New York State Department of Environmental Conservation
625 Broadway • Albany, New York 12233-7011

Modock Road Springs/DLS Sand and Gravel, Inc. Site (HW 8-35-013)
Victor, New York

Work Assignment # D-004439-9

Remedial Investigation/ Feasibility Study Work Plan

August 2007

Work Plan Prepared By:

Malcolm Pirnie, Inc.

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0266361

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1. Introduction

The New York State Department of Environmental Conservation (NYSDEC) tasked Malcolm Pirnie, Inc. (Malcolm Pirnie) to perform an Remedial Investigation/Feasibility Study (RI/FS) at the Modock Road Springs/DLS Sand and Gravel, Inc. Site (HW 8-35-013), in the Town of Victor, New York (Figure 1).

The RI/FS will be conducted under the NYSDEC State Superfund Standby Contract No. D004439-9. This RI/FS consists of the following three tasks:

- Task 1 – Background Review and Preparation of Work Plans
- Task 2 – Site Investigation
- Task 3 – Preparation of Feasibility Study

A brief summary of these tasks is included in Section 2.

1.1. Work Plan Development

Malcolm Pirnie has prepared this Work Plan following acceptance of the Work Assignment issued by the NYSDEC. The scope of the work generally includes Work Plan development, a site investigation, and a feasibility study. This Work Plan provides the following:

- Major tasks and subtasks,
- Estimated budget,
- Field Activities Plan (Appendix A),
- Site Specific Health and Safety Plan (Appendix B),
- Community Air Monitoring Plan (Appendix C), and
- Generic Quality Assurance Project Plan (Appendix D).

The Generic Quality Assurance Project Plan (QAPP) has been prepared as a generic appendix to site-specific work plans developed for work assignments issued under the New York State Department of Environmental Conservation (NYSDEC) Standby Contracts D004439 and D004443 for remedial investigation/ design, and design/ construction, respectively. The Generic QAPP provides quality assurance/ quality control (QA/QC) methods, procedures, and protocols for the collection, analysis, and evaluation of data collected during the work assignments.

1.2. Site Information

The Modock Road Springs/DLS Sand and Gravel, Inc. site (Modock Road Springs site) is located in a rural/suburban area in the Town of Victor, Ontario County, New York. In advance of a Remedial Investigation/Feasibility Study (RI/FS) at the Modock Road Springs site, a soil vapor intrusion investigation was completed as part of the immediate investigation work assignment (IIWA) during the 2006/2007 heating season. In addition, NYSDEC and NYSDOH conducted a private well sampling program in early 2007. Data collected during previous investigations have documented the presence of trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), and 1,1-dichloroethene (*1,1*-DCE) in groundwater beneath a rural and suburban residential area of the Town of Victor. The groundwater plume appears to originate near or on the DLS Sand & Gravel, Inc. property and extends approximately one mile to the north where it discharges to surface water via a series of springs (Figure 1). The springs were used as a drinking water source for the Town of Victor until 1990 when TCE and 1,1,1-TCA were detected in the spring water. Over the length of the groundwater plume, total chlorinated volatile organic compound (CVOC) concentrations have ranged from approximately 16 parts per million (ppm) near the southern portion of the plume to approximately 250 parts per billion (ppb) at the springs.

2. Scope of Work

A brief summary of the RI/FS tasks is included in Section 2.2. Details of each field activity are provided in the Field Activities Plan (Appendix A).

The scope of work summarized in this Work Plan includes the development and implementation of an RI/FS. The RI will expand on earlier site investigations and the IIWA, and will provide a thorough characterization of the nature and extent of contamination, and will provide the necessary data to evaluate interim remedial measures (IRMs), if necessary, and conduct an FS. The FS will identify and evaluate possible alternatives available to remediate the site and will be used as the basis for selecting a preferred remedial alternative.

2.1. RI/FS Objectives

The overall objectives of this RI/FS are to:

- Complete a soil gas investigation to identify possible source areas, to possibly eliminate specific locations as disposal areas, and to identify some subsequent drilling locations;
- Identify possible source areas and characterize the overall distribution of contaminants near the source areas;
- Define the limits of the groundwater plume;
- Based on the distribution of contaminants and groundwater flow patterns, determine the hydraulic relationship between the groundwater system, the Modock Road Springs, the nearby wetlands, and Irondequoit Creek;
- Perform follow-up sub-slab and indoor air sampling to further evaluate the potential for soil vapor intrusion into residential homes over the plume;
- Conduct a site survey and prepare a base map;
- Install a series of shallow and deep overburden groundwater monitoring wells and collect soil and groundwater samples for laboratory analysis; and
- Sufficiently characterize the geology and hydrogeology of the site to facilitate the evaluation of interim and final remedial alternatives.

2.2. RI/FS Tasks

A list of the RI/FS tasks and subtasks is provided below. A summary of the anticipated field activities are provided in the Field Activities Plan (Appendix A).

Task 1 - Background Review and Preparation of Work Plans

Subtask 1.1 Project Management Work Plan (PMWP)

- Includes a site visit, scoping session, and development of PMWP.

Subtask 1.2 Preparation of the RI/FS Work Plan

- Preparation of RI/FS Work Plan which includes a Site Specific HASP, Community Air Monitoring Plan, and a Generic QAPP.

Subtask 1.3 Passive Soil Gas Investigation

- Collection and analysis of 100 passive soil gas samples.

Subtask 1.4 Direct Push/Geoprobe Drilling

- Geoprobe field activities include the following:

(1) 20 shallow direct push soil borings on the DLS Sand and Gravel property

(2) Eight shallow soil borings and groundwater sampling near springs

(3) Up to 15 deep soil borings with use of Membrane Interface Probe (MIP)

Subtask 1.5 Subsurface Drilling Program and Monitoring Well Installation

- Installation and development of six groundwater monitoring wells.

Subtask 1.6 Storage and Disposal of Waste

- Investigation Derived Waste (IDW) will be stored and disposed of at the direction of NYSDEC

Subtask 1.7 Interim Remedial Measure Evaluation

- Preparation of letter report detailing interim remedial measure (IRM) alternatives analysis summarizing IRM options and associated costs.

Task 2 - Site Investigation

Subtask 2.1 Soil Gas Investigation

- Collection and analysis of approximately 50 passive soil gas samples, if needed.

Subtask 2.2 Direct Push/Geoprobe Drilling

- Drilling and soil sampling at approximately 20 shallow soil borings.

Subtask 2.3 Subsurface Drilling Program

- Installation and development of eight groundwater monitoring wells.

Subtask 2.4 Groundwater and Surface Water Sampling

- Sampling and analysis of approximately 20 wells during two sampling events.

Subtask 2.5 Indoor Air Sampling

- Collection of indoor air, sub-slab vapor, and ambient air samples at approximately 15 residences.

Subtask 2.6 Storage and Disposal of Waste

- IDW will be stored and disposed of at the direction of NYSDEC

Subtask 2.7 Data Validation/Determination of Usability

- Groundwater, surface water, indoor and ambient air, sub-slab vapor laboratory data will be validated by a third-party validator according to NYSDEC DER Data Usability Summary Report (DUSR) guidelines.

Subtask 2.8 Site Survey and Basemap Preparation

- Newly installed monitoring wells will be surveyed and referenced to NAD83 (coordinates) and NAVD 88 (elevations).

Subtask 2.9 "Qualitative" Health Exposure Assessment

- A qualitative health exposure assessment will be performed to identify potential exposure pathways of site contaminants to the general public. A quantitative assessment will not be conducted. Exposure pathway scenarios which will be evaluated include groundwater as a drinking water source, contact with surface water, utility worker contact with soil and groundwater, and residential inhalation of indoor air impacted by intrusion of sub-slab vapors containing VOCs.

Subtask 2.10 Fish & Wildlife Impact Analysis through Step II-B

- A fish and wildlife impact analysis will be performed through Step II-B in accordance with the October 1994 NYSDEC Division of Fish and Wildlife guidance entitled "Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites". Step I is a site description which includes the development of site maps (topographic, covertype, and drainage), a description of fish and wildlife resources and resource value, and an identification of applicable fish and wildlife regulatory criteria. Steps IIA and IIB are pathway and criteria-specific analyses, respectively.

Subtask 2.11 Remedial Investigation Report Preparation

- A Remedial Investigation Report will include a summary of activities, a conceptual site model, tables summarizing physical and analytical results, and conclusions and recommendations. The conceptual site model (CSM) will include a description of the site history, geology, hydrogeology, environmental setting, and nature and extent of contamination. The CSM will also provide an evaluation of contaminant fate and transport, potential human exposure pathways, and environmental concerns. The conclusions and recommendations of the Remedial Investigation Report will discuss if the collection of additional data is required, if a Supplemental RI is necessary, or if sufficient data exists to start the FS.

Subtask 2.12 Participation in one public meeting at the conclusion of the RI.

- Malcolm Pirnie will participate in and provide visual aids for one public informational meeting at the conclusion of the RI. Malcolm Pirnie will present the results of the RI and answer technical questions regarding the methodologies and findings of the RI. Visual aids may include large site maps on poster boards, data summary sheets, photographs and/or slides of site activities.

Task 3 - Preparation of Feasibility Study

Subtask 3.1 Standards, Criteria and Guidance (SCGs)

- SCGs for each contaminant detected and SCGs necessary for evaluation of remedial actions will be identified and compared to existing conditions on and off the site.

Subtask 3.2 Development of Remedial Action Objectives

- Malcolm Pirnie will develop remedial action objectives (RAOs) for all contaminants of concern and affected media and evaluate analytical results relative to appropriate guidance.

Subtask 3.3 Scoping and Development of Remedial Alternatives

- Malcolm Pirnie will attend a scoping meeting to discuss the remedial alternatives applicable to the site. Malcolm Pirnie will prepare a brief letter report discussing the remedial alternatives to be considered along with the conceptual details of the remedial alternative.

Subtask 3.4 Detailed Analysis

- The detailed analysis of the remedial alternatives will include evaluation of the following factors:

- Overall protection of human health and the environment;
- Compliance with SCGs;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility and volume;
- Short-term effectiveness;
- Implementability; and
- Cost.

Subtask 3.5 FS Report Preparation

- An FS report, including discussions of each of the evaluation criteria for each of the alternatives (or technologies) being considered, will be prepared and submitted to NYSDEC. A summary, including a comparative analysis, will also be included in the report. A preferred remedy that is protective of public health and the environment, complies to the maximum extent practicable with SCG's and cleanup objectives, reflects a preference for treatment over simple disposal, and is cost effective will be recommended. A conceptual plan for implementing the preferred alternative and verifying its feasibility will be prepared. The report will include limited site background and site characterization but will include a conceptual design of the preferred remedy which includes a detailed engineers cost estimate.

Subtask 3.6 Proposed Remedial Action Plan (PRAP) and Public Meeting

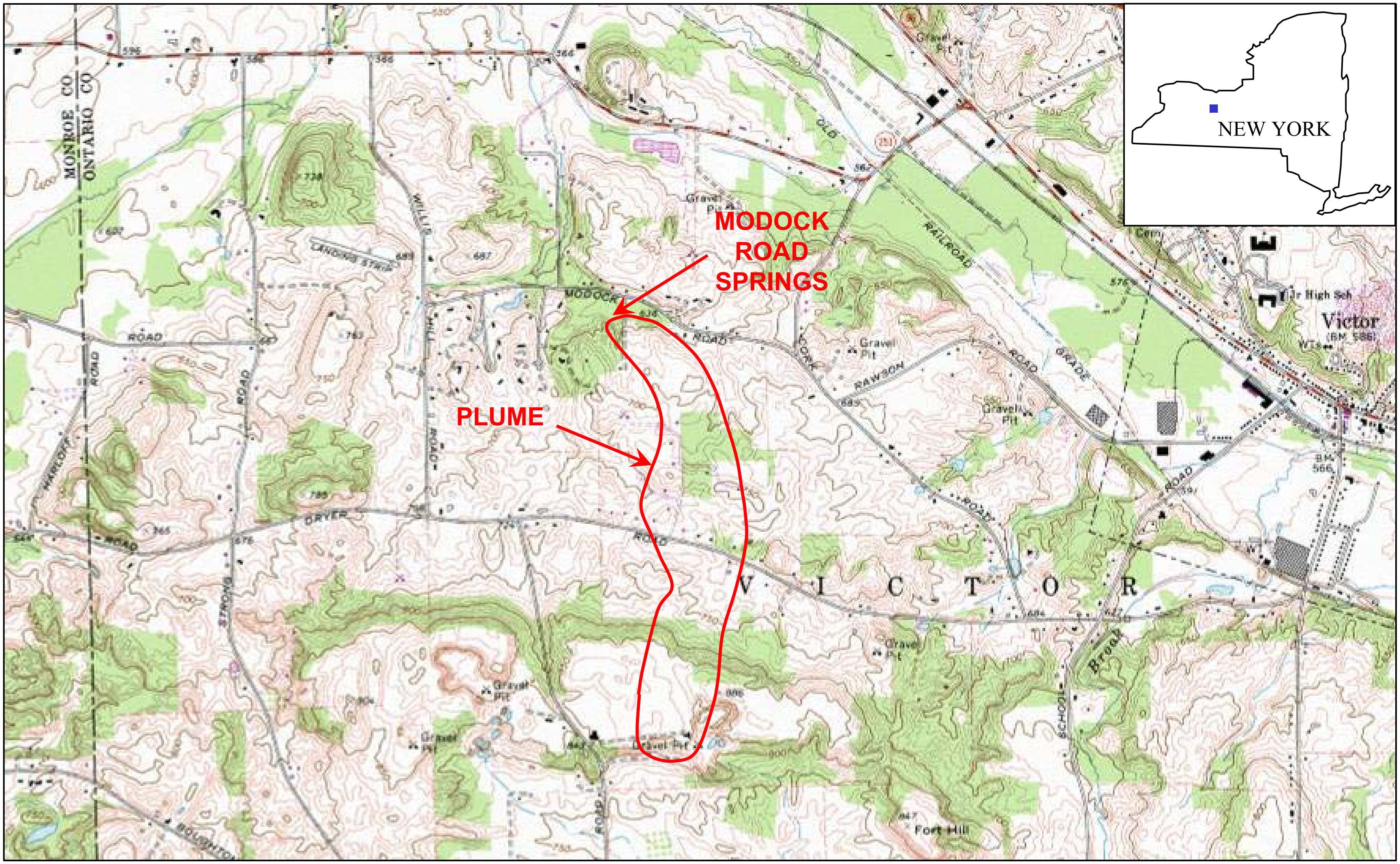
- Malcolm Pirnie will provide the tables and figures from RI/FS reports to support the NYSDEC prepared PRAP document, and review and comment on an initial draft of the PRAP. Malcolm Pirnie will prepare visual aids for and attend a public meeting and present the results of the RI/FS.

3. Estimated Budget

The estimated project budget is shown in the 2.11 series of schedules, which are provided in the Project Management Work Plan.

New York State Department of Environmental Conservation
Remedial Investigation/Feasibility Study Work Plan

Figures



MAP SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC SERIES, VICTOR QUADRANGLE (PHOTOREVISED 1978)

APPROXIMATE SCALE IN FEET

0 1200 2400 4800

MALCOLM PIRNIE

MODOCK ROAD SPRINGS/DLS SAND AND GRAVEL, INC. SITE (HW 8-35-013)
VICTOR, NEW YORK

APPROXIMATE PLUME EXTENT

FIGURE 1

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New York State Department of Environmental Conservation
Remedial Investigation/Feasibility Study Work Plan

Appendix A:
Field Activities Plan

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Modock Road Springs/DLS Sand and Gravel, Inc. Site (HW 8-35-013)
Victor, New York
Work Assignment # D-004439-9

Remedial Investigation/ Feasibility Study Work Plan
Appendix A: Field Activities Plan

August 2007

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A. Daily Observation Report
B. Field Kit Guide for Passive Soil-Gas Investigations
C. New York State Department Of Health Indoor Air Quality Questionnaire And Building Inventory

1. Project Background

The New York State Department of Environmental Conservation (NYSDEC) tasked Malcolm Pirnie, Inc. (Malcolm Pirnie) to perform an Remedial Investigation/Feasibility Study (RI/FS) at the Modock Road Springs/DLS Sand and Gravel, Inc. Site (HW 8-35-013), in Victor, New York. The RI/FS will be conducted under the NYSDEC State Superfund Standby Contract No. D004439. An initial step in the RI/FS is preparation of this Field Activities Plan, which describes the anticipated field activities. The elements of this Field Activities Plan were prepared in accordance with the most recent and applicable guidelines and requirements of NYSDEC and the New York State Department of Health (NYSDOH).

The Modock Road Springs site is located in a rural/suburban area in the Town of Victor, Ontario County, New York. In advance of the RI/FS at the Modock Road Springs site, a soil vapor intrusion investigation was completed as part of an Immediate Investigation Work Assignment (IIWA) during the 2006/2007 heating season. In addition, NYSDEC and NYSDOH conducted a private well sampling program in early 2007. Data collected during previous investigations indicate the presence of trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), and 1,1-dichloroethene (1,1-DCE) in groundwater beneath a rural and suburban residential area of the Town of Victor. The groundwater plume appears to originate on or near the DLS Sand & Gravel, Inc. property and extends approximately one mile to the north where it discharges to a series of springs. The springs were historically used as a drinking water source for the Town of Victor. Over the length of the groundwater plume, total chlorinated volatile organic compound (CVOC) concentrations have ranged from approximately 16 parts per million (ppm) near the southern portion of the plume to approximately 250 parts per billion (ppb) at the springs. Currently, data indicates that soil vapors containing CVOCs and originating from the plume may have entered into the sub-slab material and indoor air of some of the overlying residential homes.

2. Field Activities

The purpose of this RI/FS is to assess the nature and extent of concentrations of CVOCs in a groundwater plume that extends from the DLS Sand and Gravel property to the Modock Road springs and to provide the necessary data to evaluate interim remedial measures (IRMs), if applicable, and an FS. Field activities will be conducted to acquire information necessary to identify, evaluate, and design potential remedial alternatives for the site. Field notes describing each day's activities will be recorded on a Daily Observation Log, which is provided in Attachment A.

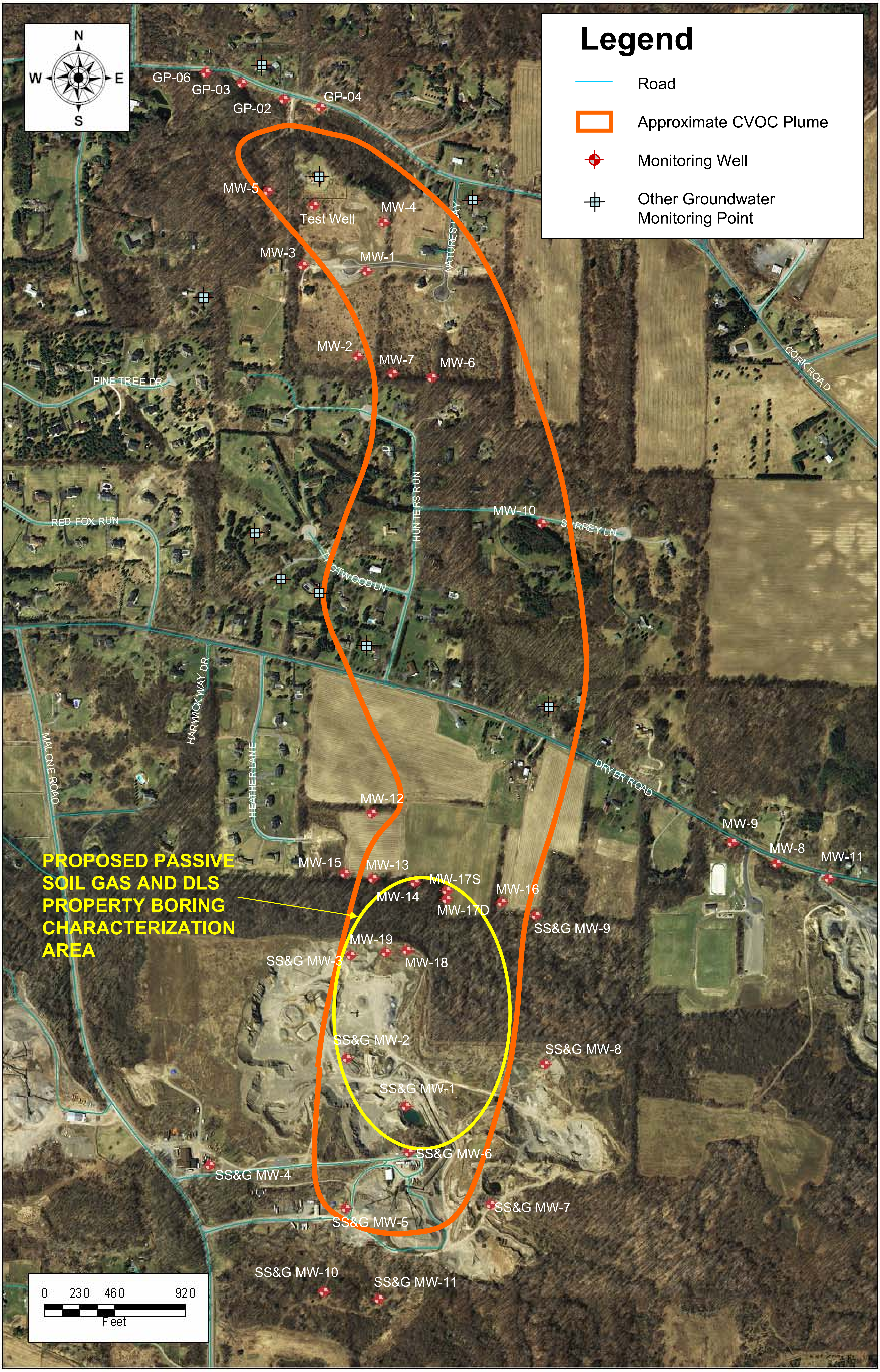
2.1. Soil Gas Sampling

A passive soil gas investigation, using samplering devices provided by Beacon Environmental Services, Inc. will be completed in the northern portion of the DLS Sand & Gravel, Inc. property and adjacent areas. The passive soil gas investigation will be completed to identify potential source areas, to characterize the lateral extent of shallow soil contamination, and to possibly remove certain areas from consideration as suspect disposal areas.

The soil gas samples will be located on an evenly-spaced sampling grid where applicable. This includes the northern portion of the DLS Sand and Gravel property and the area to the south of monitoring well MW-14. Approximately 100 passive soil gas samplers will be deployed during the first phase of sampling and approximately 50 passive soil gas samplers will be deployed during the second phase of sampling. The soil gas samples will be located within the "characterization area" shown on Figure 1.

The passive soil gas sampling will be used to optimize subsequent site characterization activities and drilling programs. The passive soil gas sampling will be completed using an acceptable methodology as summarized in the Beacon Environmental Services, Inc. Field Kit Guide for Passive Soil-Gas Investigations (Attachment B). During the initial phase of passive soil gas sampling, approximately 100 soil gas samples and three trip blanks will be collected and analyzed for VOCs by USEPA Method 8260B (Table 1).

A survey flag, marked with sample identification information, will be placed at each sample location. NYSDEC will locate the sample coordinates using a high precision GPS survey. At each sampling location, a photoionization detector capable of measuring part per billion levels of VOCs will be used to screen shallow soil gas at the respective passive soil gas sampling point.



MALCOLM PIRNIE

MODOCK ROAD SPRINGS/DLS SAND AND GRAVEL, INC. SITE (HW 8-35-013)
VICTOR, NEW YORK

PROPOSED PASSIVE SOIL GAS AND DLS PROPERTY BORING CHARACTERIZATION AREA

FIGURE 1

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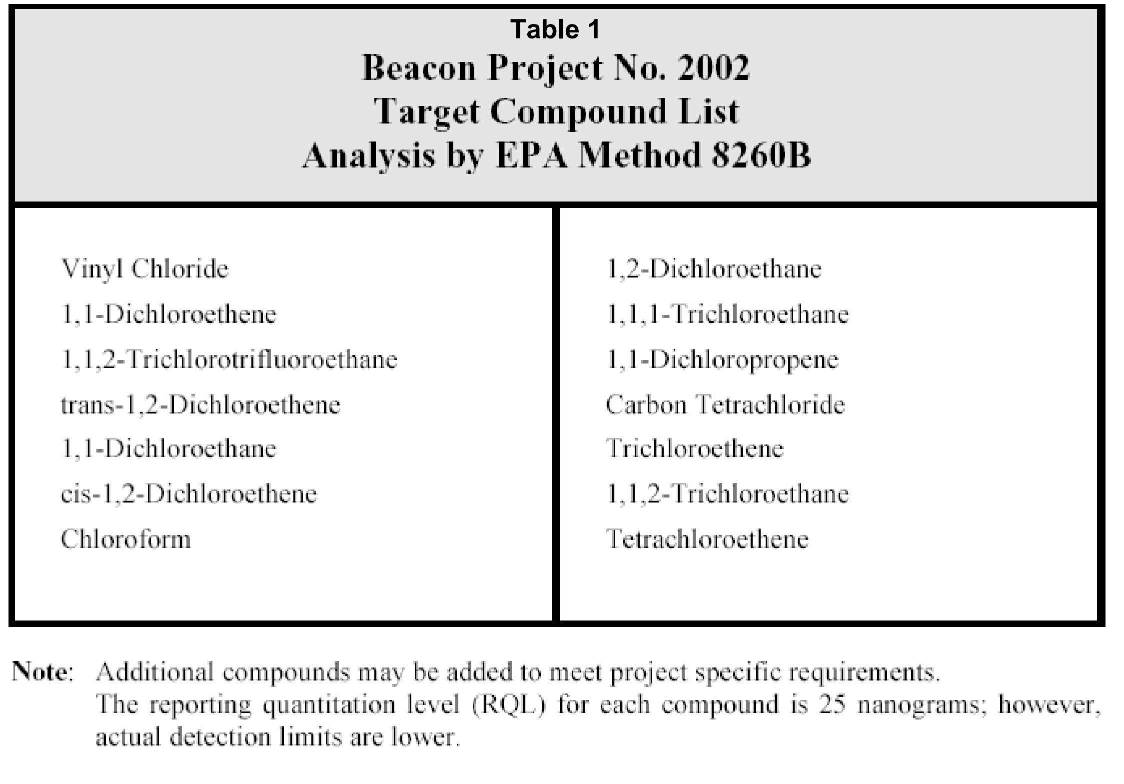


Table 1

Beacon Project No. 2002
Target Compound List
Analysis by EPA Method 8260B

Vinyl Chloride
1,1-Dichloroethene
1,1,2-Trichlorotrifluoroethane
trans-1,2-Dichloroethene
1,1-Dichloroethane
cis-1,2-Dichloroethene
Chloroform
1,2-Dichloroethane
1,1,1-Trichloroethane
1,1-Dichloropropene
Carbon Tetrachloride
Trichloroethene
1,1,2-Trichloroethane
Tetrachloroethene

Note: Additional compounds may be added to meet project specific requirements. The reporting quantitation level (RQL) for each compound is 25 nanograms; however, actual detection limits are lower.

2.2. Direct Push/Geoprobe Drilling:

The direct push/geoprobe drilling program will consist of approximately 40 shallow soil borings on or near the DLS Sand and Gravel property, 8 shallow soil borings north of the Modock Road springs, and 15 deep membrane interface probe borings on the DLS Sand and Gravel property. Soil sampling procedures are described in the Generic QAPP, which is provided in Appendix C of the Project Management Work Plan (PMWP).

2.2.1. Shallow Soil Borings on and near the DLS Sand and Gravel property

Approximately 20 soil borings will be drilled 10 to 20 feet below ground surface on and near the DLS Sand and Gravel property to evaluate shallow soil quality and possible disposal areas identified during the soil gas investigation. An additional approximately 20 soil borings will be drilled during a second phase of drilling. The soil borings will be located within the "characterization area" shown on Figure 1. A survey flag, marked with sample identification information, will be placed at each sample location. NYSDEC will locate the sample coordinates using a high precision global positioning system (GPS) survey.

Subsurface soil samples will be collected continuously from each of the soil borings. Macrocores will be collected continuously from ground surface to the desired depth. Up to two soil samples from each soil boring will be submitted to a laboratory for VOC analysis using United States Environmental Protection Agency (USEPA) method 8260B. The field screening along with field observations will be used to select soil samples for laboratory analysis. If no contamination is detected, the subsurface soil samples for laboratory analysis will either be collected from a low permeability interface or from an area with increased soil moisture in consultation with the NYSDEC.

2.2.2. Shallow Soil Borings Near Springs

Up to eight shallow soil borings near the Modock Road springs will be drilled to assess subsurface stratigraphy and to evaluate shallow groundwater quality in the vicinity of the Modock Road Springs. It is expected that the shallow soil borings will be advanced to a depth of approximately 20 feet below ground surface. Macrocores will be collected continuously from ground surface to the desired depth. Temporary monitoring wells will be installed in up to four of these borings. A groundwater sample from each of the shallow borings will be collected using a Geoprobe® Systems stainless steel screenpoint or temporary monitoring well. Surface water samples will be collected from the discharge point of the primary spring, the culvert at Modock Road, and up to two additional locations along the stream emanating from the springs. Groundwater and surface water samples will be analyzed for VOCs by USEPA Method 8260B.

2.2.3. Membrane Interface Probe (MIP)

Up to 15 deep borings will be drilled with a Membrane Interface Probe (MIP) to assess VOCs in the saturated and unsaturated zones. The boring locations will be based on the results of the passive soil gas investigation and soil samples from shallow boring on and near the DLS Sand and Gravel property. A survey flag, marked with sample identification information, will be placed at each boring. NYSDEC will locate the sample coordinates using a high precision global positioning system (GPS) survey. Soil samples will not be collected during the MIP drilling. MIP field procedures are described in the Generic QAPP, which is provided in Appendix C of the PMWP.

2.3. Subsurface Drilling and Monitoring Well Installation

During the first phase of drilling, approximately six soil borings will be completed as groundwater monitoring wells using a sonic drill rig. An additional eight monitoring wells will be installed during a second phase of drilling. These field activities will be conducted to evaluate the overburden stratigraphy; groundwater quality; and groundwater flow patterns. Existing groundwater data along with the results of the previous RI/FS field work will be used to identify drilling and monitoring well locations. Subsurface soil samples will be collected continuously from each of the soil borings until the target depth is encountered. Subsurface drilling, monitoring well installation, and well development procedures are described in the Generic QAPP, which is provided in Appendix C of the PMWP.

Subsurface soil samples will be collected to obtain information on the characteristics of the overburden material and for submittal to a laboratory for further analysis. Select soil samples will be sent to an approved laboratory for VOC analysis by USEPA Method 8260B and in accordance with the NYSDEC Analytical Services Protocol. The selection of subsurface soil materials for laboratory analysis will be made in consultation with the NYSDEC and will be based on:

1) Subsurface soil that shows visual signs of contamination; or
2) Subsurface soil that causes a sustained response above the measured background response on a calibrated flame or photoionization screening instrument; or
3) A combination of these situations.

The monitoring wells will be constructed similar to the construction of the existing monitoring well network. The drilling program will include the installation of both shallow and deep groundwater monitoring wells. Prior to well installation, boreholes will be drilled using sonic drilling methodologies, with continuous sampling to the top of the underlying confining unit. The shallow wells will be installed at the top of the saturated zone and the deep wells (where appropriate) will be installed above the confining unit. The prefix for monitoring well identifications will be "MW-". Deep monitoring wells will be identified with a "D" that is immediately preceded by the well number (i.e. MW-15D).

The monitoring wells will be developed no sooner than 24 hours following installation by surging and pumping techniques. Well development will be considered complete when temperature, conductivity, and pH have stabilized and a turbidity of less than 50 NTUs has been achieved. Well development procedures are provided in the Generic QAPP (Appendix C of the PMWP)

2.4. Groundwater and Surface Water Sampling

Groundwater samples will be collected during two separate sampling events by NYSDEC staff with support from Malcolm Pirnie. In total, approximately 40 wells, including the network of existing monitoring wells, newly installed monitoring wells as part of the Modock Road Springs RI/FS, and existing monitoring wells located on the DLS Sand and Gravel, Inc. property, will be included in the groundwater sampling program. Groundwater samples will be collected using passive diffusion bags (PDBs) or conventional sampling techniques. Prior to the start of both groundwater sampling events, water levels will be measured from the entire monitoring well network to prepare a groundwater contour map and evaluate groundwater flow patterns.

A surface water sample will be collected from the Modock Road Springs. Up to four downstream surface water samples will be collected from the wetland complex and the surface water stream emanating from the springs. Groundwater and surface water samples will be analyzed for VOCs by USEPA Method 8260B.

2.5. Air Sampling

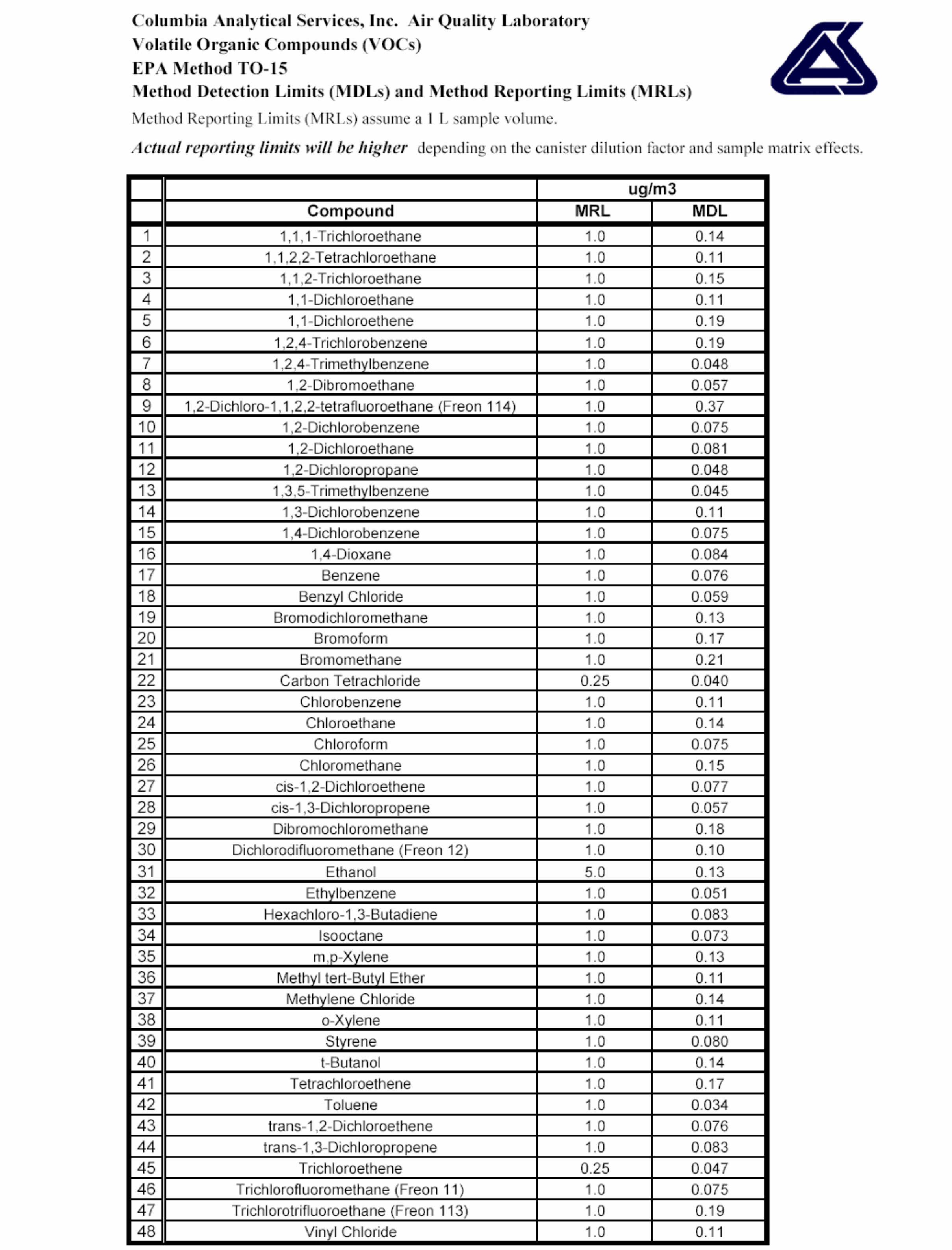
Follow-up indoor air sampling will be completed as part of the Modock Road Springs RI/FS to further evaluate the migration of vapors into buildings. The air sampling will be conducted in accordance with the October 2006 Final NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York and the February 2007 *Immediate Investigation Work Plan* (IIWP). The overall goal of the indoor air sampling is to evaluate potential human exposure to VOCs known to be present in site soil and groundwater. Air sampling procedures are described in the Generic QAPP (Appendix C of the PMWP).

Based on the results of the IIWA, it is estimated that indoor air and sub-slab vapor sampling will be collected at a total of 15 locations. It is anticipated that the sampling activities will be conducted over a three-week period and NYSDEC and/or NYSDOH personnel will provide field assistance and guidance. The NYSDEC will select the properties at which samples will be collected. Sampling at these structures is contingent upon approval by property owners.

The air and sub-slab vapor sampling procedures described below are consistent with sampling activities conducted during the IIWA and described in the IIWP. Prior to sampling at each of the selected residences, an inspection will be conducted to inventory household products that could interfere with sampling results and document heating, ventilation, and air conditioning (HVAC) systems. During the inspection, sampling locations will be selected in consultation with the NYSDEC or NYSDOH. Samples will be collected over a 24-hour period.

One indoor air sample will be collected from both the first floor living space and basement (if applicable) of each residence. Sub-slab vapor sampling will be conducted in structures with competent floors or slabs. If the floor is primarily unfinished (e.g., dirt floor), no sub-slab sample will be collected. A minimum of one outdoor ambient air sample will be collected per day of sampling concurrently with the indoor air samples in the vicinity of the residences where indoor air samples are being collected. Air and sub-slab soil vapor samples will be analyzed for a NYSDEC-specified list of VOCs utilizing USEPA Method TO-15 (Table 2).

Table 2
TO-15 Analyte List and Method Reporting Limits



Columbia Analytical Services, Inc. Air Quality Laboratory
Volatile Organic Compounds (VOCs)
EPA Method TO-15
Method Detection Limits (MDLs) and Method Reporting Limits (MRLs)

Method Reporting Limits (MRLs) assume a 1 L sample volume.

Actual reporting limits will be higher depending on the canister dilution factor and sample matrix effects.

		ug/m3	
	Compound	**MRL**	**MDL**
1	1,1,1-Trichloroethane	1.0	0.14
2	1,1,2,2-Tetrachloroethane	1.0	0.11
3	1,1,2-Trichloroethane	1.0	0.15
4	1,1-Dichloroethane	1.0	0.11
5	1,1-Dichloroethene	1.0	0.19
6	1,2,4-Trichlorobenzene	1.0	0.19
7	1,2,4-Trimethylbenzene	1.0	0.048
8	1,2-Dibromoethane	1.0	0.057
9	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	1.0	0.37
10	1,2-Dichlorobenzene	1.0	0.075
11	1,2-Dichloroethane	1.0	0.081
12	1,2-Dichloropropane	1.0	0.048
13	1,3,5-Trimethylbenzene	1.0	0.045
14	1,3-Dichlorobenzene	1.0	0.11
15	1,4-Dichlorobenzene	1.0	0.075
16	1,4-Dioxane	1.0	0.084
17	Benzene	1.0	0.076
18	Benzyl Chloride	1.0	0.059
19	Bromodichloromethane	1.0	0.13
20	Bromoform	1.0	0.17
21	Bromomethane	1.0	0.21
22	Carbon Tetrachloride	0.25	0.040
23	Chlorobenzene	1.0	0.11
24	Chloroethane	1.0	0.14
25	Chloroform	1.0	0.075
26	Chloromethane	1.0	0.15
27	cis-1,2-Dichloroethene	1.0	0.077
28	cis-1,3-Dichloropropene	1.0	0.057
29	Dibromochloromethane	1.0	0.18
30	Dichlorodifluoromethane (Freon 12)	1.0	0.10
31	Ethanol	5.0	0.13
32	Ethylbenzene	1.0	0.051
33	Hexachloro-1,3-Butadiene	1.0	0.083
34	Isooctane	1.0	0.073
35	m,p-Xylene	1.0	0.13
36	Methyl tert-Butyl Ether	1.0	0.11
37	Methylene Chloride	1.0	0.14
38	o-Xylene	1.0	0.11
39	Styrene	1.0	0.080
40	t-Butanol	1.0	0.14
41	Tetrachloroethene	1.0	0.17
42	Toluene	1.0	0.034
43	trans-1,2-Dichloroethene	1.0	0.076
44	trans-1,3-Dichloropropene	1.0	0.083
45	Trichloroethene	0.25	0.047
46	Trichlorofluoromethane (Freon 11)	1.0	0.075
47	Trichlorotrifluoroethane (Freon 113)	1.0	0.19
48	Vinyl Chloride	1.0	0.11

3. Laboratory Analysis and Data Validation

Analyses will be performed by a NYSDOH Environmental Laboratory Approval Program (ELAP) certified laboratory. The indoor air and sub-slab vapor sample analyses will achieve minimum reporting limits of 1 $\mu g/m^3$ for each compound except for trichloroethene and carbon tetrachloride, which will have a minimum reporting limit of 0.25 $\mu g/m^3$, and ethanol and acetone, which will have a minimum reporting limit of 5 $\mu g/m^3$. Soil, groundwater, and passive soil gas samples will be analyzed for VOCs by USEPA Method 8260B and air and sub-slab vapor samples will be analyzed using USEPA Method TO-15. The tables below provide the proposed number of samples to be collected.

Table 3.
Air Sampling by USEPA Method TO-15

	SDG 1	SDG 2	SDG 3
Sub-Slab	5	5	5
Indoor Air	10	10	10
Ambient Air	5	5	5
Total Number of Analyses	20	20	20

NOTES:
SDG – Sample Delivery Group
Duplicate samples will be collected at a rate of 1 per 20 samples.

Table 4.
Soil and Water Sampling by USEPA Method 8260B

Field Activity	Soil Samples	Water Samples
DLS Property Geoprobe	80	0
Modock Springs Geoprobe	0	10
Subsurface Drilling	40	0
Groundwater Sampling	0	75
Total Number of Samples	**120**	**85**

Table 5.
Passive Soil Gas Sampling by USEPA Method 8260B

Field Activity	**Phase I** **Soil Gas Samples**	**Phase II** **Soil Gas Samples**
Total Number of Samples	100	50 (if necessary)
NOTE: Laboratory quality control samples will be collected at a rate of 1 per 33 samples.		

The collection and reporting of reliable data is a primary focus of the sampling and analytical activities. Laboratory and field data will be reviewed to ensure that the procedures are effective and that the data generated provides sufficient information to achieve the project objectives. Limitations of the data will also be noted. A qualified independent third party will evaluate the soil, groundwater, and air analytical data according to NYSDEC-Division of Environmental Remediation Data Usability Summary Report guidelines and as described in the Generic QAPP (Appendix C of the PMWP).

New York State Department of Environmental Conservation
Remedial Investigation/Feasibility Study Work Plan

Field Activities Plan
Attachment A:
Daily Observation Report

0266361

MALCOLM PIRNIE

DAILY OBSERVATION REPORT

Day:____________ Date:______________

NYSDEC

Division of Environmental Remediation
Modock Road Springs
NYSDEC Site # HW 8-35-013

Contract # D-004439-9

Victor, New York

Temperature: (F) (am) (pm)

Wind Direction: (am) (pm)

Weather: (am)
(pm)

Arrive at site (am)

Leave site: (pm)

HEALTH & SAFETY:

Are there any changes to the Health & Safety Plan? Yes ( ) No ( )
(If yes, list the deviation under items for concern)

Are monitoring results at acceptable levels?	Soil	Yes ( )	n/a ( )	* No ( )
	Waters	Yes ( )	n/a ( )	* No ( )
	Air	Yes ( )	n/a ( )	* No ( )

- *If No, provide comments*

OTHER ITEMS:

Site Sketch Attached: Yes ( ) No ( )
Photos Taken: Yes ( ) No ( )

DESCRIPTION OF DAILY WORK PERFORMED:

PROJECT TOTALS:

SAMPLING (Soil/Water/Air)

Contractor Sample ID:	DEC Sample ID:	Description:

DAILY OBSERVATION REPORT

Day:____________ Date:______________

CONTRACTOR/SUBCONTRACTOR EQUIPMENT AND PERSONNEL ON SITE:

(Name of contractor/Malcolm Pirnie) personnel:

(Name of Subcontractor) personnel:

(Name of contractor) equipment:

(*Indicates active equipment)

Other Subcontractors:

Agency personnel:

VISITORS TO SITE:

1.

PROJECT SCHEDULE ISSUES:

PROJECT BUDGET ISSUES:

ITEMS OF CONCERN:

COMMENTS:

ATTACHMENT(S) TO THIS REPORT:

SITE REPRESENTATIVE:

Name: (*signature*)
cc:

DAILY PHOTOLOG

New York State Department of Environmental Conservation
Remedial Investigation/Feasibility Study Work Plan

Field Activities Plan Attachment B: Field Kit Guide for Passive Soil-Gas Investigations

MALCOLM PIRNIE

BEACON ENVIRONMENTAL SERVICES, INC.

FIELD KIT GUIDE
FOR
PASSIVE SOIL-GAS INVESTIGATIONS

[PLEASE READ ENTIRE GUIDE BEFORE STARTING SURVEY]

I. General Information

A. BEACON is furnishing this kit to **Malcolm Pirnie** (MP) specifically for use on the **Modock Road Springs** site. Field installation of samplers is scheduled for **May 30, 2007 to June 1, 2007;** retrieval is scheduled during the following week.. If deployment of the devices is delayed, please contact us as soon as possible. BEACON's phone number is (800) 878-5510. [**Note**: To meet personal or work schedules, the Samplers may be deployed days prior to and retrieved days following the specified dates.]

B. It is also essential that, prior to returning the Kit to BEACON, MP verify that the caps are tight and clean on the Passive Soil-Gas (PSG) Samplers and that the Samplers are sealed individually in the small Sampler Bags and also in the larger Return Shipment Bag, with an adsorbent pak.

C. ***Before going to the field*** please inventory the contents of the Kit, checking them against the enclosed list to verify item counts and to become familiar with all components. (Because the components are thoroughly cleaned prior to shipment, the inventory should be conducted without opening the plastic bags.) Note that Trip Blanks are to remain sealed throughout the Survey.

D. Upon receipt of the Field Kit, BEACON requests that MP sign and date the enclosed Chain-of-Custody Form to document receipt of the Kit **[NOTE the condition of the CUSTODY SEAL]**. The Field Deployment Report is to be completed during the course of the survey.

E. Following completion of the survey, fill out the Chain-of-Custody Form with the following information: (i) Field Sample IDs, (ii) the name and contact phone number of the person submitting the samples, (iii) the unique number of the custody seal that will be used, and (iv) signature and date of person relinquishing samples. The Chain-of-Custody Form and Field Deployment Report are to be returned with the Field Kit to BEACON. If possible, retain photocopies for your record. Next, pack the Samplers, tools, containers, sampling caps, and requisite documentation in the Field Kit.

Note: Place the Return Shipment Bag, which contains the individually bagged PSG Samplers, in the upper tray and place the tools in the lower compartment of the Kit so they do not damage the Samplers. One trip blank should be included with each Return Shipment Bag.

Affix the tug-tight custody seal to the latch on the Field Kit, pack it in its original cardboard shipping container, and call FedEx (1-800-238-5355) for overnight shipment to:

Beacon Environmental Services, Inc.
Attn: Sample Receiving
323 Williams Street, Suite D
Bel Air, MD 21014
410-838-8780

NOTE: DO NOT PACK IN THE KIT OR SHIPPING BOX STYRENE PEANUTS, NEWSPAPER, OR OTHER MATERIALS THAT COULD CONTAMINATE THE SAMPLES. PLEASE AVOID SMOKING WHILE HANDLING SAMPLERS.

II. Contents

A. This Field Kit contains the components needed for a **100**-point soil-gas survey, plus sufficient additional cartridges for **3** trip blanks (vial labeled **Trip-1, Trip-2, and Trip-3**, not to be opened), and **8** extra Samplers for use in the event of breakage or accidental contamination. In addition, **4** extra transport vials are provided in case a Sampler Vial breaks during retrieval. Assuming that instructions are followed, due care is exercised in QA/QC procedures, and timing schedules are observed, the Kit provides users with an extremely accurate and reliable soil-gas system. **Do not open bags until deployment.**

Code/Item		Quantity
(1)	PASSIVE SOIL-GAS SAMPLERS	**111**
(2)	EXTRA TRANSPORT VIALS	**4**
(3)	SAMPLING CAPS (in container)	**111**
(4)	CAP STORAGE CONTAINERS	**4**
(5)	TAPPING DOWELS	**2**
(6)	STAKES	**2**
(6)	12″ LENGTHS OF METAL PIPE	**105**
(7)	WIRE CUTTERS	**2**
(8)	GAUZE CLOTHS	**111**
(9)	PIPE CUTTER	**2**
(10)	SCRATCH AWL	**2**
(11)	VISE GRIPS	**2**
(12)	3” x 4” PLASTIC SAMPLER BAGS (for return shipment of samples)	**23**
(13)	12” x 12” PLASTIC RETURN SHIPMENT BAG	**4**

B. In addition to the materials found in the kit, field teams will need:

- NITRILE GLOVES
- CLEAN TOWEL
- HAMMER
- ELECTRIC ROTARY HAMMER DRILL WITH 1¼” to 1½” DIAMETER BIT WITH AT LEAST 12 INCHES OF CUTTING LENGTH
- BALL-POINT PEN and CLIPBOARD
- PIN FLAGS, WOODEN STAKES, or OTHER LOCATION MARKERS
- FLAGGING TAPE
- BOX OF ALUMINUM FOIL

C. Additional materials necessary only for deployment through asphalt or concrete:

- DRY CONCRETE MORTAR MIX and ASSOCIATED EQUIPMENT (for temporary patching of the sample holes) including:
  SMALL PAIL, WATER, SMALL PLASTIC PUTTY KNIFE
- CHISEL or SCREWDRIVER (to remove the temporary patch)
- ASPHALT COLD PATCH or CEMENT (for final repair of the sample holes)

III. Instructions

A. GENERAL:

Deployment and retrieval of Samplers requires only one person. Separate step-by-step procedures are detailed below for sampling through vegetation or bare soils and for sampling in areas covered by asphalt, concrete, or gravel. **Keep exposure of sample cartridges to ambient air to a minimum.**

Note: Do not deploy Samplers within 10 feet of a monitoring well, penetrometer, hydropunch shaft, or other intrusive sampling apparatus that potentially creates a preferential pathway for gases.

REMEMBER: TRIP BLANKS ARE NOT TO BE OPENED.

B. SAMPLER DEPLOYMENT:

Note: Each Sampler contains two sets of adsorbent cartridges. BEACON will analyze one set per Sampler; however, the second set in each Sampler can be analyzed as a field sample duplicate. MP will note at which locations, if any, duplicates are to be analyzed by writing separate entries corresponding to the sample location followed by the letter "D" (*i.e*, 3, 3-D, 4, 4-D) on the Chain-of-Custody Form. It is not necessary to alter the deployment pattern to have the duplicate samples analyzed. There is an additional per sample charge for analysis of any duplicates.

Vegetation or Bare Soils:

1. At each survey point, clear vegetation as necessary and drill a 1¼"- to 1½"-diameter hole, using a rotary hammer drill or comparable equipment, to a depth of 12 inches. **Note**: When one person is performing fieldwork, it is often more efficient to drill all holes before beginning Sampler deployment.

2. When the hole has been completed, take a 12-inch length of 1"-diameter metal pipe and lower it into the sample hole, being careful not to touch the inside of the pipe. Any portion of the pipe above grade is cut flush with the ground surface, using the pipe cutter. With the tapping dowel and a hammer, push or tap the pipe one inch into the base of the drilled hole (see **attached figure**).

3. Remove one of the PSG Samplers (a glass vial containing four ***hydrophobic*** adsorbent cartridges) and unwind the retrieval wire wrapped around it. Holding the capped end of the vial in one hand, pull the wire tight (to straighten it) with the other hand. Remove the solid cap on the Sampler Vial and replace it with a Sampling Cap (a one-hole cap with a screen meshing insert). Place the solid cap in the Field Kit.

Note: At each sampling location, verify that the (black) sampling cap is on the vial before installing the Sampler.

4. Lower the Sampler, open-end down, into the metal pipe approximately four inches so that the retrieval wire sticks out of the hole. Cover the open end of the pipe with a balled up **wad** of aluminum foil, pressing it tightly on top of the pipe with the tapping dowel. Next, cover the hole to grade with local soils or sand, leaving the end of the wire exposed above the surface of the ground. Using the hammer, collapse the soils above the Sampler. **Coil the**

wire and lay it flat on the ground surface. Place the solid cap in the Cap Storage Container. Clearly mark the sample location with a pin flag or wooden stake.

5. Close the Field Kit, and on the Field Deployment Report record: (a) sample-point number; (b) date and time of emplacement (to nearest minute); and (c) other relevant information (*e.g.*, soil type, vegetation, proximity to potential source areas). Be sure to mark the sample location and take detailed notes (*i.e.*, compass bearings and distances from fixed reference points).

6. Move to next location.

Concrete, Asphalt, or Gravel Covered Areas:

1. At each survey point, drill a 1¼”- to 1½”-diameter hole through the asphalt/concrete/gravel to bare soil using a rotary hammer drill or comparable equipment. This hole should be approximately 12 inches deep. **Note**: When one person is performing fieldwork, it is often more efficient to drill all holes before beginning Sampler deployment.

2. When the hole through concrete/asphalt/gravel has been completed, take a 12-inch length of 1”-diameter metal pipe and lower it into the sample hole, being careful not to touch the inside of the pipe. Any portion of pipe above grade is cut flush with the ground surface, using the pipe cutter. With the tapping dowel and a hammer, push or tap the pipe one inch into the base of the drilled hole (see **attached figure**).

3. Remove one of the PSG Samplers (a glass vial containing four ***hydrophobic*** adsorbent cartridges) and unwind the retrieval wire wrapped around it. Holding the capped end of the vial in one hand, pull the wire tight (to straighten it) with the other hand. Remove the solid cap on the Sampler Vial and replace it with a Sampling Cap (a one-hole cap with a screen meshing insert). Place the solid cap in the Field Kit.

Note: At each sampling location, verify that the (black) sampling cap is on the vial before installing the Sampler.

