below will be sufficient to cover many, if not most, sites. Specific requirements should be reviewed for each situation in consultation with NYSDOH to ensure proper applicability. In some cases, a separate site-specific CAMP or supplement may be required. Depending upon the nature of contamination, chemical- specific monitoring with appropriately-sensitive methods may be required. Depending upon the proximity of potentially exposed individuals, more stringent monitoring or response levels than those presented below may be required. Special requirements will be necessary for work within 20 feet of potentially exposed individuals or structures and for indoor work with co-located residences or facilities. These requirements should be determined in consultation with NYSDOH.

Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

Community Air Monitoring Plan

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for VOCs and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring. If radiological contamination is a concern, additional monitoring requirements may be necessary per consultation with appropriate DEC/NYSDOH staff.

Continuous monitoring will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. “Periodic” monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

VOC Monitoring, Response Levels, and Actions

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions, particularly if wind direction changes. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

1. If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

2. If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

3. If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

4. All 15-minute readings must be recorded and be available for State (DEC and NYSDOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

Particulate Monitoring, Response Levels, and Actions

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

1. If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

2. If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m^3 of the upwind level and in preventing visible dust migration.

3. All readings must be recorded and be available for State (DEC and NYSDOH) and County Health personnel to review.

December 2009

Arcadis of New York, Inc.
855 Route 146, Suite 210
Clifton Park, NY 12065
United States
Phone: 518 250 7300
Fax: 518 371 2757
www.arcadis.com