4. Lower the Sampler, open-end down, into the metal pipe approximately four inches.

   If sampling through asphalt or concrete, bend the end of the wire over the top of the pipe so that the coil of wire hangs over the top and outside of the pipe. Next, plug the top of the hole with a wad of aluminum foil. Using the tapping dowel, push down the aluminum foil so it forms a seal on the metal pipe and rests ¼” below the surfacing. Cover the hole to grade with a **¼” thick** concrete patch. [**Note**: A ¼” thick patch is all that is required. If it is thicker it will be difficult to remove during retrieval.] Next, place the solid cap in the Cap Storage Container.

   If sampling through gravel, extend the retrieval wire out of the pipe and plug the pipe with a wad of aluminum foil. Using the tapping dowel, push down the aluminum foil so it forms a seal on the metal pipe. Bend the wire over the aluminum foil plug and while the wire is extended out of the hole, cover the aluminum foil with local soil or sand. **Coil the wire and lay it flat on the ground surface.** Next, place the solid cap in the Cap Storage Container.

   If a hole deeper than 12 inches is created, it will be necessary to use more than one wad of aluminum foil. In these situations, extend the wire out of the pipe. While holding onto the wire, plug the top of the pipe and hole loosely with as many wads as needed. Before inserting the last wad of foil, bend the wire so it rests below the uppermost wad of foil. This will make it easy to retrieve the Sampler during retrieval.

5. Close the Field Kit, and on the Field Deployment Report record: (a) sample-point number; (b) date and time of emplacement (to nearest minute); (c) type of surfacing and approximate thickness; and (d) other relevant information (*e.g.*, surfacing material, proximity to potential source areas). Be sure to mark the sample location and take detailed notes (*i.e.*, compass bearings and distances from fixed reference points).

6. Move to next location.

C. SAMPLER RETRIEVAL:

Prior to retrieving samples, seal each Trip Blank in a 3”x4” Sampler Bag, and place the bagged Trip Blank in a separate larger bag marked “Return Shipment Bag.” One trip blank should be included with each Return Shipment Bag. Stow the sampler blocks, with the Transport vials and extra samplers, in the lower compartment of the kit. The sampler blocks are to be returned to BEACON’s lab along with the samples.

Note: Each Sampler contains two sets of adsorbent cartridges. BEACON will analyze one set per Sampler; however, the second set in each Sampler can be analyzed as a field sample duplicate. MP will note at which locations, if any, duplicates are to be analyzed by writing separate entries corresponding to the sample location followed by the letter “D” (*i.e*, 3, 3-D, 4, 4-D) on the Chain-of-Custody Form. It is not necessary to alter the deployment pattern to have the duplicate samples analyzed. There is an additional per sample charge for analysis of any duplicates.

Vegetation or Bare Soils:

1. At each sample location open the Field Kit and place it and the wire cutters within easy reach. Remove a square of gauze cloth and place it and a clean towel on the open Kit. Remove a solid cap from the Cap Storage Container and place it on the Kit, also.

2. Remove the aluminum foil plug, using vise grips and the scratch awl, if necessary, and retrieve the Sampler from the hole.

3. Holding the Sampler upright, clean the sides of the vial with the clean towel (especially close to the Sampling Cap). Remove the Sampling Cap, cut the wire from the vial with the wire cutters, and clean the vial threads completely with the gauze cloth.
[**Note**: **Completely remove the wire to ensure the cap fits tight on the vial and no soil is returned in the field kit**.]

4. Firmly screw the solid cap on the Sampler Vial and clean the vial completely with the gauze cloth. With a **ballpoint pen** record the sample number, corresponding to the sample location, on the cap’s label. [**Note**: Do not use a Sharpie marker.]

5. Return the sampling cap to the Sampling Cap container. Place the sealed and labeled Sampler Vial in the smaller 3” x 4” plastic Sampler Bag. Then place the individually bagged and labeled sampler into the larger bag labeled “Return Shipment Bag.”

   Note: Each sampler must be individually bagged and placed in a Return Shipment Bag, with approximately 40 samplers and one trip blank per Return Shipment Bag.

6. On the Field Deployment Report, record: (a) date and time of retrieval (to nearest minute); and (b) any other relevant information.

7. After all samples have been retrieved, verify that the caps on each Sampler are sealed tightly and that the seals on the Sampler Bags are closed. Verify that all Samplers are stored in the Return Shipment Bag, which contains an adsorbent pak. Seal the Return Shipment Bag and place it in the upper tray of the Field Kit, and place the provided tools and materials in the lower compartment of the Field Kit.

Note: It is not necessary to return the gauze pads or the wire with the Field Kit, but return *all* the other materials and equipment (blocks, extra samplers, tools, containers, sampling caps, *etc.*).

Asphalt, Concrete, or Gravel:

1. At each sample point covered by gravel, clear away the soil or sand to expose the aluminum-foil plug. For those locations covered by asphalt or concrete, use a small chisel and hammer to remove the concrete patch to expose the aluminum foil.

2. Next, open the Field Kit and place it and the wire cutters within easy reach. Remove a square of gauze cloth and place it and a clean towel on the open Kit. Remove a solid cap from the Cap Storage Container and place it on the Kit, also.

3. While securely holding onto the retrieval wire, remove the aluminum-foil plug, using the scratch awl, as necessary. Holding the Sampler upright, clean the sides of the vial with the clean towel (especially close to the Sampling Cap). Remove the Sampling Cap, cut all the wire from the vial with the wire cutters, and clean the vial threads completely with gauze cloth.
   [**Note**: **Completely remove the wire to ensure the cap fits tight on the vial and no soil is returned in the field kit**.]

4. Firmly screw the solid cap on the Sampler Vial and clean the vial completely with the gauze cloth. With a **ballpoint pen** record the sample number, corresponding to the sample location, on the cap's label. [**Note**: Do not use a Sharpie marker.]

5. Return the sampling cap to the Sampling Cap container. Place the sealed and labeled Sampler Vial in the smaller 3" x 4" plastic Sampler Bag. Then place the individually bagged and labeled sampler into the larger bag labeled "Return Shipment Bag."

   Note: Each sampler must be individually bagged and placed in a Return Shipment Bag, with approximately 40 samplers and one trip blank per Return Shipment Bag.

6. On the Field Deployment Report, record: (a) date and time of retrieval (to nearest minute); and (b) any other relevant information. Return the sampling cap to the Sampling Cap container.

7. After all samples have been retrieved, verify that the caps on each Sampler are sealed tightly and that the seals on the Sampler Bags are closed. Verify that all Samplers are stored in the Return Shipment Bag, which contains an adsorbent pak. Seal the Return Shipment Bag and place it in the upper tray of the Field Kit, and place the provided tools and materials in the lower compartment of the Field Kit.

Note: It is not necessary to return the used metal pipes, wire, or the gauze pads with the Field Kit, but return *all* the other materials and equipment (blocks, tools, containers, unused metal pipes, sampling caps, *etc.*).

8. Fill sampling holes to grade with an asphalt cold patch or cement.

IV. Forms

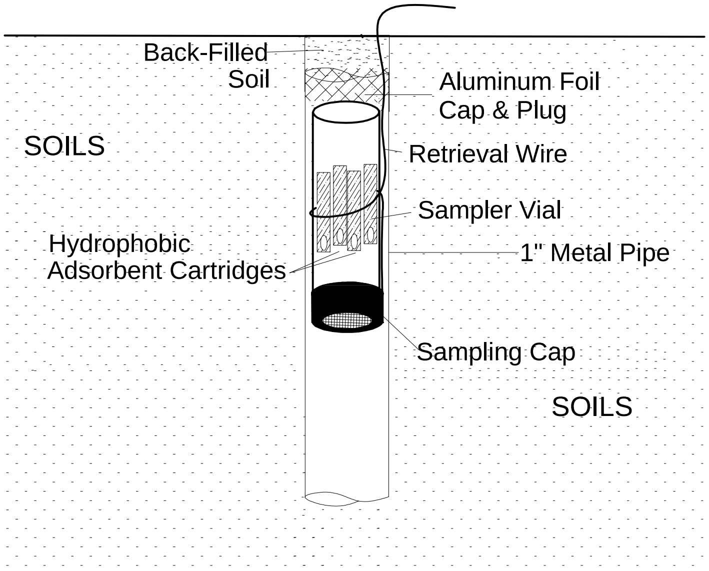
The Field Kit also contains a **Chain-of-Custody Form** and a **Field Deployment Report**.

A. The Chain-of-Custody Form is to be completed in accordance with **Section I**.

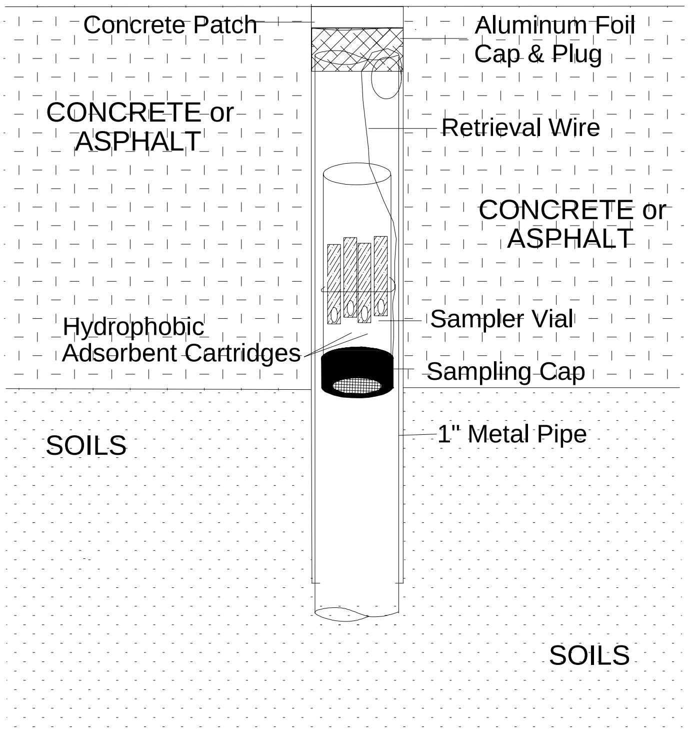
B. The Field Deployment Report is to be filled out during the Survey as indicated in **Section III**.

BEACON PASSIVE SAMPLER

DEPLOYMENT THROUGH SOILS



DEPLOYMENT THROUGH AN ASPHALT/CONCRETE CAP



New York State Department of Environmental Conservation
Remedial Investigation/Feasibility Study Work Plan

Field Activities Plan Attachment C: NYSDOH Indoor Air Quality Questionnaire and Building Inventory

0266361

MALCOLM PIRNIE

OSR – 3

NEW YORK STATE DEPARTMENT OF HEALTH
INDOOR AIR QUALITY QUESTIONNAIRE AND BUILDING INVENTORY
CENTER FOR ENVIRONMENTAL HEALTH

This form must be completed for each residence involved in indoor air testing.

Preparer's Name ____________________________________ Date/Time Prepared ______________

Preparer's Affiliation ________________________________ Phone No.______________________

Purpose of Investigation____

1. OCCUPANT:

Interviewed: Y / N

Last Name: _________________________ First Name: _________________________

Address: ____

County: _________________

Home Phone: ____________________ Office Phone: ____________________

Number of Occupants/persons at this location _______ Age of Occupants ______________________

2. OWNER OR LANDLORD: (Check if same as occupant ___)

Interviewed: Y / N

Last Name: _________________________First Name: ___________________________

Address: ____

County: _________________

Home Phone: ____________________ Office Phone: ____________________

3. BUILDING CHARACTERISTICS

Type of Building: (Circle appropriate response)

Residential	School	Commercial/Multi-use
Industrial	Church	Other: _________________

If the property is residential, type? (Circle appropriate response)

Ranch	2-Family	3-Family
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouses/Condos
Modular	Log Home	Other:_______________

If multiple units, how many? ________

If the property is commercial, type?

Business Type(s) ______________________________________

Does it include residences (i.e., multi-use)? Y / N If yes, how many? ______

Other characteristics:

Number of floors______ Building age______

Is the building insulated? Y / N How air tight? Tight / Average / Not Tight

4. AIRFLOW

Use air current tubes or tracer smoke to evaluate airflow patterns and qualitatively describe:

Airflow between floors

____

____

____

Airflow near source

____

____

____

Outdoor air infiltration

____

____

____

Infiltration into air ducts

____

____

____

5. BASEMENT AND CONSTRUCTION CHARACTERISTICS (Circle all that apply)

a. Above grade construction:	wood frame	concrete	stone	brick
b. Basement type:	full	crawlspace	slab	other ________
c. Basement floor:	concrete	dirt	stone	other ________
d. Basement floor:	uncovered	covered	covered with _______________	
e. Concrete floor:	unsealed	sealed	sealed with ________________	
f. Foundation walls:	poured	block	stone	other ________
g. Foundation walls:	unsealed	sealed	sealed with ________________	
h. The basement is:	wet	damp	dry	moldy
i. The basement is:	finished	unfinished	partially finished	
j. Sump present?	Y / N			
k. Water in sump?	Y / N / not applicable			

Basement/Lowest level depth below grade: ________(feet)

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

____

____

6. HEATING, VENTING and AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

- Hot air circulation
- Space Heaters
- Electric baseboard
- Heat pump
- Stream radiation
- Wood stove
- Hot water baseboard
- Radiant floor
- Outdoor wood boiler
- Other ___________

The primary type of fuel used is:

- Natural Gas
- Electric
- Wood
- Fuel Oil
- Propane
- Coal
- Kerosene
- Solar

Domestic hot water tank fueled by: ____________________________

Boiler/furnace located in: Basement Outdoors Main Floor Other___________

Air conditioning: Central Air Window units Open Windows None

Are there air distribution ducts present? Y / N

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

____

____

____

____

7. OCCUPANCY

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

Level	General Use of Each Floor (e.g., familyroom, bedroom, laundry, workshop, storage)
Basement	____________________
1st Floor	____________________
2nd Floor	____________________
3rd Floor	____________________
4th Floor	____________________

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage?		Y / N
b. Does the garage have a separate heating unit?		Y / N / NA
c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, atv, car)		Y / N / NA Please specify____________________
d. Has the building ever had a fire?		Y / N When?__________________
e. Is a kerosene or unvented gas space heater present?		Y / N Where? _________________
f. Is there a workshop or hobby/craft area?	Y / N	Where & Type? _________________
g. Is there smoking in the building?	Y / N	How frequently? ________________
h. Have cleaning products been used recently?	Y / N	When & Type? _________________
i. Have cosmetic products been used recently?	Y / N	When & Type? _________________

j. Has painting/staining been done in the last 6 months? Y / N Where & When? _______________

k. Is there new carpet, drapes or other textiles? Y / N Where & When? _______________

l. Have air fresheners been used recently? Y / N When & Type? ________________

m. Is there a kitchen exhaust fan? Y / N If yes, where vented?____________

n. Is there a bathroom exhaust fan? Y / N If yes, where vented?____________

o. Is there a clothes dryer? Y / N If yes, is it vented outside? Y / N

p. Has there been a pesticide application? Y / N When & Type?_________________

Are there odors in the building? Y / N
If yes, please describe: ____

Do any of the building occupants use solvents at work? Y / N
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist

If yes, what types of solvents are used? ____

If yes, are their clothes washed at work? Y / N

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, use dry-cleaning regularly (weekly)
Yes, use dry-cleaning infrequently (monthly or less)
Yes, work at a dry-cleaning service
No
Unknown

Is there a radon mitigation system for the building/structure? Y / N Date of Installation: ____________
Is the system active or passive? Active/Passive

9. WATER AND SEWAGE

Water Supply:	Public Water	Drilled Well	Driven Well	Dug Well	Other: _______
Sewage Disposal:	Public Sewer	Septic Tank	Leach Field	Dry Well	Other: _______

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended: ______________________________________

b. Residents choose to: remain in home relocate to friends/family relocate to hotel/motel

c. Responsibility for costs associated with reimbursement explained? Y / N

d. Relocation package provided and explained to residents? Y / N

11. FLOOR PLANS

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement:

First Floor:

12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s) and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.

13. PRODUCT INVENTORY FORM

Make & Model of field instrument used: ______________________________________

List specific products found in the residence that have the potential to affect indoor air quality.

Location	**Product Description**	**Size** (units)	**Condition***	**Chemical Ingredients**	**Field Instrument Reading** (units)	**Photo** ** **Y / N**

* Describe the condition of the product containers as **Unopened (UO), Used (U),** or **Deteriorated (D)**
** Photographs of the **front and back** of product containers can replace the handwritten list of chemical ingredients. However, the photographs must be of good quality and ingredient labels must be legible.

New York State Department of Environmental Conservation
Remedial Investigation/Feasibility Study Work Plan

Appendix B:
Site Specific Health and Safety Plan

SITE SPECIFIC HEALTH AND SAFETY PLAN

MALCOLM PIRNIE

SECTION 1: GENERAL INFORMATION AND DISCLAIMER		**PROJECT NUMBER:**	0266353
PROJECT NAME:	Modock Road Springs	CLIENT NAME:	New York State DEC
PROJECT MANAGER:	Bruce Nelson	DEPUTY PROJECT MANAGER:	Daniel Lang
PREPARED BY:	Mark Flusche	DATE:	5/3/07

NOTE: This site specific Health and Safety Plan - Short Form (HASP-SF) has been prepared for use by **Malcolm Pirnie, Inc.** employees for work at this site / facility. **The plan is written for the specific site / facility conditions, purposes, tasks, dates and personnel specified, and must be amended and reviewed by those personnel named in Section 4 if these conditions change.** Malcolm Pirnie, Inc. is not responsible for its use by others.

Subcontractors shall be solely responsible for the health and safety of their employees and shall comply with all applicable laws and regulations. In accordance with 1910.120(b)(1)(iv) and (v), Malcolm Pirnie, Inc. will inform subcontractors of the site / facility emergency response procedures, and any potential fire, explosion, health, safety or other hazards by making this Site Specific Health and Safety Plan and site information obtained by others available during regular business hours. All contractors and subcontractors are responsible for: (1) developing their own Health and Safety Plan, including a written Hazard Communication Program and any other written hazard specific or safety programs required by federal, state and local laws and regulations, that details subcontractor tasks, potential or actual hazards identified as a result of a risk analysis of those tasks, and the engineering controls, work practices and personal protective equipment to be utilized to minimize or eliminate employee exposure to the hazard; (2) providing their own personal protective equipment; (3) providing documentation that their employees have been health and safety trained in accordance with applicable federal, state and local laws and regulations; (4) providing evidence of medical surveillance and medical approvals for their employees; and (5) designating their own site safety officer responsible for ensuring that their employees comply with their own Health and Safety plan and taking any other additional measures required by their site activities.

Providing a copy of this Malcolm Pirnie plan to subcontractors, does not establish, nor is it intended to establish a "joint employer" relationship between the Contractor and Malcolm Pirnie. This allowance does not establish, nor is it intended to establish, a direct or indirect employer/employee relationship with subcontractor's employees.

THIS SITE SPECIFIC HASP MUST BE REVIEWED AND APPROVED BY CORPORATE HEALTH AND SAFETY FOR ONE OR MORE OF THE FOLLOWING CONDITIONS: IF AN UPGRADE TO "LEVEL C" OR ABOVE IS ANTICIPATED; A PERMIT REQUIRED CONFINED SPACE ENTRY OR ENTRY INTO AN EXCAVATION IS ANTICIPATED; SAMPLING OF UNKNOWN DRUMS AND/OR IN UNKNOWN CONDITIONS IS ANTICIPATED, OR IF THERE MAY BE RADIATION LEVELS GREATER THAN 0.5 mR (500µR)/HOUR.

SECTION 2: EMERGENCY INFORMATION

(A) LOCAL RESOURCES	**SERVICE NAME**	**TELEPHONE NUMBER**
EMERGENCY MEDICAL SERVICES	Victor Farmington Volunteer Ambulance Corps	585-924-3959 or 911
HOSPITAL (Map attached)	Strong Memorial Hospital	585-275-2100 or 911
FIRE DEPARTMENT	Victor Fire Department	911
POLICE / SECURITY	State Police, Victor Office	911
HAZMAT/ SPILL / OTHER RESPONSE	911	911

(B) CORPORATE RESOURCES

MALCOLM PIRNIE 24 / 7 EMERGENCY / INCIDENT TELEPHONE NUMBERS		**(800) 478-6870 (24 HOURS)**
CORPORATE HEALTH AND SAFETY **	JOSEPH GOLDEN, EMT-P, CET, CHMM	(914) 641-2978 WHI
FIER PROJECTS	JANE WEBER, CET	(914) 641-2559 WHI
MUNI/WEG/CMRT PROJECTS	LAURA LEE-CASEY,	(914) 641-2707 WHI
CORPORATE HEALTH PHYSICIST	LES SKOSKI	(201) 398-4377 NNJ
WORKERS COMP / OSHA LOG	LAURA LEE-CASEY, CHST, CET, EMT-P	(914) 641-2707 WHI
LEGAL DEPARTMENT **	JERRY CAVALUZZI	(914) 641-2950 WHI

**** TO BE NOTIFIED IN CASE OF ACCIDENT**

SECTION 3: PROJECT INFORMATION

(A) SITE / FACILITY INFORMATION:

SITE NAME: Modock Road Springs (Site#8-35-013)

ADDRESS: Modock Road

TOWNSHIP/ COUNTY: Victor, Ontario County, NY

SITE CLIENT CONTACT: Jason Pelton

PHONE NUMBER: 518-402-9815

SITE SAFETY CONTACT: N/A

☐ FEDERAL ☐ STATE ☐ MUNICIPAL / REGIONAL ☒ PRIVATE

(B) SITE CLASSIFICATION: (check all that apply)

☐ HAZARDOUS (RCRA)
☐ HAZARDOUS (CERCLA / STATE)
☐ CONSTRUCTION
☐ LANDFILL (NON-HAZARDOUS)
☐ UST / LUST
☐ BROWNFIELD
☐ CHEMICAL PLANT
☐ MANUFACTURING
☐ REFINERY
☐ WTP / WWTP
☒ OTHER: Rural Residential Neighborhood

☐ ACTIVE ☐ INACTIVE

(C) TYPE OF FIELD ACTIVITY

☐ HAZARDOUS WASTE
☒ HYDROGEOLOGY
☐ WASTE WATER
☐ SOLID WASTE
☒ ENVIRONMENTAL
☐ WATER
☐ CONSTRUCTION
☒ AIR / ODOR
☐ OTHER:

(D) FIELD OBJECTIVES (Check all that apply)

☐ PRE-JOB VISIT
☐ CONTRACTOR OVERSIGHT
☐ CONSTRUCTION MGMT
☒ INSPECTION
☐ INVESTIGATION SURVEY
☐ AUDIT
☐ OTHER:

SAMPLING:

☒ AIR
☐ SURFACE WATER
☐ GROUND WATER
☐ WASTE WATER
☐ WASTE STREAM
☐ SEDIMENT
☒ SUBSURFACE SOIL
☐ LANDFILL
☐ OTHER

DATE(S) OF FIELD ACTIVITIES: 2007

(E) FIELD TASKS
MALCOLM PIRNIE TASKS

M1. Air, soil vapor, and soil gas sampling
M2. Drilling oversight
M3.
M4.

TASKS PERFORMED BY OTHERS

01. Drilling services
02.
03.
04.

SECTION 4: PROJECT SAFETY ORGANIZATION, HEALTH AND SAFETY TRAINING, AND MEDICAL MONITORING

(A) PROJECT HEALTH AND SAFETY ROLES, RESPONSIBILITIES AND COORDINATION

PROJECT OFFICER	The Project Officer (PO) is ultimately responsible for project performance. The PO seeks and gets appropriate approvals for risk management decisions (e.g. from Regional/Practice Director(s), Legal Council, Corporate Health and Safety), and selects and effective and qualified project team. The PO supports the Project Manager or Deputy Project Manager with appropriate resources.
PROJECT MANAGER DEPUTY PROJECT MANAGER	The Project Manager (PM) has the responsibility for executing the project in accordance with the scope of work and good engineering practice. The PM will supervise the allocation of resources and staff to implement specific aspects of this HASP and may delegate authority to expedite and facilitate any application of the program. The PM implements and executes an effective program of site-specific personnel protection and accident prevention. The Project Manager reports to the Project Officer. Deputy Project Managers (DPM) are assigned all duties and responsibilities of the Site Safety Officer in his/her absence.
CORPORATE HEALTH & SAFETY	Corporate Health and Safety is responsible for Malcolm Pirnie's overall Health and Safety Program and provides project guidance on air monitoring methodology, data interpretation and assistance in determining appropriate project engineering controls, work practices, and personal protective equipment. Corporate Health and Safety also reviews and approve HASPs in accordance with Section 1.
SITE SAFETY OFFICER ALTERNATE SITE SAFETY OFFICER (S)	The Site Safety Officer (SSO) is responsible for interpreting and implementing the site health and safety provisions set out in this HASP, and will guide the efforts of field team personnel in their day-to-day compliance with this HASP. The SSO has the ability and authority to make necessary changes or additions to this HASP and provide technical assistance to field team personnel on problems relating to worksite safety. The SSO has the authority to correct safety-related deficiencies in materials or practice and to call a Project STOP in the most serious cases. Alternate Site Safety Officer (ASSO) is assigned all duties and responsibilities of the Site Safety Officer in his/her absence.
PUBLIC INFORMATION OFFICER:	The Public Information Officer (PIO) is responsible for all public, press and other news media request for information, and is the only person authorized to provide such information
SITE RECORDKEEPER:	The Site Recordkeeper is responsible for the documentation of all related heath and safety data documentation, including but not limited to metrological data, instrument calibration, accident and injury reports, and air monitoring data.
FIELD TEAM LEADER:	The Field Team Leader (FTL) is responsible for leading "on-site" activities of field team personnel, and to ensure field team personnel perform only those tasks that have been identified in this HASP.
FIELD TEAM PERSONNEL	Field personnel have the following health and safety responsibilities: • Implement the procedures set forth in the HASP; • Take all reasonable precautions to prevent injury to themselves and their fellow employees; and • Perform only those tasks that they believe they can do safely, and immediately report any accidents and/or unsafe conditions in accordance with Section 1.

(B) PROJECT TEAM - The following Malcolm Pirnie personnel are designated to carry out the stated project job functions on site. THE SITE SAFETY OFFICER, OR A DESIGNATED ALTERNATE WILL BE ON-SITE DURING **ALL** SITE ACTIVITIES. (NOTE: One person may carry out more than one job function.)

PROJECT MANAGER: Bruce Nelson

PROJECT OFFICER: Daniel Loewenstein

SITE SAFETY OFFICER: Mark Flusche

ALTERNATE SAFETY OFFICER(S): Kelley Roe

Mark de Jong

PUBLIC INFORMATION OFFICER: Bruce Nelson

SITE RECORDKEEPER: Mark Flusche

FIELD TEAM LEADER: Mark de Jong

FIELD TEAM PERSONNEL: Ely Moskal

Kelley Roe

Diane Bertok, Dwight Symonds

The following subcontractors and governmental agencies have been informed by Malcolm Pirnie of emergency response procedures, and any potential fire, explosion, health, safety or other hazards of the site / facility by making this Site Specific Health and Safety Plan and site information obtained by others available during regular business hours. Subcontractors and governmental agencies shall be solely responsible for the health and safety of their employees and shall comply with all applicable laws and regulations as described in **Section 1** of this plan.

SUBCONTRACTOR(S): Aztech Technologies, Inc.

Stearns Drilling, Geologic NY, Zebra Env.

FEDERAL AND STATE AGENCY REPS: Jason Pelton (NYSDEC)

Krista Anders (NYSDOH)

OTHER AGENCY REPS:

(C) HEALTH AND SAFETY TRAINING, MEDICAL MONITORING, AND FIT TESTING PROGRAM

The following project staff is included in the Malcolm Pirnie Health and Safety Training and Medical Monitoring programs. The details of these programs can be found in the Health and Safety Policies and Written Programs. (NOTE: At least one CPR/First Aid Trained person must be on-site during HAZWOPER and confined space entry activities.)

	HAZWOPER TRAINING			OTHER TRAINING						FIT TEST			
NAME	INITIAL (DATE)	8HR (DATE)	MGR (DATE)	DOT (DATE)	CSE (DATE)	CPR / (DATE)	First Aid / (DATE)	BBP (DATE)	MEDICAL (DATE)	MAKE /	SIZE /	TYPE	(DATE)
Mark Flusche	1/24/03	03/07	03/19/03			03/06	03/06	03/06	02/05	MSA	S	FF	0307
Aaron Bobar	08/99	03/06	03/19/03			09/06	09/06	09/06	08/06	MSA	M	FF	10/06
Diane Bertok	10/01	04/08	03/19/03			08/08	08/08	04/08	09/07	MSA	M	FF	09/07
Kelley Roe	07/89	03/06	03/19/06	3/25/04		03/06	03/06	03/06	04/06	MSA	M	FF	03/06
Elias Moskal	08/05	08/07	03/06			03/08	03/08	03/07	07/07				
Mark de Jong	05/04	08/07	03/06	01/07		03/08	03/08	03/07	05/08	MSA	LGE	FF	03/07

SECTION 5: HAZARD ANALYSIS

(A) **ACTUAL OR POTENTIAL PHYSICAL HAZARDS** – (Check all that apply to Malcolm Pirnie activities)

☐ ANIMALS / PLANTS
☐ ASBESTOS / LEAD
☐ CHEMICAL EXPOSURE (See Section 5B/5C)
☐ CONFINED SPACE (See Section 12)
☐ DEMOLITION
☒ DRILLING
☐ DRUM HANDLING
☐ DUST, HARMFUL
☐ DUST, NUISANCE

☐ ELECTRICAL
☐ EXCAVATIONS (See Section 13)
☐ EXTREME COLD (See Section 10)
☐ FALL, >6' VERTICAL
☐ FALLING OBJECTS
☐ HEAT STRESS
☐ HEAVY EQUIPMT
☐ HEAVY LIFTING
☐ HOT WORK
☐ HUNTING SEASON
☐ IMMERSION

☐ IONIZING RADIATION
☐ LIGHT RADIATION (i.e., Welding, High Intensity)
☐ LIMITED CONTACT
☐ MOVING PARTS (LO / TO)
☐ NOISE (> 85 dB)
☐ NON-IONIZING RADIATION
☐ OVERHEAD OBJECTS
☐ POWERED PLATFORMS
☐ POOR VISIBILITY
☐ ROLLING OBJECTS
☐ SCAFFOLDING
☐ SHARP OBJECTS

☐ STEEP / UNEVEN
☒ TERRAIN
☐ TRAFFIC (STRUCK BY)
☐ OTHER: ____________
____
____
____

(B) **PRESENCE OF HAZARDOUS MATERIALS STORED OR USED ON SITE** ☐ YES By Client / Owner ☐ YES By Malcolm Pirnie (See Section 11) ☒ NO

(CHECK ALL THAT APPLY)

TYPE

☐ EXPLOSIVES
☐ COMPRESSED GASES
☐ FLAMMABLE / COMBUSTIBLE LIQUIDS

☐ FLAMMABLE / REACTIVE SOLIDS
☐ OXIDIZERS
☐ TOXIC / INFECTIOUS

☐ RADIOACTIVE
☐ CORROSIVE
☐ MISCELLANEOUS

☐ HAZARDOUS WASTE (Stored)

(C) **CHEMICAL HAZARDS OF CONTAMINANTS INFORMATION**

(1) IDENTIFIED CONTAMINANTS - Known or suspected hazardous/toxic materials (attach historical information, physical description, map of contamination and tabulated data, if available)

SUBSTANCES INVOLVED	CHARACTERISTICS	MEDIA	ESTIMATED CONCENTRATIONS	LOWEST PEL, or TLV
TCE	VO, TO	AIR	<1ug/m^3	269 mg/m^3 TVL
DCE	VO, TO	AIR	<1ug/m^3	790 mg/m^3 PEL
1,1,1-TCA	VO, TO	AIR	<1 ug/m^3	1900 mg/m^3 PEL

Media types: GW (ground water), SW (surface water), WW (wastewater), AIR (air), SL (soil), SD (sediment), WL (waste, liquid), WS (waste, solid), WD (waste, sludge), WG (waste, gas), OT (other).

Characteristics: CA (corrosive, acid), CC (corrosive, caustic), IG (ignitable), RA (radioactive), VO (volatile), TO (toxic), RE (reactive), BIO (infectious), UN (unknown), OT (other, describe

(2) DESCRIBE POTENTIAL FOR CONTACT WITH EACH MEDIA TYPE FOR EACH OF THE MPI TASKS LISTED IN SEC 3 (E):

MPI TASK	ROUTE OF EXPOSURE (INHAL/INGEST/CONTACT/ABSORB)	POTENTIAL FOR CONTACT (HIGH / MEDIUM / LOW)	METHOD OF CONTROL
1	Inhal	Low	WORK PRACTICES/PPE
2	Inhal/contact	Low	WORK PRACTICES/PPE

The Site Safety Officer will brief the MPI field team on symptoms and signs of overexposure to chemical hazards

SECTION 6: SITE CONTROL MEASURES

(A) WORK ZONES - EXCAVATIONS, DRILLING OPERATIONS, AND HEAVY EQUIPMENT

MARK FLUSCHE has been designated to coordinate access control and security for Malcolm Pirnie operations on site. It is a Malcolm Pirnie policy that Malcolm Pirnie personnel will not enter trench or excavated areas without approval of Corporate Health and Safety. A safe perimeter has been established at the boundary of any excavation and/or a safe distance from excavators, drill rigs and other heavy equipment.

These boundaries are identified by: CAUTION TAPE/ CONES FORMING PERIMETER 15 FEET FROM WORK AREA

No unauthorized person should be within this area.

(B) WORK ZONES - CONTAMINATION

The prevailing wind conditions are WESTERLY A wind direction indicator is used to determine daily wind direction. The Command Post is located upwind from the Exclusion Zone or at a sufficient distance to prevent exposure should a release occur.

Control boundaries have been established and Exclusion Zone(s) (the contaminated area) have been identified. (Attach site map)

These boundaries are identified by: CONTAMINATION IS IN THE SUB-SURFACE – EXCLUSION ZONE WILL BE IMMEDIATE WORK AREA.

No unauthorized person should be within this area.

SECTION 7: SAFETY PROCEDURES / EQUIPMENT REQUIRED

Identify all procedures and equipment needed to eliminate or minimize exposure to hazards identified in Section 5.

- ☒ AIR MONITORING EQUIPMENT (See Section 9)
- ☒ BARRIER TAPE
- ☐ COMMUNICATIONS - ONSITE
- ☒ COMMUNICATIONS - OFFSITE (i.e., cell/digital phones if no other means)
- ☐ CONFINED SPACE PROGRAM & EQUIPMENT (See Section 12)
- ☐ EYE WASH
- ☐ EMERGENCY SHOWERS
- ☐ EMERGENCY AIR HORN
- ☐ FALL PROTECTION PROGRAM & EQUIPMENT
- ☒ FIRE EXTINGUISHER(S) - ABC
- ☒ FIRST AID KIT / BBP KIT
- ☐ FLOTATION DEVICE (USCG)
- ☐ GFCI EXTENSION CORDS
- ☐ HARNESS(S) / LIFELINE(S)
- ☐ INSECT / TICK REPELLANT
- ☐ HUNTING SEASON
- ☐ LADDER(S)
- ☐ LIGHTING - HAND HELD
- ☐ LIGHTING - FIXED / EMERGENCY
- ☐ LOCKOUT/TAGOUT PROGRAM & EQUIPMENT
- ☐ MSDSs – ATTACHED (See Section 11)
- ☐ MSDSs - FACILITY / OTHERS
- ☒ PPE - PHYSICAL HAZARDS (See Section 15)
- ☐ PPE - CHEMICAL HAZARDS (See Section 15)
- ☐ RESPIRATORY PROTECTION PROGRAM & EQUIPMENT (APR) (See Section 15)
- ☐ RESPIRATORY PROTECTION PROGRAM & EQUIPMENT (SAR) (See Section 15)
- ☒ TRAFFIC CONES
- ☐ VENTILATION EQUIPMENT
- ☐ OTHER:

SECTION 8: COMMUNICATIONS AND SAFE WORK PRACTICES

(A) COMMUNICATIONS - ONSITE

Whenever possible, communications between site personnel should be face-to-face. When verbal communications is not possible, radio communications shall be established.

In case of radio communications failure, or when respiratory protection is in use, the following hand signals will be used:

OK; I AM ALL RIGHT; I UNDERSTAND	THUMBS UP
NO; NEGATIVE	THUMBS DOWN
NEED ASSISTANCE	BOTH HANDS ON TOP OF HEAD
DANGER - NEED TO LEAVE AREA, NO QUESTIONS	GRIP PARTNERS WRIST WITH BOTH HANDS
HAVING DIFFICULTY BREATHING	HANDS TO THROAT

(B) COMMUNICATIONS - OFF SITE

If applicable, telephone communication to the Command Post should be established as soon as practical.

Telephone numbers that can be used to reach the command post are: 518-782-2100 and ____________________

(C) SAFE WORK PRACTICES

1. A "BUDDY SYSTEM" IN WHICH ANOTHER WORKER IS CLOSE ENOUGH TO RENDER IMMEDIATE AID WILL BE IN EFFECT. CLIENTS AND/OR CONTRACTORS MAY SERVE AS A "DESIGNATED BUDDY."

2. WHERE THE EYES OR BODY MAY BE EXPOSED TO CORROSIVE MATERIALS, SUITABLE FACILITIES FOR QUICK DRENCHING OR FLUSHING SHALL BE AVAILABLE FOR IMMEDIATE USE (SEE SECTION 7).

3. DO NOT KNEEL ON THE GROUND WHEN CHEMICAL PROTECTIVE CLOTHING IS BEING USED.

4. IF DRILLING EQUIPMENT IS INVOLVED, HAVE A CURRENT UTILITY SURVEY, AND KNOW WHERE THE 'KILL SWITCH' IS.

5. CONTACT WITH SAMPLES, EXCAVATED MATERIALS, OR OTHER CONTAMINATED MATERIALS MUST BE MINIMIZED.

6. ALL ELECTRICAL EQUIPMENT USED IN OUTSIDE LOCATIONS, WET AREAS OR NEAR WATER MUST BE PLUGGED INTO GROUND FAULT CIRCUIT INTERRUPTER (GFCI) PROTECTED OUTLETS (SEE SECTION 7).

7. IN THE EVENT OF TREACHEROUS WEATHER-RELATED WORKING CONDITIONS (I.E., THUNDERSTORM, LIMITED VISIBILITY, EXTREME COLD OR HEAT) FIELD TASKS WILL BE SUSPENDED UNTIL CONDITIONS IMPROVE OR APPROPRIATE PROTECTION FROM THE ELEMENTS IS PROVIDED.

8. SMOKING, EATING, CHEWING GUM OR TOBACCO, OR DRINKING ARE FORBIDDEN EXCEPT IN CLEAN OR DESIGNATED AREAS.

9. USE OF CONTACT LENSES NEAR CHEMICALS OR DURING USE OF RESPIRATORY PROTECTION IS PROHIBITED AT ALL TIMES.

10. GOOD HOUSEKEEPING PRACTICES ARE TO BE MAINTAINED.

11. SITE / FACILITY SPECIFIC SAFE WORK PRACTICES:

    NOT APPLICABLE

SECTION 9: ENVIRONMENTAL MONITORING ☐ THIS SECTION NOT APPLICABLE TO SITE ACTIVITIES

(A) The following environmental monitoring instruments shall be used on site at the specified intervals and recorded in the site logbook. (NOTE: If monitoring period is "OTHER", monitoring schedule will be attached to this plan.)

EQUIPMENT	MONITORING PERIOD				ACTION LEVEL
☐ Combustible Gas Indicator	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☐ O_2 Meter	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☐ Toxics: ☐ CO ☐ H_2S	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☐ Other:	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☒ PID (Lamp 10.6 eV)	☐ Continuous	☐ Hourly	☐ x Day	☒ Other	25 ppm
☐ FID					
☐ Colorimetric tubes:					
	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☐ Radiation: ☐ α ☐ β ☐ gamma	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☐ Respirable Dust Meter	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☐ Noise Meter	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
☐ Other:	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	
	☐ Continuous	☐ Hourly	☐ x Day	☐ Other	

(B) Monitoring equipment is to calibrated according to manufacturers' instructions. Record calibration data and air concentrations in the Health and Safety on-site log book.

(C) Recommended Action Levels for Upgrade or Downgrade of Respiratory Protection, or Site Shutdown and Evacuation. These are average values. Consideration should be given to the potential for release of highly toxic compounds from the waste or from reaction by-products. Levels are for persistent (> 10 min) breathing zone measurements in non-confined spaces. **For unexpected conditions, stop all work and contact Corporate Health and Safety.**

Oxygen Levels	
Less than 19.5%	Level B necessary for work to start / continue. Consider toxicity potential.
19.5% to 23.5%	Work may start / continue. Investigate changes. Continuous monitoring.
Greater than 23.5%	PROHIBITED WORK CONDITION

Flammability / Explosive Hazards	
Less than 10% of LEL	Work may start / continue. Consider toxicity potential.
10% to 25% of LEL	Work may start / continue. Continuous monitoring.
Greater than 25% of LEL	PROHIBITED WORK CONDITION.

Uncharacterized Airborne Organic Vapors or Gases	
Background*	Work may start / continue. Continue to monitor conditions.
Up to 5 meter units (m.u. or "ppm") above background	Level C necessary for work to start / continue. Continuous monitoring. Use Colorimetric tubes to characterize vapors.
Up to 50 m.u. above background	Level B necessary for work to start / continue. Continuous monitoring.
Greater than 50 m.u.	PROHIBITED WORK CONDITION.

*** Off-site clean air measurement**

Characterized Airborne Organic Vapors or Gases**	
Up to 50% of TLV, or PEL or REL	Work may start / continue. Continue to monitor conditions.
Up to 25 times the TLV, or PEL or REL	Level C necessary for work to start / continue. Continuous monitoring.
Up to 500 times the TLV, or PEL or REL	Level B necessary for work to start / continue. Continuous monitoring.
Greater than 500 times the TLV, or PEL or REL	PROHIBITED WORK CONDITION.

** **Use mixture calculations (% allowed = $3C_NEL_N$) if more than one contaminant is present.**

Radiation	
Less than 0.5 mR/Hour (500 μR)	Work may start / continue. Continue to monitor conditions.
Up to 1 mR/Hour above background	Work may start / continue with Radiation Safety Officer present on site.
Greater than 1 mR/Hour above background	PROHIBITED WORK CONDITION.

SECTION 10: PERSONAL MONITORING

☐ THIS SECTION NOT APPLICABLE TO SITE ACTIVITIES

(A) PERSONAL EXPOSURE SAMPLING (Consider if high levels of noise or high concentrations of lead, mercury or arsenic are present)

The following personal monitoring will be in effect on site: SIGNIFICANT NOISE IS NOT EXPECTED – NO PERSONAL MONITORING WILL BE IMPLEMENTED.

A copy of personal monitoring results is to be sent to Corporate Health and Safety for inclusion in the Employee's Confidential Exposure Record File.

(B) HEAT / COLD STRESS MONITORING

The expected air temperature will be 30-70 ºF. If it is determined that heat stress or cold stress monitoring is required (mandatory for heavy exertion in PPE at temperatures over 70ºF, or at temperatures under 40ºF or wind chill equivalent), the following procedures shall be followed (describe procedures in effect, for heat stress i.e., monitoring body temperature, body weight, pulse rate; for cold stress i.e., appropriate clothing, shelter breaks):

HEAT AND COLD STRESS MONITORING BY PERSONAL OBSERVATION WILL BE PERFORMED.

SECTION 11: HAZARD COMMUNICATION PROGRAM

☒ THIS SECTION NOT APPLICABLE TO SITE ACTIVITIES

If chemicals are introduced to the site by Malcolm Pirnie (e.g., decontamination liquids, preservatives, etc.), a copy of the Malcolm Pirnie Hazard Communication Program and Material Safety Data Sheets (MSDSs) of chemicals introduced by Malcolm Pirnie to the site is attached to this plan. The Site Safety Officer will review this information with all field personnel prior to the start of the project, and will inform other employers (e.g., Owner, Contractor and Subcontractors) the availability and location of this information. The Comprehensive List of Chemicals introduced by Malcolm Pirnie to this site is:

All chemicals being introduced to the site, hazardous/potentially hazardous samples prepared at the site, and/or any hazardous materials previously sent to the site, **that will be stored at the site or will be transported from the site by common carrier**, will be packaged, labeled and identified as hazardous materials in accordance with U.S. Department of Transportation (DOT) and/or International Air Transport Association (IATA) regulations by a trained HazMat employee.

(NOTE: At multi-employer sites, the Site Safety Officer will obtain information, if applicable, on hazardous chemicals other employers may produce or introduce to the job site to which Malcolm Pirnie employees may be exposed, including the location of their written hazard communication program(s), labeling program(s), and Material Safety Data Sheet(s).

SECTION 12: CONFINED SPACE ENTRY

☒ THIS SECTION NOT APPLICABLE TO SITE ACTIVITIES

If a permit-required confined space entry will be made on site, a copy of the Malcolm Pirnie Confined Space Entry Program, and a completed Malcolm Pirnie Confined Space Pre-Entry Inspection Check List will be attached to this plan. A Confined Space Entry Permit must be completed and posted outside the confined space prior to entry, and the entry will follow the Malcolm Pirnie Confined Space Entry written program. Permits are to be saved and logged with project documentation.

SECTION 13: EXCAVATION SAFETY

☒ THIS SECTION NOT APPLICABLE TO SITE ACTIVITIES

Excavations being created in order to accomplish Malcolm Pirnie tasks or in progress during Malcolm Pirnie inspection of other activities or tasks, shall be shored or slopped or otherwise protected to prevent accidental collapse prior to entry, in accordance with Subpart F of 29 CFR 1926. It is Malcolm Pirnie policy that Malcolm Pirnie personnel will not enter trench or excavated areas without approval of Corporate Health and Safety. If an entry into an excavation by Malcolm Pirnie personnel is necessary, a Excavation Plan identifying the Competent Person and the protective measure to be used (i.e., sloping, shoring, trench box) will be attached to this plan.

SECTION 14: DECONTAMINATION PROCEDURES ☒ THIS SECTION NOT APPLICABLE TO SITE ACTIVITIES

Personnel and equipment leaving the Exclusion Zone shall be thoroughly decontaminated. The Site Safety Officer is responsible for monitoring adherence with this decontamination plan.

A ______________________ decontamination protocol shall be used with the following decontamination stations:

(1) ______________________

(2) ______________________

(3) ______________________

(4) ______________________

(5) ______________________

(6) ______________________

(7) ______________________

(8) ______________________

(Other) ______________________

The following decontamination equipment is required: ______________________

☐ Decon Pad (Plastic Sheet)
☐ Trash Cans/Bags
☐ Dry Brushes
☐ Wet Brushes
☐ Buckets
☐ Hose / Spray
Other ______________________
____

______________________ Will be used as the decontamination solution

SECTION 15: PERSONAL PROTECTIVE EQUIPMENT

TASK *	RESPIRATORS & CARTRIDGE[1]	USE ** (See Section 16)	CLOTHING ***	GLOVES	BOOTS	OTHER
1	N/A	N/A	N/S	N	SL	N/A
2	N/A	N/A	N/A	N	SL	HH

* Same as Section 3E

**UP = Upgrade
CONT = Continuous

*** **NOTE:** PPE use will be in accordance with Malcolm Pirnie's Health and Safety Policy and Written Programs.

CODES:

RESPIRATORS[1]
HF = Half Face APR
FF = Full Face APR
ESCBA = Escape Bottle
SAR = Airline
SCBA = SCBA

CARTRIDGES[1]
P = Particulate
OV = Organic Vapors
AG = Acid Gas
Mult = Multi-Gas/Vapor
Other

CLOTHING
N/S = No Special
C = Coveralls
T = Tyvek
Sx = Saranex
PT = PE Tyvek

GLOVES[2]
Co = Cotton
Le = Leather [3]
L = Latex
N = Nitrile
B = Butyl
Neo = Neoprene
V = Viton
PVC = Polyvinyl Chloride
PVA = Polyvinyl Alcohol
Other:

BOOTS
SL = Leather Safety
H = Hip (Fireman)
O = Latex overboots

OTHER
HH = Hard Hat [3]
G = Safety Glasses [3]
GP = Glare Protection
Gl = Goggles - Impact
GS = Goggles - Splash
FS = Face Shield
HP = Hearing Protection [3]
RV = Reflective Vests [3]

[1] - List all that apply, i.e., FF w/ OV/AG/P

[2] - Use same codes for clothing and boots of same material

[3] **Should be considered for all field jobs**

Respiratory protection will be upgraded under the following conditions: NO UPGRADE ANTICIPATED BASED ON SITE CONDITIONS

IF SITE CONDITIONS CHANGE, WORK WILL BE HALTED AND HASP AMENDED TO INCLUDE RESPIRATORY PROTECTION.

The following cartridge change out schedule is to be followed onsite (attach any calculations to plan):

N/A

SECTION 16: EMERGENCY ACTION PLAN

The following standard emergency response procedures will be used by onsite personnel. The Site Safety Officer shall be notified of any onsite emergencies and be responsible for ensuring that the appropriate procedure are followed.

(A) EVACUATION

All work activities are suspended and the site is to be EVACUATED IMMEDIATELY, when there is a threat to life or health as determined by individual good judgment, i.e. fire, hazardous chemical spill, dangerous gas leak, severe weather (i.e., tornado); or when notified by other site / facility staff and local fire or police officials.

If an evacuation is called for, the emergency alarm system for weather-related, medical, fire and other evacuation emergencies is:

PERSONAL NOTIFICATION OR HAND SIGNALS

Evacuation from the Exclusion Zone should whenever possible occur through the decontamination line. In those situations where egress in this manner cannot occur, the following emergency escape routes have been designated (document on map if possible):

N/A

Once evacuated off site, all staff should gather at Nearest Cross Street which is a minimum of 250 feet away from the incident

(B) FIRE OR EXPLOSION

Upon discovery of a fire or an explosion, the above-designated emergency signal shall be sounded and all personnel shall assemble at the decontamination line. The fire department is to be notified and all personnel moved to a safe distance (minimum 250') from the involved area.

If a person's clothing should catch fire, burning clothing may be extinguished by having the individual drop to the floor and roll. If necessary, physically restrain the person and roll them around on the floor to smother the flames. Use a fire blanket or extinguisher if one is readily available and you have been trained in its use. Call emergency medical services if not already done so.

If a person's clothing should become saturated with a chemical, douse the individual with water from the nearest safety shower if available. Consult the chemical Material Safety Data Sheets (MSDSs) for further information. Call emergency medical services if indicated by the MSDSs.

NEVER RE-ENTER THE SITE / FACILITY until the emergency has been declared over and permission to re-enter has been given by site / facility health and safety staff or local fire or police officials. If any staff is unaccounted for, notify an individual in charge.

(C) MEDICAL EMERGENCY

If you discover a medical emergency and are by yourself, CALL OUT FOR HELP. When someone arrives, tell them to call for help. If no one comes or you know you are alone, provide whatever care you can for 1 minute, then make the call yourself. (See Section 2)

Upon notification of an injury in the Exclusion Zone, the designated emergency signal shall be sounded. All site personnel shall assemble at the decontamination line. The SSO or alternate should evaluate the nature of the injury, and the affected person should be decontaminated to the extent possible prior to movement to the Support Zone. The onsite CPR/FA personnel shall initiate the appropriate first aid, and contact should be made for an ambulance (and other emergency services as needed) and with the designated medical facility (if required). No persons shall reenter the Exclusion Zone until the cause of the injury or symptoms is determined.

The hospital is 20 minutes from the site. Ambulance response time is 10 minutes. N/A of N/A was contacted on __________ and briefed on the situation, the potential hazards, and the substances involved. When IDLH conditions exist, arrangements should be made for onsite standby of emergency services.
A map for directions to the nearest hospital is attached to this plan. If not, the directions are: SEE ATTACHED MAP

(D) SAFETY EQUIPMENT FAILURE

If any other equipment (i.e., air monitoring) on site fails to operate properly, the FTL and/or SSO shall be notified to determine the effect of this failure on continuing operations on site. If the failure affects the safety of personnel or prevents completion of the Work Plan tasks, all personnel shall leave the work area until the situation is evaluated and appropriate actions taken.

(E) FOLLOW UP

In all situations, when an on site / facility emergency results in evacuation of the work area, or a “large spill” has occurred, staff shall not resume work until:

- The conditions resulting in the emergency have been corrected;
- The hazards reassessed by the SSO and Corporate Health and Safety;
- The HASP has been reviewed by the SSO and Corporate Health and Safety; and
- Site personnel have been briefed on any changes in the HASP by the SSO.

SECTION 17: **SPILL CONTAINMENT / CONTROL** ☒ **THIS SECTION NOT APPLICABLE TO SITE ACTIVITIES**

For most chemicals introduced to the worksite, or under control of Malcolm Pirnie employees, spills of chemicals would be considered incidental and would be controlled in the immediate area of the spill. Such spills shall be handled utilizing precautions appropriate for the chemical characteristics specified in the MSDS for the chemical including spill control methods and selection and use of minimum personal protective equipment.

For chemicals introduced to the worksite, or under control of Malcolm Pirnie employees, that would cause a "large spill" (greater than 55 gallons), a copy of the appropriate Emergency Response Guidebook (ERG) guide shall be attached to this plan, and a spill response contractor shall be identified in Section 2.

SECTION 18: **EMPLOYEE ACKNOWLEDGEMENTS**

PLAN REVIEWED BY:

		DATE
Project Manager:		12/11/06
Project Leader:		12/11/06
Local H&S Coordinator:		12/8/2006
Corporate H & S		

I acknowledge that I have read the information on this HASP, attached Material Safety Data Sheets (MSDSs), DOT Emergency Response Guides, and Health and Safety Programs.
I understand the site / facility hazards as described and agree to comply with the contents of the plan.

EMPLOYEE (Print Name)

MARK FLUSCHE		12/8/06
Mark de Jong	Mark de Jong	2/8/07
Dwight A. Symonds	D-Symonds	5/29/07
R. J. Mishel	R. J. Mishel	5/29/07
Diane Bertok	Diane Bertok	5/29/07

VISITOR (Print Name)

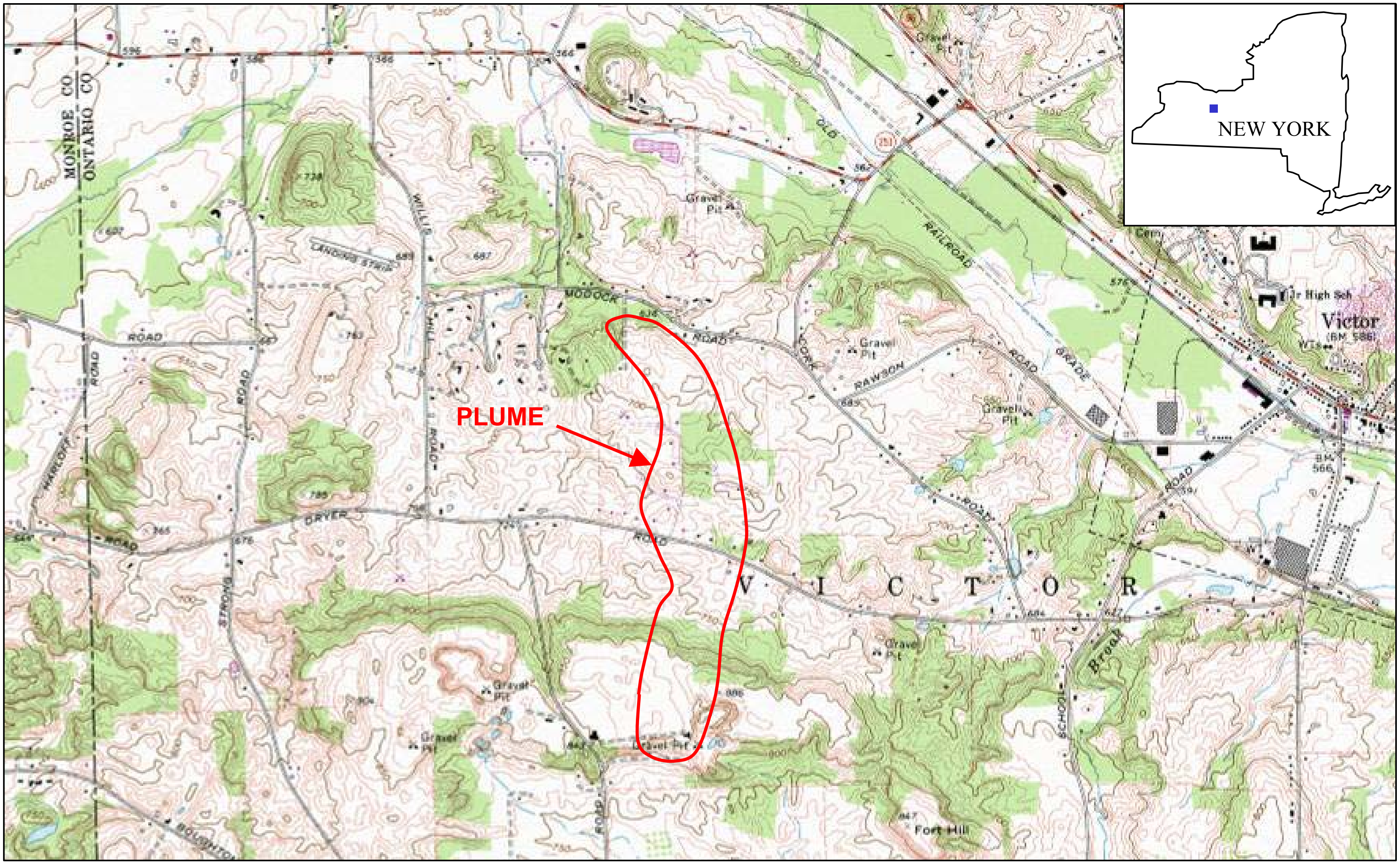
ATTACHED DOCUMENTS

☐ MSDS(s)
☒ Site Map
☒ Hospital Directions
☐ Other

☐ Hazard Communication Written Program
☒ Personal Protective Equipment Written Program
☐ Emergency Action Plan

☐ Confined Space Entry Written Program
☐ Excavation Safety Plan
☐ Evacuation Routes

☐ DOT ERG Guides
☐ Respiratory Protection Program
☐ Cartridge Change Out Calculations



MAP SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC SERIES, VICTOR QUADRANGLE (PHOTOREVISED 1978)

APPROXIMATE SCALE IN FEET

0 1200 2400 4800

F:\PROJECT\0266361\FILE\PMWP\Figure 1.ppt

MALCOLM PIRNIE

MODOCK ROAD SPRINGS/DLS SAND AND GRAVEL, INC. SITE (HW 8-35-013)
VICTOR, NEW YORK

APPROXIMATE PLUME EXTENT

FIGURE 1

Google Maps

Start **Modock Rd**
Victor, NY 14564
End **Strong Memorial Hospital**
625 Panorama Trl # 3, Rochester, NY 14625
Travel **13.1 mi (about 20 mins)**

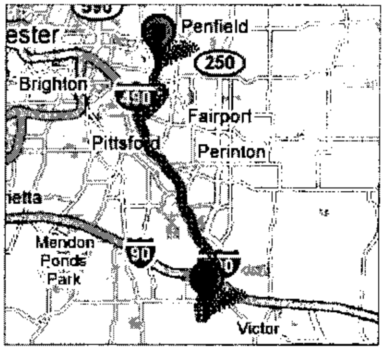
Directions

	1.	Head **west** from **Modock Rd**	**0.2 mi**
➡	2.	Turn **right** at **Raccoon Run**	**0.3 mi** 1 min
	3.	Continue on **Deer Xing**	**0.4 mi** 1 min
⬅	4.	Turn **left** at **Victor Mendon Rd**	**0.1 mi**
➡	5.	Turn **right** at **Phillips Rd**	**0.8 mi** 2 mins
➡	6.	Turn **right** at **Main St Fishers**	**0.4 mi**
⬅	7.	Turn **left** at **RT-96 N**	**0.3 mi**
	8.	Take the **I-490 W** ramp	**7.6 mi** 7 mins
	9.	Take the **RT-31F** exit **25** to **Fairport/East Rochester**	**0.3 mi**
➡	10.	Turn **right** at **Fairport Rd**	**0.4 mi**
⬅	11.	Turn **left** at **S Washington St**	**0.8 mi** 1 min
	12.	Continue on **N Washington St**	**0.5 mi** 1 min
⬅	13.	Bear **left** at **Panorama Trl S**	**1.1 mi** 2 mins
	14.	Arrive at **Strong Memorial Hospital** 625 Panorama Trl # 3, Rochester, NY 14625	

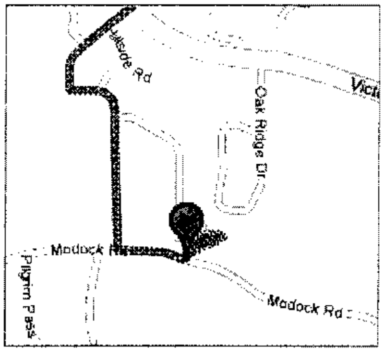
These directions are for planning purposes only. You may find that construction projects, traffic, or other events may cause road conditions to differ from the map results.

Map data ©2006 NAVTEQ™

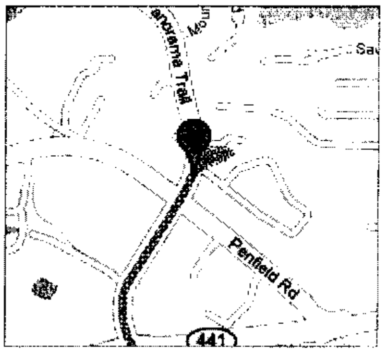
Overview



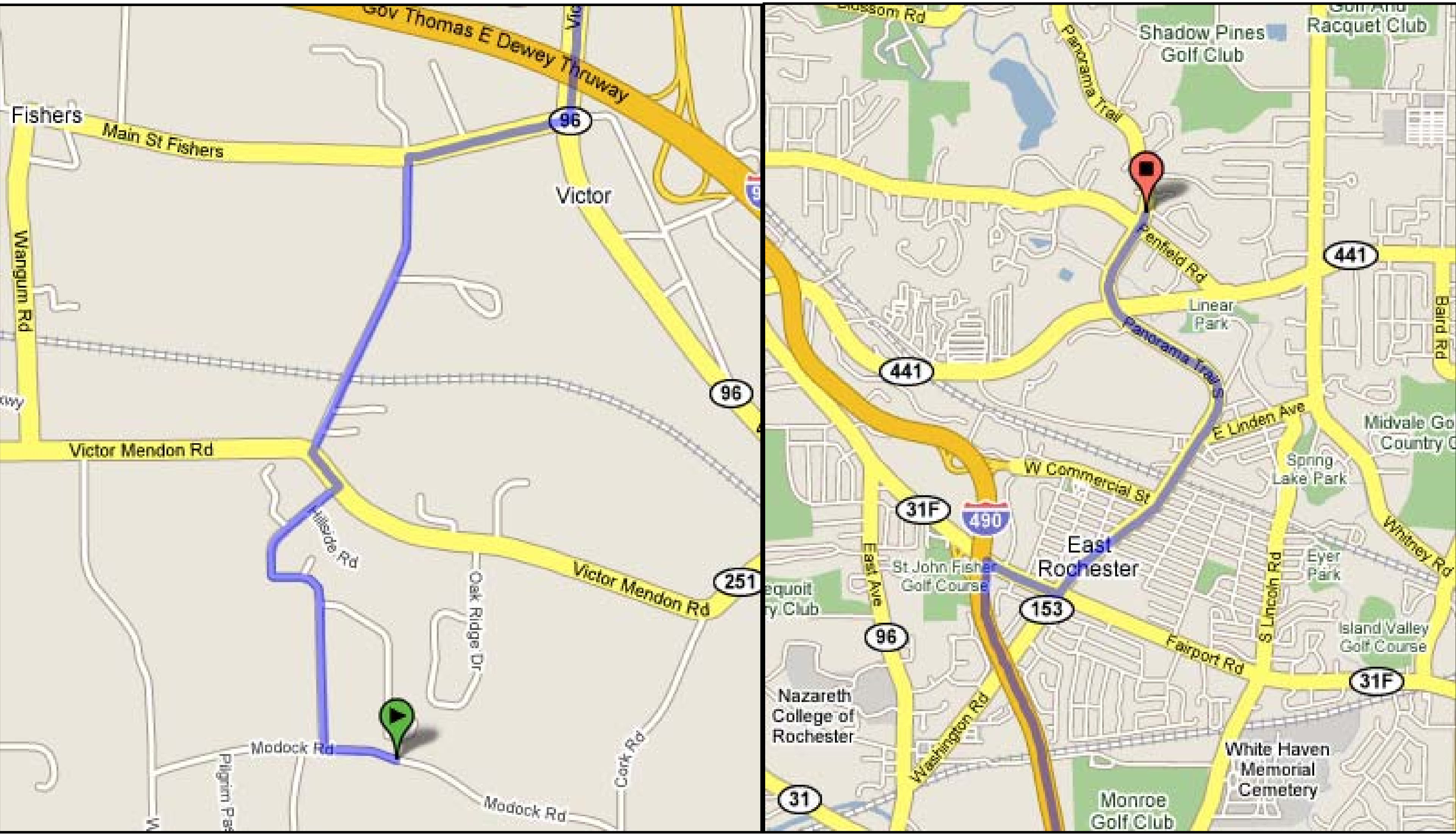
Start



End



Map data ©2006 NAVTEQ™


Gov Thomas E Dewey Thruway
Fishers
Main St Fishers
96
Victor
Wangum Rd
96
Victor Mendon Rd
Hillside Rd
Oak Ridge Dr
Victor Mendon Rd
251
Cork Rd
Modock Rd
Pilgrim Pa
Modock Rd
Blossom Rd
Panorama Trail
Shadow Pines Golf Club
Golf And Racquet Club
Penfield Rd
441
Linear Park
Baird Rd
441
Panorama Trail S
E Linden Ave
Midvale Golf Country C
Spring Lake Park
W Commercial St
31F
490
East Rochester
Whitney Rd
East Ave
St John Fisher Golf Course
Eyer Park
S Lincoln Rd
153
equoit y Club
96
Island Valley Golf Course
Fairport Rd
31F
Nazareth College of Rochester
Washington Rd
White Haven Memorial Cemetery
31
Monroe Golf Club

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APPENDIX D - AIRBORNE CONTAMINANT ACTION LEVELS FOR SELECTION OF PPE ENSEMBLES

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1.0 INTRODUCTION

The purpose of this section is to assist employees in the proper selection and use of personal protective equipment (PPE). Malcolm Pirnie staff shall use PPE when engaged in activities where there is a potential for exposure to chemical, biological, physical or mechanical hazards, or as otherwise required by applicable laws and regulations.

The occupational use of PPE is governed by a series of standards promulgated by the Occupational Safety and Health Administration (OSHA) and found in Title 29 CFR 1910, Subpart I, *Personal Protective Equipment*. These include 29 CFR 1910. 133, *Eye and Face Protection*; 29 CFR 1910.135, *Occupational Head Protection*; and, 29 CFR 1910.136, *Occupational Foot Protection*. PPE required by the OSHA *Respiratory Protection Standard*, 29 CFR 1910.134, and the *Noise Standard* including the *Hearing Conservation Amendment*, 29 CFR 1910.95, are addressed separately in this Manual.

The OSHA standards dealing with personal protective equipment consist of three types of requirements. Section 1910.132 is a set of general requirements covering all types of equipment and all situations where it is needed. Section 1910.132 requirements do not cover section 1910.134, *Respiratory Protection*, or section 1910.137, *Electrical Protective Devices*, which are subjects of separate rule making. The other sections of Subpart I each give requirements for one particular type of equipment; and certain paragraphs in standards not primarily concerned with PPE call for protective equipment to be used under working conditions regulated by that section. In deciding on protective equipment for a project, project managers may find that provisions of all three apply.

OSHA does not recommend PPE if administrative or engineering controls will eliminate a hazard. Such controls are always preferred over reliance on personal protection to shield an employee from chemicals, processes or machinery known to be dangerous.

2.0 POLICY

A written hazard evaluation will be conducted for all Malcolm Pirnie worksites, **on all field projects**, other than work in office environments, to:

- Determine potential hazards to the health and safety of Malcolm Pirnie.
- Evaluate the need for and the feasibility of engineering and/or administrative controls of the hazards.
- Specify effective types of personal protective equipment to reduce potential exposures.

Individual articles of a PPE ensemble will be chosen by a qualified employee, Project Safety Officer (PSO) or Corporate Health & Safety, to provide the best available protection against known or reasonably anticipated chemical and physical hazards.

Individual articles of a PPE ensemble will be sized to fit the individual wearing it.

Compromised PPE will not be worn by Malcolm Pirnie employees or employees of Malcolm Pirnie subcontractors.

Contaminated PPE materials will be left at the work site if this can be done in a **responsible** manner.

3.0 RESPONSIBILITIES

OSHA requires that Malcolm Pirnie initiate engineering and work practice controls, to the extent feasible, to minimize the potential for employee exposure to chemical, biological, physical, or mechanical hazards. If recognized health and safety hazards cannot be practically removed from the work environment, and if employee exposures cannot be significantly reduced by administrative means, Malcolm Pirnie must provide employees with appropriate PPE and ensure that it is used properly.

3.1. Non-Hazardous Waste Projects

Project Managers: Project Managers are responsible for providing the project resources necessary to determine the appropriate level of PPE for employees working on their projects. To this end, Project Managers and/or PSOs will conduct a preliminary hazard assessment of the worksite and tasks to be performed and specify the appropriate PPE ensemble for each task and location. The Hazard Assessment Checklist, found in Appendix A, should be used to conduct the preliminary hazard assessment. Based upon the information generated in the assessment, and good safety practices, the Project Manager or the PSO can:

- Evaluate, design or purchase feasible engineering controls to isolate the hazard.
- Develop procedures and work practices to control the hazard.
- Evaluate and specify PPE required for the safe completion of the project.

3.2. Hazardous Waste Projects

For hazardous waste projects, a hazard analysis is conducted when developing a Site Safety Plan (SSP) for field activities. The SSP writer and reviewers evaluate the potential safety and health hazards posed by the project tasks. Then, in the SSP, they specify levels of protection, the specific PPE in each level, and action level ranges that govern the selection of each level.

Any questions regarding hazard evaluations should be addressed to the SBU Health & Safety Leader or to the Manager, Health & Safety, COR.

Qualified Employee: As a practical matter, the Project Manager is likely to delegate the task and hazard evaluation to a junior member of the project team who will often serve as the PSO. Evaluating hazards and selecting appropriate engineering, work practice and PPE control methods for a project is an important responsibility. To promote the effective completion of this task, the Project Manager will delegate this task to an individual who meets certain education and training qualifications. Employees are considered qualified to select PPE if they meet either of these criteria:

- The employee has received formal training in industrial hygiene or safety practices.
- The employee has received training in the selection, use, maintenance and limitations of PPE (e.g., 40-Hour Hazardous Waste Operations, Construction Site Safety training, or PPE Training), is familiar with the site, the tasks to be completed and the known or reasonably anticipated site and task hazards.

Project Safety Officer: The Project Safety Officer (PSO) on hazardous waste projects has the responsibility and authority to see that the provisions of the approved SSP are implemented during site activities. The person selected to be PSO must meet the minimum qualifications above.

At the site, the PSO evaluates air-monitoring data, work tasks and site conditions and then specifies a pre-approved level of protection PPE ensemble to be used by Malcolm Pirnie employees. If site conditions change, the PSO may only upgrade or downgrade the level of protection in accordance with the action levels and PPE ensembles specified in the approved SSP. Modifications to the PPE ensembles, the task evaluations or the action levels as a result of unforeseen circumstances must be approved by the SBU Health & Safety Leader (HSL) and/or the Manager, Health & Safety, COR.

Equipment Coordinators: The office Equipment Coordinator (E.C.) is responsible for procuring and dispensing expendable PPE for that office.

Employees: Employees are responsible for using the PPE in accordance with both the training they receive, and instructions provided. Employees should alert the PSO or team leader if proper PPE has not been assigned, if they have not been trained in the use and limitations of assigned PPE, and if the PPE is damaged, compromised, or does not appear to be working.

4.0 HAZARD ASSESSMENT

Malcolm Pirnie prepares written hazard assessments in order to identify the appropriate PPE ensemble(s) for project work activities. The PPE ensemble(s) for hazardous waste projects are specified in the SSP. A particular ensemble is chosen based upon:

- Proposed work tasks.
- Potential routes of entry and points of contact.
- Airborne contaminant action levels specified in the SSP.

For projects that do not require a SSP, the Preliminary Hazard Assessment form (Appendix A) is used to develop PPE requirements. The written Hazard Assessment form provides the certifier's name, signature, date(s), and identification of assessment documents. Contact the HSL or the Manager, Health & Safety, COR for further assistance.

When new processes are implemented or when existing processes change, the PSO should be notified by the project staff so that the existing Hazard Assessment may be reviewed and updated as necessary.

5.0 PPE SELECTION

On projects defined by OSHA's *Hazardous Waste Operations and Emergency Response* standard (29 CFR 1910.120), and on other projects as determined by the hazard assessment, PPE ensembles (Levels of Protection) are selected based upon:

- The toxic materials, physical agents, or waste contaminants known to be present.
- Contaminant concentrations in the waste media.
- The toxicology and the probable routes of entry into the body exhibited by the contaminants.
- Known or expected airborne contaminant concentrations.
- Potential for exposure to physical agents (e.g., electrical, mechanical, hydraulic, pneumatic, chemical, thermal, nuclear, or non-ionizing radiation energy) based upon the type and strength of the energy source and the proximity of the employee to the source.

Individual articles of a PPE ensemble are chosen by a "qualified employee" (previously defined) to provide the best available protection against known or reasonably anticipated chemical and physical hazards. Multiple articles of PPE may be "layered" to provide multi-contaminant and full protection. The various elements of PPE will only protect a worker if the following conditions are met:

- The individual article of PPE must be effective against the hazard (see Appendix B).
- The individual article of PPE must be sized, fitted, worn and secured correctly.

- The functioning surface of the PPE must be intact and not compromised by holes, rips, tears, or split seams.
- The PPE ensemble (see Appendix C) chosen must be effective against all the hazards in the specific situation.

Non-specific action levels have been developed by the U.S. EPA and others as guidelines for determining respiratory and other PPE requirements when exposure air monitoring is conducted by non-specific response field instrumentation. Specific action levels may be used when a site is well characterized, the type and relative concentrations of air contaminants are well known, and appropriate field instrumentation is used to provide real-time exposure data. Malcolm Pirnie has adopted both sets of action levels. These can be found in Appendix C and in the current Malcolm Pirnie Short Form Site Safety Plan form. Airborne Contaminant Action Levels for Selection of PPE Ensembles is provided in Appendix D.

6.0 PPE USE

Individual articles of a PPE ensemble will be sized to fit the individual wearing it. To provide effective protection during removal and decontamination, PPE will be donned in the reverse order presented in the appropriate decontamination table. Duct tape will be used to seal overlaps between gloves /boots and the protective clothing, and to reinforce weak seams or tighten the waist of the garment. PPE will be cleaned and maintained in accordance with manufacturer specifications.

6.1. Fitting PPE

Proper fit of PPE is critical to providing adequate protection. Proper fit is also associated with comfort and comfort is essential if the employees are to wear the PPE provided. Malcolm Pirnie provides employees with a choice of PPE from several different vendors in a selection of sizes. In training, Malcolm Pirnie discusses and practices proper fitting, use and wear of the PPE.

OSHA believes fit is a critical factor in the overall effectiveness of PPE. PPE that fits poorly will not afford the necessary protection. PPE that is too small will bind and tear; PPE that is too large is harder to manage and can become tangled in equipment presenting additional hazards. Care should be taken to ensure the right size is selected. The user should be fit with the protective device and given instructions on care and use of the PPE. It is very important that employees be made aware of all warning labels for, and limitations of, their PPE.

Adjustment of the PPE should be made on an individual basis, with the goal of achieving a comfortable fit that will maintain the protective device in the proper position. Particular care should be taken in fitting devices for eye protection used against dust and chemical splashes, to ensure that the devices are sealed to the face. In addition, proper fitting of helmets is important to ensure that no helmet will fall off during work operations. When manufacturer's instructions are available, they should be followed carefully.

6.2. Damaged PPE

Compromised PPE will not be worn by Malcolm Pirnie employees. When a PPE wearer or their buddy notices that an article of PPE has been compromised, the two will quickly move to the decontamination/support zone to replace or repair the defective article(s).

6.3. Employee-Owned PPE

Malcolm Pirnie provides all required PPE at no or little cost to its employees. When employees plan to use personally owned PPE, the employee must present it to the PSO for inspection prior to use at the work site. If the PSO finds that the employee-owned PPE is adequate and has been properly maintained, the employee may use their personal PPE.

7.0 IN-USE PPE MONITORING

When wearing PPE at sites, Malcolm Pirnie personnel shall report any perceived problems or difficulties to the PSO. Likely concerns are:

- Perception of odors while wearing APR/SAR.
- Skin, eye, or nasal irritation.
- Unusual residues on PPE.
- Suspected degradation of PPE ensemble.
- Excessive discomfort or fatigue.
- Sudden increases in breathing resistance.
- Personal responses such as rapid pulse, nausea, and chest pain.

Should personnel experience any of these problems while wearing PPE, the PSO will temporarily shut down both Malcolm Pirnie and subcontractors operations on the site and all personnel will move to the support zone until the cause of the problem is identified and corrected.

8.0 PPE INSPECTION

PPE shall be inspected by employees before donning and periodically while in use. Protective clothing should be visually inspected before its use for imperfect seams, uneven coatings, tears, and malfunctioning closures. Gloves should be checked for pinholes by entrapping air in the glove, then rolling the cuff toward the fingers, or by inflating the glove and holding it under water. In either case, no air should escape. If a defect is observed in protective clothing or in gloves, the defective item should not be worn onsite. Clean defective apparel shall be disposed of in the trash. Contaminated defective apparel shall be left on-site in appropriate containers if possible.

During field activities, protective clothing should be periodically inspected by the employee and his/her assigned buddy for rips and punctures. Small rips or punctures observed in

garments may be taped over, or the garment may be exchanged for a new one. Large rips or punctures require exchange.

9.0 PPE DECONTAMINATION

Any site where hazardous waste operations occur must have a written plan that outlines decontamination procedures (see 29 CFR 1910.120 [k]). Employees must be trained on these procedures and the decontamination line must be operational when anyone enters areas on-site where there is suspected contamination.

9.1. The Decontamination Plan

The written decontamination plan addresses:

- The number and placement of decontamination stations.
- Decontamination equipment and methods.
- Methods for disposing of clothing and equipment that may not be completely decontaminated.
- Methods of cleaning decon equipment and disposing of decon wastes.

The decontamination plan shall be based on the assumption that all equipment and personnel leaving the Exclusion Zone ("hot zone") will be grossly contaminated. A personnel decontamination system will be established to wash and rinse (at least once) all reusable PPE worn in contaminated areas. This should be done in combination with a sequential doffing of protective equipment, starting at the first decontamination station with the most heavily contaminated item and progressing to the last decontamination station with the least contaminated article.

The decontamination plan developed should address the following factors:

- ***Type of Contaminant***. The extent of personnel decontamination is a function of the amount of the contaminant, its toxicity and its interaction with the PPE articles.
-

- ***Amount of Contamination***. Gross contamination increases the probability of personal contact or the degradation and permeation. Swipe tests may help determine the type and quantity of surface contaminants, or clear articles for disposal as non-hazardous trash.

- ***Type and Level of PPE***. Clothing variations and different levels of protection may require adding or deleting stations to the decontamination line.

- ***Work Function***. Those who are performing tasks that will not bring them into contact with contaminants may not need to have their garments washed and rinsed while others in the Exclusion Zone, with potential direct contact with the hazardous material, will require a more thorough decontamination.

- ***Location of the Contamination***. Contamination on the upper areas of protective clothing poses a greater risk to workers because volatile compounds may generate a hazardous breathing concentration for both the worker and the decontamination personnel. There is also an increased probability of skin contact when doffing the upper part of the clothing.

9.2. Decontamination Procedures and Equipment

Decontamination activities should be confined to a designed area within the Contamination Reduction Zone, known as the Contamination Reduction Corridor. The Corridor controls access into and out of the Exclusion Zone and confines decontamination activities to a limited area. The size of the Corridor varies depending on the number of stations in the decontamination procedure, overall dimensions of the work control zones, and the amount of space available at the site. On smaller sites or sites with limited contamination potential, the size of the decontamination area and the number of decontamination stations will be severely reduced.

Within the Corridor, distinct areas should be set aside for decontamination of personnel, portable field equipment, discarded clothing, etc. Step-by-step procedures for decontamination of personnel wearing PPE Levels B and C are found in Appendix E at the end of this section.

10.0 PPE DISPOSAL

There are few reference guidelines for disposal of contaminated or used PPE garments. Sites requiring Decontamination Corridors will also be equipped to drum, bag, or otherwise dispose of large volumes of PPE wastes generated by site operations. On smaller sites such as well drilling and sampling, or soils sampling projects, field teams are required to bring an adequate supply of heavy gauge opaque plastic garbage bags to hold disposable PPE garments after use.

Contaminated PPE materials will be left at the work site if this can be done in a **responsible** manner. This activity **must** be negotiated with the client / owner / operator / subcontractor in advance of the fieldwork. If this cannot be done, decontaminate contaminated PPE, conduct a swipe test on a representative sample, and bring it back, in clean plastic bags, to the office. PPE that is used but "clean" or was contaminated but tests "clean" may be disposed of in the office dumpster. PPE, which cannot be decontaminated or is contaminated by materials containing mercury, lead, solvents, petroleum, PCBs or dioxin, will be disposed of as hazardous waste.

11.0 TRAINING

Malcolm Pirnie personnel provided with PPE shall be trained in its use, care, capabilities, and limitations prior to using it in a hazardous work environment. Personnel engaged in hazardous waste operations site activities shall receive the initial 40-hour training, of which PPE instruction is an integral part. Subsequent refresher training will include an annual review in the use, limitations, inspection, and care of PPE. A combined refresher/PPE certificate will be issued documenting this training.

11.1. Initial Training

Initial training is provided to all employees that are required to wear PPE. Employees receive initial training in the proper use and care of PPE prior to wearing the PPE in the work place. This training is most effective when the employee understands the hazards that are present, how the PPE provides protection, and the limitations of the PPE.

At a minimum, the training portion of the PPE program should delineate the user's responsibilities utilizing both classroom and hands-on training when necessary to explain the following:

- When PPE is necessary to be worn.
- What PPE is necessary and the selection criteria used for this determination.
- The operation of the selected PPE, including capabilities and limitations.
- The nature of the hazards and the consequences of not using the PPE.
- The human factors influencing PPE performance.
- Instruction in inspecting, donning, doffing, checking, fitting, and using PPE.
- The user's responsibility for decontamination, cleaning, maintenance and repair of PPE.
- Limitations of the PPE.
- Useful life and disposal of the PPE.
- How to recognize emergencies.
- Emergency procedures and self-rescue in the event of PPE failure.
- The buddy system.
-

- Emergency action planning, and the user's responsibilities and duties in an emergency.

Employees are required to demonstrate their understanding in each of the subject areas listed above. Special emphasis should be placed on proper wear, fit, and limitations of the PPE. If the employee cannot demonstrate a full understanding of the material provided in the training, that employee shall be retrained and must exhibit complete understanding of the material presented before they are allowed to wear the PPE in the work place.

11.2. Additional Training

Refresher training is provided when an employee cannot demonstrate a good understanding of the five required OSHA training topics (see above). Employees that are observed using PPE improperly are retrained.

Additional training is provided whenever processes change and new hazards require the use of additional or different PPE.

Staff provided with ancillary PPE (e.g., safety belts, floatation gear) should be trained in its use and care by the PSO before actual use onsite.

Staff requesting PPE who are not in the hazardous waste Health and Safety Training Program and have not received PPE training should be trained in the use and care of the PPE by their PSO before actual use onsite. The PSO will provide the Administrator, Health and Safety, WHI, with an attendance list and a brief summary of the training material covered to document the training and to issue certificates.

Since PPE use often causes discomfort and inconvenience, there is a natural resistance toward wearing it conscientiously. The major thrust of training must be to make the user aware of the need for PPE and to instill the motivation to properly wear and maintain the necessary PPE.

12.0 RECORDKEEPING

PPE training should be documented in the site health and safety logbook. The Manager, Health and Safety, COR, will maintain a copy of all corporate PPE training records. A summary record will be maintained by Health and Safety, COR, in the PeopleSoft database, and will be updated according to the schedule established in the Health and Safety Training section of this manual.

The training records maintained in the local office file will include the following information:

- The dates of the training sessions.
- The contents or a summary of the training sessions.
- The names and qualifications of persons conducting the training.
- The names and job titles of persons attending the training sessions.

Training records shall be maintained for three years from the date on which the training occurred. Upon request, employees will have access to any of his/her training records maintained by the local office, the Manager, Health and Safety, COR.

APPENDIX A

PRELIMINARY HAZARD ASSESSMENT CHECKLIST

MALCOLM PIRNIE

PERSONAL PROTECTIVE EQUIPMENT

PART A

TASK(S)

WORK AREA(S)

PART B

HEAD PROTECTION

Hazards/Operations	*PPE/Options*
☐ **Construction**	☐ **Hard Hat**
☐ **Cold Weather**	**ANSI Z89.1-1986**
☐ **Confined Space**	**Class A and B**
☐ **Electrical**	☐ **Chin Strap**
☐ **Frequent Bending or Leaning**	☐ **Liner**
☐ **Heavy Equipment**	☐ **Hood**
☐ **Hot Weather**	☐ **Protective Hair Covering**
☐ **Low Ceilings/Piping**	☐ **Bump Cap**
☐ **Moving Machinery**	
☐ **Overhead Activity**	

PROTECTIVE BODY CLOTHING

Hazards/Operations	*PPE/Options*
☐ **Chemical Transfer**	☐ **Fully Encapsulating Suit**
☐ **Cold Weather**	☐ **Non-Encapsulating Suit**
☐ **Confined Space**	☐ **Aprons, Leggings, and Sleeve Protectors**
☐ **Dirty Area**	☐ **Anti-Radiation Suit**
☐ **Fire Potential**	☐ **Flotation Gear**
☐ **Hot Weather**	☐ **Cooling Garment**
☐ **Laboratory**	☐ **Tyvek**
☐ **Sampling**	☐ **Warm Weather Clothing (Carhartt's, etc.)**
☐ **Wet Area**	☐ **Rain Gear**

EYE PROTECTION

Hazards/Operations	*PPE/Options*
☐ **Acids/Caustics**	☐ **Safety Glasses with Side Shields**
☐ **Chemical Splashes**	☐ **Goggles**
☐ **Chemical Transfer**	☐ **Face Shields**
☐ **Confined Space**	☐ **Optical Inserts for Full Face Respirators**
☐ **Construction**	
☐ **Flying Particles**	
☐ **Gases and Vapors**	
☐ **Light (UV, Laser)**	

☐ Liquid Chemicals	
☐ Liquid Sampling	
☐ Molten Metal	
☐ Scraping	
☐ Waste Water/Sludge	
☐ Wire Wheel/Chipping	

HAND PROTECTION

Hazards/Operations	*PPE/Options*
☐ Acids/Caustics	☐ Gloves to Match Hazard(s)
☐ Chemical Transfer	☐ Inner linings
☐ Confined Space	☐ Mittens
☐ Cold Weather	☐ A combination of gloves, liners and mittens may be best
☐ Construction	
☐ Cutting Snips	
☐ Hammering	
☐ Hazardous Waste	
☐ Hot Surfaces	
☐ Laboratory	
☐ Liquid Chemicals	
☐ Pinch Points	
☐ Rough or Sharp Objects	
☐ Sample Handling	
☐ Sampling	
☐ Shoveling	
☐ Waste Water/Sludge	

FOOT PROTECTION

Hazards/Operations	*PPE/Options*
☐ Biological Decay	☐ Work Shoes
☐ Broken Ground	☐ Safety Shoes
☐ Confined Space	☐ Overboots
☐ Cold Weather	☐ Waders
☐ Construction	☐ Hip Boots
☐ Demolition	☐ A combination of foot protectors may be best
☐ Dirty Area	
☐ Drum Movement	
☐ Electrical Hazards	
☐ Falling or Rolling Objects	
☐ Heavy Equipment	
☐ Inclement Weather	
☐ Laboratory	
☐ Moving Machinery	
☐ Shallow Water (to 2 Feet)	
☐ Shallow Water (to 4 Feet)	
☐ Waste Water/Sludge	
☐ Wet Soil	
☐ Uneven Ground	

FALL PROTECTION

Hazards/Operations	*PPE/Options*
☐ Confined Space	☐ Full Body Harness w/Shock-absorbing Lanyard

MALCOLM PIRNIE

PERSONAL PROTECTIVE EQUIPMENT

☐ **Floor Openings (Above 6')**	☐ **Retractable Life Line**
☐ **Ladders (Above 28')**	☐ **Safety Line and Rope Grab**
☐ **Platforms (Above 6')**	
☐ **Roofs**	
☐ **Scaffolds**	

RESPIRATORY PROTECTION

Potential Hazards/Operations	*PPE/Options*
☐ **Acids/Caustics**	☐ **Half Face Air Purifying Respirator**
☐ **Chemical Transfer**	☐ **Full Face Air Purifying Respirator**
☐ **Confined Space**	☐ **Self Contained Breathing Apparatus (SCBA)**
☐ **Dusts and Mists**	
☐ **Gases and Vapors**	
☐ **Hazardous Waste**	
☐ **Laboratory**	
☐ **Liquid Chemicals**	
☐ **Sample Handling**	
☐ **Sampling**	
☐ **Waste Water/Sludge**	

Respiratory Protection Addendum--Partial List of Available Cartridges:

Multi-Gas/Vapor Super Cartridge
Organic Vapors Cartridge
Organic Vapors/Acid Gases Cartridge
Acid Gases Cartridge
Formaldehyde Cartridge
Organic Vapors Cartridge/P100 Filter Cartridge
P100 Filter Cartridge
Multi-Gas/Vapor Super Cartridge/P100 Filter Cartridge
Acid Gases Cartridge/P100 Filter Cartridge
Organic Vapors Cartridge/Acid Gases Cartridge/P100 Filter Cartridge
Ammonia/Methylamine Cartridge
Ammonia/Methylamine Cartridge/P100 Filter Cartridge
N95 Filter/Prefilter

Hearing Protection Addendum--Available Hearing Protection

Ear Plugs, Many Types and Styles
Ear Muffs
Combination of Ear Muffs and Plugs

Evaluator: ______________________________ **Date:** ________________

Department Head: ___________________________ **Date:** ________________

APPENDIX B

PPE SPECIFICATIONS, CAPABILITIES AND LIMITATIONS

- Introduction
- Protective Clothing
- Types of Protective Clothing
- Head Protection
- Eye and Face Protection
- Hearing Protection
- Hand Protection
- Foot Protection
- Ancillary PPE
- Reference

PPE SPECIFICATIONS, CAPABILITIES AND LIMITATIONS

1) INTRODUCTION

This appendix provides information on the technical specifications, capabilities and limitations of various types of PPE typically used by Malcolm Pirnie employees. This information is by no means exhaustive and may become rapidly dated by new research findings and product development. If you have any questions regarding the applicability of a particular piece of PPE, contact your SBU Health and Safety Leader or the Manager, Health and Safety, COR.

2) PROTECTIVE CLOTHING

Protective clothing is a type of PPE that provides protection against dermal contact with dirt, hazardous chemicals or waste. Protective clothing is made of various fabrics and fabric treatments, which impart the desired physical and chemical resistive properties. Protective clothing may be limited-use or repetitive use and is usually worn over street clothes, underwear, or bathing suits.

Protective clothing has two critical components: the fabric and the tailoring. The fabric imparts the physical and chemical properties of the garment. Fabric manufacturers conduct tests using American Society of Testing Materials (ASTM), American National Standards Institute (ANSI), and National Fire Protection Association (NFPA) protocols to determine and rate the protective characteristics of their products.

Protective fabrics are sold to safety clothing manufacturers who produce the final garment. The manufacturer's design or manufacturing (tailoring) processes may make superior protective clothing; or garments entirely unsuitable for their intended use. Common failure points are the seams, stitching and the zippers. Chemicals, which may not be able to permeate through the fabric, may easily pass through split seams, stitch holes or zipper teeth. Seams should be sewn, heat-sealed or taped.

a) Selection Criteria

Protective clothing shall be selected to protect employees from occupational hazards while considering the hazards presented by the garments themselves. When selecting protective clothing;

- Consider the hazardous chemicals present, the task(s) to be performed, and the ambient site conditions.
- Match the physical and chemical resistance characteristics of the garment against the requirements and limitations of the site and task-specific conditions.

- Choose the garment with the widest range of protection for a site that has a variety of chemical hazards.

Multiple layers of protection may be needed when more than one contaminant is present or when the hazards are unknown. Disposable boots, gloves, and splash suits are used to provide an extra layer of protection.

Evaluate the physical performance characteristics of each garment under consideration. These performance characteristics may increase the hazards associated with using the garment. The cost of certain types of protective clothing and the affect of the clothing on employee productivity are secondary but valid concerns.

b) Performance Characteristics

Heat Transfer - A garment with a low rate of heat transfer increases heat stress of the person wearing it.

Durability - is the degree to which the protective clothing resists tears, punctures, abrasions, and repeated decontamination.

Flexibility - The garment should be flexible to allow mobility.

Temperature effects - The garment should be able to maintain its protective integrity and flexibility in the temperature ranges expected at the work site.

Decontamination - If reusable protective clothing cannot be decontaminated easily, use a disposable garment with the same resistive properties.

Compatibility - The selected garment should not make it difficult or impossible to use other required protective equipment (e.g., a hard hat).

Lifetime - Lifetime is determined by the length of time a reusable garment can resist aging, especially under severe conditions.

Protective clothing comes in various sizes. The larger sizes (large, XL or XXL) are preferable during cold weather because they allow the garment to be worn over layered winter clothing. Pay particular attention to project team members who have special sizing requirements.

While protective clothing is useful to protect personal clothing from becoming soiled, there may be hazards involved in using protective garments. Therefore, using unnecessary PPE is discouraged.

The project or task evaluation in Appendix A, EPA's *Guidelines for the Selection of Chemical Protective Clothing* (Ref. 1), the *Quick Selection Guide to Chemical Protective Clothing* (Ref. 2), are useful in selecting appropriate protective clothing.

3) TYPES OF PROTECTIVE CLOTHING

a) Repetitive-Use Rainwear / Splash Protection

Rainwear garments are used alone or in combination with chemical protective clothing to prevent exposure to inclement weather and incidental mud or chemical splashes. When choosing these garments consider:

- Whether the garment will be subject to limited use or continuous exposure.
- What will be the specific physical or chemical hazards?
- What are the flexibility and thermal requirements?

b) **Available Materials:**

Vinyl - extremely lightweight PVC material that offers a reasonable initial barrier to liquid penetration. Good flexibility through changing temperatures. Best for short-term use with water-based liquids, mild acids, solvents, oils and salts.

PVC-Coated Fabrics - a broad class of synthetic thermoplastic polymers that protects against many liquids and chemicals. The degree of protection varies depending upon the specific formulation and the thickness of the coating. Resists salts, alkalies, oils, ketones, aldehydes, alcohols, some acids and organic esters.

Rubber-Coated Fabrics - A very flexible heavy fabric for heavy-duty use in extreme cold or heat. Abrasion and tear resistant and offers general protection against solvents and chemicals.

Neoprene-Coated Fabrics - A very flexible heavy fabric for heavy-duty use in extreme cold or heat. Abrasion and tear resistant and offers general protection against acids, hydrocarbons and oils.

Nitrile-Coated Fabrics - Thin-gauge material resistant to cuts and punctures. Resistant to grease, acids and solvents.

Polyurethane-Coated Fabrics - Light weight and sheds liquids easily. Breath ability depends upon thickness of coating and material additives. Good abrasion resistance. General protection against many liquids.

c) Laboratory Wear

Lab coats or splash aprons are required when using chemicals in a laboratory setting. Lab coats will be of cotton or cotton/polyester blend, have long sleeves and extend to the knee. Standard lab coats are not especially fire resistive nor do they provide protection against chemical splashes. Care should be exercised near open flames or hot surfaces. Splash aprons and over-sleeves made of the appropriate material (see Rainwear/Splash Protection) should be used in laboratory situations where chemical, sample or waste splashing is likely.

d) Limited-Use General Protection Clothing

Economical choice for protection against limited hazards such as lead and asbestos dusts, radionuclides, light chemical splashes and biohazards. When choosing these garments consider:

- Whether the garment will be stand up to the rigors of the work environment.
- The degree of protection offered by the garment against the contaminants (and concentrations) present.
- What are the flexibility and thermal requirements?

e) Available Materials

Tyvek - registered trademark of the E.I. DuPont Company. Tyvek is a spun-bonded olefin fiber, which delivers high tear resistance and a high level of protection against particulate materials. Available in a variety of styles and colors.

Kleenguard - registered trademark of the Kimberly-Clark Corporation. Kleenguard is a non-woven polypropylene fabric, usually layered, which effectively repels most non-hazardous liquids, oils and greases and but allows air to pass through reduce the potential for heat stress. Available in a variety of styles and colors.

f) Limited-Use Chemical Protective Clothing

Chemical Protective Clothing (CPC) is used prevent exposure to chemical contact or splashes. For protection from significant chemical or vapor hazards, choose garments that prevent hazardous liquid breakthrough for at least 240 minutes and prevent hazardous vapor breakthrough for at least 1440 minutes as tested by the ASTM F739 protocol. When choosing these garments consider:

4) HEAD PROTECTION

Head protection shall be worn when working in areas where there is danger of head injury from impacts, falling and flying objects, electrical shock and burns, and contact with hazardous chemicals.

Hard hats shall be worn on all construction sites, in the immediate vicinity of drilling operations, in industrial facilities where there are overhead activities, during confined space entry tasks, and in posted hardhat areas. Hardhat suspensions must always be in place, properly adjusted and free from defects. The hard hat selected shall be compatible with any other type of PPE in use including suits, respirators, face shields, and hearing protection.

a) Available Equipment

Hard Hats - hard hats that comply with ANSI Z89.1-1986, Class A and B, and are SEI certified, provide appropriate head protection from overhead impact and electrical hazards. Bump caps are not acceptable. Employees shall not deface, drill holes, or other wise tamper with hard hats in any way that might compromise their effectiveness.

Chin Straps - employees shall use chin straps when tasks involve strenuous bending, downward movements or in any circumstance, for instance, confined space entry, that may result in the hard hat falling off the employee's head.

- Liners - Hardhat liners can be worn inside the hard hat to provide thermal protection during cold weather.

Hoods - hoods can be worn with hard hats, and are usually attached to a whole-body CPC. Hoods protect the head and neck from hazardous chemicals. Hoods can be used to protect the hair when wearing respirators.

Visitor's Hardhats - project offices and trailers should be equipped with an adequate number of spare hard hats for the use of visitors to the project site.

b) Inspection and Maintenance

Hardhats and suspensions systems will be inspected before each use. Cracking, signs of excessive wear, or frayed webbing is cause for replacement. Contact your Equipment Coordinator for parts or hardhat replacement.

2) EYE AND FACE PROTECTION

Appropriate eye and face protection shall be worn by employee when exposed to hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation.

Employees shall use eye protection that provides side protection when there is a hazard from flying objects.

Employees who wear prescription lenses while engaged in operations involving eye hazards shall wear eye protection that incorporates the prescription in its design, or shall wear eye protection that can be worn over the prescription lenses without disturbing the proper position of the prescription lenses or the protective lenses.

Contact lens shall not be worn in the presence of particulate, chemical, or gaseous eye hazards.

Employees working near sources of injurious light radiation including welding arc, cutting flame, class III and IV lasers, etc., shall use equipment with filter lenses that have a shade number that will protect the eyes from injury.

a) Available Equipment

Safety Glasses with Side Shields - safety glasses with full side shields (prescription to 20/40 vision if required) complying with ANSI Z87.1-1989 shall be worn during drilling operations, and when working near impact tools or equipment. The glasses protect the eyes from large particles

Goggles - goggles complying with ANSI Z87.1-1989 are available in two types: chemical-splash (indirectly vented) and non-vented. Both are available with polycarbonate lenses to protect the eyes from impact injury, chemical splashes, large particles, and projectiles. Non-vented goggles provide additional protection against vapors and gases. Goggles may be worn over prescription eyeglasses.

Face shields - face shields complying with ANSI Z87.1-1989 and at least 8" long protect the face and neck from chemical splashes but do not protect against projectiles. Face shields provide only limited eye protection. Goggles or safety glasses should be worn in conjunction with face shields. Face shields that attach directly to the hard hat are sealed to prevent overhead splashes from running down the inside of the face shield.

Full-face Respirators - because the lens of the full-face respirator is constructed of polycarbonate material meeting the impact resistance standards specified in 30 CFR 11, additional eye and face protection is not required when wearing a full-face respirator.

Optical Inserts - spectacle kits are provided by Malcolm Pirnie to users of full-face respiratory protection who wear corrective eye wear. Each eligible employee may take a spectacle kit to his or her personal eyewear provider to have prescription lens ground and fitted to the kit. The inserts should correct visual acuity to at least 20/40. Reasonable costs, excluding eye exams, are reimbursable as an group Health & Safety expense (Chart of Accounts 7931). The cost of associated eye examinations can be covered by VSP with any balance submitted for reimbursement from your Flexible Spending Account (Medical).

b) Visitor's Safety Glasses
Project offices and trailers should be equipped with an adequate number of spare safety glasses and goggles for the use of visitors to the project site.

3) HEARING PROTECTION

Hearing protection shall be worn by employees who are exposed to noise levels in excess of those defined in OSHA standard 29 CFR 1910.95. See the Section on Hearing Conservation for additional information.

Two basic types of hearing protectors are available: ear plugs and earmuffs. The use of earplugs shall be considered with caution because earplugs can introduce chemical contaminants into the ear. The selection of hearing protectors shall be based on the attenuation requirements of 29 CFR 1910.95, and on the comfort of the wearer. Employees may require hearing protection when working near drilling and heavy equipment operations, high impact tools, or when working in the vicinity of generators, air compressors or other noisy machinery. Earmuffs are not a stock item since they need to be sized to the individual.

4) HAND PROTECTION

Employees shall use appropriate hand protection when exposed to hazards such as those from skin absorption of harmful substances; severe cuts and lacerations; severe abrasions; punctures; chemical burns; thermal burns; and harmful temperature extremes.

A qualified employee shall select gloves designed to provide protection against specific chemicals and physical demands of the site. Use flexibility, resistance to tearing and puncturing, and resistance to specific chemicals as criteria for selection.

If roughened-surface, chemical-resistant gloves are not available wear heavy leather gloves or disposable studded cotton gloves over chemical-resistant gloves to provide better gripping during manual labor.

Combinations or layers of chemical-resistant gloves are used to protect against multiple chemical contaminants. For example, a mixture of acids, caustics, and aromatic hydrocarbons may require the use of outer neoprene gloves for protection against acids and caustics, and inner PVA gloves for protection against the aromatics.

Disposable latex or vinyl (surgical) gloves are a general-purpose disposable inner glove and are routinely discarded after each use. Permeation-resistant outer gloves such as Viton and butyl rubber are selected based on the chemicals involved. Neoprene is a general-purpose outer glove. Cotton liners are used inside chemical-resistant gloves to provide warmth during cold weather, or to absorb sweat during summer.

The qualified employee shall consider the glove's thickness and cuff length. Thick gloves with long cuffs (gauntlet type) provide more protection than thin, short gloves. However, the material should not be so thick that it interferes with the dexterity required by the task.

a) Available Materials

Natural Rubber (Polyisoprene). Resists degradation by alcohols and caustics. Not recommended for organics.

Butyl Rubber (Synthetic Rubber). Resists degradation by many contaminants including ketones and esters. Especially resistant to permeation by gases and water vapors. Not recommended for halogenated hydrocarbons and petroleum compounds.

Polyvinyl Alcohol (PVA). Resists degradation and permeation by aromatic and chlorinated hydrocarbons and petroleum compounds. Not recommended for water-based solutions, acids, bases, ethers and esters.

Neoprene (Chloroprene). Resists degradation by caustics acids, alcohols, and oils. Not recommended for halogenated and aromatic hydrocarbons, PCBs and ketones.

Nitrile (Acrylonitrile Polymers / Butadiene). Resists degradation by petroleum compounds, gasoline, alcohols, acids, caustics, and peroxides. Not recommended for aromatic or halogenated hydrocarbons, amines, ketones, and esters. Can be used for some chlorinated compounds.

Viton. Resists degradation and permeation by aromatic and chlorinated hydrocarbons and petroleum compounds, oxidizers, acids, and water-based solutions. Not recommended for aldehydes, esters, ketones, amines, and acetone.

Latex Surgical Vinyl (disposable). Poor chemical resistance. Not recommended as an outer glove. This type of glove rips and tears easily. Remember to remove large rings or rings with protrusions or sharp points to prevent tearing. Use only when dexterity and flexibility are needed in non-hazardous chemical situations.

Silver Shield. Resists degradation and permeation by aromatic and chlorinated hydrocarbons and petroleum compounds, oxidizers, acids, and most water-based solutions. Not recommended for amides.

5) FOOT PROTECTION

Footwear worn at field sites shall comply with the ANSI Z41-1991 and shall be chemically resistant. Proper footwear protects the foot from crushing, puncture, electrical, and chemical hazards.

a) Available Materials

Leather safety boots with steel toe and shank - resists punctures and crushing. Employees are responsible for purchasing their own boots and this expense may be reimbursed up to $120.00 per year with their manager's approval. These boots are generally not chemical or water-resistant without the use of disposable latex/butyl/"Tyvek" boot covers or neoprene overboots.

Overboots - made of PVC, latex, butyl, natural rubber, polyethylene, neoprene or vinyl provide protection from a wide range of chemicals. Some overboots have an integrated steel toe and puncture resistant insert.

Waders - waders are one-piece waterproof garments with boots and coveralls that protect the lower body (up to the hip/chest) from water immersion. Employees sampling water from ponds, streams or sewers at locations that are no more than waist deep are to wear waders.

Hip boots - are useful for water sampling or sewer inspections when the water level is below the thighs. Hip boots are less expensive and provide more mobility than chest-high waders.

6) ANCILLARY PPE

Ancillary PPE is used for protection against specific health and safety hazards.

a) Available Equipment

Belts, Harnesses, Lanyards and Lifelines - body harnesses, lanyards, and lifelines are used to prevent falls from elevated areas or into water, and to make possible the emergency retrieval of employees who have entered confined spaces. Fall protection belts are no longer allowable. Employees working on or moving across unguarded platforms or catwalks at elevations **greater than 6 feet** are required to tie off to some type of effective fall protection.

Safety belts used at sites shall comply with 29 CFR 1926.104 and also shall be constructed of spark-free hardware and chemical- resistant materials. Lifelines and fall protection devices must use double-action snap hooks. Safety restraints are selected on the basis of applicability to the task(s) for which they will be used.

Cooling Vests - cooling vests are used to remove excess heat generated by worker activity, protective clothing, or extremely hot environments. The most commonly used units resemble vests with cold pack pockets, and are used when personnel are wearing level B or C protection in warm weather, usually above 80°F. To use the vests, ice-making equipment and cold pack storage must be available on-site. The availability of this equipment must be addressed in planning for the work.

Other cooling devices use forced air or circulation of a refrigerant through caps and vests. Maintenance problems and the increased weight (up to 25 pounds) borne by workers shall be evaluated when selecting these units.

Floatation Gear - floatation gear such as life jackets, work vests and cold water survival suites that meet United States Coast Guard (USGS) standards (46 CFR Part 160) shall be worn when working in or on surface waters e.g., ponds, lagoons, and streams, at chest high depths (four feet) or greater. Floatation gear is commonly worn over protective clothing. Floatation vests add bulk to the wearer and may restrict mobility. Floatation vests may be difficult to decontaminate.

Reflectorized Vests - reflectorized vests are to be worn be all employees when working near vehicular traffic and in situations where visibility is essential.

Tool Pouches and Belts - equipment pouches and belts may be worn by site personnel who use portable equipment and tools during field activities. Pouches and belts are worn around the waist, outside of the protective clothing.

Infection Control Kits - an infection control kit (ICK KIT) shall be available in each office, field office, field trailer, and field vehicle for use in the event of an injury resulting in contact with blood or other bodily fluids.

Protective Leggings - leggings are worn to protect against snakebites or other hazards to the lower extremities.

7) REFERENCES

- *EPA. Guidelines for the Selection of Chemical Protective Clothing. -1987.*

- *Forsberg, K. and S.Z. Mansdorf. Quick Selection Guide to Chemical Protective Clothing. Van Nostrum Reinhold, New York, 1989.*

APPENDIX C

PPE ENSEMBLES FOR HAZARDOUS WASTE OPERATIONS

Levels of Protection for Levels A - D

1) ENSEMBLES FOR HAZARDOUS WASTE OPERATIONS

Various types of personal protective clothing, respirators, and ancillary protective equipment are combined into ensembles that provide a sufficient level of protection from site-specific hazards. Using excessive levels of PPE is discouraged.

Four distinct levels -- A, B, C, and D -- have been defined by EPA, each providing protection against varying degrees of respiratory, dermal, and safety hazards. A specific level of protection shall be selected based on:

- The type, concentration, and toxicity of airborne contaminants.
- The potential for personal exposures, liquid splashes, or direct contact with hazardous materials in relation to site tasks /activities.

The main factor in selecting a level of protection is the magnitude of the respiratory and dermal hazards present or potentially present on- site. Levels A and B specify the same respiratory protection (self- contained or air-line breathing apparatus), but Level A includes specific dermal protection (fully encapsulating suit). Levels B and C generally specify the same dermal protection (chemical-resistant coveralls or partially encapsulating suit) but Level B includes a higher degree of respiratory protection. Level D, essentially an ordinary work uniform ensemble, is used only when there is minimal potential for exposure to hazardous materials or waste on-site.

Each standard level of protection may be modified in the Site Safety Plan (SSP) to account for varying degrees of respiratory and dermal hazard. For instance, a Level C ensemble may be modified for a task involving surface soil sampling for a semi-volatile compound in wet conditions by making the use of the respirator contingent upon air monitoring results but mandating full body protective clothing for dermal exposure control.

The SSP specifies the level of protection required for various site tasks and work zones. Upgrades or downgrades of protective levels are based on the action levels specified in the air-monitoring procedures of the SSP. An increase or decrease in the potential for exposure to hazardous materials necessitating a level of protection not specified in the SSP requires a written amendment to the SSP approved by the Project Safety Officer (PSO), the SBU Health and Safety Leader, and/or the Manager, Health and Safety, COR.

The four levels of protection that may be used by Malcolm Pirnie personnel are described below. Selection criteria are presented for general guidance only: protection shall be tailored to the site-specific contaminants and conditions.

a) Level A Protection

Level A shall be selected when the highest level of respiratory, skin, and eye protection is required due to the presence in the air of high concentrations of hazardous materials, or the presence of contaminants highly toxic to the skin. Level A is also used when the hazards are unknown, inadequately defined, or when Level B protection is not adequate. Level A protection is extremely cumbersome and may be life- threatening due to heat stress. Level A is generally appropriate in emergency response and rescue circumstances not normally performed by Malcolm Pirnie personnel. For example, workers would use Level A protection when entering a confined area to repair a leaking chlorine gas valve.

Selection Criteria - Use Level A when:

- Hazardous materials have been identified on-site that require the highest level of respiratory, skin, and eye protection based on measured (or potentially) high concentrations of hazardous vapors, gases, or particulate atmospheres that are greater than levels determined to be "immediately dangerous to life or health" (IDLH).
- Site operations or tasks present a high potential for splashing of, contact with, or airborne exposure to substances highly toxic by skin absorption.
- Site operations or tasks to be conducted in confined or poorly ventilated areas where there is potential for encountering highly toxic substances.

Personal Protective Equipment at Level A consists of:

- Pressure-demand, full-face, self-contained breathing apparatus (SCBA) or a pressure-demand, supplied-air respirator / SCBA combination i.e., a dual-purpose breathing apparatus (DPBA).
- Fully encapsulating suit with intrinsic gloves, booties, and polycarbonate lens.
- Inner chemical-resistant gloves (latex or vinyl surgical type).
- Overboots of appropriate chemical - resistant materials with steel toe and shank. (The boots are worn over the intrinsic booties of the rubber suit, and the boots themselves may be covered by disposable booties.)

Additional Equipment that may be required for a Level A entry:

- Cooling vest/jacket
- Disposable chemical-resistant booties (latex/butyl)
- Coveralls
- Cotton long underwear
- Hard hat
- Hearing Protection
- Two-way radio communications (rated intrinsically safe)

b) Level B Protection

Level B shall be selected when the highest level of respiratory protection is required but a degree of dermal protection lower than that afforded by Level A is acceptable. The specific type of dermal protection may vary from site to site. A good quality, chemical-resistant, one-piece garment with taped wrists, ankles, and hood often provides adequate dermal protection for splash or contact hazards on-site.

Level B is generally used in situations where respiratory hazards are difficult to evaluate. Level B protection is cumbersome and may cause heat stress. Level B protection shall be the minimum used during initial response or reconnaissance except when the respiratory hazard has been evaluated and it is determined that a lower level of respiratory protection is acceptable.

Selection Criteria: Use Level B when:

- The type and concentration of airborne contaminants have been identified as those requiring a high level of respiratory protection, but a lower level of skin protection, for example, when specific airborne substances, present in IDLH concentrations, do not present a severe skin contact/absorption hazard. Also when atmospheres do not meet the criteria that would permit use of air-purifying respirators.
- Atmospheres contain less than 19.5 percent oxygen.
- Site activities generate high concentrations of substances highly toxic by skin absorption but skin contact with toxic substances is not likely.
- When the air contaminants of concern do not have adequate warning properties of breakthrough or there are no approved filter cartridges for Level C respiratory protection.
- When significant time will be spent in areas with contaminant concentrations at or above occupational exposure limits.

Personal Protective Equipment at Level B consists of:

- Pressure-demand, full-face SCBA or DPBA.
- Chemical-resistant clothing, including disposable "Tyvek" coveralls, with or without various coatings. Also, butyl rubber aprons, or neoprene, acid-resistant, full body coveralls.
- Inner chemical-resistant gloves (latex or vinyl surgical type.)
- Outer chemical-resistant gloves (butyl, neoprene, Viton, or other appropriate material.)
- Neoprene rubber boots with steel toe and shank.
- Emergency escape bottle with 5 - 15-minute air supply.

Additional Equipment that may be required for a Level B entry:

- Cotton coveralls worn beneath CPC.
- Cotton long underwear.
- Disposable chemical-resistant booties (latex/butyl).
- Hard hat

- Hearing protection
- Two-way radio communications
- Cooling vest/jacket.

c) Level C Protection

Level C protection is composed of dermal protection and an air- purifying respirator (APR). Level C shall be used only when the types and concentrations of airborne substances are known, when the criteria for using APRs are met, and when skin exposure is unlikely.

Use of this level is limited by the restrictions placed on the use of APRs in 29 CFR 1910.134 and ANSI Z88.2-1992. Air contaminants shall be measured and compared to action levels specified in the SSP. Level C may be sufficiently cumbersome to cause heat stress.

Selection Criteria: Use Level C when:

- The type and concentration of airborne contaminants are known, an approved respirator cartridge/canister is available that will remove the contaminants, and the following criteria for use of APRs are met:
- Oxygen content is equal to or greater than 19.5 percent.
- Concentrations do not exceed the NIOSH-approved use levels for the respirator and cartridge/canister.
- Contaminants have obvious warning properties (e.g., contaminant can be detected by odor, taste, or irritation at concentrations below its exposure limit).
- Atmospheres are not IDLH.
- Airborne contaminants are known and will be monitored throughout site activities.

Site activities will not generate high airborne concentrations or liquid splashes or other means of contact with substances highly toxic to the skin.

Personal Protective Equipment at Level C consists of:

- Full-face APR or full-face powered APR with cart ridge/canister appropriate for the airborne contaminant present.
- Chemical-resistant clothing (same alternatives as for Level B, determined by site).
- Inner chemical-resistant gloves (latex or vinyl surgical type).
- Outer chemical-resistant gloves (butyl, neoprene, Viton, or other appropriate material).
- Work boot with neoprene rubber sole, and steel toe and shank.

Additional Equipment that may be required for a Level C entry:

- Coveralls.
- Disposable chemical-resistant latex or butyl booties.
- Cotton long underwear.
- Hardhat.
- Hearing protection.
- Two-way radio communications.

d) Level D Protection

A work uniform providing minimal protection constitutes Level D protection. Level D shall not be used in a hazardous atmosphere or environment. Level D will be used only when there is no indication of a hazardous atmosphere, and the work tasks preclude splashes, immersion, or other bodily contact with hazardous substances.

In situations where the possibility of a hazardous atmosphere exists, Level D is permissible when prescribed by the SSP as long as monitoring indicates the continued absence of a hazardous atmosphere. When hazardous atmospheres are detected, workers in Level D shall upgrade their protection in accordance with instructions in the SSP.

Selection Criteria: Use Level D on:

- Sites where the SSP writer and reviewer have made a reasonable determination that exposure to hazardous materials is unlikely.
- Sites where there is limited potential for exposure to hazardous materials, but procedures for monitoring onsite air and upgrading the protection level or evacuating the site have been established, and are being followed.

Personal Protective Equipment at Level D consists of:

- Coveralls (cotton or "Tyvek").
- Work boots with steel toe and shank.
- Safety glasses with side shields.

Additional Equipment that may be required for a Level D entry:

- Inner and outer gloves.
- Hardhat.
- Hearing protection.
- Emergency escape respirator (readily available onsite.)
- Air-purifying respirator (readily available onsite.)
- Aprons, boot covers.

APPENDIX D

AIRBORNE CONTAMINANT ACTION LEVELS FOR SELECTION OF PPE ENSEMBLES

Appendix D Airborne Contaminant Action Levels for Selection of PPE Ensembles

Action Levels

Uncharacterized Airborne Vapors or Gases		Characterized Gases, Vapors, Particulates**
Level D	Background*	Up to 50% of PEL, REL or TLV
Level C	Up to 5 ppm above background	Up to 25 times PEL, REL or TLV
Level B	5 ppm to 500 ppm above background	UP to 500 times PEL, REL or TLV
Level A	500 ppm to 1000 ppm above background	Up to 1000 times PEL, REL or TLV
	* Off-site "clean" air measurement.	** Use mixture calculations (% allowed = $\Sigma C_n\ PEL_n$) if more than one contaminant is present

Oxygen Deficiency

Concentration	Action Taken
< 19.5% O_2	Leave area. Reenter only with supplied-air respirators.
19.5% to 23.5% O_2	Work may continue. Investigate changes from 21%.
> 23.5% O_2	Work must stop. Ventilate area before returning.

Flammability

Concentration	Action Taken
< 10% of LEL	Work may continue. Consider toxicity potential.
> 10% LEL	Work must stop. Ventilate area before returning.

Radiation

Intensity	Action Taken
< 0.5 mR/hr	Work may continue.
< 1 mR/hr	Work may continue. Continue to Monitor. Notify Corporate Health and Safety and Corporate Health Physicist.
5 mR/hr	Radiation work zone. Work must stop.

APPENDIX E

MINIMUM AND MAXIMUM DECONTAMINATION STATIONS AND EQUIPMENT FOR PPE ENSEMBLE LEVELS B AND C

E-1 *MAXIMUM* DECONTAMINATION PROCEDURES FOR *LEVEL B*

Equipment Worn

This decontamination procedure outlined is the **maximum** number of decontamination stations necessary for Malcolm Pirnie workers wearing the following protective clothing and equipment:

- one-piece, hooded chemical-resistant splash suit
- SCBA
- hard hat
- chemical-resistant boots with steel toe and shank
- boot covers
- inner and outer gloves
- taped joints between gloves, boots, and suit

DECONTAMINATION PROCEDURES

Station 1: Segregated Equipment Dump

Deposit equipment used on the site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Each piece of equipment may be contaminated to a different degree; therefore, segregation at the drop reduces the potential for contamination. Equipment needed:

- containers of various sizes
- plastic liners
- plastic drop cloths

Station 2: Suit, Boot Covers, and Glove Wash

Thoroughly wash and scrub fully encapsulating suit, outer boot covers, and gloves with a decontamination solution or detergent-waste solution. Equipment needed:

- container (20 to 30 gallon)
- decontamination solution
- detergent-water solution
- two or three long-handled, soft-bristled scrub brushes

Station 3: Suit, Boot Covers, and Glove Rinse

Rinse off the decontamination solution from Station 2 using copious amounts of water. Repeat as many times as necessary. Equipment needed:

- container (30 to 50 gallon)
- high-pressure spray unit and splash guard
- water
- two or three long-handled, soft-bristled scrub brushes

Station 4: Tape Removal

Remove tape around boots and gloves and deposit it in a container with a plastic liner. Equipment needed:

- container (20 to 30 gallon)
- plastic liners

Station 5: Boot Cover Removal

Remove boot covers and deposit them in a container with a plastic liner. Equipment needed:

- container (30 to 40 gallon)
- plastic liners
- bench or stool

Station 6: Outer Glove

Remove outer gloves and deposit them in a container with a plastic liner. Equipment needed:

- container (20 to 30 gallon)
- plastic liners

Station 7: Suit, SCBA, Boot, and Glove Wash

If design does not include *Station 2*, wash suit at this station. Thoroughly wash suit, SCBA, boots, and gloves with a long-handled, soft-bristled scrub brush and copious amounts of decontamination solution or detergent-water solution. Wrap SCBA regulator (if belt-mounted type) with plastic to keep out water. Wash backpack assembly with sponges or cloth. Equipment needed:

- container (30 to 50 gallon)
- decontamination solution
- detergent-water solution
- two or three long-handled bristled scrub brushes
- small buckets
- sponges or cloths

Station 8: Suit, SCBA, Boot, and Glove Rinse

If design does not include *Station 3*, rinse suit at this station. Rinse off the decontamination solution or detergent-water solution using copious amounts of water. Repeat as many times as necessary. Equipment needed:

- container (30 to 50 gallon)
- high-pressure spray unit and splash guard
- water
- small buckets
- two or three long-handled, soft-bristled scrub brushes
- sponges or cloths

Station 9: Tank Change
If a worker leaves the exclusion zone to change their air tank, this is the last step in the decontamination procedure. They exchange the tank, don new outer gloves and boots, and have the joints taped. They then return to duty. Equipment needed:

- air tanks
- tape
- boot covers
- gloves

Station 10: Chemical-resistant Boot Removal
Remove chemical-resistant boots and deposit them in a container with a plastic liner. Equipment needed:

- container (30 to 50 gallon)
- plastic liners
- bench or stool
- bootjack

Station 11: SCBA Backpack Removal
While still wearing face piece, remove backpack and place it on a table. Disconnect hose from regulator valve and proceed to next station. Equipment needed:

- table

Station 12: Splash Suit Removal
With assistance, remove splash suit. Deposit it in a container with a plastic liner. Equipment needed:

- container (30 to 50 gallon)
- plastic liners
- bench or stool

Station 13: Inner Glove Wash
Wash with decontamination solution or detergent-water solution that will not harm skin. Repeat as many times as necessary. Equipment needed:

- basin or bucket
- decontamination solution
- detergent-water solution
- small table

Station 14: Inner Glove Rinse
Rinse with water. Repeat as many times as necessary. Equipment needed:

- water
- basin or bucket
- small table

Station 15: Face Piece Removal
Remove face piece. Deposit it in a container with a plastic liner. Avoid touching face with fingers. Equipment needed:

- container (30 to 50 gallon)
- plastic liners

Station 16: Inner Glove Removal
Remove inner gloves and deposit them in a container with a plastic liner. Equipment needed:

- container (20 to 30 gallon)
- plastic liners

Station 17: Inner Clothing Removal
Remove inner clothing. Place it in a container with a plastic liner. Do not wear inner clothing off the site, since small amounts of contaminants may have been transferred in removing fully encapsulating suit. Equipment needed:

- container (30 to 50 gallon)
- plastic liners

Station 18: Field Wash
Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available. Equipment needed:

- water
- soap
- small table
- basin or bucket
- field showers
- towels

Station 19: Redress
Put on clean clothes. A dressing trailer is needed in inclement weather. Equipment needed:

- table
- chairs
- lockers
- clothes

E-2 *MINIMUM* DECONTAMINATION PROCEDURES FOR *LEVEL B*

Equipment Worn

This decontamination procedure outlined is the **minimum** number of decontamination stations necessary for Malcolm Pirnie workers wearing the following protective clothing and equipment:

- one-piece, hooded chemical-resistant splash suit
- SCBA
- hard hat
- chemical-resistant boots with steel toe and shank
- boot covers
- inner and outer gloves
- taped joints between gloves, boots, and suit

DECONTAMINATION PROCEDURES

Station 1: Segregated Equipment Dump

Deposit equipment used on the site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability for cross-contamination. During hot weather operations, cool-down station may be set up within this area. Equipment needed:

- containers of various sizes
- plastic liners
- plastic drop cloths

Station 2: Suit, Boot Covers, and Glove Wash and Rinse

Thoroughly wash and scrub chemical-resistant splash suit, outer boots, and gloves with a decontamination solution or detergent-waste solution. Rinse off using copious amounts of water. Equipment needed:

- containers (20 to 30 gallon)
- decontamination solution
- detergent-water solution
- rinse water
- high-pressure spray unit and splash guard
- two or three long-handled, soft-bristled scrub brushes

Station 3: Outer Boot and Glove Removal

Remove outer boots and gloves and deposit them in a container with a plastic liner. Equipment needed:

- container (30 to 40 gallon)
- plastic liners
- bench or stool
- water
- two or three long-handled, soft-bristled scrub brushes

Station 4: Tank Change

If a worker leaves the exclusion zone to change their air tank, this is the last step in the decontamination procedure. They exchange the tank, don new outer gloves and boots, and have the joints taped. They then return to duty. Equipment needed:

- air tanks
- tape
- boot covers
- gloves

Station 5: Outer Garment Removal

Chemical-resistant splash suit, if worn outside the SCBA, is removed and deposited in separate containers with plastic liners. If the suit is worn underneath the SCBA, see station 5A. Equipment needed:

- containers (20 to 30 gallon)
- plastic liners

Station 5A: Suit Removal When Worn Underneath the SCBA

If the chemical-resistant splash suit is worn beneath the SCBA, remove SCBA backpack, but not the face piece, and hand to a buddy or lay down on plastic sheeting and remove suit. Equipment needed:

- plastic sheeting

Station 6: SCBA Removal and Decontamination

Wrap SCBA regulator (if belt-mounted type) with plastic to keep out water. Wash backpack assembly with sponges or cloth. Remove face piece while avoiding facial contact by fingers. SCBA is deposited on a clean plastic sheet. Equipment needed:

- water
- small buckets
- sponges or cloths
- plastic sheeting
- two or three long-handled, soft-bristled scrub brushes

Station 7: Inner Glove Removal

Remove inner gloves and deposit them in a container with a plastic liner. Equipment needed:

- container (20 to 30 gallon)
- plastic liners

Station 8: Field Wash

Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available. Equipment needed:

- water
- soap
- small table
- basin or bucket
- field showers
- towels

E-3 *MAXIMUM* DECONTAMINATION PROCEDURES FOR *LEVEL C*

Equipment Worn

This decontamination procedure outlined is the **maximum** number of decontamination stations necessary for Malcolm Pirnie workers wearing the following protective clothing and equipment:

- one-piece coverall
- full-face respirator
- hard hat
- safety boots with steel toe and shank
- boot covers
- inner and outer gloves
- taped joints between gloves, boots, and suit

DECONTAMINATION PROCEDURES

Station 1: Segregated Equipment Dump

Deposit equipment used on the site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Each piece of equipment may be contaminated to a different degree; therefore, segregation at the drop reduces the potential for contamination. Equipment needed:

- containers of various sizes
- plastic liners
- plastic drop cloths

Station 2: Boot Covers, and Glove Wash

Thoroughly wash and scrub outer boot covers, and gloves with a decontamination solution or detergent-waste solution. Equipment needed:

- container (20 to 30 gallon)
- decontamination solution
- detergent-water solution
- two or three long-handled, soft-bristled scrub brushes

Station 3: Boot Covers, and Glove Rinse

Rinse off the decontamination solution from Station 2 using copious amounts of water. Repeat as many times as necessary. Equipment needed:

- container (30 to 50 gallon)
- high-pressure spray unit and splash guard
- water
- two or three long-handled, soft-bristled scrub brushes

Station 4: Tape Removal
Remove tape around boots and gloves and deposit it in a container with a plastic liner. Equipment needed:

- container (20 to 30 gallon)
- plastic liners

Station 5: Boot Cover Removal
Remove boot covers and deposit them in a container with a plastic liner. Equipment needed:

- container (30 to 40 gallon)
- plastic liners
- bench or stool

Station 6: Outer Glove Removal Remove outer gloves and deposit them in a container with a plastic liner. Equipment needed:

- container (20 to 30 gallon)
- plastic liners

Station 7: Canister or Mask Change
If a worker leaves the exclusion zone to change their canister (or mask), this is the last step in the decontamination procedure. The worker's canister is exchanged, new outer gloves and boot covers are donned, joints are taped, and the worker returns to duty. Equipment needed:

- respirator canisters appropriate to the field hazard
- extra respirators
- tape
- boot covers
- gloves

Station 8: Outer Garment Removal
One-piece coverall is removed and deposited in containers with plastic liners. Equipment needed:

- containers (20 to 30 gallon)
- plastic liners

Station 9: Inner Glove Wash
Wash with decontamination solution or detergent-water solution that will not harm skin. Repeat as many times as necessary. Equipment needed:

- basin or bucket
- decontamination solution
- detergent-water solution
- small table

Station 10: Inner Glove Rinse

Rinse with water. Repeat as many times as necessary. Equipment needed:

- water
- basin or bucket
- small table

Station 11: Face Piece Removal and Decontamination

Remove face piece while avoiding facial contact by fingers. Face-piece is deposited on a clean plastic sheet. Canisters are removed and deposited in containers with plastic liners. Respirators are scrubbed with soap and water and rinsed with copious amounts of clean water. Equipment needed:

- water
- soap
- small buckets
- small brushes
- sponges or cloths
- plastic sheeting

Station 12: Inner Glove Removal

Remove inner gloves and deposit them in a container with a plastic liner. Equipment needed:

- container (20 to 30 gallon)
- plastic liners

Station 13: Inner Clothing Removal

Remove inner clothing. Place it in a container with a plastic liner. Do not wear inner clothing off the site, since small amounts of contaminants may have been transferred in removing outer suit. Equipment needed:

- container (30 to 50 gallon)
- plastic liners

Station 14: Field Wash

Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available. Equipment needed:

- water
- soap
- small table
- basin or bucket
- field showers
- towel

Station 15: Redress

Put on clean clothes. A dressing trailer is needed in inclement weather. Equipment needed:

- table
- chairs
- lockers
- clothes

E-4 *MINIMUM* DECONTAMINATION PROCEDURES FOR *LEVEL C*

Equipment Worn

This decontamination procedure outlined is the **minimum** number of decontamination stations necessary for Malcolm Pirnie workers wearing the following protective clothing and equipment:

- one-piece coverall
- full-face respirator
- hard hat
- safety boots with steel toe and shank
- boot covers
- inner and outer gloves
- taped joints between gloves, boots, and suit

Station 1: Segregated Equipment Dump

Deposit equipment used on the site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability for cross-contamination. During hot weather operations, cool-down station may be set up within this area. Equipment needed:

- containers of various sizes
- plastic liners
- plastic drop cloths

Station 2: Boot Covers, and Glove Wash and Rinse

Thoroughly wash and scrub outer boots, and gloves with a decontamination solution or detergent-waste solution. Rinse off using copious amounts of water. Equipment needed:

- containers (20 to 30 gallon)
- decontamination solution
- detergent-water solution
- rinse water
- high-pressure spray unit and splash guard
- two or three long-handled, soft-bristled scrub brushes

Station 3: Outer Boot and Glove Removal

Remove outer boots and gloves and deposit them in a container with a plastic liner. Equipment needed:

- container (30 to 40 gallon)
- plastic liners
- bench or stool
- water
- two or three long-handled, soft-bristled scrub brushes

Station 4: Canister or Mask Change

If a worker leaves the exclusion zone to change their canister (or mask), this is the last step in the decontamination procedure. The worker's canister is exchanged, new outer gloves and boot covers are donned, joints are taped, and the worker returns to duty. Equipment needed:

- respirator canisters appropriate to the field hazard
- extra respirators
- tape
- boot covers
- gloves

Station 5: Outer Garment Removal

One-piece coverall is removed and deposited in containers with plastic liners. Equipment needed:

- containers (20 to 30 gallon)
- plastic liners

Station 6: Face Piece Removal and Decontamination

Remove face piece while avoiding facial contact by fingers. Face-piece is deposited on a clean plastic sheet. Canisters are removed and deposited in containers with plastic liners. Respirators are scrubbed with soap and water and rinsed with copious amounts of clean water. Equipment needed:

- water
- soap
- small buckets
- small brushes
- sponges or cloths
- plastic sheeting

Station 7: Inner Glove Removal

Remove inner gloves and deposit them in a container with a plastic liner. Equipment needed:

- container (20 to 30 gallon)
- plastic liners

Station 8: Field Wash

Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available. Equipment needed:

- water
- soap
- small table
- basin or bucket
- field showers
- towels

New York State Department of Environmental Conservation
Remedial Investigation/Feasibility Study Work Plan

Appendix C: Community Health and Safety Plan and Community Air Monitoring Plan

MALCOLM PIRNIE

New York State Department of Environmental Conservation
Remedial Investigation/Feasibility Study Work Plan

Appendix D:
Generic Quality Assurance Project Plan for Work Assignments

MALCOLM PIRNIE

New York State Department of Environmental Conservation
625 Broadway • Albany, New York 12233-7011

Standby Contract for Remedial Investigation and Design (D004439) and Remedial Design and Construction (D004443)

Generic Quality Assurance Project Plan for Work Assignments

June 2007

Plan Prepared By:

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Contents

Appendices

ACRONYMS AND ABBREVIATIONS

ASP	Analytical Services Protocol
CRQLs	Contract Required Quantitation Limits
DCA	Dichloroethane
DCE	Dichloroethene
FSP	Field Sampling Plan
GW	Groundwater
gpm	gallons per minute
HASP	Site Specific Health and Safety Plan
IDL	Instrument Detection Limit
MDL	Minimum Detection Limit
MPI	Malcolm Pirnie, Inc.
MS	Matrix spikes
MSD	Matrix spike duplicate
NBS	National Bureau of Standards
NYSDEC	New York State Department of Environmental Conservation
OSWER	Office of Solid Waste and Emergency Response
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
PCE	Perchloroethene (Tetrachloroethene)
RCRA	Resource Conservation and Recovery Act
PID	Photoionization Detector
PPE	Personal protective equipment
RFI	RCRA Facility Investigation
RPD	Relative percent difference
SOPs	Standard Operating Procedures
SVOCs	Semi-volatile organic compounds
SWMU	Solid Waste Management Unit
TAGM	Technical and Administrative Guidance Memorandum
TCA	Trichloroethane
TCE	Trichloroethene
VC	Vinyl chloride
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
EPA	United States Environmental Protection Agency

1. Purpose and Objectives

1.1. Purpose

This Generic Quality Assurance Project Plan (QAPP) has been prepared as a generic appendix to site-specific work plans developed for Work Assignments issued under the New York State Department of Environmental Conservation (NYSDEC) Standby Contracts D004439 and D004443 for remedial investigation/ design, and design/ construction, respectively. 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 work assignments.

This Generic QAPP is provided as a supplement to the site-specific Project Management Work Plan (PMWP) and Field Sampling Plan (FSP) for each Work Assignment under the NYSDEC Standby Contract. Any deviations from, or additions to, the procedures and protocols provided in this generic QAPP are detailed in a Supplemental QAPP, which is provided as Appendix A to this Generic QAPP.

1.2. QAPP Objectives

The objective of this Quality Assurance Project Plan (QAPP) is to ensure that data collected during Work Assignments investigations are of suitable quality and quantity to meet the investigation objectives. To meet this objective, the following topics are presented and discussed in this QAPP:

- Project organization and responsibilities
- Data quality objectives
- Field measurement collection procedures
- Sample collection procedures and sample integrity
- Analytical method requirements
- Data validation requirements

This QAPP has been prepared to address field sample collection procedures, laboratory analysis of samples, and data evaluation of the laboratory sample results. In addition, this QAPP addresses components that influence these processes and provides a detailed plan to ensure that decisions being made from the analytical data are valid, accurate, and defensible in support of subsequent recommendations.

2. Project Organization and Responsibilities

2.1. Project Organization

Malcolm Pirnie will provide oversight, coordination, health and safety, field support, and evaluation of analytical data. Malcolm Pirnie will also be responsible for evaluation of analytical test results, which will be submitted to NYSDEC. Malcolm Pirnie staff members involved in the overall management of the Standby Contract and associated Work Assignments will be identified in the site-specific work plans developed for each site.

2.2. Analytical Laboratories

Analytical laboratories subcontracted with Malcolm Pirnie will perform analysis of samples collected during the work assignments. The laboratories under subcontract were selected in accordance with the provisions of the NYSDEC *Draft Handbook for Standby Consultant Contracts* (NYSDEC, 2005). All laboratories subcontracted by Malcolm Pirnie under the NYSDEC Standby Contract are approved under applicable United States Environmental Protection Agency (USEPA) and New York State Department of Health (NYSDOH) protocols. These laboratories will maintain their certification 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 Malcolm Pirnie. In addition, Malcolm Pirnie will contract a 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) provided by the data validation service (Section 7.2.2).

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 Work Assignments may include both field measurements and analytical samples. This Section will discuss the various types of data anticipated and provides QA/QC objectives for data collected during the Work Assignments.

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 ensure 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 each specific site, 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 each planned data collection task, which identifies the particular sampling protocols, analysis methods, and laboratory deliverables to be provided for each data type anticipated.

3.1.1. DQOs for Air and Soil Vapor

The objective of the soil vapor intrusion study is to evaluate the nature and extent of contamination at concentrations exceeding the NYSDOH CEH BEEI guidance levels in ambient and indoor air and sub-slab soil vapor. 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 ASP Category B deliverables 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. Air and soil vapor sample analyses are summarized in the FSP. All 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 contamination at concentrations exceeding the 6 NYCRR Subpart 375-6 Remedial

Program cleanup objectives in surface and subsurface soil. To be useful in meeting this objective, the data from the soil samples must be of known quality. To support the DQOs for soil, USEPA SW-846 analytical methodologies with NYSDEC ASP Category B deliverables have been chosen for soil analyses. These procedures and deliverables are capable of producing high quality data characterized by rigorous QA/QC protocols and documentation. Soil sample analyses are summarized in the FSP. All soil 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 ensure the collection of 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 any groundwater contamination, to aid in evaluating contaminant source locations, and to assess if any SCGs have been exceeded. In order to meet these objectives, the data from the groundwater samples must be of known quality. Therefore, USEPA SW-846 analytical methodologies with NYSDEC ASP Category B deliverables have been chosen for all 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. Groundwater sample analyses are summarized in the FSP. All 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 ensure the collection of a representative sample. Analytical data will be used to evaluate the presence of contamination and to assess if any SCGs have been exceeded. In order to meet these objectives, the data from the surface water samples must be of known quality. Therefore, USEPA SW-846 analytical methodologies with NYSDEC ASP Category B deliverables have been chosen for all 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. Surface water sample analyses are summarized in the FSP. 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 Objective

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 test kits. To ensure the accuracy and quality of the data provided by field measurements, this QAPP provides DQOs for taking field measurements during site investigations, including the following:

- Water Quality Parameters
- Field Screening of Soil Samples
- Field Test Kits
- Data Collection Using GPS and Data Point Surveys
- Membrane Interface Probe (MIP) and Soil Conductivity Sampling
- Radiological Screening

The DOQs developed for each method will ensure that the data is appropriate and reliable for the extent they will be used in the investigation. A summary of field measurement methods, documentation, and QA/QC protocols is provided in Section 4. Specific field measurements anticipated for each data collection task are detailed in the FSP included with the PMWP.

3.3. Laboratory Quality Assurance Objectives

Laboratory generated data are used to accurately identify and quantify hazardous substances, while the field generated data are 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 investigation. In general, laboratory QC programs are more rigorous than field QC programs.

The scope and description of QC samples and QC methods are well 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, and surrogates, and are contained in the methodologies.

Laboratory QC data will be reviewed by Malcolm Pirnie 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 due 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 ensure 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 ensure data quality.

4. Field Investigation Procedures

4.1. Field Quality Control Samples

Quality control procedures will be employed to ensure that sampling, transportation and laboratory activities do not bias sample analytical quality. Trip blanks, field blanks, duplicate samples, matrix spike samples and matrix spike duplicates will provide a quantitative basis for validating the analytical data. A summary of the anticipated QA/QC samples for each media is included in the FSP.

4.1.1. Trip Blanks

The 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 accompany the day's sample containers at all times. One trip blank will be returned to the laboratory with each 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.

4.1.2. Field Blanks

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. One field blank will be collected per every 20 environmental samples sent to the analytical laboratory, per media.

4.1.3. 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 each 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:

- Each Case for field samples, or
- Each 20 field samples within a Case, or
- Each 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 any extra volume of sample be submitted to the laboratory for MS/MSD samples.

4.1.4. Field Duplicates

For each sample matrix, 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 4.12. 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.

4.2. Field Measurements

Tasks requiring taking 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 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 5.

4.2.1. Water Quality Parameters

Water quality parameters, including pH, conductivity, dissolved oxygen, temperature, and turbidity will be collected during monitoring well development and groundwater sampling tasks, and from surface water samples, as detailed in the FSP. The parameters are typically collected using a multi-parameter water quality instrument equipped with a flow-through cell (e.g., Horiba U-22 or equivalent). A Generally Acceptable Procedure (GAP) for measuring water quality parameters is provided in the Low-flow Groundwater Sampling GAP presented in Appendix B.

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

- Temperature
- Conductivity
- Dissolved oxygen (DO)
- pH
- Turbidity
- Salinity

4.2.1.1. Instrument Operation

A thermistor is used by the instrument to measure temperature. The thermistor also measures the change in electrical resistance accompanying changes in temperature. The instrument uses the temperature data in conductivity temperature conversions, DO temperature compensation, and pH temperature compensation. The unit of measurement for temperature is ºC (Celsius). The conductivity of water is determined by measuring the resistance of ion flow in between charged plates because conductivity is inversely proportional to resistance. The instrument reports conductivity as mS/cm (milli Siemen / centimeter). The instrument uses the membrane-electrode method for Dissolved Oxygen (DO). A reduction reaction in the cathode is caused by oxygen diffusing through the membrane of the sensor to create a current. This current is proportional to the concentration of oxygen dissolved in water. DO is reported as mg DO/L.

The instrument uses a glass-electrode method to determine pH. The known pH of a reference solution is determined by using two electrodes, a glass electrode and a reference electrode, and measuring the voltage (difference in potential) generated between the two electrodes. The difference in pH between solutions inside and outside the thin glass membrane creates electromotive force in proportion to this difference in pH. The reporting unit is the standard unit of pH (for example, 7.00 pH units). The instrument measures turbidity using the light-transmission scattering method. The unit for turbidity is NTU (Nephelometric Turbidity Unit).

4.2.1.2. Water Quality Measurement Procedures

The Horiba U-22 utilizes a flow-through cell to collect measurements during groundwater sampling, or can be used without the cell for measuring surface water parameters. Field personnel will follow all procedures outlined for calibration and operation of the Horiba U-22 or equivalent instrument when collecting field parameter measurements. Specific procedures for operation and calibration of the multi-parameter water quality instrument are provided in Appendix C.

For measuring surface water DO, a YSI 550A Dissolved Oxygen Instrument (or equivalent) may be used in conjunction with the Horiba U-22. This instrument provides greater accuracy in surface water bodies due to better agitation of samples, and is easier to use in surface water applications. Field personnel will follow all procedures outlined for calibration and operation of the YSI 550A or equivalent DO instrument when collecting field parameter measurements. Specific procedures for operation and calibration of the DO instrument are provided in Appendix C.

4.2.2. Field Screening of Soil Samples

Soil samples are screened using a photoionization detector (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 as detailed in the FSP. The PID will be a MiniRAE 2000 or equivalent portable-type instrument that is programmable and contains 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 compound.

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

4.2.2.1. Field Screening Equipment

The following equipment will be required for field screening of soil samples:

- PID (MiniRAE 2000 or equivalent)
- Self-sealing quart-size polyethylene freezer bags, or 16 ounce glass jars. Jars must be decontaminated or certified as clean from a laboratory.

4.2.2.2. Field Screening Procedures

The polyethylene bag headspace method described below will be used to screen soil samples at the site. The collapse of the polyethylene bag during analysis allows uniform flow of contaminant vapors into the PID, giving accurate readings. However, a 16 ounce, decontaminated glass jar may be substituted.

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.
2. When using glass jars:
    - Fill jars with a total capacity or 16 oz.
    - Seal each jar with one (1) or two (2) sheets of aluminum foil with the screw cap applied to secure the aluminum foil.

Note: Immediately after opening the split spoon sampler, direct-push Macro-core sampler, or other soil sampler, transfer soil to field screening bags. Collect surface soil samples from freshly exposed surfaces.

3. Allow headspace development for at least 10 minutes at approximate room temperature. Vigorously shake bags or jars for 15 seconds at the beginning and end of the headspace development period.

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.

4. 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.
5. 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: any erratic headspace data in the sampling form. Do not collect analytical samples from the polyethylene bag.

4.2.3. Field PCB Test Kits

PCB Test Kits (e.g., RaPID Assay®) will be used to provide quantitative, semi-quantitative or qualitative enzyme immunoassay (EIA) for the analysis of PCB (polychlorinated biphenyl) in water (groundwater, surface water, well water) as detailed in the FSP. The PCB Test Kit allows reliable and rapid screening for PCB (measured and reported as Aroclor 1254), with quantitation between 0.5 and 10 ppb (as Aroclor 1254), in water.

The PCB RaPID Assay® kit applies the principles of enzyme linked immunosorbent assay (ELISA) to the determination of PCB and related compounds. The sample to be tested is added, along with an enzyme conjugate, to a disposable test tube, followed by paramagnetic particles with antibodies specific to PCB attached. Both PCB (which may be in the sample) and the enzyme labeled PCB (the enzyme conjugate) compete for antibody binding sites on the magnetic particles. At the end of an incubation period, a magnetic field is applied to hold the paramagnetic particles in the tube and allow the unbound reagents to be decanted. After decanting, the particles are washed with Washing Solution. The presence of PCB is detected by adding the enzyme substrate (hydrogen peroxide) and the chromogen (3,3’,5,5’ – tetramethylbenzidine). The enzyme labeled PCB analog bound to the PCB antibody catalyzes the conversion of the substrate/chromogen mixture to a colored product. After an incubation period, the reaction is stopped and stabilized by the addition of acid.

Since the labeled PCB was in competition with the unlabeled PCB for the antibody sites, the color developed is inversely proportional to the concentration of PCB in the sample:

- Darker color = lower concentration
- Lighter color = higher concentration

The determination of the PCB level in an unknown sample is interpreted relative to the standard curve generated from kit standards after reading with a spectrophotometer.

4.2.3.1. Field PCB Test Kit Procedures

Field personnel will follow all procedures for use, calibration, and standard preparation for the RaPID Assay® Field PCB test kits provided by the manufacturer. Manufacturers' instructions for applicability, use, and QA/QC procedures for RaPID Assay® Field PCB test kits are provided in Appendix C.

4.2.4. Data Collection Using GPS and Data Point Surveys

Sampling locations, temporary groundwater sampling points, and groundwater monitoring wells will be surveyed with accuracy and precision requirements discussed in the Supplemental QAPP provided as Appendix A to this Generic QAPP. Measurement of sampling points will be made 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.

4.2.5. Membrane Interface Probes (MIP)

The Membrane Interface Probe with Soil Conductivity sensor (MIP-SC) will be used to provide real-time vertical characterization of subsurface soils and provide subsurface contaminant data as detailed in the FSP. The MIP-SC system is a subsurface, continuous-logging instrument developed by Geoprobe Systems®, a division of Kejr, Inc. of Salina, Kansas, to screen for the presence of volatile contaminants in soil. The instrument is comprised of a permeable membrane and carrier gas system used to detect volatile organic compounds (VOCs) and a dipole soil conductivity measurement tip. The MIP- system will be used to qualitatively characterize shallow subsurface VOC contamination at the site, including fuel releases, chlorinated solvents, and non-aqueous phase liquid (NAPL). The MIP system also includes a soil conductivity tip to measure soil conductivity for subsurface correlation and soil characterization.

The MIP portion of the probe uses a heated permeable membrane advanced into the formation by direct-push methods. The membrane does not allow fluids to move across the membrane, allowing the instrument to function in the saturated zone. The probe is advanced into the subsurface at a speed of approximately one foot per minute. A heating element within the probe heats the membrane, which in turn heats the surrounding soil and/or groundwater in contact with the membrane, causing VOCs present in the media to volatize and diffuse through the polymer membrane (Christy, 1996). The VOCs are collected by an inert carrier gas and carried to the surface detectors through a pressurized gas return tube within the MIP trunkline. The carrier gas is fed into an applicable detector, typically an ECD, PID or FID, which qualitatively measures the VOCs. The detector output (in millivolts) is recorded versus a corrected depth measurement based on the travel time of contaminants through the carrier gas return tube as determined by membrane response testing.

The SC tool uses a dipole arrangement at the tip of the probe, in which an alternating electrical current is passed from an insulated center electrode into the formation and returned to the probe body. The response of the formation to the current is measured as a voltage drop across the dipoles, which is then used to calculate formation resistance using Ohm's Law. The formation conductivity is determined as the inverse of the resistance (1/R), typically in units of milliSiemens per meter (mS/m).

4.2.5.1. Personnel

Generally, three personnel are required to operate the drilling and MIP equipment- two crew members under the direction of the field scientist overseeing field activities. One crew member operates the direct-push drilling equipment, and the other operates the MIP controller, logging equipment, and detectors as directed by the field scientist.

The field scientist overseeing SC-MIP operation and the assisting crew member will have a working knowledge of the principals of equipment operation and QA/QC procedures. The field scientist should also be familiar with the expected output of the detectors and how this output is affected by the SC-MIP system controls.

4.2.5.2. MPI-SC Detector Selection

Detector selection is based on the subsurface contaminants expected at the site. In general:

- The FID will be used for detection of unsaturated hydrocarbons, including methane;
- A PID will be used for general VOC screening including petroleum hydrocarbons; and,
- An ECD will be used primarily for detection of chlorinated VOCs (CVOCs).

Other detectors, including DSITMS and similar low-volume gas chromatography detectors, may be used to provide qualitative analysis and differentiation of VOC and CVOC compounds. More than one detector can be used simultaneously for initial investigations where subsurface contaminant characteristics are unknown.

Regardless of the detector used, each detector will be calibrated following the instructions provided by the manufacturer. All standards, methods, and operating procedures for the selected detector will be in accordance with manufacturer specifications. Detectors and associated equipment will be operated by a competent subcontractor trained in their operation and calibration.

4.2.5.3. MIP-SC Procedures

The general field procedures for MIP-SC sampling are outlined in the GAP provided in Appendix B. A subcontractor competent and trained in the operation and calibration of

MIP equipment will provide MIP-SC services and equipment at the site. The contractor will follow all requirements of the Standard Operating Procedure (SOP) for MIP-SC logging provided by the manufacturer. Calibration and preparation of standards for the MIP will be performed in accordance with manufacturer specifications.

4.2.6. Radiological Screening

A radiological survey will be conducted to evaluate the presence of low level radioactive materials at levels two times greater than the background, which will be established based on non-impacted areas at the site or adjacent sites. Specific sampling objectives are outlined in the PMWP and FSP. If radiological characterization of subsurface soil and groundwater is necessary based on survey results, levels of radioactive materials in soil will be compared to NYSDEC TAGM RAD-05-01 Cleanup Guidelines for Soils Contaminated with Radioactive Materials.

All 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 (ACOE).

Characterization of the extent of radiological contamination in the surface soils at the 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 the FSP.

4.2.6.1. 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.

4.2.6.2. Radiological Screening Procedures

A screening of the soils outside of the on-site building 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 (approximately 32,000 square feet) 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.

4.3. Sampling Equipment Decontamination

Cross contamination of samples from any source is to be avoided. All sampling equipment must be clean and free from the residue of any previous samples. All 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, with the exception of split spoons or equivalent samplers. All heavy equipment and drilling equipment will be steam cleaned in a predesignated location prior to use and between locations.

To accomplish this, the following procedures will be followed:

1. Wash and scrub with low phosphate detergent;
2. Rinse with tap water;
3. Rinse with isopropanol (pesticide grade or better);
4. Rinse thoroughly with deionized water; and
5. Air dry.
6. Tubing and equipment such as pneumatic bladder pumps used for sampling monitoring wells will be decontaminated by thoroughly washing all internal and external surfaces with soapy water and rinsing with deionized water prior to use. All tubing must be dedicated to individual monitoring wells (i.e., tubing cannot be reused).

Field instrumentation will be cleaned per manufacturer's instructions (Appendix C). Probes, such as those used in pH and conductivity meters, and thermometers will be rinsed prior to and after each use with deionized water.

4.4. Monitoring Well Installation and Development

4.4.1. Installation Objectives

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

4.4.2. Installation Equipment

A truck-mounted rotary drilling rig equipped with 4.25-inch hollow-stem augers will be used to create an eight-inch diameter borehole. The two-inch diameter polyvinyl chloride (PVC) screen and riser pipe will be lowered through the borehole to five to seven feet below the water table by hand and with the use of the augers. Comparable methods may be used based on site conditions and project objectives. Probes and any other large pieces of equipment that come into contact with the soil must be steam cleaned before use and between boreholes. If visibly contaminated with free phase products or any other contaminants, probes and other equipment must be decontaminated by the following the procedures in Section 4.2

4.4.3. Installation Procedures (Rotary Drilling)

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. Monitoring well screens will be placed so that a minimum of two feet of well screen is above the water table as described in the Work Plan.

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.

4.4.4. Monitoring Well Completion

Each well will be completed with a flush-mount manhole cover set into a one square foot concrete pad as described in the monitoring well completion GAP document provided in Appendix B.

4.4.5. Monitoring Well Development

4.4.5.1. 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.

4.4.5.2. Development Equipment

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

- Electric water level indicator.
- Polyethylene 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.
- Field logbook and field data sheets.
- Roll of polyethylene sheeting.
- Decontamination equipment.

4.4.5.3. 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 within 24 hours of well installation. Prior to developing each monitoring well, 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 4.3, 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 each well volume has been removed by measurements of field parameters, such as turbidity, pH, ORP, temperature, and conductivity, as described in Section 4.2.1. These field measurements and other observations will be recorded on a Well Development/Purging Log, an example of which is presented in Appendix D.

In general, monitoring well development will be discontinued after a minimum of 10 well volumes 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 GAP document provided in Appendix B.

4.5. Water Level Measurements

4.5.1. Measurement Objectives

Water levels in monitoring wells will be measured and used in conjunction with horizontal and vertical ground survey data to determine 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 during the RI. These measurements made during the Phase I RI will be utilized to provide a baseline of groundwater elevations and flow at the site prior to Remedial Investigation and Feasibility Study (RI/FS) activities.

4.5.2. 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.
- Photoionization Detector.
- Deionized Water.
- Low Phosphate Detergent.

4.5.3. Measurement Procedure

At each monitoring well, the expansion cap will be removed and the head space and breathing zone's air quality will be monitored with a PID. The criteria for PID sensitivity shall be the same as that discussed in Section 2.3. 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 HASP, appropriate measures will be taken as listed in the HASP.

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 each monitoring well 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 audible signal is heard or the instrument light goes on, indicating that the sensor in the probe has made contact with the water surface in the monitoring well.

In the presence of NAPL, an interface probe, which 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 makes contact with the NAPL or water surfaces in a monitoring well, an audible signal will be heard. In order to distinguish between NAPL and water surfaces, a different audible signal is used for each medium (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 book.

4.6. Groundwater Sampling

4.6.1. Sampling Objectives

Groundwater samples will be collected to evaluate the nature and extent of contaminants at concentrations greater than NYSDEC Class GA standards in groundwater. Specific sampling objectives are outline in the PMWP and FSP. Samples will be collected within one week of well development. Samples will also be collected from temporary monitoring points utilizing a direct-push retractable screen sampler.

4.6.2. Sampling Equipment

The following equipment will be required for groundwater sampling:

- Electric water level indicator and/or interface probe
- Peristaltic pump.
- Teflon®-lined polyethylene tubing.
- Silicone tubing.
- Direct-push retractable screen sampler or something equivalent.
- Temperature, pH, dissolved oxygen, ORP, specific conductivity, and turbidity meters.
- Photoionization detector.
- Field logbook and field data sheets.
- Laboratory prepared sample containers.

- Roll of polyethylene tubing.
- Decontamination equipment.
- Latex gloves (disposable).
- Neoprene gloves.

4.6.3. Sampling Procedures (Permanent Monitoring Wells)

Groundwater sampling will be conducted in accordance with the USEPA Low-Flow Sampling Protocol (USEPA, 1998). Passive diffusion bags may be used for collecting groundwater samples at some sites based on project requirements. Specific procedures are provided in the low-flow groundwater sampling and passive diffusion bag GAPs provided in Appendix B. General low-flow sampling procedures are summarized below.

A piece of polyethylene sheeting will be fitted over the monitoring well and laid on the ground. The sampling equipment will be placed on the polyethylene sheeting. The well cap will be removed and the headspace at the top of the monitoring well will be measured with a PID. 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 vapors of gases. The PID will be calibrated before the start of each sampling event.

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. 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. 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 each sample 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 each sampling event.

The volume of water removed from each monitoring well 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. The purge water will be discharged in accordance with Section 4.2. Once a groundwater sample is collected from the well, the polyethylene tubing is disposed of.

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 preservation requirements are presented in the FSP. 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 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.

4.6.4. 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 each location. A 1 ¾-inch hollow push rod with a steel drop off tip will be advanced to a designated depth and than 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. 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 each sample 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 each sampling event.

The volume of water removed from each sampling point 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 4.2.

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 preservation requirements are presented in the FSP. 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.

4.7. Surface Water Sampling

4.7.1. Sampling Objectives

A surface water sample will be collected from a stormwater catch basin to evaluate the nature and extent of TCL VOCs and SVOCs at concentrations greater than NYSDEC Class A standards in surface water. Specific sampling objectives are outlined in the PMWP and FSP.

4.7.2. Sampling Equipment

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

- Polyethylene sheeting.
- Glass beaker.
- Laboratory prepared sample containers.
- Temperature, pH, dissolved oxygen, ORP, specific conductivity and turbidity meters.
- Field logbook and field data sheets.
- Latex gloves (disposable).

- Neoprene gloves.

4.7.3. Sampling Procedures

The surface water sample will be collected directly from the surface water body by partially submerging a pre-cleaned glass beaker 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 catch basin 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 preservation requirements are presented on Table C-5. 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.

4.8. Sediment Sampling

4.8.1. Sampling Objectives

Surface soil samples will be collected to evaluate the nature and extent of contaminants metals at concentrations greater than 6 NYCRR Subpart 375-6 Remedial Program cleanup objectives in surface soil. Specific sampling objectives are outlined in the PMWP and FSP. The location of each surface soil sample will be measured relative to permanent site features and marked on a site diagram in the field logbook. Additionally, all sampling locations will be marked in the field with a survey stake and labeled with the sample I.D. to facilitate subsequent surveying of the sampling location.

4.8.2. 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

4.8.3. Sampling Procedures

In general, the following considerations should be taken into account 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.
- 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

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. Each quarter 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 by the site specific FSP/QAPP or as described in this GAP.
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 each location following the procedures discussed in Section 4.3.

4.9. Surface Soil Sampling

4.9.1. 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 in surface soil. Specific sampling objectives are outlined in the PMWP and FSP. The location of each surface soil sample will be measured relative to permanent site features and marked on a site diagram in the field logbook. Additionally, all sampling locations will be marked in the field with a survey stake and labeled with the sample I.D. to facilitate subsequent surveying of the sampling location.

4.9.2. Sampling Equipment

The following equipment will be required for surface soil sampling:

- Hand Augers (multiple size stainless steel buckets)
- Labels
- Power Auger (if required for 2+ foot depth)
- Cooler
- Stainless steel trowels
- Field log book
- 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 and film
- Compass
- 200 ft tape

4.9.3. 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. While drilling the hole, remove gravel or other debris before obtaining the sample. Advance the auger or trowel to a depth of approximately six inches and then removed from the hole. 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 all data into a permanent field log book. 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.

A qualified geologist will describe the soil samples, screen the soil samples for VOCs with a PID, and record any observations in the field log. The criteria for PID sensitivity shall be the same as that discussed in Section 4.1.2. The location(s) for collection of field duplicates, field blanks, and matrix spike/matrix spike duplicate samples shall be determined in the field.

Sampling equipment will be decontaminated as discussed in Section 4.2. Disposable gloves will be worn by the sampling personnel and changed between sampling points.

4.10. Soil Sampling

4.10.1. 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. Specific sampling objectives are outlined in the PMWP and FSP.

4.10.2. Soil Sampling Equipment

The following equipment will be used to collect soil samples:

- Photoionization Detector.
- Roll of polyethylene sheeting.
- Stainless steel spatula or spoon.
- Stainless steel trowel.
- Stainless steel bowl.
- Latex gloves (disposable).
- Neoprene gloves.
- Certified, pre-cleaned sample containers.
- Aluminum foil.
- Field logbook and pen.
- Decontamination equipment.

4.10.3. Soil Sampling Procedures

4.10.3.1. 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-foot intervals in acrylic tubes. The total number of four-foot tubes collected from each soil boring will be dependent on the final depth of the boring.

A qualified geologist will characterize the soil samples and record observations on a field boring log. A standard boring log is provided in Appendix D.

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. The criteria for PID sensitivity shall be the same as that discussed in Section 4.1.2, above.

A qualified geologist will describe the soil samples, screen the soil samples for VOCs with a PID, and record any observations in the field log. The criteria for PID sensitivity shall be the same as that discussed in Section 4.1.2. The location(s) for collection of field duplicates, field blanks, and matrix spike/matrix spike duplicate samples shall be determined in the field.

Soil samples designated for VOC analysis shall be collected directly from the sampling device. Each 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 and NYSDEC ASP-certified laboratory and analyzed for the applicable analyses. All samples will be collected in accordance with the EPA Part 136 protocols (40 CFR, Part 136). The location(s) for collection of field duplicates, field blanks, and matrix spike/matrix spike duplicate samples shall 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 split-barrel sampler 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 4.2. Disposable gloves will be worn by the sampling personnel and changed between sampling points.

4.10.3.2. 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 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) Method D 1586-99: Standard Test Method for Penetration Test and Split-barrel Sampling of Soils (ASTM, 1999).

Analytical samples will be collected from the split-barrel sampler following the procedure described in Section 4.10.3.1.

4.11. Test Pits

Test pits 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. Test pit sampling will include visual observations and information on the nature of the soil, including whether or not it is native soil or fill.

4.11.1. 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.

4.11.2. Test Pit Sampling Procedures

A test pit log (Appendix D) should be provided for each test pit 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 any 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 any 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 4.9). 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 D):

- 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 any odors and, if so, describe.
- If appropriate, take and record a PID measurement (section 4.2.2) at each depth interval.
- 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 any relevant observations.

4.12. Soil Vapor and Ambient Air Sampling

4.12.1. Air and Soil Vapor Sampling Objectives

Air and soil vapor sampling is intended to evaluate the potential for migration of VOCs in the subsurface to the indoor air and the potential for current and future human exposures. Indoor and ambient air samples and sub-slab soil vapor samples will be collected during the Phase I RI. Indoor air samples will be collected from within the building on-site to evaluate the nature and extent of TO-15 VOCs at concentrations greater than NYSDOH CEH BEEI Soil Vapor Intrusion Guidance levels inside the building. An ambient air sample will be collected from outside of the building to provide background VOC concentrations for the site. Sub-slab soil vapor samples will be collected from just below the concrete slab of the building to evaluate potential soil vapor intrusion pathways and to assess the impact of operating a sub-slab depressurization system on soil vapor VOC concentrations. Specific sampling objectives are outlined in the PMWP and FSP.

4.12.2. 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. All 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 each sampling location:

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.

4.12.3. Air Sampling Procedures – Indoor and Ambient Air

Indoor and ambient air samples will be collected in accordance with the NYSDOH Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (2006), the USEPA standard operating procedure (SOP) for installation of sub-slab vapor probes (Attachment B-3 to the FSP), and the Generally Acceptable Practice for Sampling with Summa Canisters document (Malcolm Pirnie, 2006) (Attachment B-4 to the FSP). 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 less than negative 26 inches of mercury, then the canister is acceptable for sampling. Any canisters with a vacuum greater than negative 26 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. Each fitting should be hand tightened and then tightened with a wrench approximately ¼ turn.
4. Confirm that the sampling train is air tight 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 increases, there is a leak in the system. All of the 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 ensure 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 above 12 in. Hg or below 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.

4.12.4. Air Sampling Procedures – Sub-slab and Soil Vapor Sampling

Soil vapor probe installations will be semi-permanent points. Soil Vapor implants will be constructed in the same manner at all sampling locations to minimize possible discrepancies. Soil vapor sampling points will be constructed in compliance with the procedures outlined in the NYSDOH Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (2006), the USEPA standard operating procedure (SOP) for installation of sub-slab vapor probes (Attachment B-3 to the FSP), and the Generally Acceptable Practice for Sampling with Summa Canisters document (Malcolm Pirnie, 2006) (Attachment B-4 to the FSP), and will include the following:

- 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 1/4 inch diameter), and of laboratory or food grade quality;

- Tubing will not extend further than 2 inches into the sub-slab material or soil;
- porous, inert backfill material (e.g., glass beads, washed #1 crushed stone, etc.) will be added to cover approximately 1 inch of the probe tip; and,
- Implants will be sealed to the surface with non-VOC-containing and non-shrinking cement/bentonite grout.

The 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 soil vapor probe, the building floor will be inspected and any 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.

To obtain representative samples that meet the data quality objectives, sub-slab or soil vapor samples will be collected in accordance with the NYSDOH Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (2006), the USEPA standard operating procedure (SOP) for installation of sub-slab vapor probes (Attachment B-3 to the FSP), and the Generally Acceptable Practice for Sampling with Summa Canisters document (Malcolm Pirnie, 2006) (Attachment B-4 to the FSP) and summarized as follows:

- To ensure samples collected are representative, one to three volumes (i.e., the volume of the sample probe and tube) will be purged using laboratory-grade 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;
- A helium tracer gas will be used to verify the integrity of the soil vapor point seal. Prior to and after sampling of the sub-slab soil vapor, the atmosphere in the immediate vicinity of the area where the vapor point tubing intersects the ground will be enriched with the tracer gas. This will be accomplished by using an inverted plastic pail to keep the tracer gas in contact with the vapor point during testing. A portable monitoring device (specific to the tracer gas) will be used to analyze a sample of soil vapor for the tracer gas prior to and after sampling for VOCs. If the tracer gas is detected at a concentration of less than 20 percent, it will be assumed that the probe is sealed and the vapor sample has not been diluted by surface air.
- Samples will be collected, using conventional sampling methods, in a laboratory-certified summa canister that is consistent with the sampling and analytical methods; and,
- Samples will be collected over the same period of time as concurrent indoor and outdoor air samples.

4.13. Field Documentation

Documentation of an investigative team's field activities often provides the basis for technical site evaluations and other such related written reports. All records and notes generated in the field will be considered controlled evidentiary documents and may be subject to scrutiny in litigation.

Personnel designated as being responsible for documenting field activities must be aware that all notes may provide the basis for preparing responses for legal interrogatories. Field documentation must provide sufficient information and data to enable reconstruction of field activities. Numerically serialized field logbooks provide the basic means for documenting field activities. The following information must be provided on the inside front cover of each 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.

4.13.1. Sample Designation

A sample numbering system will be used to identify each sample. This system will provide a tracking procedure to allow retrieval of information about a particular sample, and will assure that each sample is 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.

Project Identification: The first component consists of a two- or three-letter designation, which identifies the project site.

- Sample type: The second component, which identifies the sample type, will consist of a two-letter code as follows:
  - IA - Indoor Air
  - AA - Ambient Air
  - MW - Monitoring Well (Groundwater Sample)
  - SB - Soil Boring
  - SS - Surface Soil
  - SV - Soil Vapor
  - SW - Surface Water

- Sample Location: The third component identifies the sample location using a two-digit number.
- Sample Identification: The fourth component will only be used for soil boring samples to indicate the interval from which the sample was collected.
- Quality Assurance/Quality Control Samples: The samples will be labeled with the following suffixes:
  - FB - Field Blank
  - MS - Matrix Spike
  - MSD - Matrix Spike Duplicate
  - TB - Trip Blank

Duplicate samples will be numbered uniquely as if they were samples. A record of identification for duplicate samples will be maintained.

Examples of identification numbers are given below:

- CD-SB-02-10: Soil boring, boring location number 2, 10 feet below ground surface.
- CD-MW-03-MSD: Monitoring well groundwater sample, monitoring well sample location 3, matrix spike duplicate.
- CD-SS-FB: Field blank for surface soil sample.

4.13.2. Documentation of Field Activities

Field logbook entries must be legibly written and provide an unbiased, concise, detailed picture of all field activities. Use of preformatted data reporting forms must be identifiable and referenced to field notebook entries.

Step-by-step instructions and procedures for documenting field activities are provided below and in following sub-sections. Instruction and procedures relating to the format and technique in which field logbook entries are made are as follows:

- Leave the first two pages blank. They will provide space for a table of contents to be added when the field logbook is complete.
- The first written page for each day identifies the date, time, site name, location, Malcolm Pirnie 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.
- All photos taken must be traceable to field logbook entries. It is recommended to reference photo locations on the site sketch or map.
- All entries must be made in ink. Waterproof ink is recommended.

- All entries must be accompanied by the appropriate military time (such as 1530 instead of 3:30).
- Errors must be lined through and initialed. No erroneous notes are to be made illegible.
- The person documenting must sign and date each page as it is completed.
- Isolated logbook entries made by a team member other than the team member designated responsible for field documentation, must be signed and dated by the person making the entry.
- Additions, clarifications, or corrections made after completion of field activities must be dated and signed.

4.13.3. General Site Information

General site characteristics must be recorded. Information may include:

- Type of access into facility (locked gates, etc.).
- Anything that is unexpected on-site (e.g., appearance of drums that have not been previously recorded).
- Information obtained from interview with access or responsible party personnel (if applicable), or other interested party contact on-site.
- Names of any community contacts on-site.
- A site map or sketch may be provided. It can be sketched into the logbook or attached to the book.

4.13.4. Sample Activities

A chronological record of each sampling activity must be kept that includes:

- 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 any other important distinguishing features.
- 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 any preservative used. 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 thirty party (e.g., the responsible party representative; state, county, or municipal, environmental and/or health agency, etc.) must be documented.

4.13.4.1. 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,
- Any 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 each soil vapor sample location that includes 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.

4.13.5. Sample Dispatch Information

When sampling is complete, all sample documentation such as chain-of-custody forms shall 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.

4.14. Sample Handling

The analytical laboratory will provide the sample containers necessary for all soil, groundwater, surface water, air, and soil vapor samples. Container closures for all 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.

All samples collected will be identified with a sample label. A label will be attached to each bottle and each sample will be identified with a unique sample number.

Immediately following sample collection, each sample container 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 all sample identification information has been recorded, each sample label will be covered with waterproof clear plastic tape to preserve its integrity. All samples will be recorded and tracked under strict chain-of-custody protocols. In the field, each sample will be checked for proper labeling. The samples will then be packed into coolers with ice and shipped to the laboratory, if applicable. A chain-of-custody form will be completed for each cooler. 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.

4.14.1. Chain-of-Custody Record

A chain-of-custody 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 D. 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 practicable after sample collection, preferably after decontamination, the following information must be entered on the chain-of-custody form. All information is to be recorded in black ink:

- Malcolm Pirnie project number. Enter the seven-digit alphanumeric designation assigned by Malcolm Pirnie 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 each sample in the shipment. This number appears on the Malcolm Pirnie, Inc. sample identification label.
- Date. Enter a six-digit number, indicating the year, month, and day of sample collection (YYMMDD); for example, 051125.
- 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 each sample number, enter the number of sample bottles that are contained in the shipment.
- Remarks. Enter any appropriate remarks.

4.14.2. Transferring to Common Carrier

Instructions for Malcolm Pirnie, Inc. shipper transferring custody of samples to a common carrier are as follows:

Sign, date, and enter time under "Relinquished by" entry.

Enter name of carrier (e.g., UPS, Federal Express) under "Received by."

Enter bill-of-lading of Federal Express airbill number under "Remarks."

Place the original of the chain-of-custody form in the appropriate sample shipping package. Retain a copy with field records.

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.

Wrap the seal across filament tape that has been wrapped around the package at least twice.

Fold the custody seal over on itself so that it sticks together.

Complete other carrier-required shipping papers.

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

4.14.3. Transferring Custody Directly to a Courier

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

5. Calibration 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. In the event that the data is used in court, documented calibrations are necessary to ensure that the data is legally defensible.

5.1. 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 C. General calibration procedures and requirements include the following:

- All instruments will be calibrated at least once a month.
- All instruments will have the calibrations checked at a minimum at the start of each 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.
- All calibration information will be recorded in the field log book. This includes date and time, technician signature, calibration procedure, calibration results, calibration problems, recalibration and maintenance, and instrument serial numbers.

All 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.

5.2. Laboratory Calibration Procedures

All samples analyzed according to the USEPA SW-846 analytical methodologies shall follow the procedures described in the applicable Statement of Work (SOW). The calibration procedures and frequency are specifically described for each analysis contained in the SOW. All calibration results shall 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 analysis of any sample. The standards used for calibrations will be traceable to the NBS, and each calibration will be recorded in the laboratory notebook for the particular analysis. Any printouts, chromatograms, etc., generated for the calibration will be kept on file.

6. Analytical Procedures

All groundwater, surface water, and soil samples collected for laboratory analysis during the Phase I RI will be analyzed by a NYSDEC ASP-certified laboratory for VOCs, SVOCs, pesticides/PCBs, and metals using USEPA SW-846 analytical methodologies accompanied by NYSDEC ASP Category B deliverables. The FSP summarizes the analytical procedures and their sources that will be utilized for the site.

The analytical methods listed in the FSP are sufficient to support the DQOs for this project. In particular, the detection limits of these methods are adequate to support the DQOs. The general SW-846 methods and procedures used for the analysis of VOCs (Method 8260B), SVOCs (Method 8270C), pesticides/PCBs (Methods 8081A and 8082), and metals (Methods 6010B, 7470A, and 7471A) are summarized as follows:

- All instruments will have the calibrations checked at a minimum at the start of each 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.
- All calibration information will be recorded in the laboratory log book. This includes date and time, technician signature, calibration procedure, calibration results, calibration problems, recalibration and maintenance, and instrument serial numbers.

All air and soil vapor samples collected for laboratory analysis during the Phase I RI will be analyzed by a NYSDOH-approved laboratory for VOCs (TO-15) that can meet the required method detection limits determined for this Work Assignment.

7. Data Reduction, Validation, and Reporting

The purpose of this section is to ensure that the large amounts of data produced by the laboratory are presented in a clear and useable format. In addition, data quality and technical validity must be verified prior to data use. The samples collected at the site will be analyzed according to USEPA SW-846 analytical methodologies, in which data reduction and reporting schemes are well developed and clearly defined. The employment of this method ensures comparability with other similarly analyzed environmental samples. 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 takes the form of area counts or instrument responses, is processed by the laboratory and converted into concentrations expressed in terms of milligrams per kilogram (mg/kg), parts per million (ppm), or micrograms per kilogram (ug/kg), and parts per billion (ppb). 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 clearly defined in the USEPA SW-846 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

Data validation identifies invalid data and qualifies the usability of the remaining data. The output of data validation is qualitative or quantitative statements of data quality. Once the quality of individual measurements is known, a compilation of all 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.

Although rigorous validation of the data generated by the laboratory will be performed by a third party data validation subcontractor, the laboratory will be responsible for reviewing data to determine if any analytical problems exist. Specifically, the laboratory will develop a case narrative describing how closely the data meet the DQOs presented in this QAPP.

7.2.1. Data Review

The data review process shall consist of a contractual review that shall include an evaluation of the analysis and specific requirements of the published method in addition to the laboratory SOP. Data qualification shall be performed following the intent of the National Functional Guidelines in conjunction with the data validator's professional judgment, where applicable, since there are no formal validation guidelines written for this analysis.

Data will be declared invalid whenever documented evidence exists demonstrating that a VOC sample was not collected under representative conditions, such as a canister leaking to ambient pressure during shipment.

The laboratory will provide a data reporting package. One copy of the ASP Category B data packages will be delivered to a third party data validation subcontractor for data assessment. The data packages will include the case narrative. The data validation report and the data usability report will be submitted to the NYSDEC as part of the corresponding Phase I RI Letter Report. This package will include sampling analysis and summary forms.

Data validation will be performed using guidance from the following documents:

- USEPA Region 2 *Evaluation of Metals Data for the Contract Laboratory Program* (SOP# HW2 Rev. 11);
- USEPA Region 2 *Validating Semi-volatile Organic Compounds by SW-846 Method 8270* (SOP# HW22 Rev. 2);
- USEPA Region 2 *Validating Volatile Organic Compounds by SW-846 Method 8260B* (SOP# HW24 Rev. 1).
- USEPA Region 2 *Validating Polychlorinated Biphenyls by SW-846 Method 8082* (SOP# HW23B Rev. 1).

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 shall review the submitted data package to determine compliance with those portions of the work plan 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 QAPP and the laboratory subcontract.
3. All protocol required QA/QC criteria have been met.
4. All instrument tune and calibration requirements have been met for the time frame during which the analyses were completed.

5. All protocol required initial and continuing calibration data is present and documented.
6. All data reporting forms are complete for all samples submitted. This will include all sample dilution/concentration factors and all pre-measurement sample cleanup procedures.
7. All problems encountered during the analytical process have been reported in the case narrative along with any and all 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.

Data are never declared invalid solely because they are unlikely to occur in nature, but may be flagged as suspect and be subjected to further review until the cause for the apparent anomaly is determined. The results from all QA/QC checks are evaluated to determine if the DQOs for each measurement are being met. Evidence of overwhelming measurement bias, external influences on the representativeness of the data, or lack of reproducibility of the measurement data may be cause for the data to be judged invalid.

7.2.2. Data Usability Summary Report (DUSR)

The Data Validator shall submit a DUSR covering the results of the data review process. This report shall include the following:

- A general assessment of the data package as determined by the accomplishment of Section 11.2, above.
- Detailed descriptions of any and all deviations from the required protocols. (These descriptions must include references to the portions of the protocols involved in the alleged deviations).
- Any and all 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). Telephone logs should be included in the validation report.
- A detailed assessment by the Validator of the degree to which the data has been comprised by any deviations from protocol, QA/QC breakdowns, lack of analytical control, etc., that occurred during the analytical process.
- The report shall include, as an attachment, a copy of the laboratory's case narrative including the NYSDEC required sample and analysis summary sheets.
- The report shall include an overall appraisal of the data package.

The validation report shall include a chart presented in a spreadsheet format, consisting of site name, sample numbers, data submitted to laboratory, year of analytical protocol used, matrix, fractions analyzed, e.g., volatiles, semi-volatiles, metals, cyanide, PCBs. Space should be provided for a reference to the NYSDEC ASP when non-compliance is involved and a column for an explanation of such violation.

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 FSP and PMWP. 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. Any limitations on the use of the data will be detailed in the Phase I RI Report. Corrective action procedures are discussed further in Section 10.

7.4. Data Reporting

The laboratory will report TCL and TAL data consistent with ASP reporting requirements. The QA reporting will include the following accuracy and precision protocols as performed on the appropriate QA samples.

If any of 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.

Most often a single isolated incident in which the performance objective is not met does not automatically render the data useless, but rather slightly reduces the confidence that the measurement is reliable, and indicates that increased quality control measures are needed. Any potential limitations of the data set will be identified and communicated. The project team will present all 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:

- <u>Precision</u> is a measure of mutual agreement among individual measurements of the same property, usually under prescribed conditions. Assessing 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 RPD, is calculated using the formula below.

$$\mathrm{RPD} = \frac{(V_1 - V_2)}{\frac{(V_1 + V_2)}{2}} \times 100$$

where: V1 = value 1
V2 = 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 and is calculated using the following formula:
- Completeness is calculated as follows:

$$\%\ \mathrm{Completeness} = 100 \times \frac{V}{n}$$

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 for this project is 100%.

- Comparability expresses the confidence with which one data set can be compared to another. Comparability shall be performed as described in Section 1.5.2.
- Sensitivity is the capability of a method or instrument to discriminate between small differences in analyte concentration.

8. Preventative Maintenance

The purpose of the preventative maintenance program is to ensure that the sampling, field testing, and analytical equipment perform properly thereby avoiding erroneous results, and minimizing equipment downtime. The preventative maintenance program also provides for the documentation of all maintenance to be used as evidence of instrument maintenance and for scheduling of future maintenance. This section describes the equipment maintenance program for field instruments and those responsible for implementation of the program at the Site. The specific field equipment maintenance procedures are given in the manufacturer specifications and operating manuals provided in Appendix B. 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	■ Keeping all maintenance records.
	■ Development and implementation of maintenance program.
Equipment Manager	■ Maintaining storage of equipment within the Malcolm Pirnie equipment inventory.
	■ Carrying out all maintenance according to schedule. Informing field team members of specific maintenance requirements.
	■ Keeping records of all maintenance performed under his care. Sending out equipment for service/repair. Maintaining adequate supply of spare parts.
Field Personnel	■ Maintenance of all equipment located on-site on a regular basis and after each use. Keeping 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 each use:
  - Cleaning.
  - Lubrication of moving parts.
  - Check/charge battery.
  - Inspect for damage.
  - Check for operation problems.
  - Inspect all hoses and lines.
- Partial list of important spare parts for environmental monitoring instruments frequently used:
  - Fuses.
  - Mini Rae-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 each instrument provided in Appendix C.

Minor service and repair will be performed by the Equipment Manager who is trained 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.

All maintenance, servicing and repair of equipment shall be recorded and kept on file. Field personnel shall record maintenance and instrument problems in the field instrument log books. These will ultimately be kept on file by the Field Team Leader. The Equipment Manager shall keep a record of all equipment released to the field and a record of all maintenance and service on file.

8.3. Laboratory Instrument Maintenance

Preventative maintenance procedures will be clearly defined and written for each measurement system. Maintenance activity, preventative or repair, will be documented on standard forms, which are maintained in log books. 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 SOPs listed in Section 6.0.

8.4. Rental Equipment

Rental equipment will be obtained only from known, reputable rental suppliers. The equipment will require a pre-receipt to verify accuracy, maintenance and upkeep of the equipment.

9. Quality Assurance Procedures

In order to monitor the quality of the analytical data generated for this focused investigation, an appropriate number of QC methods will be employed for all field and laboratory measurement systems. The employment of QC methods permits the validation of the analytical methodology utilized and provides a measure of the suitability of the methodology to meet the DQOs prior to the beginning of measurement or analysis. Once the measurement and analysis has begun, the employment of QC methods permits the monitoring of the system output for quality. The QC results presented with the environmental sample data, allows the data to be assessed for quality, and a determination made on 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 all field measurement activities in Sections 3 and 5 of this QAPP. Section 3 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 Sample	■ Insures proper working order of instrument. ■ Measures instrument accuracy and sensitivity.	Daily
Background Sample	■ Provides measure of instrument reliability.	Daily
Duplicate Sample	■ Measures instrument precision	5 %

Trip Blanks	■ Measures potential contamination from sample transport, the environment and/or shipping.	Minimum of one per cooler of aqueous volatile samples.
Field Blanks	■ Measures potential contamination due to poor sampling device decontamination procedures	One per every 20 environmental samples per media.

The calibration check samples will be analyzed 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 Malcolm Pirnie 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 undertaken 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, approved by the Project Officer, and issued to the Project Manager and other appropriate parties. 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 ASP laboratory, the NYSDEC, the Project Officer 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

A Stop-Work Order may be issued, upon authorization, by the site QAO, if corrective action does not adequately address a problem or if no resolution can be reached. To issue a Stop-Work Order, written authorization is required from the Project Manager and the NYSDEC Representative. If disagreement occurs among these individuals, it will be brought before successively higher levels of management until the issue is resolved.

10.3.1. Stop Work Order Documentation

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.

10.3.2. Resumption of Work

In order for work to resume following a Stop-Work Order, the Project Manager and the NYSDEC Representative must rescind it in writing.

10.4. Course and Action to Prevent Recurrence

The site QAO is responsible for tracking non-conforming conditions, evaluating the effectiveness of corrective measures, and assuring that the necessary steps have been taken to prevent recurrence of the original problem.

10.5. Field Changes

The Project Manager is responsible for all 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, the Project Officer, 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 any departure from established procedures.

Changes in the program will be documented on a field change request, which is signed by the Field Team Leader and the Project Manager. The Project Manager will maintain a log for the control of field change requests.

The Project Manager is responsible for controlling, tracking and implementing the identified changes. Completed field change requests are distributed to affected parties which will include as a minimum: Project Officer, Project Manager, site QAO, Field Team Leader, and the NYSDEC Representative.

11. Quality Assurance Reports

Malcolm Pirnie field staff will promptly report any difficulties to the Project Manager. The laboratory will provide a written description on any quality assurance, problems to Malcolm Pirnie with submission of the analytical data packages.

Following any 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

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New York State Department of Environmental Conservation
Generic QAPP for Work Assignments

Appendix A: Supplemental QAPP

0266-NYSDEC

MALCOLM PIRNIE

A Supplemental QAPP was not produced for this Work Assignment. The Field Activities Plan, which is provided in Appendix A of the Remedial Investigation/Feasibility Study, describes project specific field activities and sampling procedures.

New York State Department of Environmental Conservation
Generic QAPP for Work Assignments

Appendix B:
Field Activities Generally Acceptable Procedures (GAPs)

MALCOLM PIRNIE

GENERALLY ACCEPTABLE PRACTICE (GAP)

GROUNDWATER MONITORING WELL SURFACE COMPLETION METHODS AND BEST PRACTICES

PURPOSE/ APPLICATION

The purpose of this document is to provide guidance in selecting an appropriate surface completion for groundwater monitoring wells. A groundwater monitoring well is typically completed at the surface using either a flush-mount design (well box, curb box, vault, or manhole) installed flush with the land surface, or an above-ground design (stick-up casing). The purpose of either design is to secure the well from potential tampering, protect the well casing at the surface, and reduce the potential for surface infiltration to move vertically along, or in to the monitoring well and to reach the groundwater. It is also important to confirm that the wellhead completion meets applicable State and local regulatory requirements for well construction.

TECHNIQUES

Flush-mount Surface Completion

Flush-mount surface completion is typically used in areas where monitoring wells may be exposed to vehicular traffic, such as parking lots or roadways, within buildings and/or work areas, or in areas where the visual impacts of above-ground well casings are considered undesirable. A flush-mount well casing terminates below the ground surface and is protected by a steel curb-box, vault, or man-hole installed in a concrete pad set flush with the ground surface or pavement. The benefits of flush-mount surface completion include:

- Protection of wellhead from vehicular traffic;
- Protection of wellhead in buildings and work areas; and,
- Lower visibility.

Potential drawbacks of flush-mount surface completion include:

- Wells can be difficult to locate;
- Wells can be obscured by vegetation or buried by sediment deposited by surface runoff, snow, work activities, storage of materials, etc.;
- Unsuitable for areas where wellhead location may be temporarily, seasonally, or permanently flooded (wetland areas, adjacent to streams, etc.); and,
- More susceptible to infiltration.

Above-ground (Stick-up) Surface Completion

Stick-up surface completion is typically used in areas where monitoring wells may be obscured by heavy vegetation, snowfall, or work activities, in areas where vehicular traffic is not a concern, or in areas where wells may be subject to surface water ponding or runoff. The benefits of stick-up surface completion include:

- Wells are highly visible and relatively easy to locate, as they are generally above low vegetation and/or snow cover;
- Top of well casing is generally high enough to avoid submergence during flooding; and,
- Wells are less susceptible to infiltration.

Limitations of stick-up surface completion include:

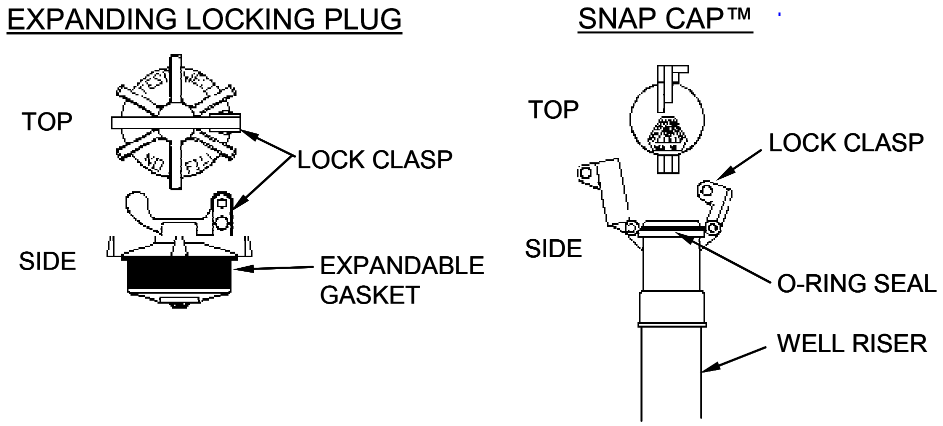
- Unsuitable for areas with heavy traffic; and,
- Unsuitable for aesthetically sensitive areas, such as parks.

EQUIPMENT

Well Plugs

Well plugs are used to seal the riser pipe of the well to prevent foreign material from entering the well (i.e., sediment, insects, debris, liquids, etc.). There are numerous types, the most common of which are expanding locking plugs and Snap Caps™ (Figure 1). The plugs come in various sizes appropriate for the diameter of riser being used. The most common type used for monitoring wells is the expanding locking type, which uses a gasket that expands to fit the top of the well casing to provide a water-tight seal.

Figure 1
Well Plugs



Curb Boxes

Curb boxes include various types of flush-mounted protective devices that secure the wellhead while providing access to the well. Curb boxes typically consist of a body or rim, lid or cover, and skirt. Common types of curb boxes include:

- Round curb boxes with non-bolted covers, used where security is not an issue and/or water-tight conditions are not required;
- Limited access curb boxes, with bolted and gasketed covers, that are used where access to the well must be limited and water-tight conditions are not required;
- Watertight monitoring well curb boxes, which limit or prevent the vertical movement of surface water into the wellhead area;
- Vaults (square manholes) for wells where sampling equipment is stored at the wellhead. This type is not typically used for monitoring well applications; and,
- Flush fill boxes, which mount directly to the monitoring well riser pipe and may or may not include a concrete pad. This type is typically used for temporary monitoring points or in areas not subject to vehicular traffic.

The choice of curb box will be dictated by the site conditions and the expected hazards to the well. Limited-access curb boxes and watertight monitoring well curb boxes are the most commonly used types of curb boxes for permanent groundwater monitoring wells.

Above-ground Well Protectors/ Casings

Above-ground protective casings include both round and square steel casings installed around the well casing to protect the casing from damage. Above-ground casings include lockable covers to secure the well. The protective casings are installed in a concrete pad for wells in unconsolidated formations, and are typically keyed into bedrock for bedrock monitoring wells. The protective casings can be painted in high-visibility colors to help avoid collisions by vehicles and other site equipment and to facilitate locating wells in vegetated areas. Also bollards can be constructed around the protective casings for additional protection from vehicle collisions.

PROCEDURES

Installation of Well Plugs

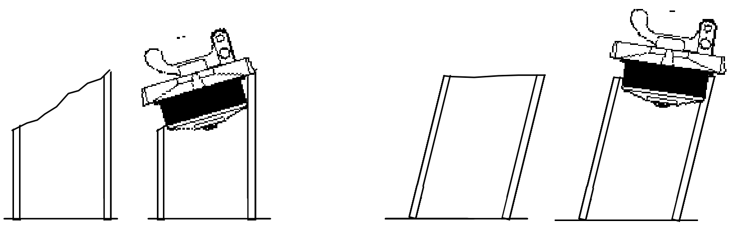
To increase the likelihood of a water-tight seal between the well casing and the well plug, final cutting of the well casing must be completed properly. The drilling contractor should verify the following when cutting the surface casing to final length:

1. The well casing is straight and level (plumb). If the casing is not plumb and cannot be made plumb, then the casing should be cut at right angles to the sides of the casing, not parallel with the ground surface (Figure 2).

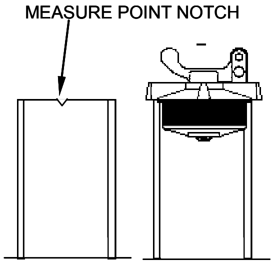
2. When cut to finished length, the casing cut should be as smooth and level as possible. The top of the casing should not be cut at an angle that prevents the well plug from sealing properly (Figure 2).

3. The top of the casing should include a small notch or permanent mark to indicate the measuring point for water level measurements.

Figure 2
Proper Well Plug Installation



IMPROPER IMPROPER



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Flush-mount Installation

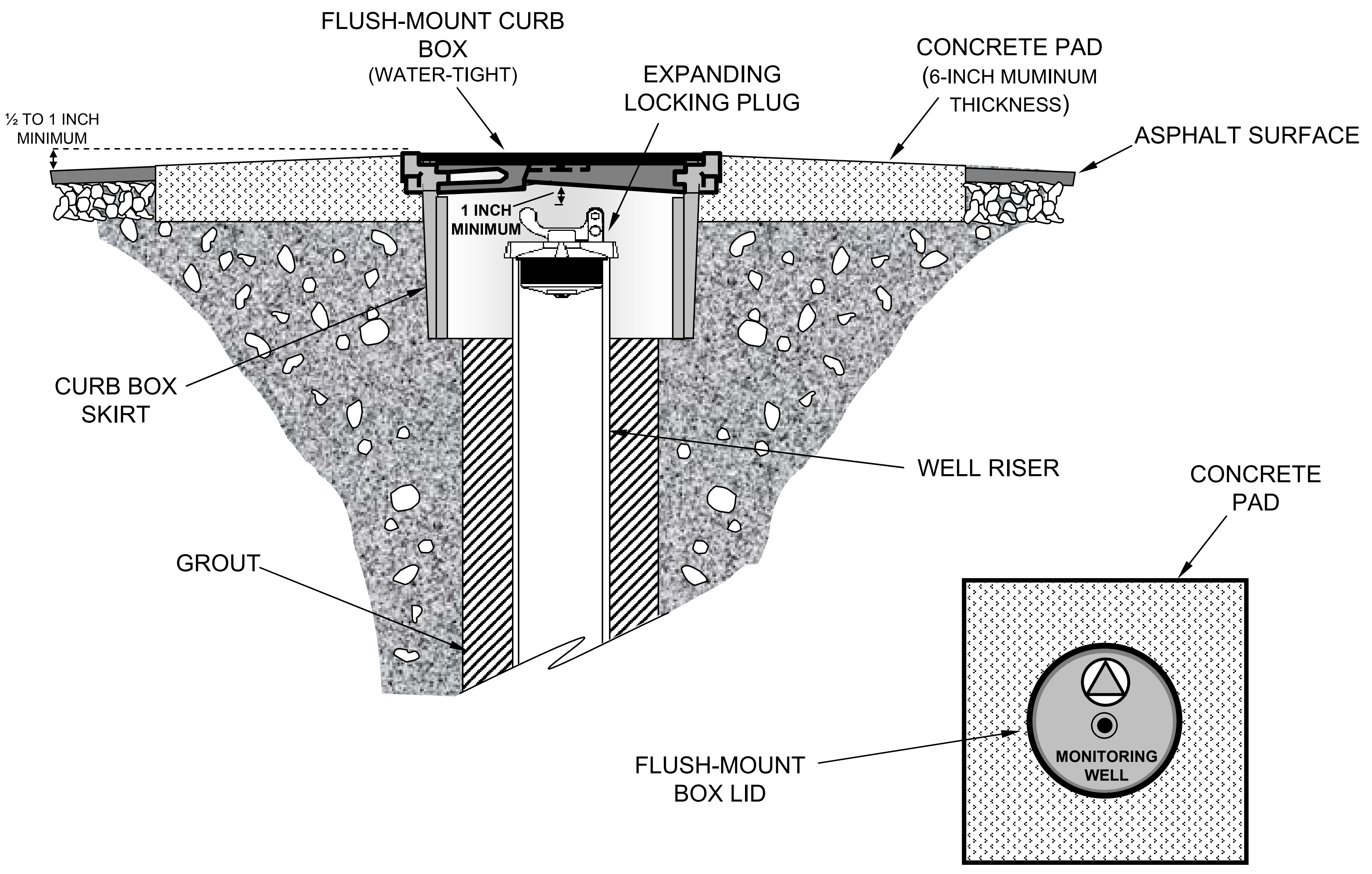
Typical flush-mount surface completions are shown on Figures 3 (pavement) and 4 (unpaved areas). For flush-mount installations, the following general procedures are required:

1. Excavate an area approximately equal to the diameter of the curb box skirt around the well casing to a depth approximate to the depth of the curb box skirt. Alternatively, the skirt typically can be installed in the concrete grout in the upper portion of the borehole.

2. Cut the well casing to a finished length, so that the top of the well casing (including well plug) will be a minimum of one inch below the bottom of the curb box lid.

3. Install the curb box so that the well casing is centered in the box (Figure 5).

4. Using a suitable form, pour a concrete pad to the top of the curb box rim to secure the curb box. The curb box should be slightly above ground level, with the pad constructed so that the pad surface slopes away from the curb box lid to reduce the potential for surface water to accumulate in the vicinity of the wellhead.

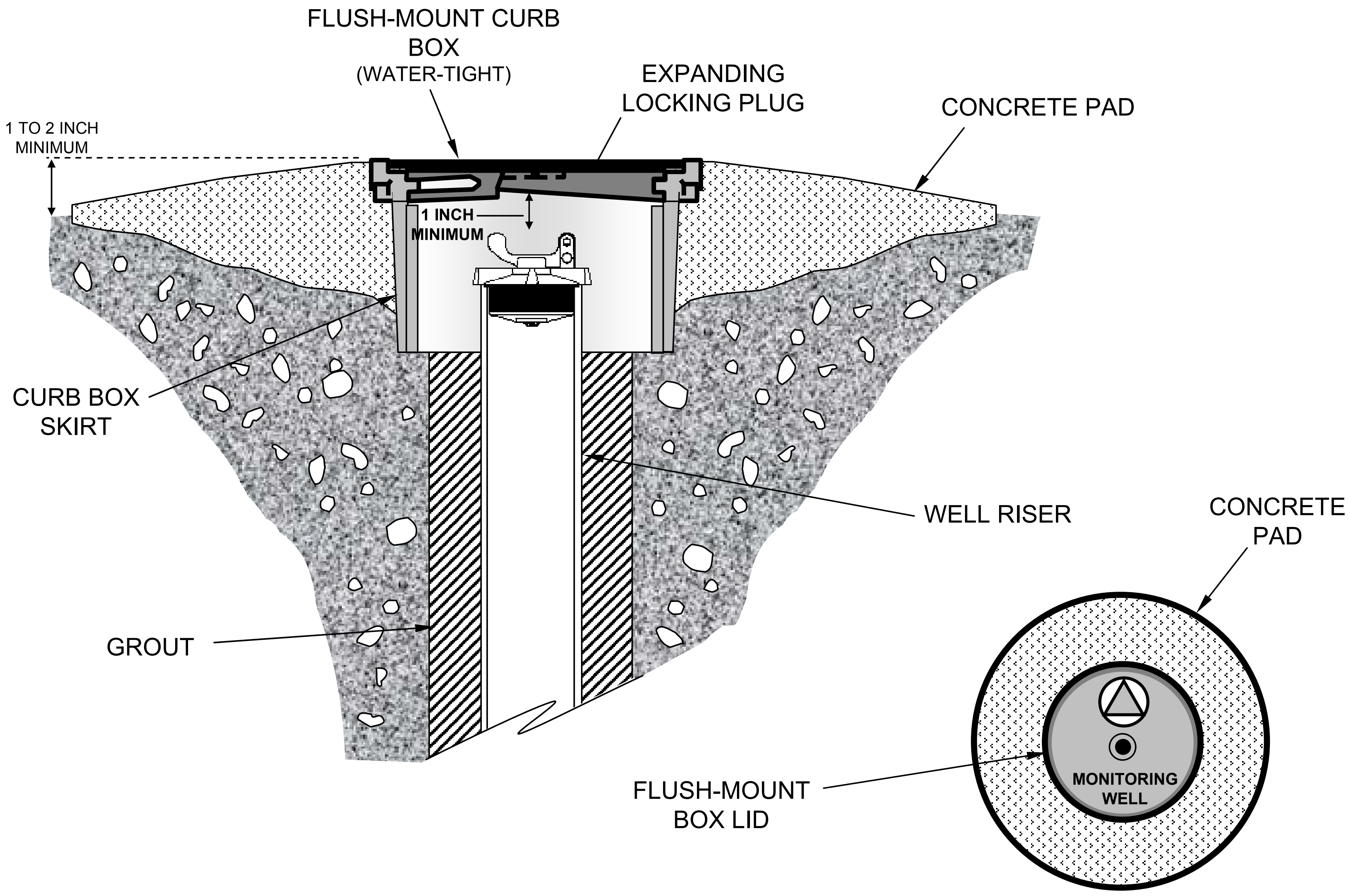


NOT TO SCALE

GENERALLY ACCEPTED PRACTICE
MONITORING WELL SURFACE
COMPLETION

FLUSH MOUNT - PAVEMENT

FIGURE 3



NOT TO SCALE

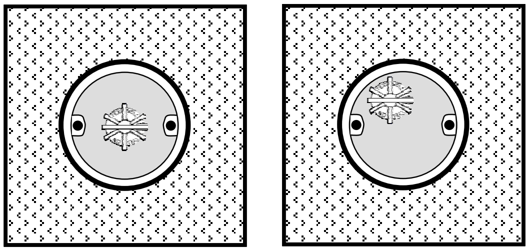
MALCOLM PIRNIE

GENERALLY ACCEPTED PRACTICE
MONITORING WELL SURFACE
COMPLETION

FLUSH MOUNT – UNPAVED AREA

FIGURE 4

Figure 5
Centering Casing in Curb Box



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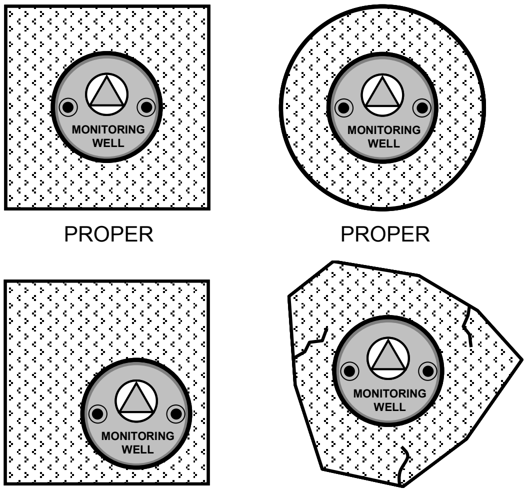
For flush-mount installations in pavement, the following additional procedures are required:

1. The pad should be constructed square or rounded, with a minimum nominal thickness of approximately 6 to 12 inches. In areas of heavy vehicular traffic, the pad should be at the thicker end of this range. Excavate the pad area as necessary to achieve this thickness. The pad should be of even thickness, and sloped away from the curb box as described above. At minimum, the curb box should be approximately ½ to 1 inch above the paved surface when completed.

2. The pad should not be oddly shaped (Figure 6), and should have a smooth surface. The curb box must be centered in the pad.

3. If a significant area of pavement was damaged during drilling, the pavement should be repaired using asphalt patch after installation of the concrete pad.

Figure 6
Concrete Pad Construction



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Above-ground Installation

Typical above-ground surface completions are shown in Figures 7 (pavement) and 8 (unpaved areas). For above-ground installations, the following general procedures are required:

1. Install the surface casing in the borehole so that the surface casing extends below the frost line, or a minimum of three feet below ground surface, into the cement grout within the borehole.

2. Backfill the annular space between the well casing and protective casing with grout to ground surface.

3. Install a concrete pad around the protective casing to provide additional support of the casing. The pad should be constructed in the same manner as described for flush-mount wells (pavement or unpaved areas), with a thicker pad in areas of heavy vehicular traffic.

4. Install a 1/4-inch weephole in the protective casing just above the concrete pad to allow any water entering the protective casing to drain.

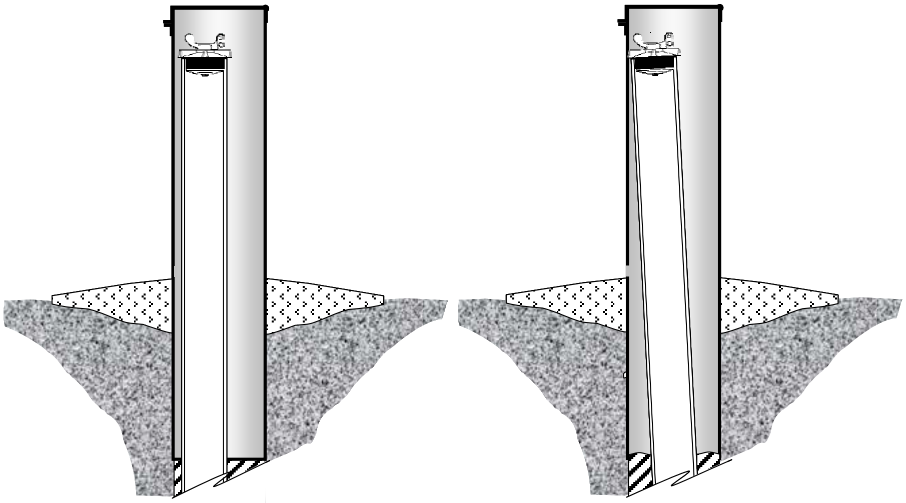
During installation of the protective casing, ensure the following:

1. The protective casing should be plumb.

2. The well casing should be plumb and centered in the protective casing (Figure 9).

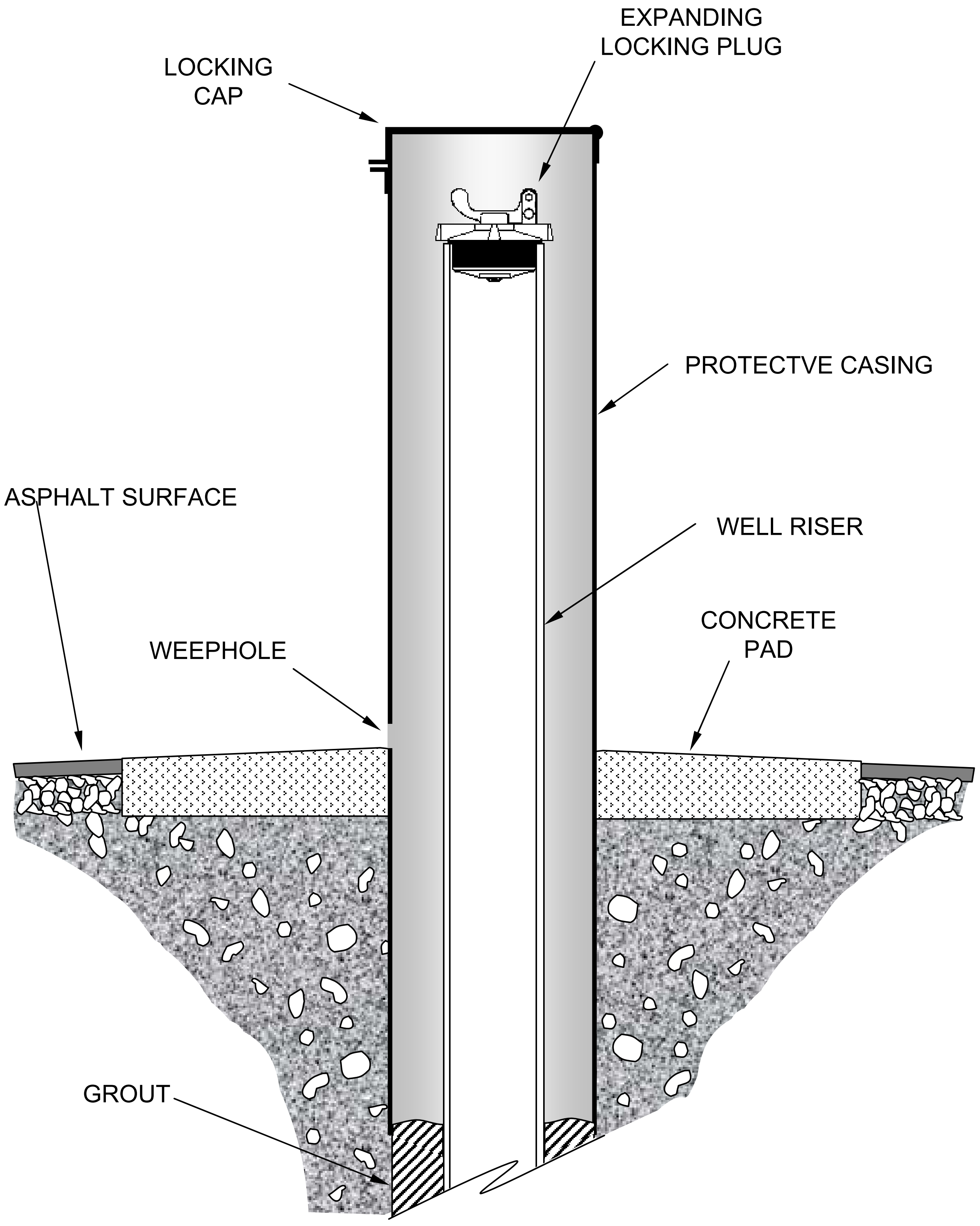
3. The top of the well casing should be no more than 4 inches below the protective casing lid, and no less than 1 inch below the protective casing lid.

<u>Figure 9</u>
Unacceptable Protective Casing Installations



CASING NOT CENTERED

CASING NOT PLUMB



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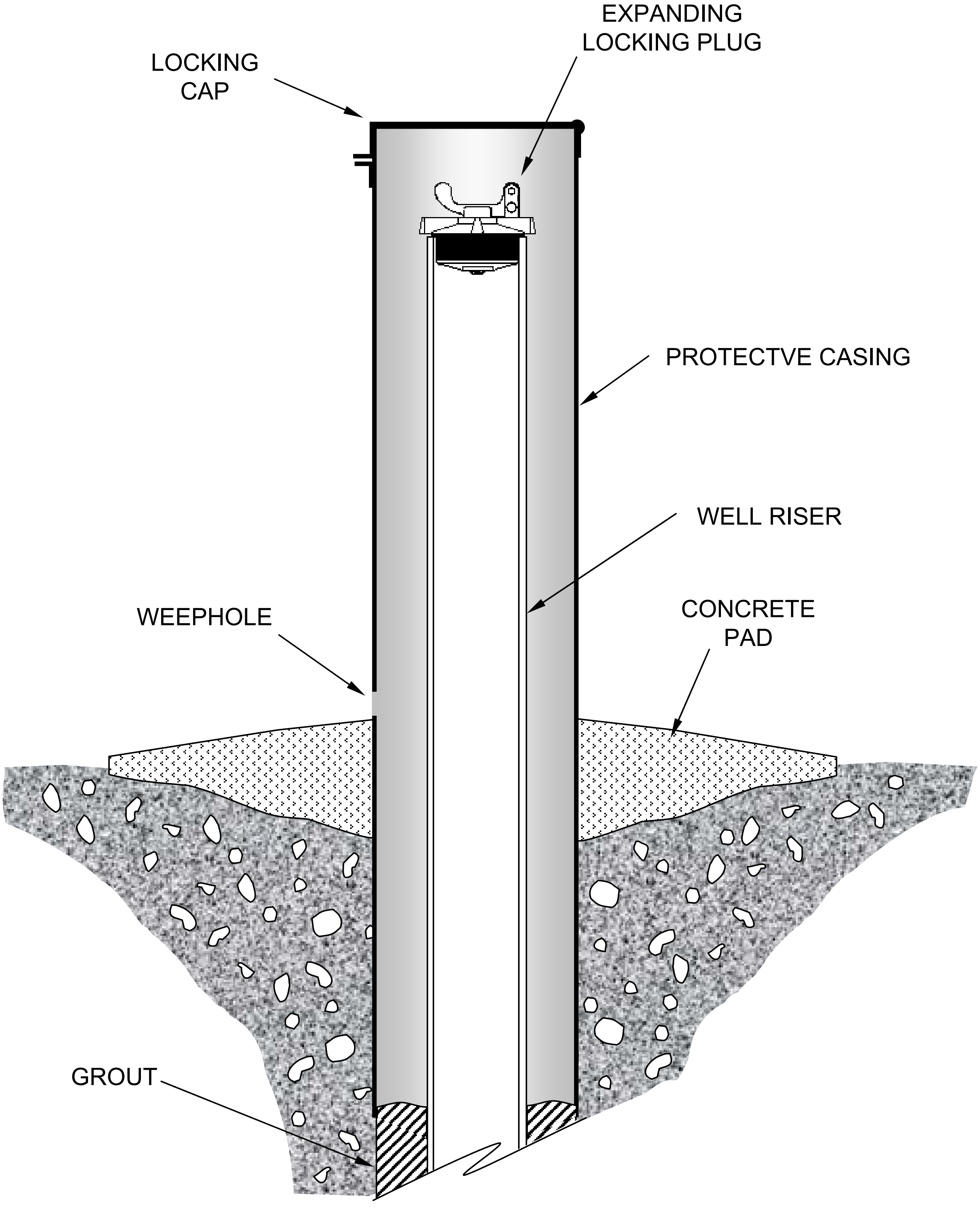
GENERALLY ACCEPTED PRACTICE
MONITORING WELL SURFACE COMPLETION

ABOVE GROUND MOUNT – PAVEMENT

FIGURE 7



MALCOLM PIRNIE

GENERALLY ACCEPTED PRACTICE
MONITORING WELL SURFACE COMPLETION

ABOVE GROUND MOUNT – UNPAVED AREA

FIGURE 8

GENERALLY ACCEPTABLE PROCEDURE

FOR

GEOPROBE SYSTEMS® SOIL CONDUCTIVITY AND MEMBRANE INTERFACE PROBE (SC-MIP)

USE AND DATA QUALITY ASSURANCE/ QUALITY CONTROL (QA/QC)

INTRODUCTION

The SC-MIP is a subsurface, continuous-logging instrument developed by Geoprobe Systems®, a division of Kejr, Inc. of Salina, Kansas, to screen for the presence of volatile contaminants in soil. The instrument is comprised of a permeable membrane and carrier gas system used to detect volatile organic compounds (VOCs) and a dipole soil conductivity measurement tip. The SC-MIP system can be used to qualitatively characterize any site with shallow subsurface VOC contamination, including sites with fuel releases, chlorinated solvents, and non-aqueous phase liquid (NAPL).

POTENTIAL APPLICATIONS

Potential applications of the SC-MIP system include:

- High-resolution characterization of the vertical and lateral distribution of contaminants in the subsurface.
- Determining the presence of NAPL and locating source areas.
- Identification of VOCs present in the subsurface (depending on type of detector).
- Identification of low-permeability soil zones and relative characterization of stratigraphy.
- Focusing remediation efforts.
- Assessing performance of existing remedial systems and pilot studies.

ADVANTAGES

Advantages of the SC-MIP system include:

- Provides rapid, continuous measurements of the presence and vertical extent of VOCs in the subsurface.
- Can operate in both vadose zone and saturated zone.
- Can qualitatively identify specific compounds using a direct-sampling ion trap mass spectrometer (DSITMS).

- Provides useful information for accurately placing more conventional sampling points, such as monitoring wells, multi-level sampling systems, and soil borings.
- Provides simultaneous information on contaminant distribution, general stratigraphy, and the depth and vertical extent of low-permeability soils.
- The SC probe helps to identify low-permeability zones, helping to avoid drilling through an aquitard and possibly carrying contamination into a lower, uncontaminated zone.
- Potential cost savings over more conventional sampling techniques.

POTENTIAL LIMITATIONS

Potential Limitations of the SC-MIP system include:

- Cannot identify specific VOCs using electron capture detectors (ECD), photoionization detectors (PID), or flame ionization detectors (FID).
- ECD, PID, and FID instruments provide a relative (qualitative) response only.
- Results in vadose zone may be misleading due to increased sample area and greater availability of free vapor.
- Significant QA/QC protocols are required.
- The effectiveness of the system is highly dependent on the experience of the operator.
- Relatively shallow operating range (typically no greater than 60-80 feet below ground surface).
- The relatively small sampling area can make correlation between bulk media sampling (soil, groundwater) results and MIP results difficult.

EQUIPMENT DESCRIPTION

System Components

The major field components (see Figure 1) required to collect data and record a data log include the following:

- Field Instrument (FC4000)
- MIP Controller (MP3500)
- MIP/EC Acquisition Software
- MIP Probe, Pull Cap, and Drive Cap
- MIP Trunkline
- Detector (ECD, PID, FID, DSITMS, or other applicable detector)
- Direct-push Soil Boring Equipment (Geoprobe®, CPT rig, or equivalent)
- Stringpot and Stringpot Piston Weight (for depth measurement)
- Rod Rack with MIP Probe Rods
- Carrier Gas System (nitrogen or helium)

Other required or optional system components are listed in the Geoprobe Systems® MIP Standard Operating Procedure (SOP) (Kerj, Inc., 2003).

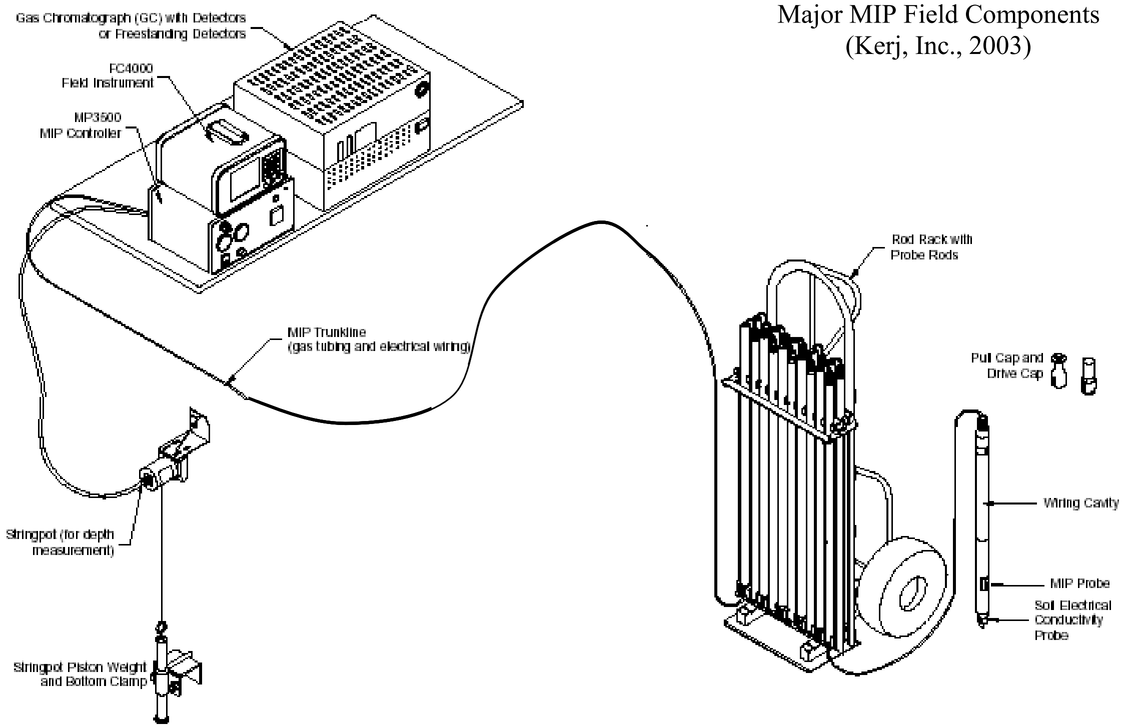


Figure 1.
Major MIP Field Components
(Kerj, Inc., 2003)

Principal of SC-MIP Operation

The MIP portion of the probe uses a heated permeable membrane advanced into the formation by direct-push methods (Figure 2). The membrane does not allow fluids to move across the membrane, allowing the instrument to function in the saturated zone. The probe is advanced into the subsurface at a speed of approximately one foot per minute. A heating element within the probe heats the membrane, which in turn heats the surrounding soil and/or groundwater in contact with the membrane, causing VOCs present in the media to volatize and diffuse through the polymer membrane (Christy, 1996). The VOCs are collected by an inert carrier gas and carried to the surface detectors through a pressurized gas return tube within the MIP trunkline. The carrier gas is fed into an applicable detector, typically an ECD, PID or FID, which qualitatively measures the VOCs. The detector output (in millivolts) is recorded versus a corrected depth measurement

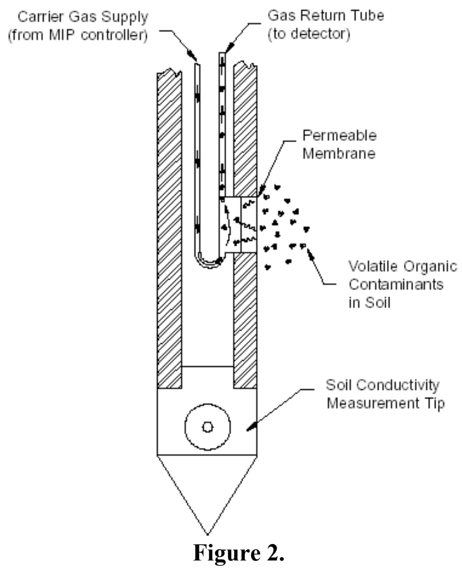


Figure 2.
Schematic of SC-MIP Probe
(Kerj, Inc., 2003)

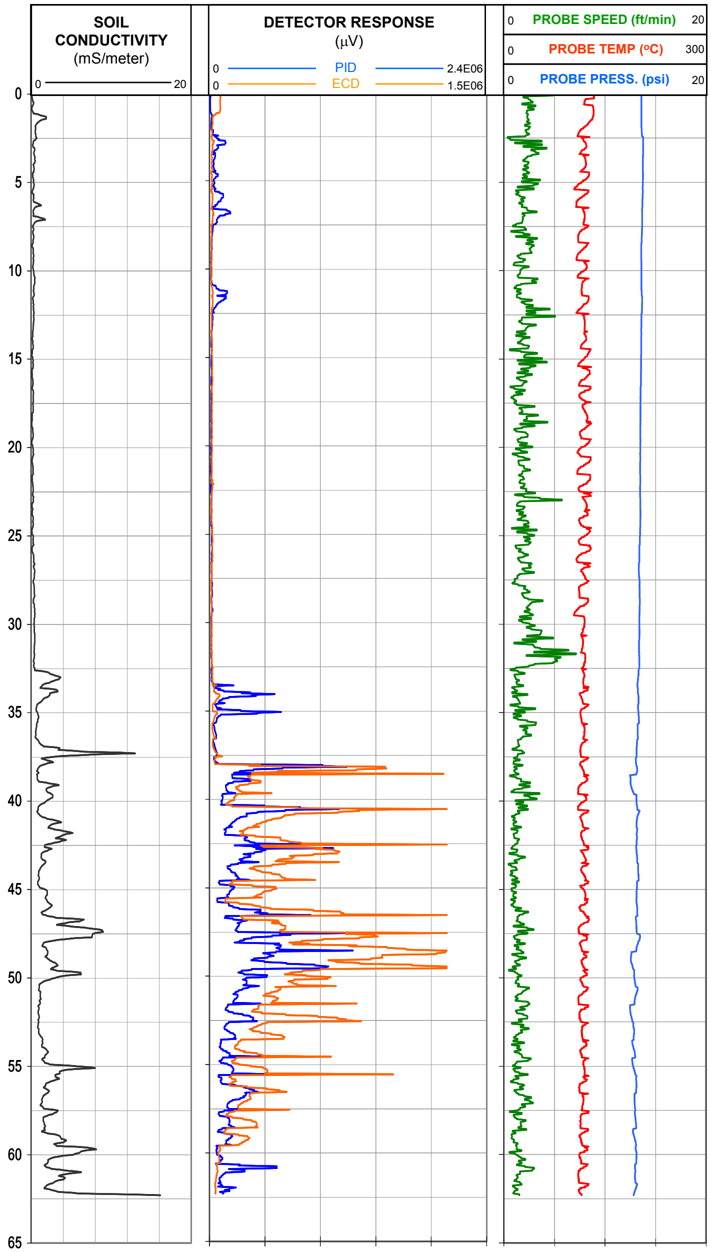
(Figure 3) based on the travel time of contaminants through the carrier gas return tube as determined by membrane response testing.

The SC tool uses a dipole arrangement at the tip of the probe, in which an alternating electrical current is passed from an insulated center electrode into the formation and returned to the probe body. The response of the formation to the current is measured as a voltage drop across the dipoles, which is then used to calculate formation resistance using Ohm's Law (Kerj, Inc., 1995):

$$Resistance\ (R) = \frac{Voltage(V)}{Current(I)}$$

The formation conductivity is determined as the inverse of the resistance (1/R), typically in units of milliSiemens per meter (mS/m).

Figure 3.
Example SC-MIP Output Log



EQUIPMENT OPERATION

Personnel

Generally, three personnel are required to operate the drilling and MIP equipment- two crew members under the direction of the field scientist overseeing field activities. One crew member operates the direct-push drilling equipment, and the other operates the MIP controller, logging equipment, and detectors as directed by the field scientist.

The field scientist overseeing SC-MIP operation and the assisting crew member should have a working knowledge of the principals of equipment operation and QA/QC procedures as outlined in this GAP. The field scientist should also be familiar with the expected output of the detectors and how this output is affected by the SC-MIP system controls.

Detector Selection

Detector selection is based on the subsurface contaminants expected at the site. In general:

- The FID is used for detection of unsaturated hydrocarbons, including methane;
- A PID is used for general VOC screening including petroleum hydrocarbons; and,
- An ECD is used primarily for detection of chlorinated VOCs (CVOCs).

Other detectors, including DSITMS and similar low-volume gas chromatography detectors, may be used to provide qualitative analysis and differentiation of VOC and CVOC compounds. More than one detector can be used simultaneously for initial investigations where subsurface contaminant characteristics are unknown.

Regardless of the detector used, each detector should be calibrated following the instructions provided by the manufacturer.

Membrane Response Testing

Response testing is an important check to examine if the system is operating properly and to demonstrate that the system is detecting the correct compounds. The response test also provides the operator with the travel time of the contaminant from membrane to detector, which allows the logging software to correct depth for each reading.

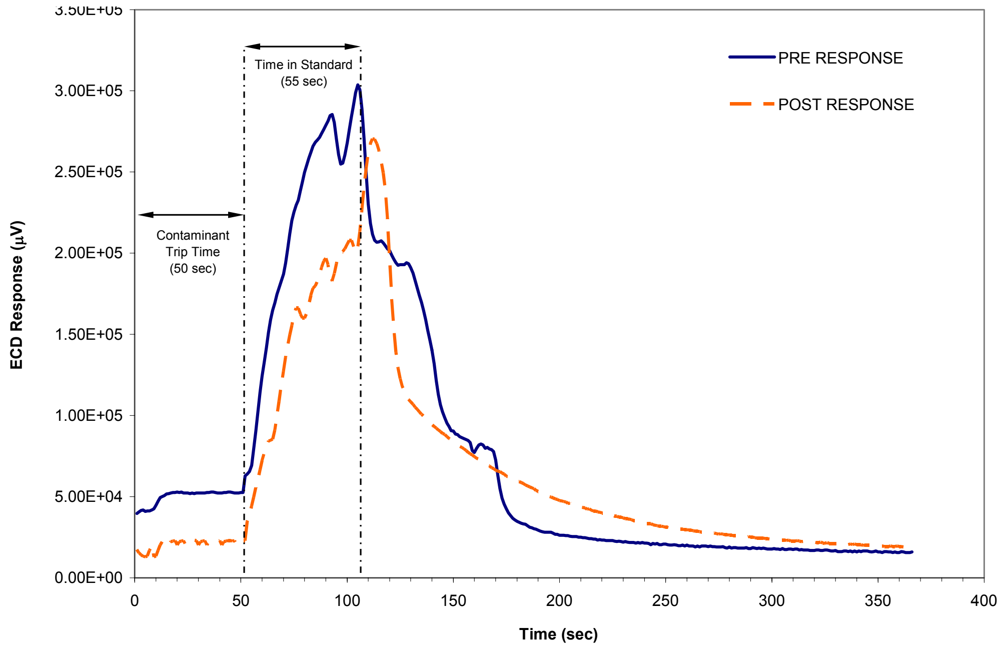
The procedure for response testing is detailed in the Geoprobe Systems® MIP SOP (Kerj, Inc., 2003). In general, the steps for response testing to be performed by the contractor are as follows:

1. Using a neat sample of the analyte of interest, prepare a stock standard of the analyte at a concentration of 50 mg/ml.
2. Immerse the probe in a 5-gallon bucket containing fine sand and distilled water, to simulate saturated subsurface conditions. The response represents the baseline reading.
3. Access the MIP time software and view the detector vs. time data - wait for the detector to stabilize to the baseline output.

4. Using 500ml of distilled water, mix the desired test concentration (working standard) using the stock standard solution in step 1 (above), following the instructions detailed in the Geoprobe Systems® MIP SOP (Kerj, Inc., 2003).
5. Pour the working standard into a 2-inch by 24-inch PVC test cylinder (Kerj, Inc., 2003) and insert the SC-MIP probe.
6. View the results of the MIP response using the MIP time software. Determine contaminant trip time and response time from the output graph.

Typical pre-logging and post-logging response curves are shown in Figure 4. Detector response during both the pre-logging and post-logging response tests should be at a minimum one order of magnitude above the baseline response. Additionally, the response test should be performed both prior to and after the subsurface run. The results of the pre-logging and post-logging response tests are then compared and should show detector responses within at least 10 percent of each other. If the pre-logging detector response is less than one order of magnitude above baseline response, ensure that the contractor performs the following checks:

Figure 4.
Typical Response Test (ECD) with 10ppm Standard



- ■ Inspect the detector for correct settings, and ensure that the detector is functioning properly.
- ■ If using a PID, inspect the lamp for film. A film may form on the detector lamp due to the constant flow of carrier gas over the lamp, causing the PID response to diminish. Clean or replace the lamp and repeat the response test.
- ■ Check the carrier gas trunkline for leaks, and ensure proper carrier gas pressure (approximately 13 to 17 psi).
- ■ Confirm the MIP is on and at proper temperature (80-125°C, 100°C optimal).

- Ensure the detector is calibrated to the instructions provided by the manufacturer.
- Visually inspect the membrane. Allow the membrane to cool, and apply water while the carrier gas system is operating. If bubbling occurs, or damage is observed indicating the membrane is compromised, replace the membrane as per the Geoprobe Systems® MIP SOP (Kerj, Inc., 2003) and repeat the response test.

Field Operation

The procedure for field operation of the SC-MIP system is detailed in the Geoprobe Systems® MIP SOP (Kerj, Inc., 2003). In general, the field operation procedure is as follows:

1. Power on the field equipment generator.
2. Turn on the carrier gas system and check the flow rate. Inspect the system for leaks or kinks. Allow the system to purge for at least 3 minutes prior to each boring.
3. Power up the detector(s) and allow them to warm-up as required. Ensure that the detectors are calibrated as per the instructions provided by the manufacturer.
4. Turn on the MIP controller and FC4000 Field Instrument.
5. Advance a pre-probe rod 3 to 4 feet into the subsurface at the location to be logged. Install the SC-MIP into the hole and connect to the direct-push drill string as per the Geoprobe Systems® MIP SOP (Kerj, Inc., 2003).
6. Load the MIP time software, and perform the pre-logging membrane response test to confirm that the system is responding as expected. If response is less than one order of magnitude above baseline, perform system checks as described above.
7. Ensure that the proper contaminant travel time is entered into the software. If the trip time is incorrect, restart the software and enter the correct contaminant travel time.
8. Prepare the SC-MIP system for driving (stringpot setup, drive cap, etc.) as per the Geoprobe Systems® MIP SOP (Kerj, Inc., 2003).
9. Record the carrier gas trunkline pressure, contaminant travel time, Detector response time, and baseline detector readings in a field notebook.
10. Advance the probe at a rate of 1 ft/min to the boring depth.
11. When the boring is complete, remove the probe as per the Geoprobe Systems® MIP SOP (Kerj, Inc., 2003).
12. Perform the post-logging membrane response test to confirm that the system continues to as expected. If response is less than one order of magnitude above baseline or is not within 10 percent of the pre-logging response test, perform system checks as described above.
13. Perform QA/QC checks as described below by reviewing the datalog and data plots.

If the post-logging membrane response test was not within 10 percent of the pre-logging response test, evaluate the data plot for the sample point. If the data is suspect (i.e., limited response or significant noise in the response) or the system stopped functioning properly during sampling (i.e., loss of carrier gas pressure of greater than +/- 1 psi, heater malfunction, etc.)

repeat the boring at a new location with steps 5 through 11 after completing system checks (as described above under membrane response testing).

If a new membrane was installed prior to performing the pre-logging response test, the difference in response between the pre-logging and post-logging test may be greater than 10 percent. However, the system should be thoroughly checked, and an additional post-logging response test performed, which should be within 10 percent of the first post-logging response test.

QUALITY ASSURANCE/ QUALITY CONTROL

The following are important to note when evaluating MIP data:

- The movement of VOCs across the permeable membrane is a function of the contaminant vapor pressure, which can be affected by temperature and the pressure gradient across the membrane created by the movement of carrier gas through the trunkline.
- The response of the MIP in the vadose zone may be misleading, as increased sample area and greater availability of free vapor may cause increased detector response.
- When an ECD is detecting very high levels of CVOCs in a particular zone, and the PID or FID is detecting relatively low levels of VOCs or unsaturated hydrocarbons in the same zone, be wary. High levels of CVOCs present in the subsurface may be detected by an FID or PID and misinterpreted as low levels of VOCs or unsaturated hydrocarbons when they are not in fact present.
- Carrier gas pressure should be kept within 1 psi of the pressure used during response testing, and monitored closely during logging. If the pressure increases or decreases more than 1 psi, the cause should be determined and corrected.
- If a trunkline restriction is suspected due to a loss of flow at pressure, reverse the gas system and purge the line. Restrictions in flow may be caused by kinks in the trunkline tubing or accumulation of debris at trunkline connection points.
- MIP temperature should remain between 100 to 120^{o}C during logging.
- As stated previously, the post-logging membrane response test should be within 10 percent of the pre-logging response test. A change in membrane response greater than 10 percent may indicate that the data is suspect or the system stopped functioning properly during sampling. Check the system thoroughly to determine a cause, and re-perform the response test.

REFERENCES

Christy, Thomas M., P.E., 1996. “A Permeable Membrane Sensor for the Detection of Volatile Compounds in Soil,” National Groundwater Association, National Outdoor Action Conference, Las Vegas, Nevada. May 1996.

Kerj, Inc., 1995. “A Percussion Probing Tool for the Direct Sensing of Soil Conductivity”, Geoprobe Systems Technical Paper No. 94-100.

Kerj, Inc., 2003. “Geoprobe Membrane Interface Probe (MIP) Standard Operating Procedure”, Geoprobe Systems Technical Bulletin No. MK3010.

McAndrews, B., Heinze, K., and DiGuiseppi, W., 2003. *Defining TCE Plume Source Areas Using the Membrane Interface Probe (MIP)*. In: Soil & Sediment Contamination, 12: 799-813, 2003. Prepared by Earth Tech, Englewood, Co.

GENERALLY ACCEPTABLE PROCEDURE

FOR

LOW STRESS (LOW FLOW) GROUNDWATER SAMPLING

PURPOSE/APPLICATION

This low flow groundwater purging and sampling procedure presents a standard method for collecting groundwater samples that are representative of the formation from which they are being withdrawn. By using low flow rates for purging and sampling to minimize drawdown within the well, three primary benefits gained. First, using a low flow rate during sampling promotes laminar flow, which minimizes the disturbance of sediment at the bottom of a well or fine particles in the well's filter pack. Groundwater samples are therefore less turbid, which reduces sampling time and generally eliminates the need to filter. Second, the amount of groundwater purged from the sampling well is significantly reduced, minimizing investigation derived waste. Third, low flow purging and sampling reduces aeration and therefore helps to preserves the natural chemical characteristics of the groundwater sample. Low flow sampling may be used to collect groundwater samples for analysis of contaminants of concern, as well as geo-chemical and biological parameters.

This guideline is for information purposes and should not take precedence over the requirements of project specific plans. This is especially true for federal project sites, which are governed by regionally directed United States Environmental Protection Agency (USEPA) low flow groundwater sampling protocols.

EQUIPMENT

Low flow groundwater sampling requires traditional groundwater sampling equipment with the addition of the following:

Multi-parameter water quality monitoring system (e.g. Horiba U-22 or equivalent) equipped with a flow through cell.
An adjustable rate, positive displacement, groundwater pump (e.g., centrifugal, submersible, or bladder pumps) constructed of stainless steel or Teflon capable of achieving low flow pumping rates (i.e., 100 to 500 ml/min).
Polyethylene tubing or equivalent.
Flow measurement device (e.g., a graduated container and stop watch).
A water level probe or oil/water interface probe.

PRE-SAMPLING PROCEDURES

The pre-sampling procedures for low flow groundwater sampling and purging are as follows:

1. To minimize the risk of cross-contamination, if possible, begin with the monitoring well that is known or believed to have the lowest contaminant concentrations.

2. Position a sheet of polyethylene over the monitoring well for placement of all sampling equipment.

3. Where applicable, measure the concentration of volatile organic compounds (VOCs) in the well's headspace with a photoionization detector (PID) and record the concentration in the field log book.

4. Measure and record the depth to water and if applicable, the depth to light non-aqueous phase liquid (LNAPL).

SAMPLING PROCEDURES

The procedures for collecting groundwater samples using low flow are as follows:

1. **Pump Installation:** Install the pump by slowly lowering the pump assembly and tubing into the well. The pump should be set to the appropriate depth with the intake being a minimum of two-feet above the bottom of the well to prevent disturbing and re-suspending any sediment at the bottom of the well.

2. **Water Level Measurement:** Measure the depth to groundwater from the top of the well casing using a water level probe. Leave the probe in the well for subsequent water level measurements.

3. **Purging:** Begin purging the well at a rate of 200 to 500 milliliters per minute (ml/min) and measure the water level. If excessive drawdown is observed in the well (i.e. greater that 0.3 feet), reduce the flow rate until the water level stabilizes. When the water level has stabilized, subsequent measurements should be made on five minute intervals. The flow rate, as well as flow rate adjustments should be recorded on a field purge log.

4. **Field Parameter Monitoring:** Field parameters (pH, conductivity, reduction/oxidation potential, DO, and turbidity) should be recorded every five minutes with water level measurements. The well is considered stable and ready to be sampled once the field parameters are stable over three consecutive readings (USEPA Region 2, 1998). The following criteria identify stabilized field parameters:
   - ± 0.1 for pH
   - ± 3.0 percent for conductivity
   - ± 10.0 mv for redox potential
   - ± 10.0 percent for DO and turbidity

   The pump should **<u>not</u>** be removed or shut off between purging and sampling.

5. **Sample Collection:** If necessary, reduce the flow rate to 100 to 250 ml/min to reduce turbulence while filling sample containers during sample collection. Where wells are purged at a flow rate less than 100 ml/min, maintain the same flow rate during sample collection. Disconnect the inflow line from the flow through cell and collect the groundwater sample. All sample containers should be filled directly from the tubing. Allow water to flow from the tubing gently down the inside of the containers to minimize turbulence during sample collection. Groundwater samples should be collected in order of importance, according to the project requirements.

6. **Pump Removal:** Once sampling is complete, slowly remove the pump assembly and tubing from the well. If the tubing is dedicated to the well, disconnect the tubing from the pump, re-insert the tubing into the well, and secure the tubing so it is easily accessible.

7. **Secure Well:** Secure the top of the well casing with a locking cap or expansion plug and close the well. In the case of a stick-up protective well cover, , lock the outer casing.

DECOMTAMINATION

All dedicated or "single use" groundwater sampling equipment should be disposed in accordance with all applicable local and federal regulations. The decontamination procedures for non-dedicated low flow groundwater sampling equipment are as follows:

1. **Pre-rinse:** Operate the pump and flush equipment thoroughly with deionized or distilled water for approximately five minutes.

2. **Wash:** Operate the pump and flush equipment thoroughly with Alconox or other non-phosphate detergent solution for approximately five minutes.

3. **Rinse:** Operate the pump and flush equipment thoroughly with deionized or distilled water for approximately five minutes or until all of the detergent has been removed from the equipment.

FIELD SAMPLING FORM

See attached.

REFERENCES

United States Environmental Protection Agency (USEPA) Region II, 1998, Ground Water Sampling Procedure, Low Stress (low flow) Purging and Sampling, GW Sampling SOP, March 16th.

POTENTIAL PROBLEMS/TROUBLESHOOTING

Insufficient yield, cascading, field parameters failing to stabilize, and aerating the groundwater sample are potential problems when trying to use low flow protocols to collect representative groundwater samples.

Insufficient Yield/Cascading

A low yielding well that cannot sustain a low flow purge rate may eventually go dry. The sampler should take care not to dewater the well below the top of the well screen to prevent cascading of the sand pack. Therefore, pumping a well dry should be avoided in all situations. If a well should go dry, the groundwater sample should be collected as soon as there is sufficient recharge to collect the sample. If the well has not recharged sufficiently within 48 hours, the well should not be sampled.

A low yielding well that consistently demonstrates that it cannot sustain a low flow purge rate of 250 ml/min or less should not be sampled using low flow protocols. Groundwater samples collected from low yielding wells are often representative of the stagnant groundwater within the well and the surrounding sand pack, and not representative of the geologic formation. In addition, these samples are typically very turbid, which can skew the analytical results of groundwater samples being analyzed for organic compounds and metals.

Key Field Parameters Fail to Stabilize

If any key parameters fail to stabilize within four hours of purging, then the following alternatives should be considered:

1. Continue purging until stabilization.

2. Stop purging, do not collect a sample, and document the activity.

3. Stop purging, collect a sample, and document the activity.

4. Stop purging, secure the well, and resume purging the following day.

The key parameter for samples being analyzed for VOCs is dissolved oxygen (DO). The key parameter for all other analytical samples is turbidity. Typically DO and turbidity take the longest to stabilize.

Non-stabilizing turbidity measurements may be avoided by periodically removing sediments that may be trapped in the flow through cell during purging. Trapped sediments may cause artificial fluctuations in turbidity measurements. Additionally, the sampler should visually compare the turbidity of the groundwater in the Cell with the groundwater entering the Cell. If the groundwater entering the Cell is clearer, disconnect the inflow line, drain the turbid groundwater from the Cell, and reconnect the inflow line. Turbidity readings should more accurately reflect true groundwater conditions.

Fluctuations in DO measurements may be caused by air bubbles that form in the flow through cell or sample tubing. Ensure that the inflow tubing is sealed tightly to the flow through cell to prevent the intrusion of air. It may be necessary to drain the flow through cell to remove all air bubbles that may interfere with accurate DO readings.

Aerating the Sample

To prevent inadvertently aerating the groundwater sample, the flow rate should be set so that pump suction and positive groundwater flow through the sample tubing is maintained. The sampler should minimize the length and diameter of the sample tubing. It is recommended that either one-quarter or three-eights-inch inner diameter tubing are used.

Where centrifugal pumps are being used to collect a groundwater sample from a deep well, preventing aeration and sustaining a low flow rate becomes problematic. These issues can be minimized if an impeller is removed from the pump. This allows the pump to run at a lower flow rate and reduces the potential for aerating the groundwater sample. There is also concern that the centrifugal pump will heat the groundwater sample, however, the increases in temperature rarely increases more than two degrees Celsius during sampling.

GENERALLY ACCEPTABLE PROCEDURE

FOR

MONITORING WELL DEVELOPMENT

INTRODUCTION

Drilling a borehole for monitoring well installation or sampling disrupts the natural alignment of soil particles in the formation adjacent to the borehole. With some drilling methods, bentonite or other fine-grained materials are added to drilling fluids to generate drilling mud, which is used to maintain an open borehole. The physical disturbance of the subsurface soils, and in some cases the use of drilling mud, affects the hydraulic conductivity of the saturated formation adjacent to the well and can create a "skin" of fine-grained material along the annulus of the borehole. The objectives of well development are to restore the natural alignment of soil particles to the extent possible, remove finer-grained particles and drilling fluids in and adjacent to the well, and ensure that water in the well is representative of formation groundwater. The appropriate development method to use will vary according to the hydraulic characteristics of the aquifer, the drilling method used, and the type of well completion. Of the various methods available for use in developing wells, mechanical surging, pumping, backwashing, and bailing are best suited for developing monitoring wells.

TECHNIQUES AND ASSOCIATED EQUIPMENT

The necessary equipment, monitoring instruments and field procedures are presented herein for four monitoring well development techniques. Since other procedures may be applicable depending on site conditions, references are provided for more complex development needs, including predevelopment techniques. Development using any of these methods should not be initiated less than 24 to 48 hours after final grouting of the monitoring well (USACE, 1998).

1. **Mechanical Surging**

   Operation of a piston-like device (surge block) in combination with periodic purging of water from the well is a very effective development method, even in stratified formations with variable hydraulic conductivity. The surge block should be constructed with rubber disks secured to stainless steel or PVC pipe with a pipe fitting on top to attach it to drill rods or HDPE tubing. The rubber discs on the surge block should be slightly smaller than the inside diameter of the well. The surge block is carefully lowered into the well and an up-and-down plunging action is used to alternately force water to flow into and out of the well, similar to a piston in a cylinder. The use of a surge block can agitate and mobilize particulates around the well screen. Periods of surging should be alternated with periods of water extraction from the well so that sediment brought into the well is removed. Surging should initially be gentle to assure that water can come into the well and that the surge block is not so tight as to damage the well pipe or screen. For short well screens (1.6 m (5 ft) or less) in relatively homogeneous formations, the surge block does not have to be operated within the screen interval. However, if the screened interval includes materials of high and low hydraulic conductivities, the block may have to be operated gently within the screen.

Equipment needed for mechanical surging would include:

- Surge block
- HDPE pipe if drilling rig not used
- Water-level probe
- Pump or bailer for purging
- Graduated bucket or flow meter to measure volume of water removed
- Multi-parameter field instrument (at a minimum able to measure pH, specific conductance, turbidity, and temperature)

2. **Backwashing**

Backwashing is the reversal of flow through a well screen by first drawing water up through the well with a pump and then releasing the water back into the well. When supplemented with periodic purging, backwashing facilitates the removal of fine-grained materials from the formation surrounding the borehole. The well is pumped until water reaches the surface. At this point the pump is shut off, and water in the hose is drained by gravity creating a reversed flow through the well screen. At times this method can be effective; however in low hydraulic conductivity formations the flow may not be sufficient to achieve the desired results.

Equipment needed for backwashing would include:

- Water-level probe
- Pump for purging
- Tubing with no backflow preventer or check valve
- Graduated bucket or flow meter to measure volume of water removed
- Multi-parameter field instrument (at a minimum able to measure pH, specific conductance, turbidity, and temperature)

3. **Bailing**

The use of bailers is an effective way of manually developing small diameter wells that have a high static water table or are relatively shallow in depth (generally less than 20 feet). Since the diameter of the bailer is commonly close to the same diameter as the well screen, the bailer agitates the water in the well in much the same manner as a surge block. The well should be surged using the bailer for 10 to 20 minutes prior to beginning bailing. To have its most effective surging action, the bailer should be operated throughout the screened interval. Bottom loading bailers can extract sediment that has settled to the bottom of the well by rapid short upward/down motions of the bailer at the bottom of the well.

Equipment needed for bailing would include:
- Water-level probe
- Weighted, bottom-filling bailer (sized appropriately depending on well diameter)
- Graduated bucket or flow meter to measure volume of water removed
- Multi-parameter field instrument (at a minimum able to measure pH, specific conductance, turbidity, and temperature)

4. **Overpumping**

Overpumping is a commonly used development method and consists of pumping a well at a higher rate than water will be extracted during purging or sampling events. This overpumping, however, is usually only successful in relatively non-stratified, relatively homogeneous and permeable formations. By pumping the well at a higher rate than expected during sampling, the particulates may be mobilized and removed. Overpumping should be supplemented with the use of a bottom discharge/filling bailer, (for sediment removal). During development, water should be removed throughout the entire water column in the well by periodically lowering and raising the pump intake.

A disadvantage of only pumping the well is that the smaller soil grains of the filter pack may be bridged in the screen or in the filter pack, as the direction of flow is only toward the screen. To overcome this, overpumping is often used in conjunction with backwashing or surging. This technique is probably the least effective because the well development is occurring in the most permeable zones, often near the top of the well screen (Driscoll 1986). Additionally, overpumping may actually compact finer-grained soils.

Equipment needed for overpumping would include:
- Water-level probe
- Pump for purging
- Graduated bucket or flow meter to measure volume of water removed
- Multi-parameter field instrument (at a minimum able to measure pH, specific conductance, turbidity, and temperature)

PROCEDURES

Well development can be conducted by a drilling contractor or manually by field personnel. In either case, the techniques discussed above should be used and the procedures below should be followed and documented.

1. **Preparation**

In preparation of monitoring well development:

- Coordinate site access and obtain keys to well locks.
- Obtain information on each well to be developed (i.e., drilling method, well diameter, well depth, screened interval, anticipated contaminants).
- Obtain a water level meter, a weighted tape to measure well depth, air monitoring instruments and materials for decontamination, if necessary, and water quality instrumentation capable of measuring, at a minimum, pH, specific conductivity, temperature, and turbidity.
- Assemble graduated containers for temporary storage and measurement of water removed during well development. Containers must be structurally sound, compatible with anticipated contaminants, and easy to manage in the field. The use of truck-mounted or roll-off tanks may be necessary in some cases; alternately, a portable water treatment unit (i.e., activated carbon) may be used to treat the purge water.

2. **Operation**

Development should be performed as soon as it is practical after the well is installed, but no sooner than 48 hours after well completion to allow grout to set. No water shall be added to the well to assist development without prior approval of the regulatory agency. In some cases, small amounts of potable water could be added to help develop a poor yielding well. If practicable, at least five times the amount of water added should be recovered from the well to ensure that all added water is removed from the formation.

For typical well development, a minimum of three borehole volumes of water should be removed and water quality parameters should be measured in the field until it is evident that water purged from the well is representative of formation water. A borehole volume includes the volume of the water column in the well and the volume of water in the saturated portion of the filter pack. Assume 30 percent porosity of the filter pack unless more site-specific information is available. If drilling fluids were used or lost to the formation during well installation, a minimum of five times the estimated quantity of un-recovered water should be removed in addition to the minimum three borehole volumes.

Use the attached Monitoring Well Development/Purging Log and follow these procedures to develop a monitoring well:

- Assemble necessary equipment on a plastic sheet surrounding the well.
- Record pertinent information in the site or personal logbook (client, project, personnel, date, time, location ID, weather conditions, etc.).
- Open monitoring well and measure air quality at the top of casing and in the breathing zone as appropriate.

- Measure and record depth to water and the total depth of the monitor well. Calculate the water column and borehole volume of the well. Note hard or soft bottom to indicate presence or absence of fines in the well.
- Begin development and measure the initial pH, temperature, turbidity, and specific conductivity (at a minimum) of the water and record in the site logbook. Note the initial color, clarity, and odor of the water.
- Continue to develop the well and periodically measure the water quality parameters indicated in step 5 (above). Depending on project objectives, development should proceed until these water quality parameters stabilize, or until the water has a turbidity of less than a predetermined threshold, preferably between 5 and 50 nephelometric turbidity units (NTUs). This may not be obtainable in some fine-grained formations.
- Measure and record the volume of water removed during development, either with a flow meter or a graduated container. Estimate and record the well recovery rate if water is purged during development.
- Containerize or treat water produced by development of contaminated or suspected contaminated wells. Each container must be clearly labeled with the well ID, date collected, and sampling personnel. Determination of the appropriate disposal method will be based on the analytical results from each well and regulatory requirements.
- Note the final water quality parameters in the logbook along with the following data:
  - Well designation (location ID)
  - Date(s) of well installation
  - Date(s) and time of well development
  - Static water level before and after development
  - Quantity of water removed, and initial and completion time
  - Type and capacity of pump or bailer used
  - Description of well development techniques

3. Post-Operation

Follow these procedures to demobilize upon completing well development:

- Decontaminate all equipment;
- Secure and label holding tanks or containers of development water; and
- Review analytical results and determine the appropriate water disposal method.

REFERENCES

Driscoll, Flecther G., 1986. *Groundwater and Wells*. Johnson Screens, pp 497-507.

U.S. Army Corps of Engineers, 1998. *Engineering and Design - Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites.* Publication Number EM 1110-1-4000.

New York State Department of Environmental Conservation
Generic QAPP for Work Assignments

Appendix C:
Operation and Calibration Procedures for Field Instruments

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Appendix C included as a PDF on CD

New York State Department of Environmental Conservation
Generic QAPP for Work Assignments

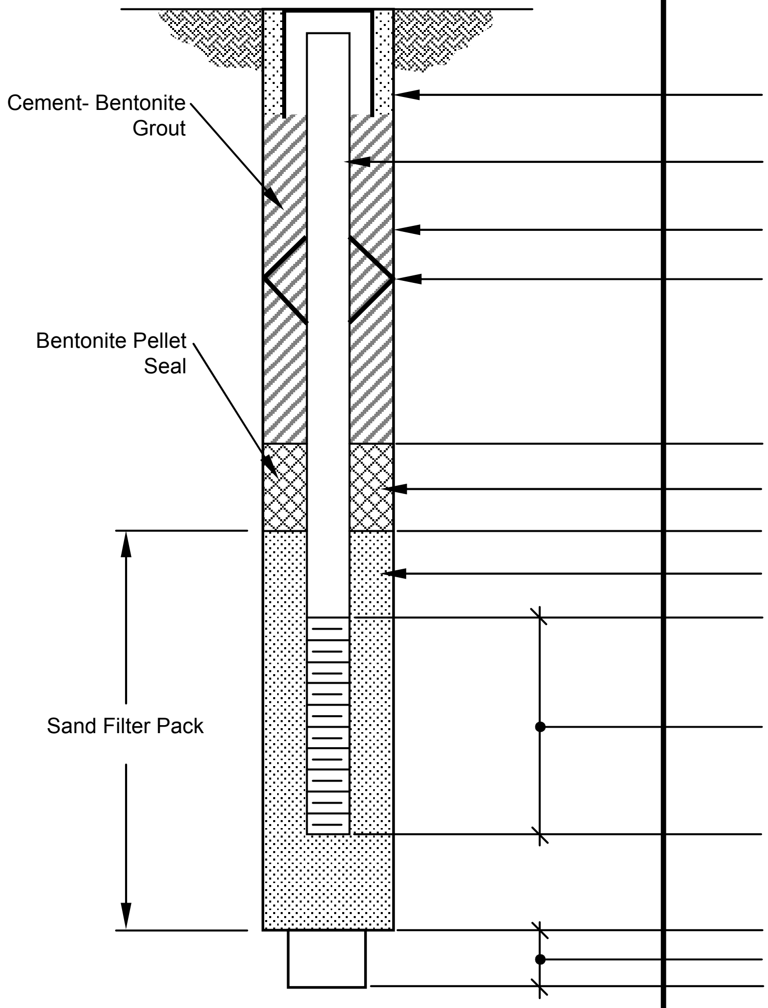
Appendix D:
Field Logs

Overburden
Monitoring Well Construction Sheet

WELL NO. ____________

Project	Start Date	End Date	Drilling Co.
Project No.	Field Geologist		Driller(s)
Location			Drilling Method(s)
			Development Method(s)

Not To Scale



Depth to Top of Grout/ Bottom of Cement .... ____________

Riser Diameter and Material .... ____________

Borehole Diameter .... ____________

Depth to Centralizers .... ____________

Depth .... ____________

Pellet Size .... ____________

Depth .... ____________

Sand Size .... ____________

Depth .... ____________

Screen Diameter, Slot Size and Material .... ____________

Depth .... ____________

Depth .... ____________

Backfill Material .... ____________

Bottom of Borehole .... ____________

NOTE: DEPTHS ARE FEET BELOW GRADE

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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: ____________________			
Surface Drainage	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: ____________	
PID Reading	______ ppm			
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:

____

____

____

____

____

____

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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**

$$v = 0.0408\ (B)^2 \times (A-C) = D$$

$$v = 0.0408\ (\qquad\qquad)^2 \times (\qquad - \qquad) = \_\_\_\_\_\_\_\_\_\_\_\_ \text{ gal.}$$

PARAMETER	ACCUMULATED VOLUME PURGED											
Time												
Gallons												
Well Volume												
Conductivity (mohm/cm)												
Dissolved Oxygen												
REDOX (mV)												
pH												
Temperature (^{o}C)												
Trubidity												
Salinity												
TDS												

Notes: ____________________________________

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INDEPENDENT ENVIRONMENTAL ENGINEERS, SCIENTISTS AND CONSULTANTS

CHAIN OF CUSTODY RECORD

518-782-2100
fax: 518-782-0500

MALCOLM PIRNIE, INC.
43 BRITISH-AMERICAN BOULEVARD
LATHAM, NEW YORK 12110
http://www.pirnie.com

CLIENT: ______________________

PROJECT: ______________________

PROJECT NUMBER: ______________________

LABORATORY: ______________________

LABORATORY CONTACT: ______________________

SPECIAL INSTRUCTIONS:

LAB ID	SAMPLE ID/ DESCRIPTION	DATE	TIME	MATRIX	GRAB/ COMPOSITE	No. of Cont.	ANALYSIS REQUIRED	NOTES / PRESERVATIVE

Matrix Identification:

S - SOIL
SE- SEDIMENT
SO - SOLID
SL - SLUDGE
DW - DRINKING WATER
GW - GROUND WATER
O - OIL
SW - SURFACE WATER
L - LEACHATE
A - AIR
WI - WIPE
DS - DRUM SOLID
DL - DRUM LIQUIDS
X - OTHER
WW - WASTE WATER

LAB USE ONLY

SAMPLED BY (SINGATURE):	DATE/TIME	RECEIVED BY (SIGNATURE):	DATE/TIME:
RELINQUISHED BY (SIGNATURE):	DATE/TIME	RECEIVED BY (SIGNATURE):	DATE/TIME:
RELINQUISHED BY (SIGNATURE):	DATE/TIME	RECEIVED BY (SIGNATURE):	DATE/TIME:
METHOD OF SHIPMENT:	DATE/TIME	LAB USE ONLY:	
RECEIVED AT LABORATORY:	DATE/TIME		

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AIR AND SOIL VAPOR SAMPLING FIELD LOG

PROJECT NAME: ____________________

PROJECT NUMBER: ____________________

PERSONNEL: ____________________

DATE: ____________________

WEATHER: ____________________

TEMPERATURE: ____________________

Sample ID	Indoor Air, outdoor air, or soil vapor?	Canister Size (1-L / 6-L)	Canister #	Flow controller #	Sample Duration	Initial Time	Initial Vacuum (in. Hg)	Final Time	Final Vacuum (in. Hg)	Notes

Notes: ____________________

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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.

COMMUNITY HEALTH AND SAFETY PLAN
COMMUNITY AIR MONITORING PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
MODOCK ROAD SPRINGS SITE, VICTOR, NEW YORK

To provide a measure of protection for any potential downwind receptors, and to confirm that work activities do not generate airborne contaminants, Malcolm Pirnie will conduct continuous monitoring for volatile organic compounds (VOCs) and particulate matter (dust) during all ground intrusive activities at the site. Monitoring will be conducted at the downwind perimeter of each work area.

VOC MONITORING, RESPONSE LEVELS, AND ACTIONS

Volatile organic compounds (VOCs) will be monitored on a continuous basis during all ground-intrusive activities. Upwind concentrations will be measured at the start of each workday and periodically thereafter to establish background conditions. VOC monitoring will be conducted using a MiniRae 2000 photoionization detector (PID) or PPB Rae PID. The PID will be calibrated at least daily using the span calibration gas recommended by the manufacturer. The PID will calculate 15-minute running average concentrations. These averages 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, all work activities will be stopped.

All 15-minute average readings will be recorded and be available for review by the New York State Department of Environmental Conservation (NYSDEC) or the NYS Department of Health (DOH). Instantaneous readings, if any, used for decision purposes will also be recorded.

PARTICULATE MONITORING, RESPONSE LEVELS, AND ACTIONS

Particulate concentrations will be monitored continuously at the upwind and downwind perimeter of the each work area during all 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. Any fugitive dust migration will also be visually assessed during all 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.

All particulate monitoring measurements readings will be recorded and made available for NYSDEC and NYSDOH review.

New York State Department of Environmental Conservation
Generic QAPP for Work Assignments

Appendix C: Operation and Calibration Procedures for Field Instruments

MALCOLM PIRNIE

MiniRAE 3000
User's Guide

RAE SYSTEMS

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 rubber boot):	Polycarbonate, splashproof and dustproof Battery can be changed without removing rubber boot.

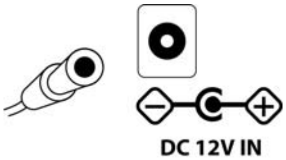
Charging The Battery

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

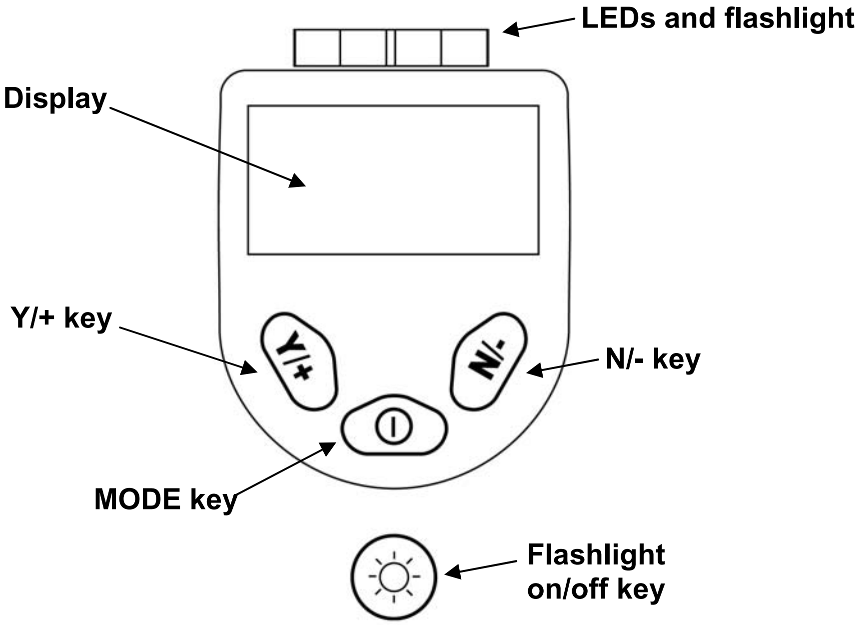
When the instrument is turned off, all the current real-time data including last measured values are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost.

User Interface

The instrument's user interface consists of the display, LEDs, an alarm transducer, and four keys. The keys are:

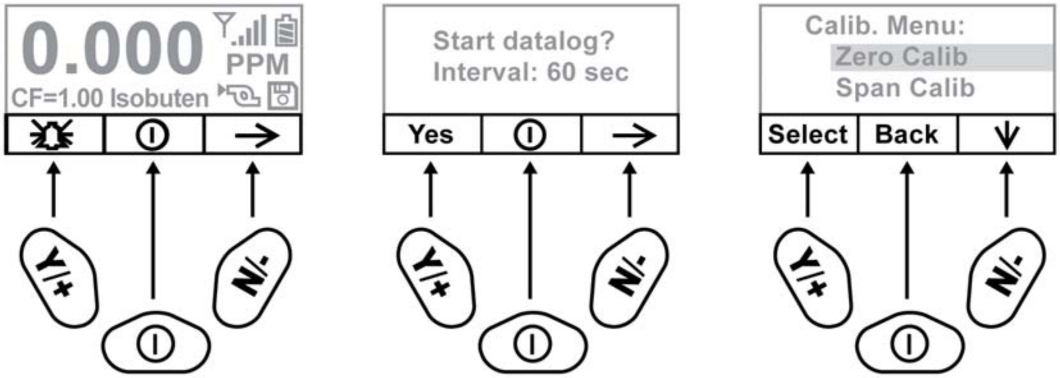
Y/+
MODE
N/-
Flashlight on/off

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.

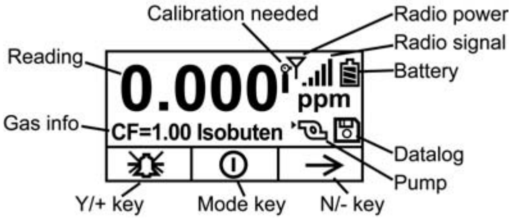
Three panes along the bottom of the display are "mapped" to the keys. These change as menus change, but at all times the left pane corresponds to the [Y/+] key, the center pane corresponds to the [MODE] key, and the right pane corresponds to the [N/-] key. Here are three examples of different menus with the relationships of the keys clearly shown:



RELATIONSHIP OF BUTTONS TO CONTROL FUNCTIONS

Display

The display shows the following information:



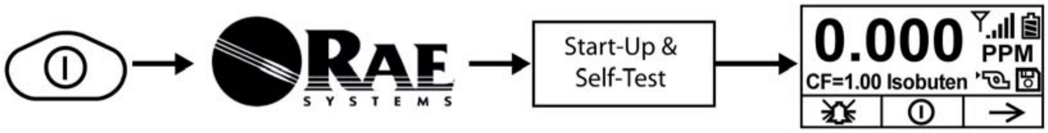
Graph	Graphic representation of concentration plotted over time
Gas info	Tells the Correction Factor and type of calibration gas
Reading	Concentration of gas as measured by the instrument
Calibration needed	Indicates that calibration should be performed
Radio power	Indicates whether radio connection 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)

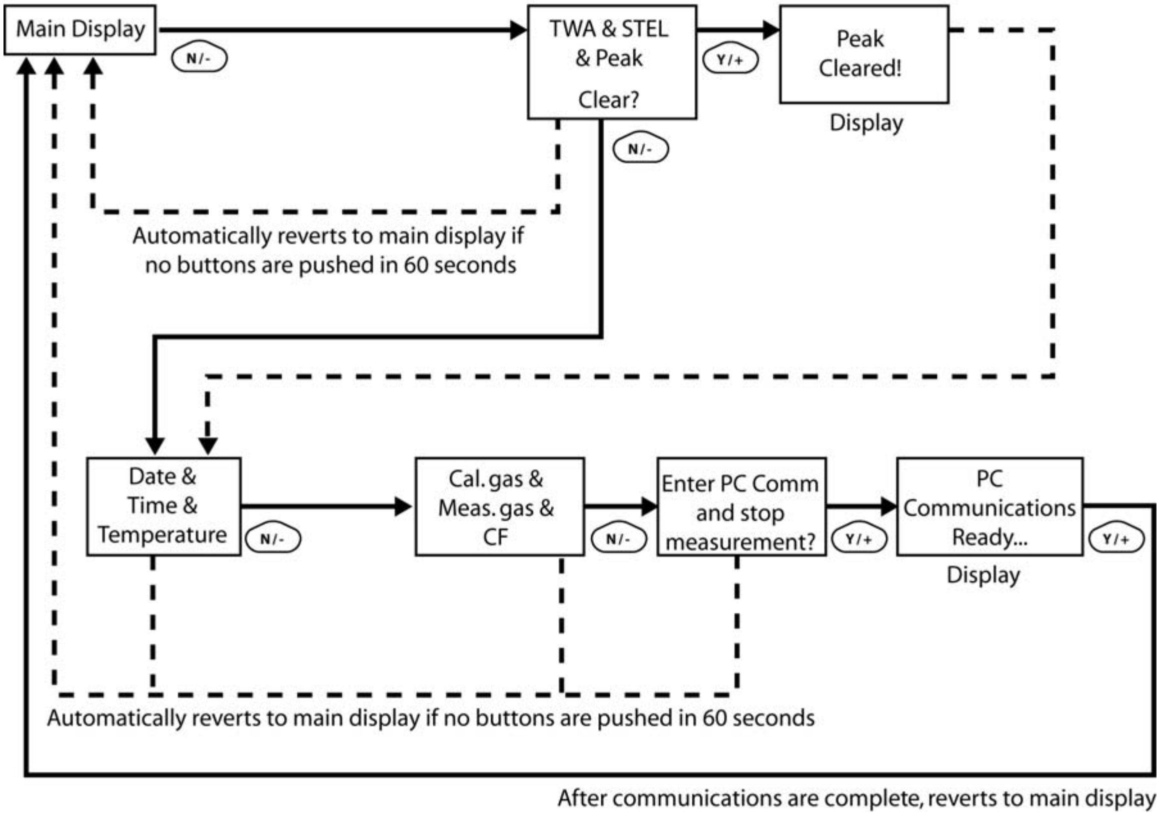
Using ProRAE Studio allows access to other options. In addition, Diagnostic Mode (page 62) is available for service technicians.

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 downloaded 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.

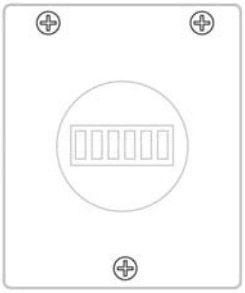
A completely discharged instrument can be charged to full capacity within 8 hours. Batteries drain slowly even if an instrument is off. Therefore, if the instrument has been in storage or has not been charged for several days or longer, check the charge before using it.

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

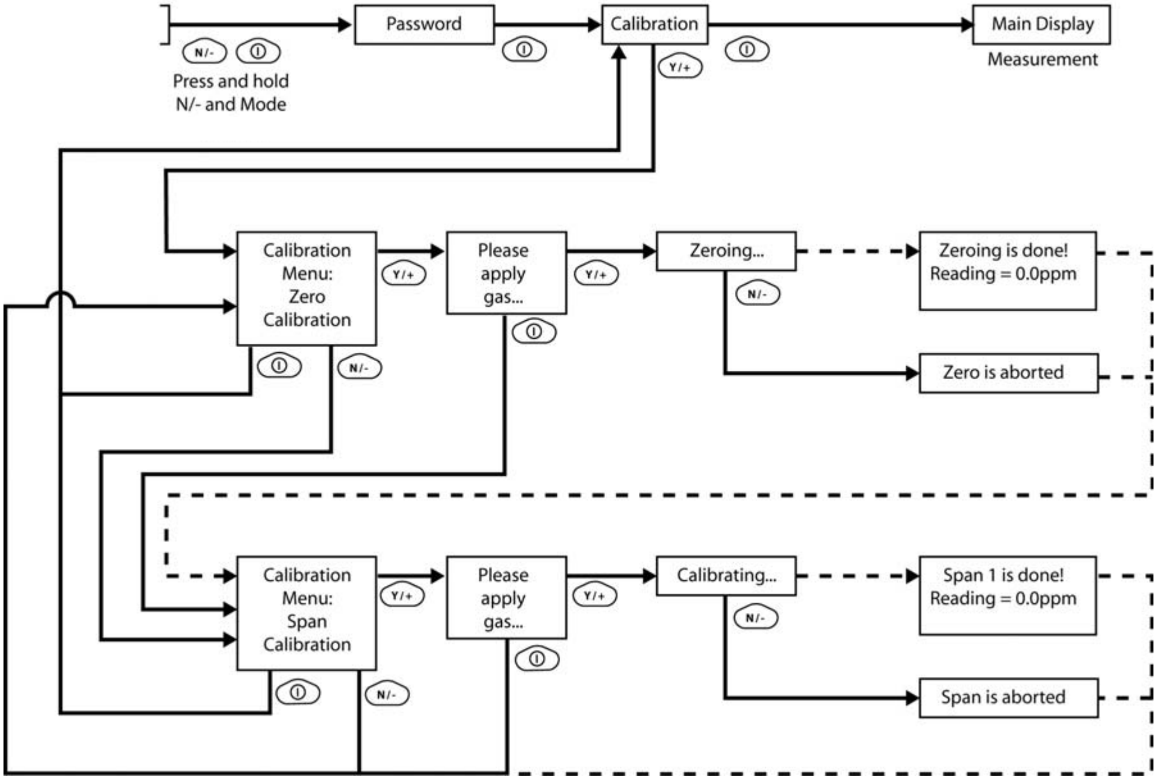
The Calibration Regulator is used in the calibration process. It regulates the gas flow rate from the Span gas cylinder into the gas inlet of the instrument during calibration process. The maximum flow rate allowed by the flow controller is about 0.5L/min (500 cc per min.). Alternatively, a demand-flow 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)

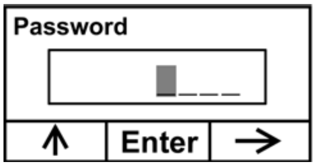
The following diagram shows the instrument's calibrations in Basic/Hygiene mode.



Note: Dashed line indicates automatic progression.

Entering Calibration

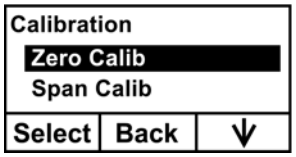
1. Press and hold [MODE] and [N/-] until you see the Password screen.



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.

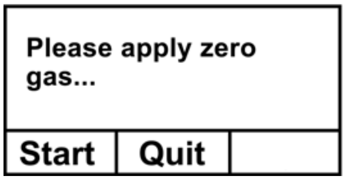
Zero (Fresh Air) Calibration

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...

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

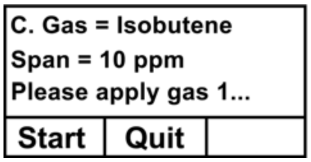
This procedure determines the second point of the sensor calibration curve for the sensor. A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure. Choose the 500 cc/min. regulator only 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...

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…

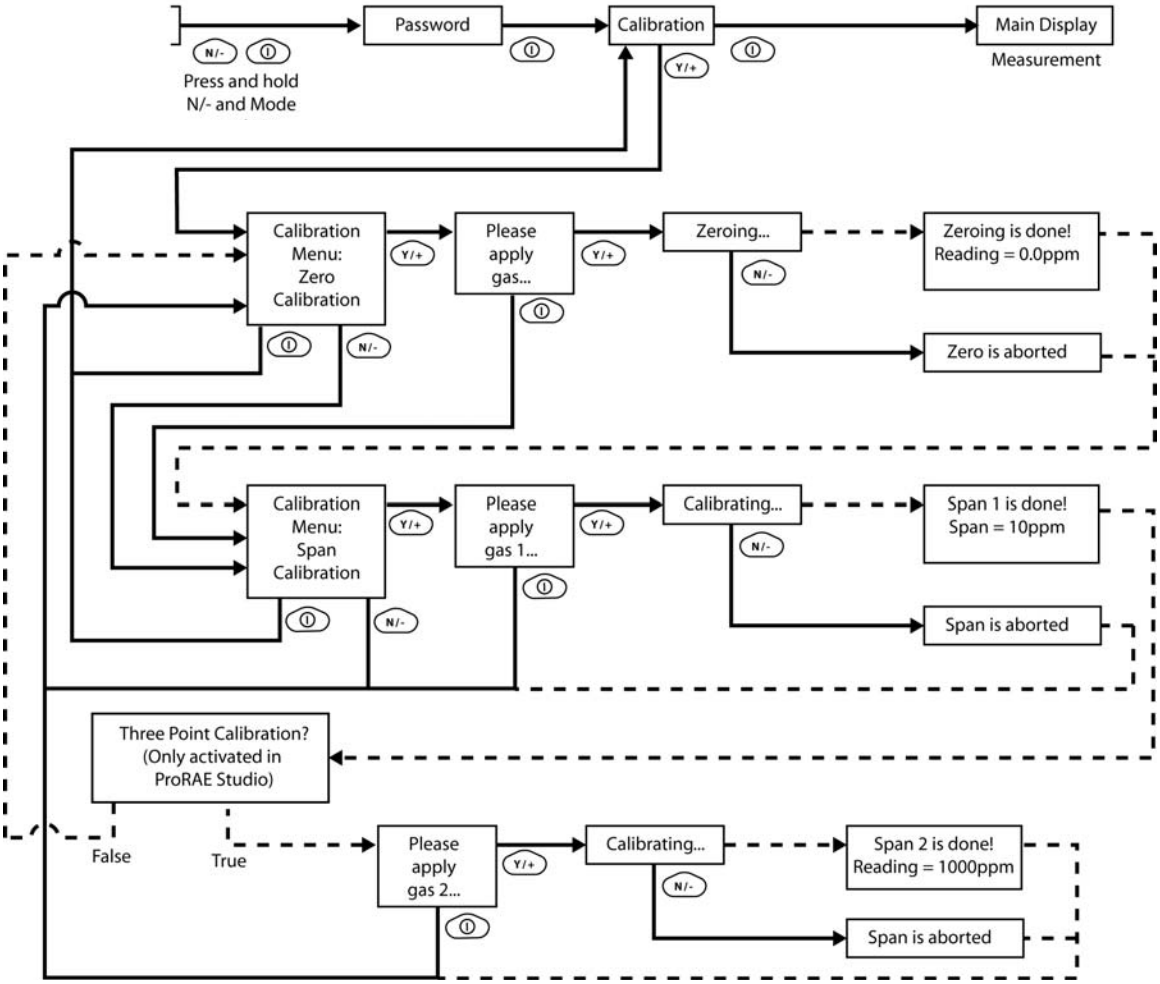
The instrument updates its settings and then returns to the main display. It begins or resumes monitoring.

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…

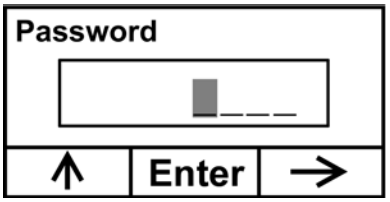
The instrument updates its settings and then returns to the main display. It begins or resumes monitoring.

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.



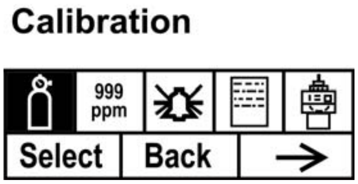
2. Input the 4-digit password:

- 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.

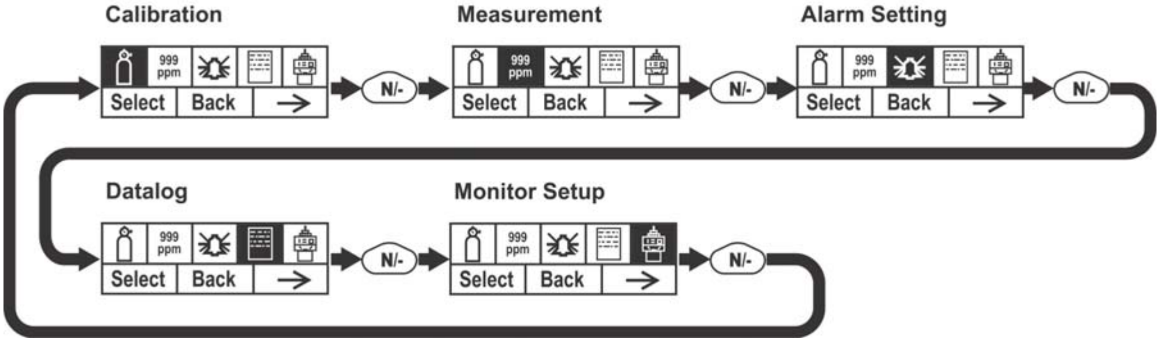
Note: The default password is 0000.

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:

	999 ppm			
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

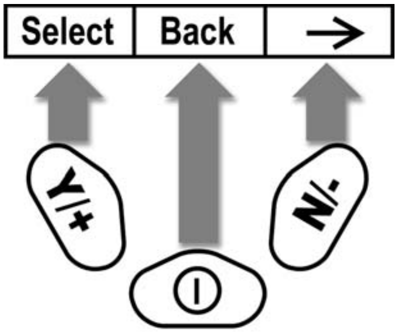
Once you enter Programming Mode, the LCD displays the first menu, Calibration. Each subsequent menu is accessed by pressing [N/-] repeatedly until the desired menu is displayed. To enter a sub-menu of a menu, press [Y/+].

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:



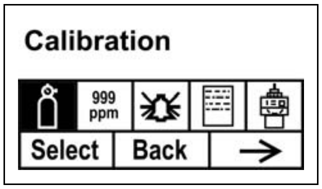
Note: Pressing [MODE] in the Programming Mode's top level causes the instrument to exit Programming Mode and return to monitoring.

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

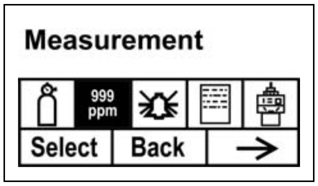
The procedure for performing a zero calibration is covered on page 27.

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/-].

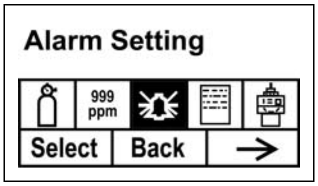
Leave the sub-menu and return to the Programming Mode menus by pressing [MODE].

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

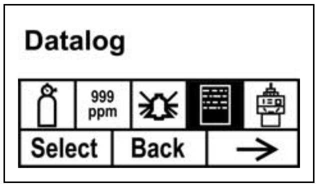
2. Press [N/-] to step from one option to the next.
3. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates your selection).
4. When you have completed your selections, press [MODE].

   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.

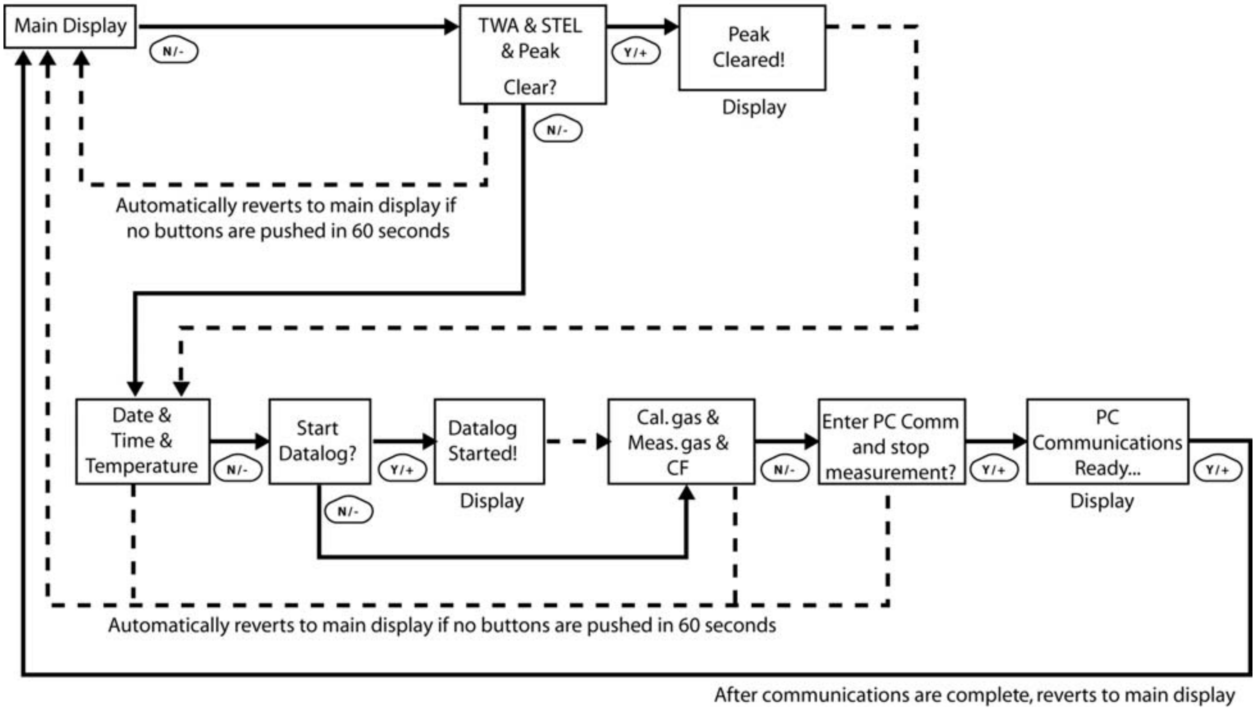
- Press [Y/+] to save the changes.

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.



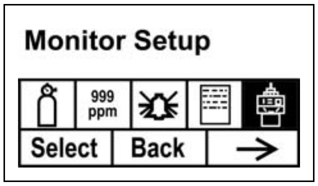
Snapshot Datalog

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.

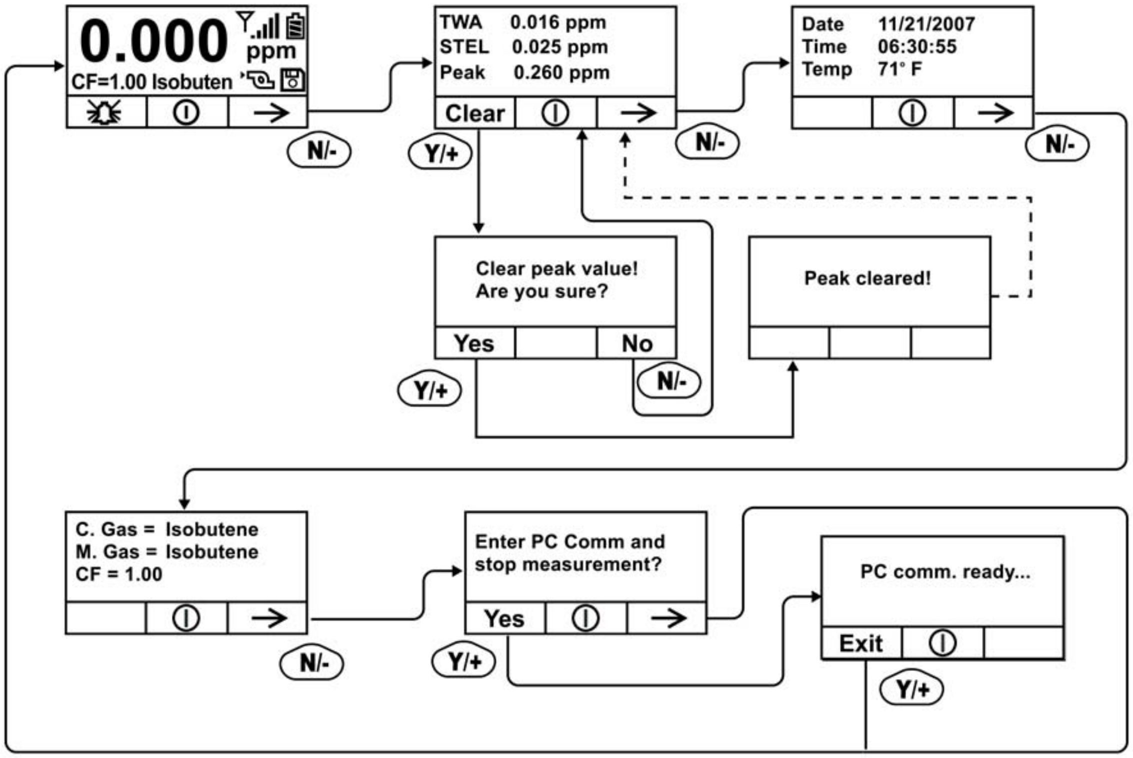
Hygiene Mode

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:

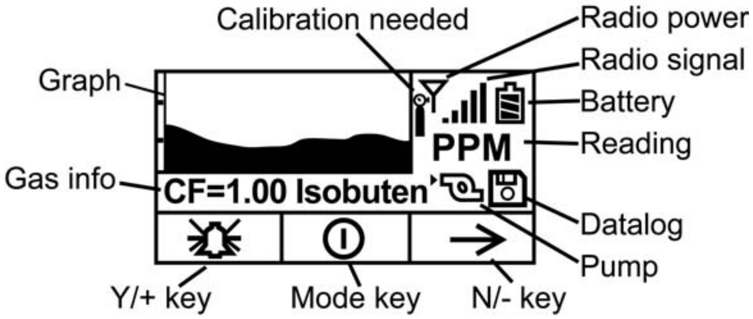
Hygiene
Search

The current mode is indicated by a dark circle within the circle in front of either Hygiene or Search.

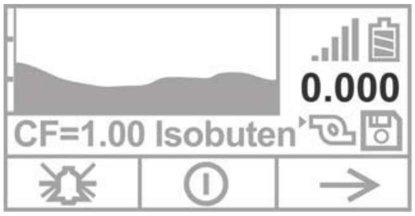
1. Select Hygiene or Search by pressing [N/-].
2. Press [Y/+] to place the instrument into the selected mode.
3. Press [MODE] when you want to register your selection to place the instrument in the selected mode.
4. Press [Y/+] to commit the change and exit to the Monitor Setup screen, or press [N/-] to Undo (exit to the Monitor Setup screen without changing the Mode).

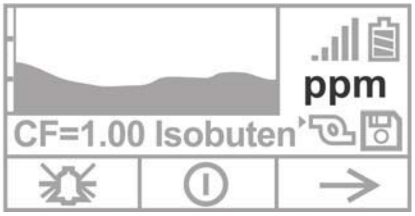
Optional Graphic Screen In Search Mode

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)

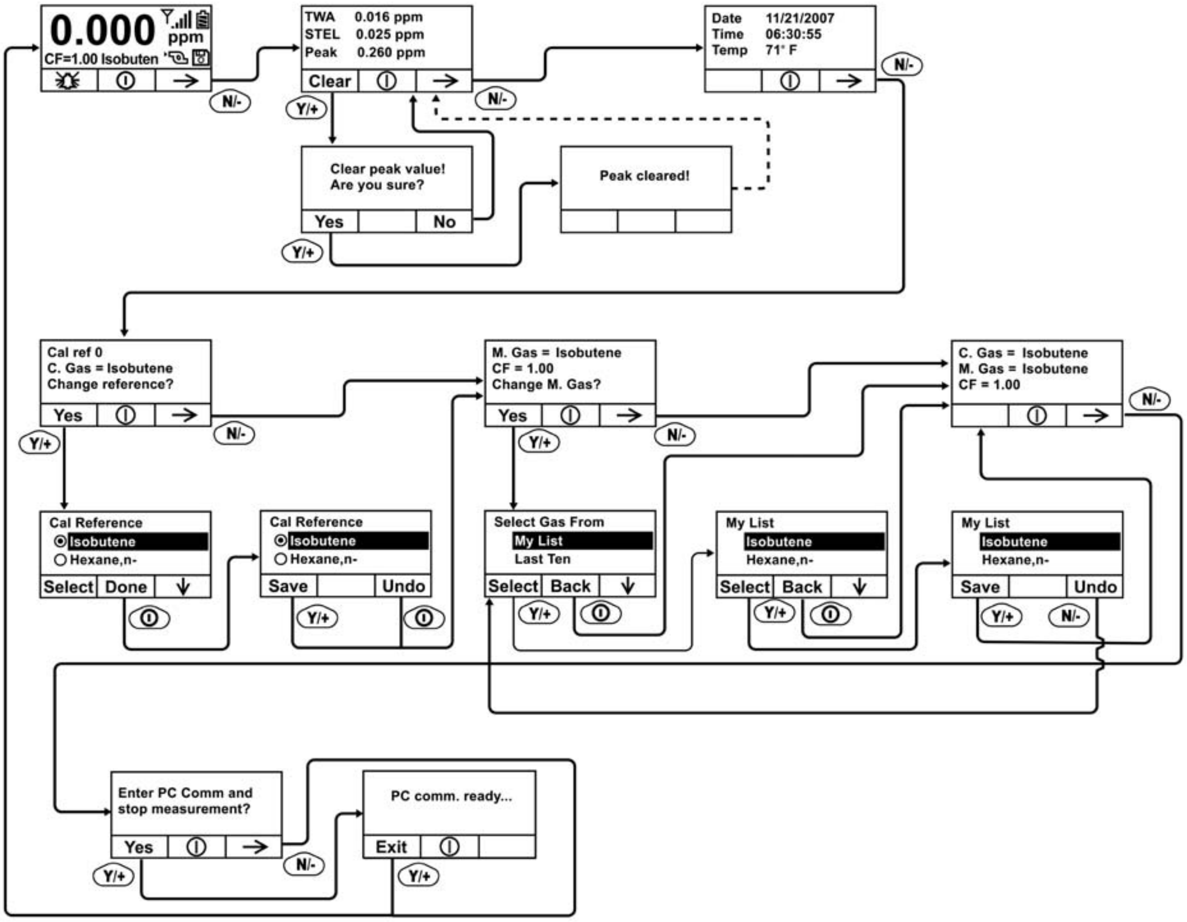
The User Mode called Advanced User Level allows a greater number of parameters to be changed than Basic User Level. It can be used with either of the Operation Modes, Hygiene Mode or Search Mode.

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.

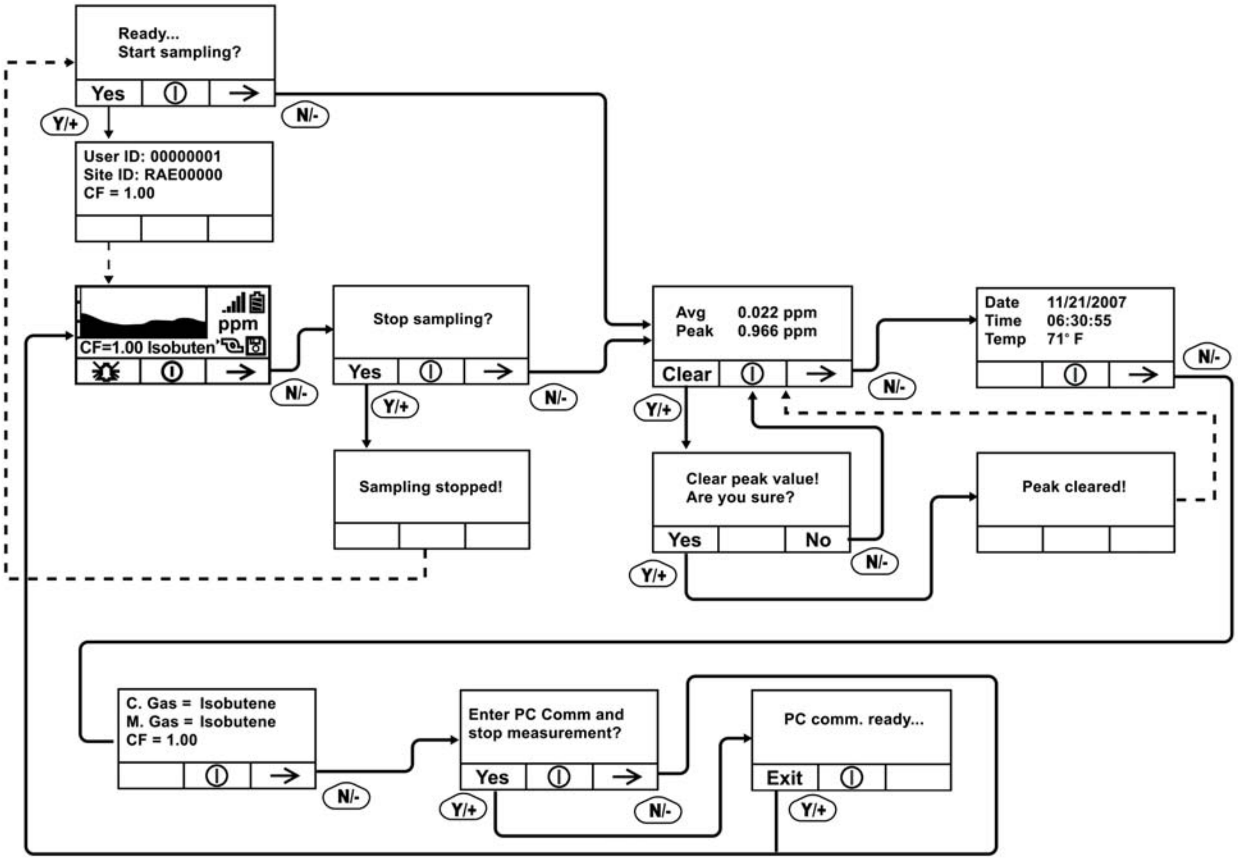


Note: Dashed line indicates automatic change to another screen.

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).

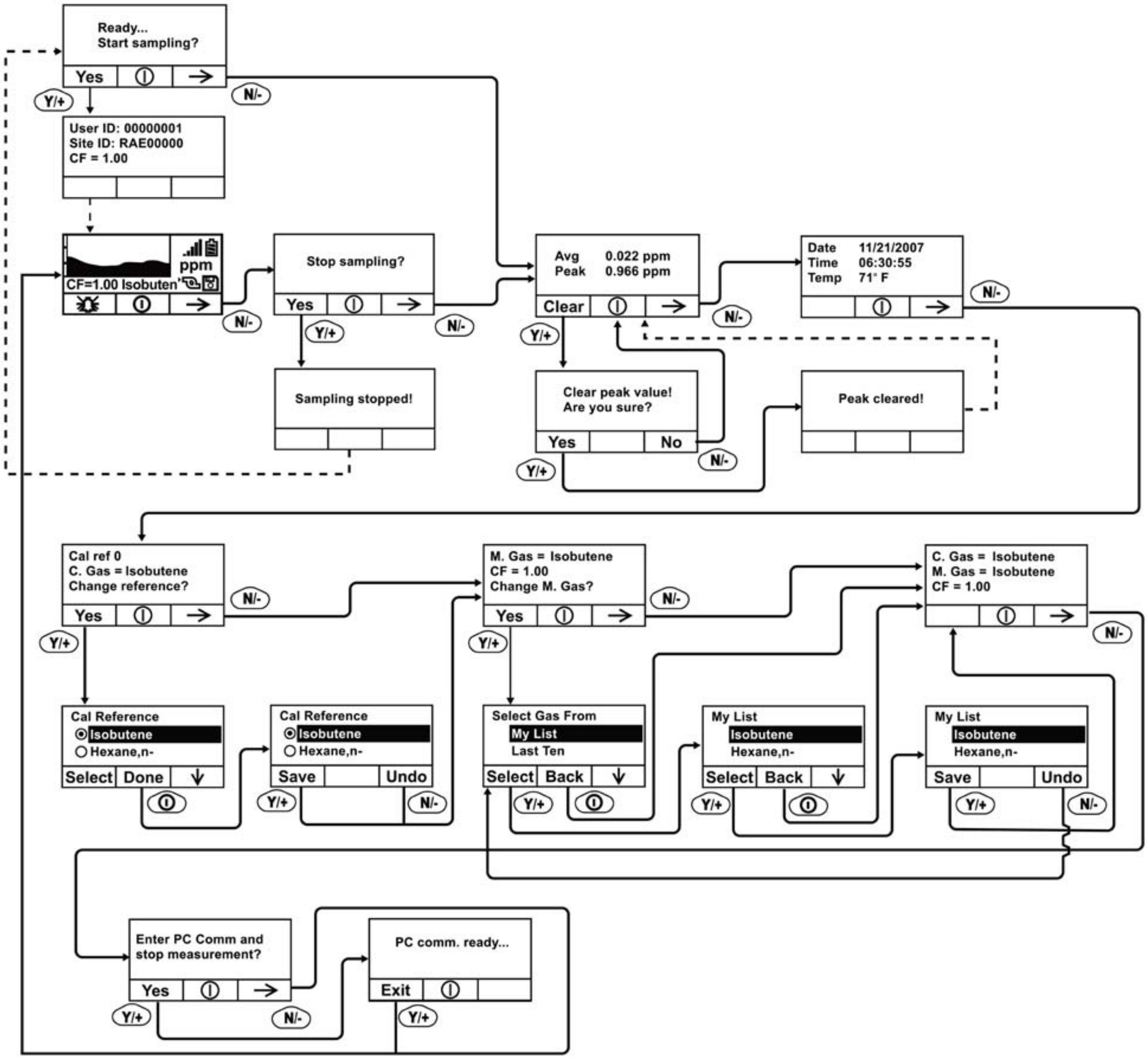
When the instrument is in Search Mode, it only samples when you activate sampling. When you see the display that says, "Ready…Start sampling?" press [Y/+] to start. The pump turns on and the instrument begins collecting data. To stop sampling, press [N/-] while the main display is showing. You will see 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

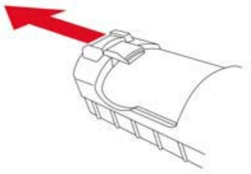
When the display shows a flashing empty battery icon, the battery requires recharging. It is recommended to recharge the instrument upon returning from fieldwork. A fully charged battery runs a instrument for 16 hours continuously. The charging time is less than 8 hours for a fully discharged battery. The battery may be replaced in the field (in areas known to be non-hazardous), if required.

WARNING!

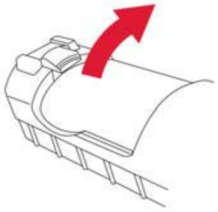
To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in areas known to be non-hazardous.

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.

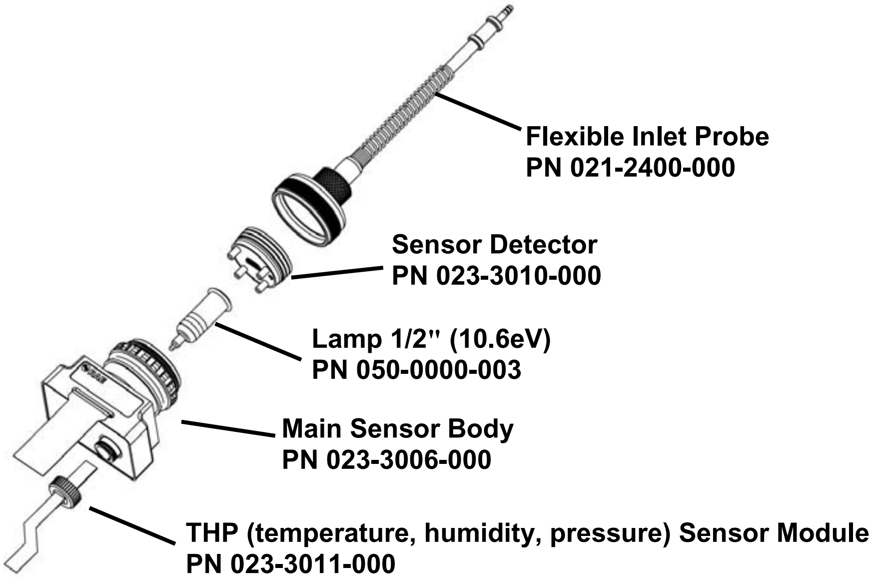
WARNING!

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:**	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

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

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Web Site: www.raesystems.com

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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

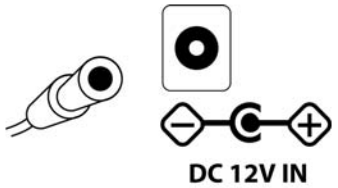
Charging The Battery

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

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Rev. A
April 2007
P/N 059-4020-000

STRATEGIC DIAGNOSTICS INC.

RaPID Assay® PCB Test Kit
A00133/A00134

Intended Use

The RaPID Assay® PCB Test Kit can be used as a quantitative, semi-quantitative or qualitative enzyme immunoassay (EIA) for the analysis of PCB (polychlorinated biphenyl) in water (groundwater, surface water, well water). For applications in other matrices please contact our Technical Service department or refer to the soil application procedure provided. The RaPID Assay® PCB Test Kit allows reliable and rapid screening for PCB (measured and reported as Aroclor 1254), with quantitation between 0.5 and 10 ppb (as Aroclor 1254), in water. The minimum detection level of the kit is 0.2 ppb (as Aroclor 1254.)

Test Principles

The PCB RaPID Assay® kit applies the principles of enzyme linked immunosorbent assay (ELISA) to the determination of PCB and related compounds. The sample to be tested is added, along with an enzyme conjugate, to a disposable test tube, followed by paramagnetic particles with antibodies specific to PCB attached. Both PCB (which may be in the sample) and the enzyme labeled PCB (the enzyme conjugate) compete for antibody binding sites on the magnetic particles. At the end of an incubation period, a magnetic field is applied to hold the paramagnetic particles (with PCB and labeled PCB analog bound to the antibodies on the particles, in proportion to their original concentration) in the tube and allow the unbound reagents to be decanted. After decanting, the particles are washed with Washing Solution.

The presence of PCB is detected by adding the enzyme substrate (hydrogen peroxide) and the chromogen (3,3',5,5' – tetramethylbenzidine). The enzyme labeled PCB analog bound to the PCB antibody catalyzes the conversion of the substrate/chromogen mixture to a colored product. After an incubation period, the reaction is stopped and stabilized by the addition of acid. Since the labeled PCB (conjugate) was in competition with the unlabeled PCB (sample) for the antibody sites, the color developed is inversely proportional to the concentration of PCB in the sample.

NOTE: Color development is inversely proportional to the PCB concentration.

Darker color = lower concentration
Lighter color = higher concentration

The determination of the PCB level in an unknown sample is interpreted relative to the standard curve generated from kit standards after reading with a spectrophotometer.

Performance Characteristics

The PCB RaPID Assay® will detect different PCB Aroclors to different degrees. Refer to the table below for data on several of these. The PCB RaPID Assay® kit provides screening results. As with any analytical technique (GC, HPLC, etc.) positive results requiring some action should be confirmed by an alternative method.

The PCB RaPID Assay® immunoassay test does not differentiate between PCB and other related compounds. The table below shows compounds at the method detection limit (MDL) which is the lowest concentration of the compound, in water, that can be picked up in the assay. The limit of quantitation (LOQ) is an approximate concentration, in water, required to yield a positive result at the lowest standard. **This is the lowest concentration of the compound that can be quantified in the assay**. The IC50 is the concentration required to, inhibit one half of the color produced by the negative control. It is also used to calculate cross-reactivity values to similar compounds.

Compound	MDL (ppb)	LOQ (ppb)	IC50 (ppb)
Aroclor 1254	0.20	0.50	3.6
Aroclor 1260	0.20	0.32	2.3
Aroclor 1248	0.22	0.59	4.22

Aroclor 1242	0.34	1.22	8.8
Aroclor 1262	0.36	0.66	4.74
Aroclor 1232	0.84	2.61	18.76
Aroclor 1268	0.92	3.03	21.80
Aroclor 1016	0.94	3.56	25.60
Aroclor 1221	13.54	22.58	162.60

*The following compounds demonstrated no reactivity in the PCB RaPID Assay® test kit at concentrations up to 10,000 ppb: Biphenyl, 2,5-Dichlorophenol, 2,3,5-Trichlorophenol, Di-n-octyl-phthalate.

The presence of the following substances up to 250 ppm were found to have no significant effect on PCB RaPID Assay® results: copper, nickel, zinc, mercury, manganese, phosphate, sulfate, sulfite, magnesium, calcium, nitrate and thiosulfate. Humic acid up to 25 ppm and iron to 100 ppm were found to have no significant effect. In addition, sodium chloride concentrations up to 1.0 M showed no effect on results.

Precautions

- Training is strongly recommended prior to using the RaPID Assay® test system. Contact Strategic Diagnostics for additional information.
- Treat PCB, solutions that contain PCB, and potentially contaminated samples as hazardous materials.
- Use gloves, proper protective clothing, and methods to contain and handle hazardous material where appropriate.
- Reagents must be added in a consistent manner to the entire rack. A consistent technique is the key to optimal performance. Be sure to treat each tube in an identical manner.
- Water samples should be at a neutral pH prior to analysis. Samples containing gross particulate should be filtered (e.g. 0.2 um Anotop™ 25 Plus, Whatman, Inc.) to remove particles.
- Store all test kit components at 2°C to 8°C (36°F to 46°F). Storage at ambient temperature (18°C to 27°C or 64°F to 81°F) on the day of use is acceptable. *Test tubes require no special storage and may be stored separately to conserve refrigerator space.*
- Allow all reagents to reach ambient temperature (18°C to 27°C or 64°F to 81°F) before beginning the test. This typically requires at <u>least</u> 1 hour to warm from recommended storage conditions.
- Do not freeze test kit components or expose them to temperatures above 100°F (39°C).
- Do not use test kit components after the expiration date.
- Do not use reagents or test tubes from one test kit with reagents or test tubes from a different test kit.
- Do not mix reagents from kits of different lot numbers.
- Use approved methodologies to confirm any positive results.
- Do not under any circumstances attempt to disassemble the base of the magnetic rack. Magnets will be violently attracted to each other.
- Adequate sample number and distribution are the responsibility of the analyst.
- The photometer provided in the accessory kit requires electricity and comes with a 110V adapter. Adapters for 220V are available. Do not attempt to operate with a car adaptor.
- Do not expose color solution to direct sunlight.
- Do not dilute or adulterate test reagents or use samples not called for in the test procedure; this may give inaccurate results.
- Tightly recap the standard vials when not in use to prevent evaporative loss.

Materials Provided

- Antibody Coupled Paramagnetic Particles in buffered saline containing preservative and stabilizers.

  30 test kit: one 20 mL vial
  100 test kit: one 65 mL vial
- Enzyme Conjugate.

  30 test kit: one 10 mL vial
  100 test kit: one 35 mL vial
- Standards

Three concentrations (0.25, 1.0 and 5.0 ppb) of PCB standards (as Aroclor 1254) in buffered saline containing preservative and stabilizers are supplied. Each vial contains 4 mL.

- Control

  A concentration (approximately 3 ppb) of PCB (as Aroclor 1254) in buffered saline containing preservative and stabilizers. A 4 mL volume is supplied in one vial.

- Diluent/Zero Standard

  Buffered saline containing preservative and stabilizers without any detectable PCB.

  30 test kit: one 10 mL vial
  100 test kit: one 35 mL vial

- Color Solution containing hydrogen peroxide and 3,3',5,5'-tetramethylbenzidine in an organic base.

  30 test kit: one 20 mL vial
  100 test kit: one 65 mL vial

- Stop Solution containing a solution of 2M sulfuric acid.

  30 test kit: one 20 mL vial
  100 test kit: one 60 mL vial

- Washing Solution containing preserved deionized water.

  30 test kit: one 70 mL vial
  100 test kit: one 250 mL vial

- Polystyrene test tubes

  30 test kit: one 36 tube box
  100 test kit: three 36 tube boxes

- User's Guide

Materials Required and Ordered Separately

See "Ordering Information" for the appropriate catalogue numbers.

Rapid Assay® Accessory Kit

Accessory equipment may be rented or purchased from Strategic Diagnostics. See "Ordering Information" for the appropriate catalogue numbers.

The accessory kit contains the following items:

- Adjustable Volume Pipet
- Eppendorf™ Repeater® Pipettor
- Electronic timer
- Portable balance capable of weighing 10 g (for soil samples)
- Vortex mixer
- Magnetic separation rack
- RPA-I RaPID Analyzer (or equivalent spectrophotometer capable of reading 450 nm in a 1 mL sample size).

Other Items

- 12.5 mL Combitips® for the Repeater pipettor - for 0.25 mL to 1.25 mL dispensing volumes (5)
- Pipet tips for adjustable volume pipet (100-1000 uL)

NOTE: Order replacement Combitips® and pipet tips separately. See the "Ordering Information" section.

Materials Required but Not Provided

- Methanol (HPLC grade or equivalent) – for water analysis
- Protective clothing (e.g., latex gloves)
- Absorbent paper for blotting test tubes
- Liquid and solid waste containers
- Marking pen
- Instructional video (optional)

Suggestions for Pipettor Use

- Practice using both pipettes (adjustable volume and Repeater pipettor) with water and extra tips before you analyze your samples.
- Use a new tip each time you use the Repeater pipettor to pipette a different reagent to avoid reagent cross-contamination. Tips can be rinsed thoroughly, dried completely and reused. By using the same tip to dispense the same reagent each time you can avoid cross contamination.

NOTE: **Repeator tips should be changed periodically (after ~10 uses) since precision deteriorates with use.**

- Draw the desired reagent volume into the Repeater pipettor and dispense one portion of the reagent back into the container to properly engage the ratchet mechanism. If you do not do this, the first volume delivered may be inaccurate.
- To add reagents using the Repeater pipettor, pipette down the side of the test tube just below the rim.
- When adding samples and standard using the positive displacement pipettor, always pipette into the bottom of the tube without touching the sides or bottom of the tube.
- Use a new adjustable volume pipet tip each time you pipette a new unknown.

Assay Procedure

Prior to performing your first Rapid Assay®, please take time to read the package inserts in their entirety and review the videotape if available. **On site training is strongly recommended for new users of this test system.** Please contact your account manager for further information. This procedure is designed for quantitative analysis. For running the kit semi-quantitatively or qualitatively, please contact Technical Support.

Collect/Store the Sample

The following steps explain how to properly collect and store your samples.

1. Water samples should be collected in glass vessels with teflon cap liners). **Immediately upon collection, water samples should be diluted with an equal volume (1:1) of methanol (HPLC grade) to prevent adsorptive losses to the glass containers.** This is a 2x dilution, which must be accounted for when interpreting results. See "Results Interpretation", Section 3a for further details. Use this diluted sample as "sample" in "Perform the Test".

NOTE: **This 2x dilution is <u>not</u> required for soil samples.**

2. Samples should be collected in appropriately sized and labeled containers.
3. If testing soil samples, follow the SDI Sample Extraction Kit User's Guide or the appropriate technical bulletin to properly collect and store your sample.
4. Samples should be tested as soon as possible after collection. If this is not possible, storage at 4°C (39°F) is recommended to minimize evaporative losses.

Set Up

1. Remove kits from refrigerator. All reagents must be allowed to come to room temperature prior to analysis. Remove reagents from packaging and place at room temperature <u>at least</u> 1 hour prior to testing.
2. Turn on the RPA-1 or other spectrophotometer. The RPA-1 should be warmed up for at least 30 minutes prior to the run.
3. Label five 12.5 mL Combitips "Conjugate", "Particles", "Wash", "Color" and "Stop". In addition, add the name of the compound you are testing for to each Combitip.
4. Remove nine clean blank test tubes for standards and control and one test tube for each sample (if testing in singlicate). Label the test tubes according to contents as follows.

Tube #	Contents
1	Negative control (replicate 1)
2	Negative control (replicate 2)
3	Standard 1 (replicate 1)
4	Standard 1 (replicate 2)
5	Standard 2 (replicate 1)
6	Standard 2 (replicate 2)
7	Standard 3 (replicate 1)
8	Standard 3 (replicate 2)
9	Control
10	Sample 1
11	Etc.

***Label at top of tubes to avoid interference with reading of tubes in photometer**

Sample Extraction, Filtration and Dilution

Filtration may be necessary to remove gross particulate from the water sample. If testing samples at levels higher than standard kit level is desired, contact SDI for special instructions. Water samples should be diluted 1:1 in methanol as described in "Collect/Store the Sample".

Please follow the instructions from the SDI Sample Extraction Kit to prepare and dilute the soil extract prior to running the assay.

Perform the Test

1. Separate the upper rack from the magnetic base. Place labeled test tubes into the rack.

2. Add **200 uL** of standards, control or samples to the appropriate tubes using the adjustable volume pipet with the dial set on **0200**. The negative control, standards and control must be run with each batch of samples.

NOTE: Sample should be added to the bottom of the tube by inserting the pipet tip into the tube without touching the sides or the bottom of the tube. Take care not to contact sample with pipette tip once dispensed into bottom of the tube.

3. Using the Repeater Pipettor with the "Conjugate" tip attached and the dial set on **"1"**, add **250 uL** of Enzyme conjugate down the **inside wall** of each tube. (Aim the pipet tip ¼" to ½" below the tube rim or tube wall; deliver liquid gently to avoid splashback.)

4. Thoroughly mix the magnetic particles by swirling (avoid vigorous shaking) and attach the "Particles" tip to the Repeater Pipettor. With the dial set on **"2"** add **500 uL** of magnetic particles to each tube, aiming down the side of the tube as described above. Vortex, mixing each tube 1 to 2 seconds at low speed to minimize foaming. Pipetting of magnetic particles should be kept to 2 minutes or less.

5. Incubate 15 minutes at room temperature.

6. After the incubation, combine the upper rack with the magnetic base and press all tubes into the base; allow 2 minutes for the particles to separate.

7. With the upper rack and magnetic base combined, use a smooth motion to invert the combined rack assembly over a sink and pour out the tube contents.

NOTE: If the rack assembly inadvertently comes apart when lifting to pour out tube contents, re-combine and wait an additional 2 minutes to allow particles to separate.

8. **Keep the rack inverted** and gently blot the test tube rims on several layers of paper towels. It is important to remove as much liquid as possible but **do not bang** the rack or you may dislodge the magnetic particles and affect the results.

9. Set the Repeater Pipettor dial to **"4"** and put on the tip labeled "Wash". Add **1 mL** of Washing Solution down the inside wall of each tube by using the technique described earlier. Vortex tubes for 1-2 seconds. **Wait 2 minutes** and pour out the tube contents as described previously. **Repeat this step one more time.**

NOTE: The number of washes and wash volume are important in ensuring accurate results.

10. Remove the upper rack (with its tubes) from the magnetic base. With the "Color" tip attached to the Repeater Pipet and the dial set to **"2"** add **500 uL** of Color Reagent down the inside wall of each tube as described previously. Vortex 1 to 2 seconds (at low speed).

11. Incubate 20 minutes at room temperature. During this period, add approximately 1 mL of Washing solution to a clean tube for use as an instrument blank for "Results Interpretation".

12. After the incubation, position the Repeater pipettor at Setting **"2"** and use the "Stop" tip to add **500 uL** of Stop solution to all test tubes.

13. Proceed with results interpretation.

WARNING: **Stop solution contains 2M sulfuric acid. Handle carefully.**

Results Interpretation

1. After addition of Stop Solution to the test tubes, results should be read within 15 minutes.

2. Wipe the outside of all antibody coated tubes prior to photometric analysis to remove fingerprints and smudges.

Photometric Interpretation Using the RPA-I

1. The RPA-I photometer (provided in the Rapid Assay® Accessory kit) can be used to calculate and store calibration curves. It is preprogrammed with

various RaPID Assay® protocols. For the PCB RaPID Assay® test kit, parameter settings are as follows:

Data Reduct: Lin. Regression
Xformation : Ln/LogitB
Read Mode : Absorbance
Wavelength : 450 nm
Units : PPB
Rgt Blk : 0

Calibrators:

# of Cals : 4
# of Reps : 2

Concentrations:

#1: 0.00 ppb
#2: 0.25 ppb
#3: 1.00 ppb
#4: 5.00 ppb
Range : 0.10 – 5.00
Correlation : 0.990
Rep. %CV : 10%

NOTE: Prior to analysis the RPA-I User's Manual should be thoroughly reviewed for more detailed operation instructions.

2. Follow the instrument prompts to read the absorbance of all tubes:

Instrument Display	Operator Response
SELECT COMMAND RUN PROTOCOL	Press RUN Scroll using the YES [] or NO [] keys until the desired protocol appears. Then press ENTER
SPL. REPLICATES (1-5)	Press 1 (for analysis of samples in singlicate.) Press ENTER
BLANK TUBE, INSERT TUBE, EVALUATING TUBE, REMOVE TUBE (Beep)	Insert blank tube containing 1mL wash solution. Remove tube
CAL #1, REP. #1, INSERT TUBE, EVALUATING TUBE, REMOVE TUBE (Beep)	Insert Tube #1 Remove tube

Follow prompts to read tubes.

NOTE: Tube order is important. The RPA-I expects to see the standards in ascending order, in duplicate, starting with the negative control.

Following evaluation of all standards, the instrument will display:

PRINTING DATA,	Data will print
PRINTING CURVE	Curve will print only if programmed to print (See RPA1 User's Manual).
CTRL #1 REP #1, INSERT TUBE, EVALUATING TUBE, REMOVE TUBE (Beep)	Insert Control Tube Remove Tube
EDIT CALIBRATORS YES/NO	Press NO (if editing is necessary press YES and refer to the RPA1 User's Manual).
SPL #1 REP#1 INSERT TUBE EVALUATING TUBE REMOVE TUBE (Beep)	Insert first sample tube Remove tube

Continue to follow prompts. After all samples have been read, press STOP.

Expected Results:

- **%CV (coefficient of variation) between standard duplicates of 10% or less.**
- **Absorbance reading for the 0 ppb standard should be between 0.8 and 2.0 for all assays.**
- **Correlation (r) of 0.990 or greater for all assays.**
- **Kit control within range specified on vial.**

- **Absorbance of negative control and standards should be as follows:**

  Negative Control>Std. 1>Std. 2>Std. 3.

3. Concentrations will be indicated for all samples on the RPA-I printout.

   a) The concentration, as indicated on the printout, is multiplied by the appropriate dilution factor (if applicable) introduced in the procedure. The quantitation range of the kit is also multiplied by this factor.

EXAMPLE: Water samples were diluted 2-fold with methanol upon collection (see "Collect/Store the Sample" in this User's Guide). As a result, the concentrations listed on the printout should be multiplied by 2 to determine the sample concentration. The standard concentrations are also multiplied by 2 to give a quantitation range in water for this test kit of 0.5 to 10 ppb.

   b) Samples with an "nd" and no concentration listed have an absorbance greater than the negative control; therefore, no concentration can be computed for these samples. Results must be reported as < 0.5 ppb (or Standard 1 multiplied by the dilution factor.)

   c) Samples with an "nd" next to a listed concentration have an estimated concentration below the minimum detection level of the test kit. Results must be reported as <0.5 ppb (or Standard 1 multiplied by the dilution factor.)

   NOTE: Any samples with concentrations determined to be lower than Standard 1 (the limit of quantitation) must be reported as < 0.5 (or Standard 1 multiplied by the dilution factor.) Quantitation is not possible below this standard as this is outside the linear range of the assay.

   d) Similarly, samples with a "hi" next to a listed concentration have an estimated concentration higher than Standard 3 and must be reported as >10 ppb (or Standard 3 multiplied by the dilution factor.)

NOTE: In order to determine the concentration of samples with concentrations greater than Standard 3, they must be subjected to repeat testing using a diluted sample. A ten-fold or greater dilution of the sample is recommended with an appropriate amount of PCB diluent. This additional dilution must then be taken into account when calculating the concentration. Please contact technical support for assistance in performing dilutions.

Photometric Interpretation Using Other Photometers

Other photometers may also be used to interpret results obtained from the RPA-I photometer. It is important that the photometer be able to read absorbance at 450nm and that the instrument can read at a 1 mL fill volume. Absorbances obtained from other spectrophotometers (reading at 450 nm) may be used to manually calculate sample concentrations as outlined below.

1. Calculate the mean absorbance for each of the three standards and the negative control.

2. Determine the standard deviation and %CV (coefficient of variation) of each standard and ensure %CV is less than 10% for each.

3. Calculate the %B/Bo for each standard by dividing the mean absorbance value for the standard by the mean absorbance value for the negative control and multiplying the results by 100.

4. Construct a standard curve by plotting the %B/Bo for each standard on the vertical logit (y) axis versus the corresponding analyte concentration on the horizontal logarithmic (x) axis on the graph paper provided in the test kit. **Graph papers are specific for each method. Use only the graph paper supplied with each kit.**

5. Draw the best straight line through all points. Using the %B/Bo of the sample, the concentration can be interpolated from the standard curve.

6. Multiply results by the appropriate dilution factor (if applicable) introduced in the procedure. For example, if the sample was diluted 10-fold to increase the detection levels of the kit then the results must be multiplied by 10. This dilution also changes the range of the assay (standards) by the same factor.

NOTE: Do not forget to account for the 2x dilution introduced in the "Collect/Store the Sample" procedure for water samples.

Limitations of the Procedure

The Rapid Assay® PCB Test Kit is a screening test **only**. Sampling error may significantly affect testing reliability. Adequate sample number and distribution are the responsibility of the analyst.

Ordering Information

Description	Catalogue Number
Rapid Assay® PCB Kit	A00133/A00134
Rapid Assay® Accessory Kit**	6050100
Adjustable Volume Pipet Tips (100-1000 uL)	A00013
12.5 mL Combitip for Repeating Pipette (1 each)	A00009
PCB Diluent	A00136
PCB Soil Proficiency Sample	A00175
Rapid Assay® Accessory Kit Rental	6997010
**** To obtain part numbers and pricing for individual items in the Accessory Kit contact SDI at the number below.**	

Ordering/Technical Assistance

Should you have any questions regarding this procedure prior to analysis contact Technical Service to avoid costly mistakes.

To Place an Order or Receive Technical Assistance, please call Strategic Diagnostics Inc. at:

Call toll-free **800-544-8881`**

Or 302-456-6789 Phone
302-456-6782 Fax
Web site: www.sdix.com
E-mail: techservice@sdix.com

General Limited Warranty

SDI's products are manufactured under strict quality control guidelines and are warranted to be free from defects in materials and workmanship. New instruments and related non-expendable items are warranted for one year from date of shipment against defective materials or workmanship under normal use and service.
Warranty obligation is limited to repair or replacement of the defective product or to refund of the purchase price, at the discretion of SDI. Other warranties, express or implied, are disclaimed. SDI's liability under any warranty claim shall not exceed the refund of the purchase price paid by the customer. Under no circumstances shall SDI be liable for special, indirect or consequential damages.

Safety

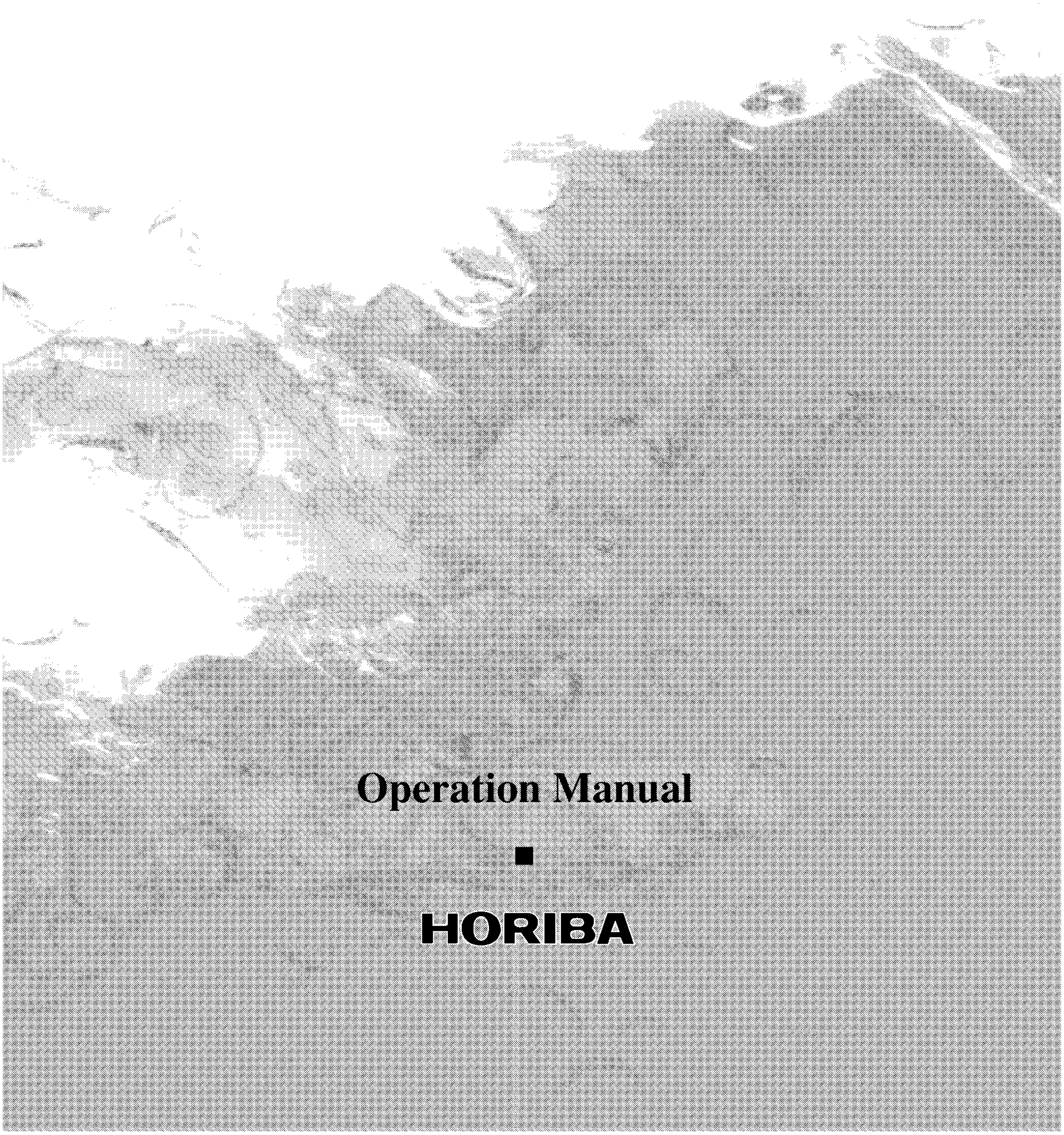
To receive an MSDS for this product, visit our web site at www.sdix.com.

Z00245.1, Rev 4/4/00

MULTI-PARAMETER WATER QUALITY MONITORING SYSTEM

U-20XD Series

U-22XD



Operation Manual

■

HORIBA

HORIBA's Warranty and Responsibility

Your U-20XD series multi-parameter water quality monitoring system is covered by HORIBA's warranty for a period of one (1) year, under normal use. Although unlikely, if any trouble attributable to HORIBA should occur during this period, necessary exchange or repairs shall be conducted by HORIBA, free of charge.

The warranty does not cover the following:

- Any trouble or damage attributable to actions or conditions specifically mentioned in the operation manuals to be avoided
- Any trouble or damage attributable to use of the multi-parameter water quality monitoring system in ways or for purposes other than those described in the operation manuals
- If any repairs renovations, disassembly, etc. are performed on this multi-parameter water quality monitoring system by any party other than HORIBA or a party authorized by HORIBA
- Any alteration to the external appearance of this multi-parameter water quality monitoring system attributable to scratches, dirt, etc. occurring through normal use
- Wear and tear to parts, the exchange of accessories, or the use of any parts not specified by HORIBA

INSTALLATION ENVIRONMENT

This product is designed for the following environment:

→ Installation Categories II
→ Pollution degree 2

LIMITATION OF LIABILITY FOR DAMAGES

HORIBA will not accept responsibility for damage or malfunction that may occur as a result of operation or situation not recommended in this manual. HORIBA shall not be liable for Customer's incidental, consequential or special damages, or for lost profits or business interruption losses, in connection with the operation of the Manufactured Parts, CPU hardware, disk drives or Software.

CE MARKING

U-20XD Series conforms with the following directive(s) and standard(s):

Directives:
the EMC Directive 89/336/EEC, in accordance with Article 10(1) of the Directive
the Low Voltage Directive 73/23/EEC

Standards:
[the EMC Directive] EN61326:1997+A1:1998
(EMISSION : Class B, IMMUNITY Category : General)
[the Low Voltage Directive] EN61010-1:1993 +A2:1995

FCC 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 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.

Unauthorized reprinting or copying of this operation manual

No unauthorized reprinting or copying of all or part of this operation manual is allowed. The utmost care has been used in the preparation of this operation manual. If, however, you have any questions or notice any errors, please contact the HORIBA customer service printed on the back cover of this operation manual.

Preface

Thank you very much for purchasing HORIBA's "MULTI-PARAMETER WATER QUALITY MONITORING SYSTEM" U-20XD Series.

Compact and one-hand-held, our multi-parameter water quality monitoring system makes measurements about a large number of items simultaneously.

The instrument uses a large-sized LCD display and has a variety of functions through easy operation, being useful for use at sites where measurements are to be made.

The water-proof construction of the instrument is compliant with IP-67 of IEC 529, "Water-proof test on electrical and mechanical equipment and tools and protection grade against entry of solids." Please use the instrument by following the information in this Operation Manual to maintain the water-proof construction of the instrument.

IP-67 standards

- Keeping dust and grit out of the instrument
- Up to 5 °C difference between water and an instrument employed and no entry of water into. the inside of the instrument at a depth of 1 m for 30 minutes

This Operation Manual contains information on the basic way of handling the instrument, notes, etc. for the user. Be sure to read through the Operation Manual before use.

Symbols employed

The symbols employed herein have the following meanings:

⚠ **WARNING** : Improper use can result in serious injury or even death.

⚠ **CAUTION** : The improper use of the instrument may cause the following dangers:

- Danger of injury
- Danger of damage to the instrument, its peripherals, and data

🛇 : Description of what should never be done, or what is prohibited.

❗ : Description of what should be done, or what should be followed.

Important : Explanation necessary for the proper operation of the instrument

Note : Explanation that is useful and necessary for handling the instrument

☞ : Refer to the item shown.

Symbols employed in screen description

The symbols ☼ and ⌜ ⌟ used in screen description have the following meanings:

☼ : The letters and numbers in this symbol are blinking on the screen.

⌜ ⌟ : The letters and numbers in this symbol are lighting up on the screen.

◈ CONTENTS ◈

1. Introduction

2. Before use

3. Basic operation

4. Using the data memory function

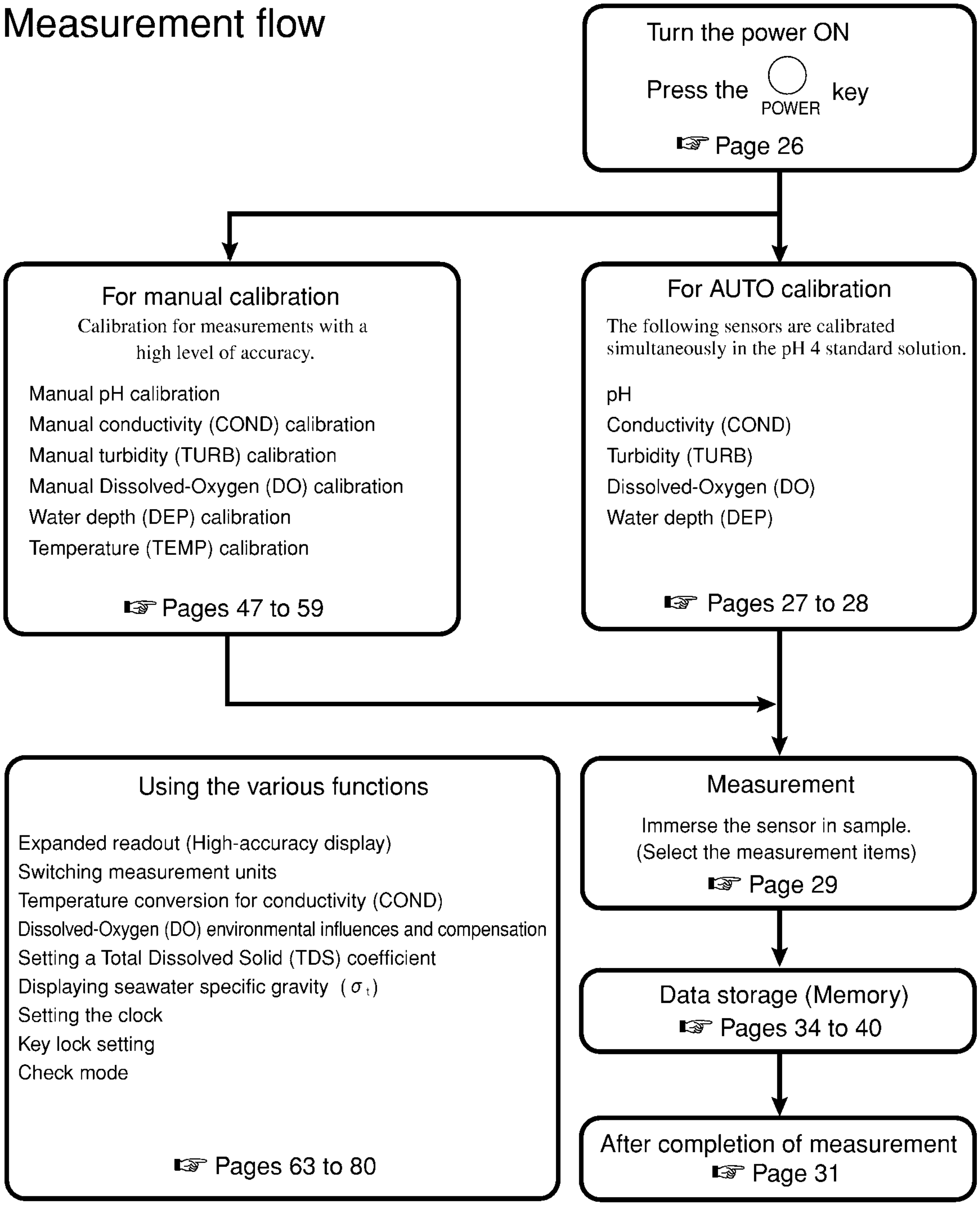
5. Techniques for more accurate measurement

6. Using the various functions

7. Instrument specifications

8. Reference data

Measurement flow



Turn the power ON

Press the ○ POWER key

☞ Page 26

For manual calibration

Calibration for measurements with a high level of accuracy.

- Manual pH calibration
- Manual conductivity (COND) calibration
- Manual turbidity (TURB) calibration
- Manual Dissolved-Oxygen (DO) calibration
- Water depth (DEP) calibration
- Temperature (TEMP) calibration

☞ Pages 47 to 59

For AUTO calibration

The following sensors are calibrated simultaneously in the pH 4 standard solution.

- pH
- Conductivity (COND)
- Turbidity (TURB)
- Dissolved-Oxygen (DO)
- Water depth (DEP)

☞ Pages 27 to 28

Measurement

Immerse the sensor in sample.
(Select the measurement items)

☞ Page 29

Data storage (Memory)

☞ Pages 34 to 40

After completion of measurement

☞ Page 31

Using the various functions

- Expanded readout (High-accuracy display)
- Switching measurement units
- Temperature conversion for conductivity (COND)
- Dissolved-Oxygen (DO) environmental influences and compensation
- Setting a Total Dissolved Solid (TDS) coefficient
- Displaying seawater specific gravity (σ_t)
- Setting the clock
- Key lock setting
- Check mode

☞ Pages 63 to 80

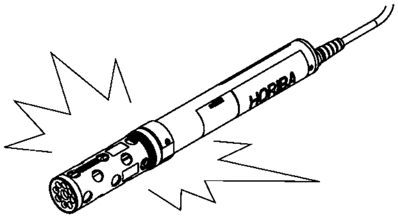
1. Introduction

Introduction
Before Use
Basic operation
Using the data memory function
Techniques for more accurate measurement
Using the various functions
Instrument specifications
Reference data

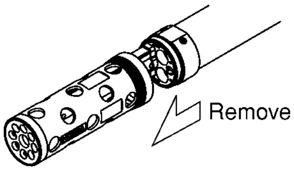
1.1 Notes on handling the instrument

Handling of sensor probe

⊘ Do not give a shock to the sensor probe.
The sensor will be damaged.

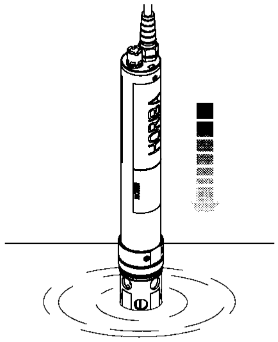


⊘ Do not remove the protection cover from the sensor probe to use.
Damage may occur to the sensor.



❗ Slowly lower the sensor probe into the sample.

⊘ Dropping it from a height of 1m or more may cause damage to the sensor.
Do not immerse the sensor probe at the depth of exceeding 100 m.
The device can resist the hydraulic pressure at the dept up to 100 m.



- The protection cover may rust due to the environment in which it is used. The damage caused by this usage shall not be warranted by the manufacturer. Solve it with parts which users need to replace periodically.

⚠ WARNING

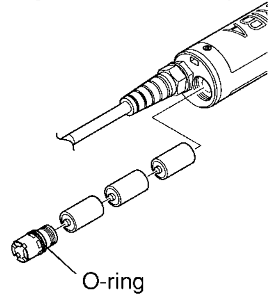
- Fix the sensor probe to the cable or the reel to use.
- In place with a large distance to the water level or with a rapid water flow, fix the sensor probe hook to a point except your body before use for safety purposes.
  Be careful not to let go off the sensor probe by mistake. Otherwise, the sensor probe together with the instrument will fall into the water or a sharp shock will occur to yourself while you are holding the instrument.

Replacing batteries and sensor of the sensor probe

⊘ Do not replace the sensor probe batteries and sensor in the atmosphere of high temperature and humidity.

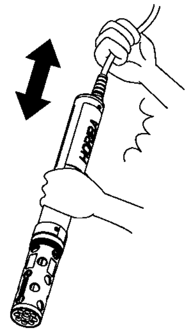
❗ Put connector plugs into the sensor probe connectors with sensors off.

❗ The sensor probe's battery cover is kept waterproof by the use of an O-ring. After checking that there are no foreign bodies adhering to the O-ring, apply silicon grease (included) to the face of the O-ring and close. Be sure to close it all the way to the indicated level. Do not close with the O-ring twisted or warped.

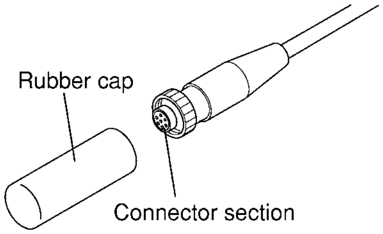


Handling of cable

Do not store the cable with its connector being greatly tensed or bent.
Do not submit the connector to strong shocks or the cable will snap.

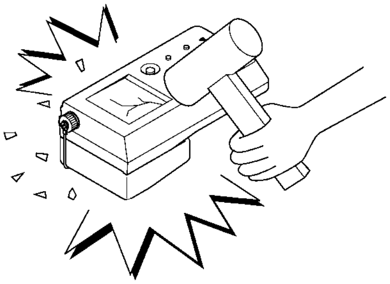


If sample waterdrops remain onto the connector section, metal part of the connector is likely to rust. When storing, wipe the area around the connector well and cover it with the rubber cap.

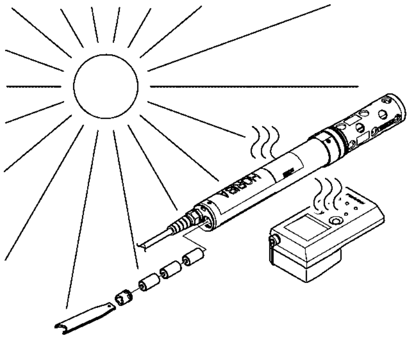


Handling of the instrument

Do not give a shock to or drop the sensor or instrument. The sensor or instrument will be damaged.

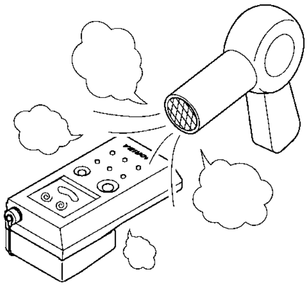


The display part includes LCD. Do not expose the instrument to ultraviolet rays for a long time. Otherwise, the LCD may deteriorate.

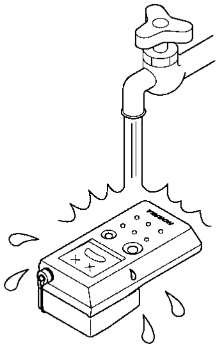


The instrument will be water-proof in construction (IP-67) when the sensor connector is connected to the instrument. However, if the instrument has been dropped into water or become wet, use a soft cloth to dry up the instrument.

Do not use a hair dryer to dry up the instrument.

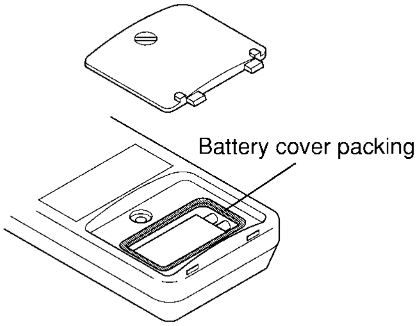


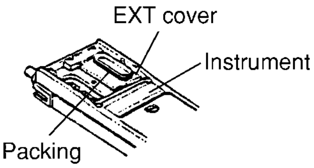
Do not wash directly the instrument using tap water from the faucet.



Note on replacing battery of the instrument and the section to which the EXT unit is attached

Waterproof function of the main unit is maintained by the packing of battery cover and EXT unit cover. Foreign matter on the packing can cause water to enter the instrument. Check for foreign matter on the packing before closing the battery cover and the EXT cover.
If the packing is twisted, do not close the battery cover and the EXT cover.





For a long use
We recommend that the packing be replaced once a year.
For battery cover packing replacement, contact your sales agent.

Note on place for use

- Avoid continuous measurement in water containing alcohol, organic solvent, strong acid, strong alkali or neutral detergent; otherwise the sensor surface will deteriorate.
- Do not use the instrument in the atmosphere with ambient temperatures below 0 °C (incl.) or above 55 °C (incl.).
- Avoid using the instrument in the condition exposed to strong vibrations or corrosive gases.
- Do not use the instrument near a source of strong electromagnetic field such as high-voltage cables and motors.

Batteries

The improper use of batteries may cause leaks and explosion.
Observe the followings:

- Set the batteries in place properly while paying attention to the plus (+) and minus (-) poles.
- Do not use both an old and new batteries or batteries of different types.
- Batteries for use in the instrument are not of the rechargeable type.
- Remove the batteries when not in use for a long time.
  In case of leaks, wipe off the solution in the battery case thoroughly and place new batteries in position.

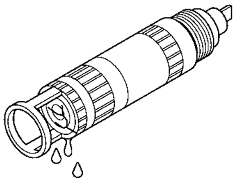
Handling the DO sensor

- In case of breakage of DO sensor diaphragm, replace DO sensor or replace just the diaphragm by using diaphragm replacement unit, without directly touching the internal solution.
- When removing the DO sensor from the sensor probe, make sure to install the short socket (included).

- Do not give a shock to the DO sensor. The sensor will be damaged.

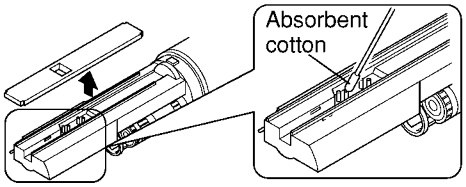
⚠ CAUTION

- The DO sensor holds a strong-alkaline solution. Protect the eye and skin from the solution. If there is any solution in the eye or on the skin, immediately use sufficient water to wash off the solution. Consult a doctor as required.



Handling the COND/TURB unit

When cleaning the COND/TURB unit, use an absorbent cotton to avoid damage to the TURB cell.

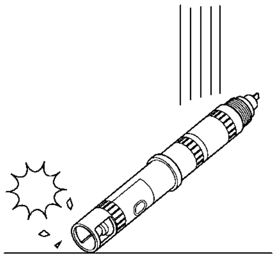


Handling the pH/ORP sensor

The pH/ORP sensor has a glass electrode at the end. Handle the sensor carefully to avoid a break in the glass electrode.

⚠ CAUTION

- Be careful not to break the glass on the top of the sensor. Otherwise you may get hurt with a piece of glass.



Disposal

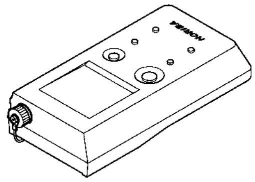
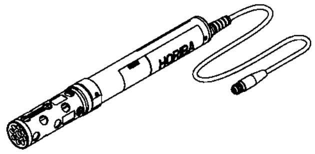
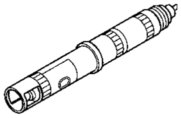
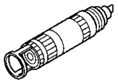
Dispose of this product as special waste, otherwise this may affect the environment.

Handling in transportation

- When transporting this product as freight, use the carrying case to prevent damage.
- Remove the flow cell from the sensor probe in transportation.

1.2 Packing list

The U-20XD series is comprised of the following items.

Model	U-22XD
Meter (U-2000)	
Sensor probe	
Sensor	pH/ORP sensor 
	DO (Dissolved-Oxygen) Sensor 
Accessories	pH 4 standard solution (500 mL) pH internal solution (250 mL)
	pH syringe with needle
	Sensor spanner
	Calibration beaker
	Probe cap
	Grip holder
	Carrying case
	Manganese battery 6F22 (006P) (1 piece)
	Alkaline batteries LR03 (AAA) (3 pieces)
	Silicon grease
	Sensor O-ring (S8) (10 pieces)
	Sponge for probe cap (5pieces)
	Operation manual

- The included battery is for the monitor. Its life is not guaranteed.

2. Before Use

2.1 Introduction to the instrument

2.1.1 Measurement items

Components that can be measured with the U-20XD series models are as follows:

Model	U-22XD
Measurement items	
pH	○
Dissolved Oxygen (DO)	○
Conductivity (COND)	○
Salinity (SAL) [Conductivity conversion]	○
Total dissolved solids (TDS) [Conductivity conversion]	○
Specific gravity of seawater [Conductivity conversion]	○
Temperature (TEMP)	○
Turbidity (TURB)	○
Water depth (DEP)	○
Oxidation-Reduction Potential (ORP)	○

○ .... Measurable

2.1.2 Introduction to functions of the instrument

Outline of the functions of the instrument is described below.

Feature	Function name	Page
Data obtained during measurement can be saved in the memory.	Manual data storage	Page 34
Data can be automatically saved in the memory at constant time intervals.	Auto data storage	Page 36
Saved data can be called.	DATA OUT	Page 41
The latest date of calibration and its details can be called.	Calibration history	Page 43
Enlarged display is available.	Expand readout	Page 63
Measurement units can be switched.	Switching measurement unit	Page 64

* Other functions possible in the check mode are available. (☞ Page 73)

2.1.3 Functions of expansion units

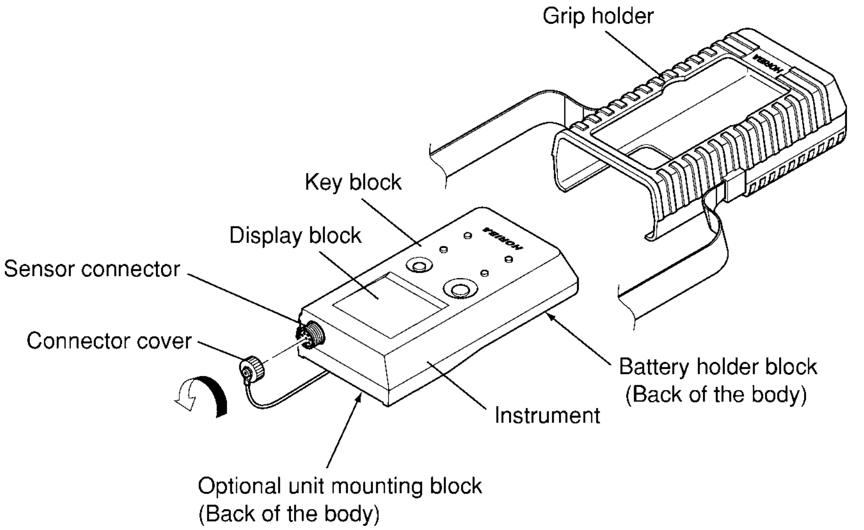
For the U-20XD series, use of expansion units allows communications with personal computers through RS-232C, the storage of G.P.S. data in the memory, and printer output, and commercial power supply.
Expansion units are available in the following two types:

Unit/name	Contents	Functions
U-2001 Expansion adaptor	• Expansion adaptor • Software for PC	<RS-232C communications, G.P.S connection, and printer output> The above functions cannot be used at the same time. One of the connectors for these three functions needs to be used.
U-2002 System unit	• System unit contain case • Software for PC • G.P.S. unit • Printer set	<RS-232C communications, G.P.S connection, printer output, battery power supply*> The above functions can be used at the same time. * A battery power supply can be used for measurements outdoors for 30 consecutive days.

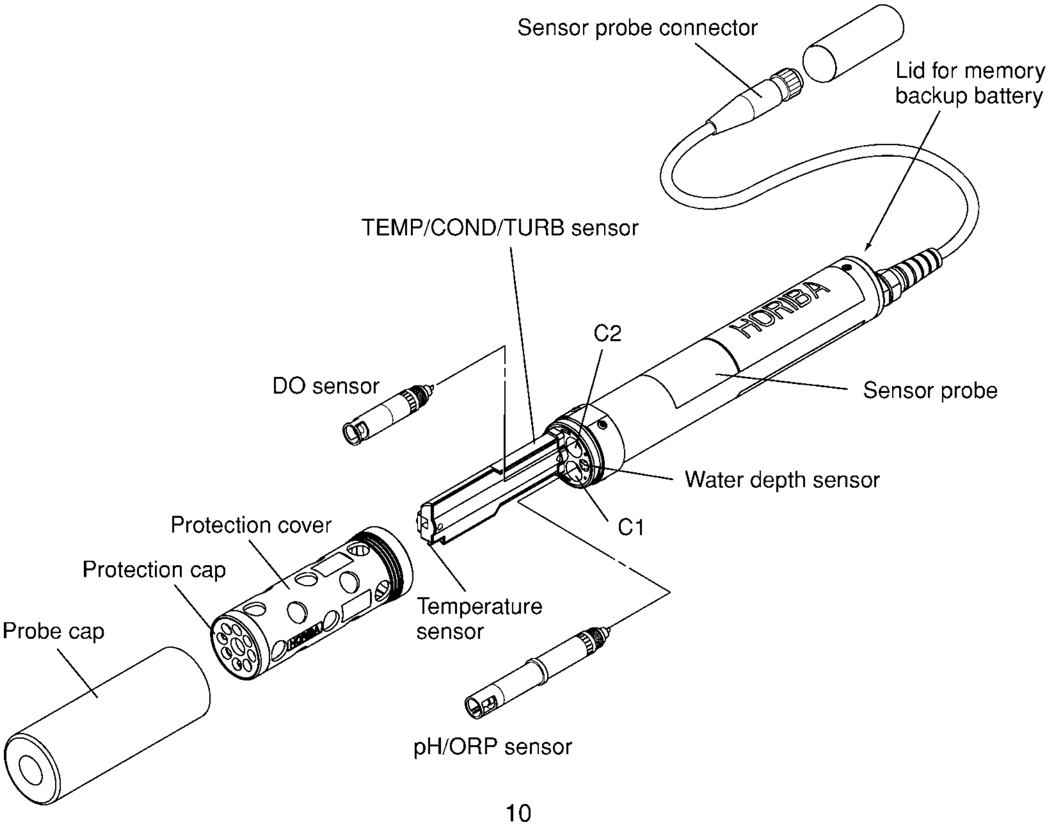
* U-2001 and U-2002 can operate on a commercial power supply through the use of an AC adapter (optional). However, the AC adapter cannot be used for the G.P.S. unit or printer set.

2.2 Names of the parts

2.2.1 Instrument name

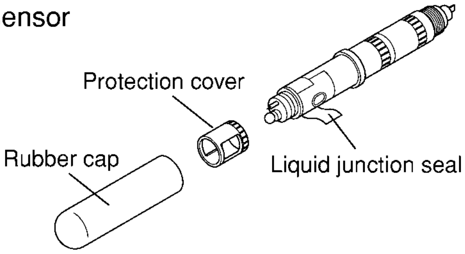


2.2.2 Sensor probe names

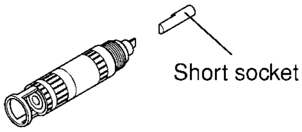


2.2.3 Sensor names

pH/ORP sensor



DO sensor



2.2.4 Use of carrying case

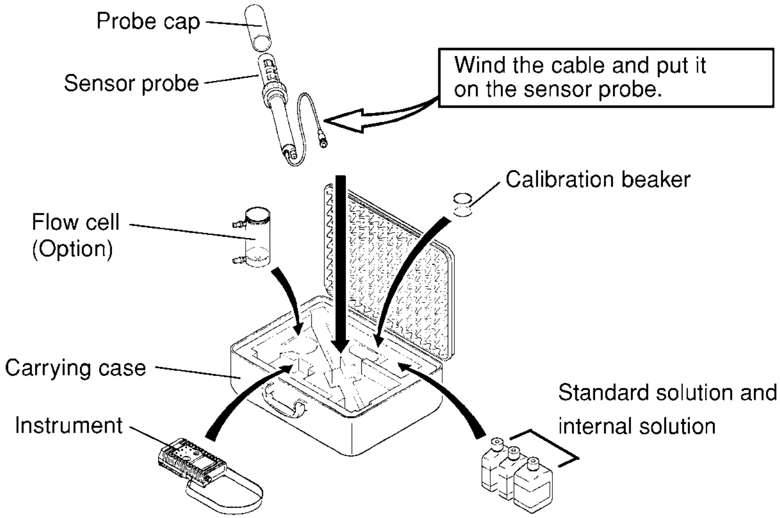
The carring case models W-2010 and W-2030 are applicable to store or transport U-22XD series.

Model	Applied to	Storage temperature	Material
W-2010	Cable length 10 m or less	-5 to 60℃	PP, ABS
W-2030	Cable length 30 m or more		

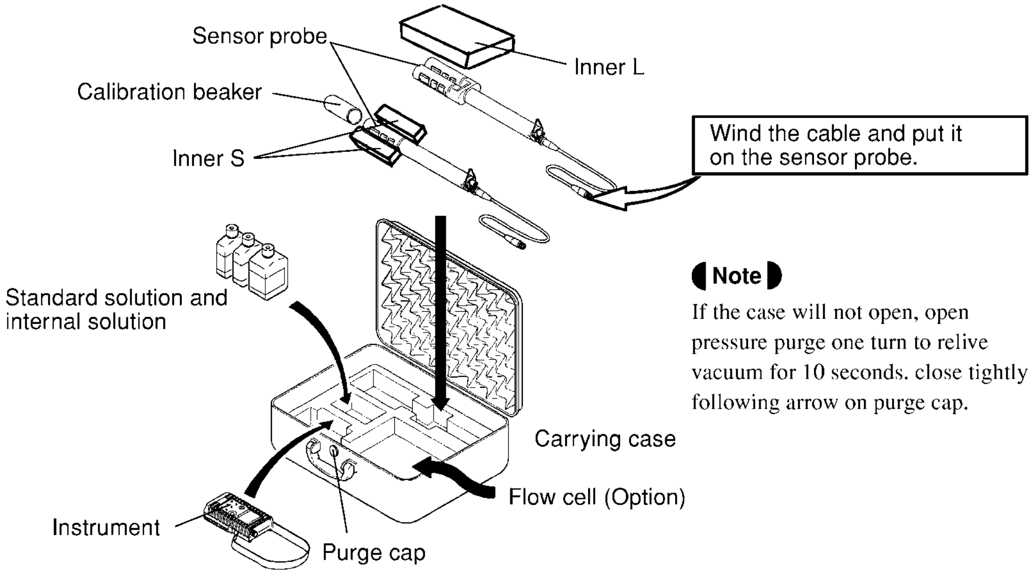
⚠CAUTION

- Do not drop or hit the carring case to protect the units against damage.
- When using the sensor probe with flow cell, separate them for strage.
- Be careful not to catch your finger, when fastening or releasing the laches.

• W-2010



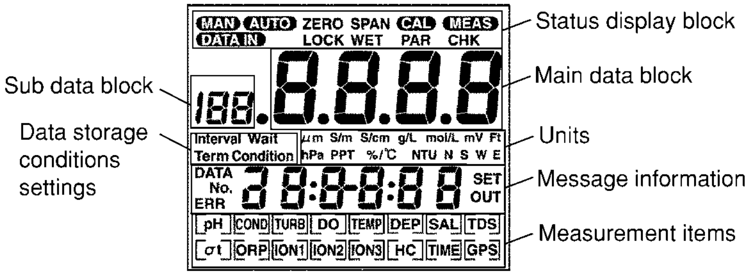
• W-2030



Note

If the case will not open, open pressure purge one turn to relive vacuum for 10 seconds. close tightly following arrow on purge cap.

2.2.5 Display



Status display block

MAN .... On when the data memory and calibration settings are set to manual.
AUTO .... On when the data memory and calibration settings are set to automatic.
DATA IN ..... On when the data memory operation and the data memorys operation settings are being performed. Blinking during calibration.
ZERO .... On in the Zero calibration mode.
SPAN .... On in the Span calibration mode.
CAL .... On in the Calibration mode.
MEAS .... On in the Measurement mode. (Measurements are being made when light up.)
LOCK .... On when the keys are locked.
CHK .... On when the instrument is in the check mode.

Sub data block

Display of the pH, Latitude (degree), Longitude (degree), Year and Check No.

Main data block

Display of Measurement data, Latitude (minute, 〔second〕), Longitude (minute, 〔second〕), and month and day.

Data storage conditions setting

Interval .... On when a time interval is set for storage of data.
Wait .... On when a time is set for waiting from the automatic data storage instruction until the start and during data processing through individual operations.
Term .... On when a period is set for automatic data storage.

Units

Displays the units for measurement items.

Message information

Displays the stored data (data mode) and the data No. when the data is stored.
SET .... Indicates that the instrument is in Set mode.

Measurement items

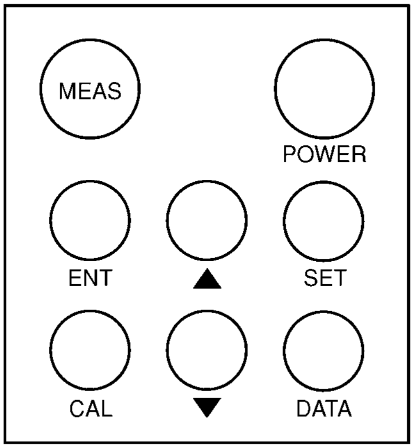
Displays the measurement items for the data in the main data block display. The display is read as follows.

Items without brackets ([ ]) .... Items with the highlighted text will be stored in the data memory.
(☞ *Measurement item setting,* page 76)
Items with brackets ([ ]) .... Displays the measurement items with data display.
(☞ *Measurement item setting,* page 76)

Note

- Because of the instrument's automatic power off function, the indication will disappear if the unit is not used for about 30 minutes. For operation of the unit and display of the indication, turn ON the instrument again.

2.2.6 Key names



POWER: Power key

Turns the instrument On and Off. Immediately after the power is switched on, the initial screen is displayed to indicate the status of the instrument.

MEAS: Measurement key

In the Measurement mode (MEAS is on), this key switches the measurement item. In addition, pressing the MEAS key returns you from the Setting, Calibration and Memory Call Up modes to the Measurement mode.

◖Note◗

- Regardless of which mode the instrument is in, it is always possible to return to the Measurement mode by pressing the MEAS key.

ENT: Enter key

In the Measurement mode (MEAS is on), pressing the ENT key stores the data in memory.
In the Calibration mode (CAL is on), pressing the ENT key performs calibration.
In the Setting mode, pressing the ENT key switches the setting and registers entered setting values.

CAL: Calibration key

Pressing the CAL key switches the instrument to the Calibration mode. If automatic data storage is in progress, it is aborted.

SET: Set key

Pressing the SET key switches the instrument from the Measurement mode to the Set mode. If the SET key is pressed on the "year, month, day, time" display screen, it switches the instrument to the Check mode.

DATA: DATA key

Pressing the DATA key switches the instrument to the Data mode.

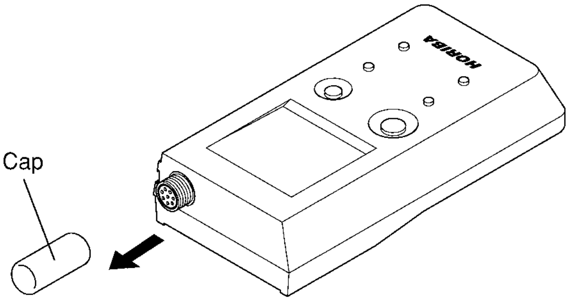
▲▼ : UP/DOWN keys

Use the UP/DOWN (▲▼) keys to set the calibration value in the Manual mode.

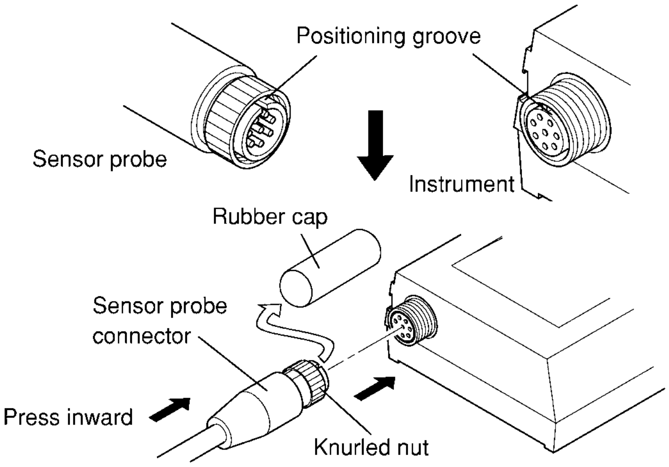
2.3 Setting up the U-20XD series models

2.3.1 Instrument and sensor probe connection

1. Remove the cap from the instrument's connector.



2. Align the positioning grooves of the instrument's connector and sensor probe connectors, and fit the connector of the sensor probe into the this other.



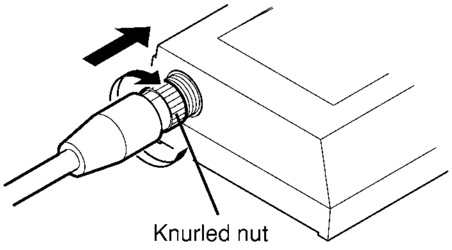
3. Press the sensor probe connector inward and turn. Tighten the connector until it will not turn any more.

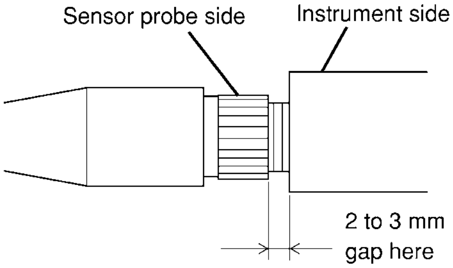
⚠CAUTION

- Turn the knurled nut with holding the knurled part. Otherwise, it will cause breaking of wire.

Important

- The connector cover or sensor probe connector should be connected to the instrument. Otherwise, the instrument will not be waterproof.
- Unless snugly attached, the instrument is not fully waterproof. When the sensor probe connector is tightened as far as it can go, a 2 to 3 mm gap is left between the instrument's connector and sensor probe connector.





Note

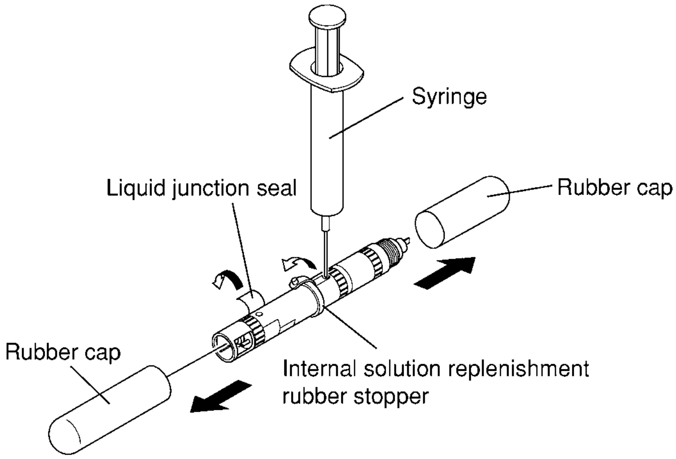
- Tighten the sensor probe connector until it will not turn any more.

2.3.2 Sensor installation

Connect the Dissolved Oxygen (DO) and pH/ORP sensors to the sensor probe.

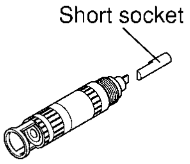
Preparing pH/ORP sensor

1. Remove the liquid junction seal and rubber caps.
2. Open the internal solution replenishment rubber stopper. Then use a syringe to take internal solution (#330).
   Air bubbles in the internal solution may impair the pressure compensation of the sensor. Allow as few air bubbles as possible to enter the inside solution.



Preparing DO sensor

1. Remove the short socket.



Important

- Provide the DO sensor with a short socket or connect the sensor to the sensor probe for storage. Otherwise, the sensor may have a shorter life or stable instructions may not be obtained.
- The short socket is used when storing. Do not throw it away.

Resetting the DO sensor when storing without having installed the short socket.

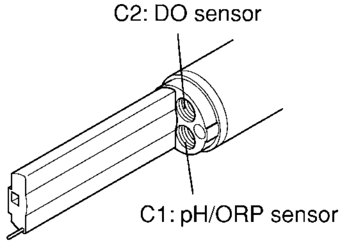
When leaving the DO sensor unattended for a brief period (1 or 2 days) without the short socket, the DO sensor can be reset by connecting it to the short socket or the probe. However, an amount of time corresponding to the period it was left unattended is necessary. If left unattended without being connected to the short socket or the probe for a long period (1 month), it cannot be reset.

Where to attach

1. The hole on the sensor probe in which each sensor is attached is determined by the type of sensor. Check the type of sensor and the assigned hole before attaching anything.

Important

- Installing the sensor in the wrong hole will damage both the sensor and sensor probe.

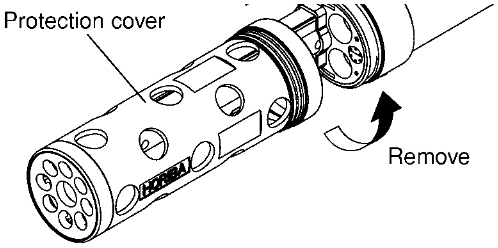


Installation procedure

Important

- With the U-22XD sensor probe install the DO sensor first and then the pH/ORP sensor.
- We recommend that the O-ring of the sensor be replaced with a new one each time the sensor is removed.

1. Remove the probe cap and remove the protection cover from the sensor probe.



❗ When the protection cover's screws are firmly fixed in place and cannot be removed by hand, place a spanner on the protection cover and the surface of the cover guide and remove.

⊘ Do not try to remove the protection cover by hitting it or submitting it to shocks.

2. Apply silicon grease to the DO sensor's O-ring.

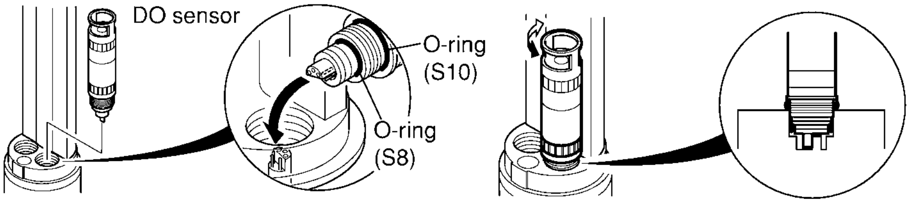
⊘ Make sure that no silicon grease gets on the connector.

3. Fit the DO sensor inside the sensor probe hole, being careful to align the shape of the connectors.

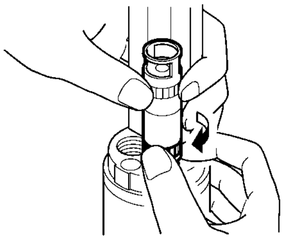
- Make sure that the O-ring is not scratched or twisted. Leakage will cause failures.
- Remove the DO sensor connected to the probe and, when reconnecting them, replace the O-ring (S8) on the smaller end of the DO sensor with a new O-ring.

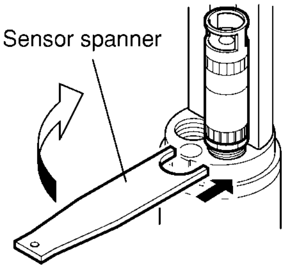
Important

- Press the sensor slightly inward and try turning to check the fit. The sensor cannot be turned if inserted properly.



4. Turn the screw 2 or 3 turns by hand and then fully tighten with the sensor spanner.



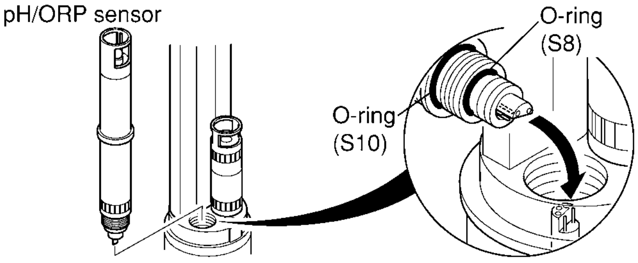


5. Apply silicon grease to the pH/ORP sensor's O-ring.

Make sure not to get silicon grease on the connector.

6. Fit the pH/ORP sensor inside the sensor probe hole, being careful to align the shape of connectors.

- Make sure that the O-ring is not scratched or twisted. Leakage will cause failures.
- Remove the pH/ORP sensor connected to the probe and, when reconnecting them, replace the O-ring (S8) on the smaller end of the pH/ORP sensor with a new O-ring.



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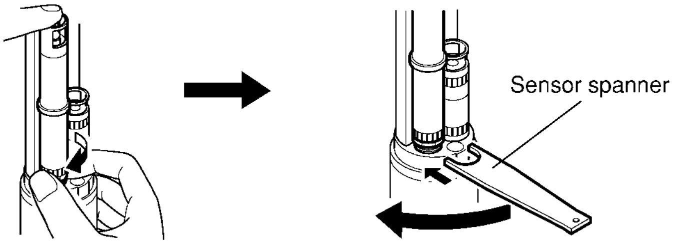
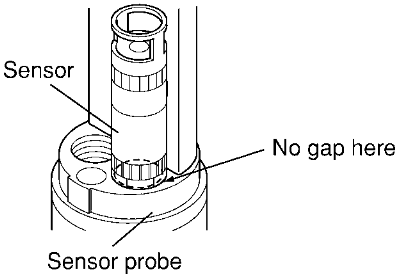
7. Holding the top of the pH/ORP sensor with your finger, turn the screw 2 or 3 turns by hand and then fully tighten with the sensor spanner.



⚠CAUTION

- Unless snugly attached, the sensor is not fully waterproof. The sensor is snugly fit inside the sensor probe when tightened as far as it will go.

Example for DO sensor



8. Attach the removed protection cover to the sensor probe as it was.

Important

- Before attaching each sensor to the sensor probe, do not soak the connector block in water.
- Be careful not to contaminate or wet the sensor probe or sensor connector.

Fasten the guard cover with your hand until it touches the end surface. If improperly fastened, it will slacken and, when storing the instrument, there will be a lack of humidity control. Fastening by hand is enough, do not use a spanner or other tool to fasten or the screws may break.

2.3.3 Installation and replacement of the battery

The U-20XD series is shipped from the factory with the battery packed separately.
When using the instrument for the first time or replacing the battery, perform the following procedure:

Type of battery:

Instrument (U-2000) .... Alkaline battery 6LR61 (Manganese battery 6F22 [006P])
1 piece. (Battery for instrument operation)
Sensor probe .... Alkaline batteries LR03 [AAA] (Manganese battery [R03])
3 pieces. (Battery for memory backup)

Notes on handling the battery

The improper use of battteries may cause leaks and explosion.
Observe the followings:

- Set the batteries in place properly while paying attention to the plus (+) and minus (-) poles.
- Do not use both an old and new batteries at a time or batteries of different types.
- Battteries for use in the instrument are not of the rechargeable type.
- Remove the batteries when not in use for a long.
  In case of leaks, wipe off the solution in the battery case thoroughly and place new battteries in position.

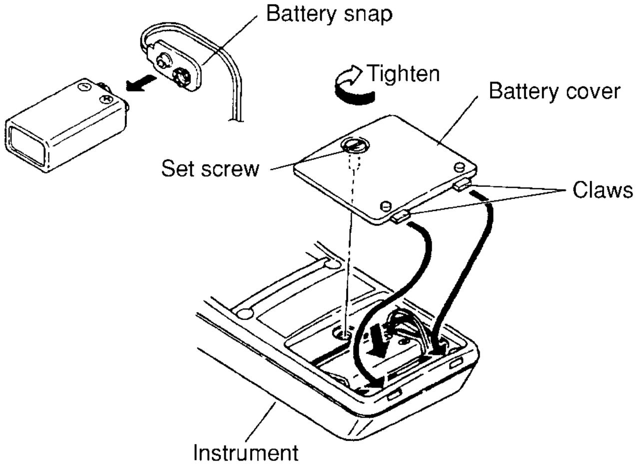
Note

- The battery originally attached to your unit is for monitor and the service life of the battery cannot be guaranteed.

Instrument (U-2000)

1. Loosen the set-screw on the battery cover and remove the cover.
2. Remove any old battery.
3. Fit the battery snaps to a new battery and insert the battery assembly into the instrument.
4. Insert the claws on the battery cover into the grooves in the instrument. Then tighten the set screw.

   The battery snap may be loose for some batteries. In such a case use radio pliers and tighten the metal snap fittings.



Important

- When removing the battery snap, do not pull it too strongly.

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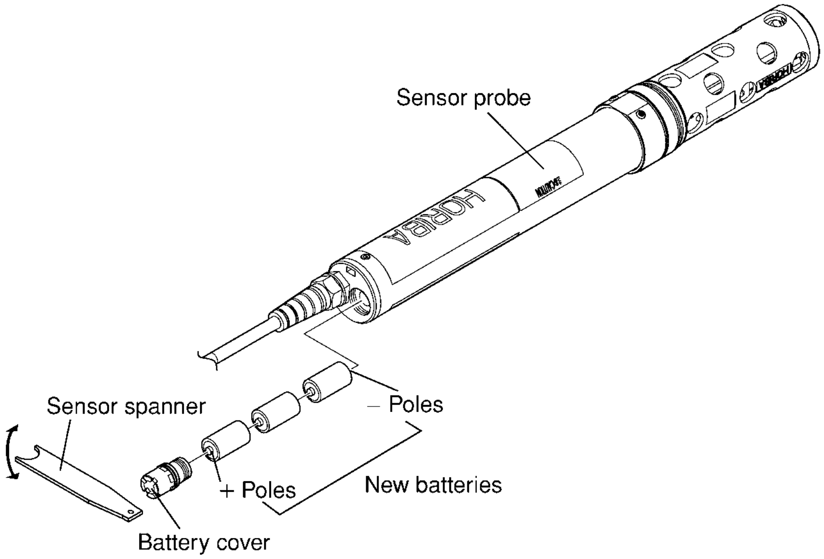
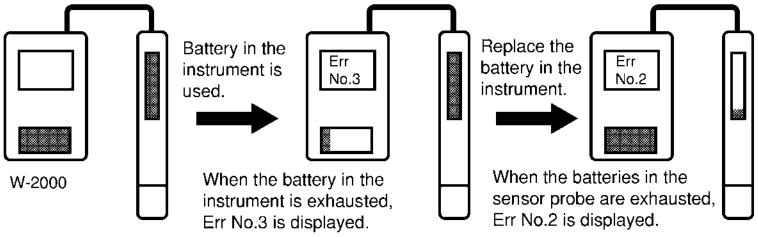
Sensor probe (for memory back up)

1. Remove the battery cover using a sensor spanner or a suitable object.
2. Remove any old batteries.
3. Insert new batteries making sure that the plus (+) and minus (-) poles match the terminals correctly.
4. To keep the sensor probe water-resistant, use a chip spanner as illustrated below and tighten the battery cover until the cover does not turn any more.



⚠CAUTION

- When replacing the batteries of the sensor probe, be sure to connect the sensor probe to the instrument. Otherwise, the memory will be reset and all the data saved in the memory will disappear.
- When the sensor probe is connected to the instrument, battery in the instrument is consumed.

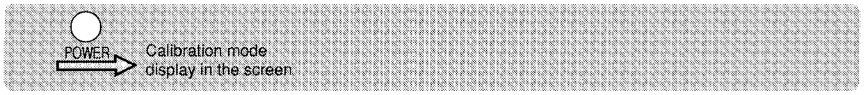


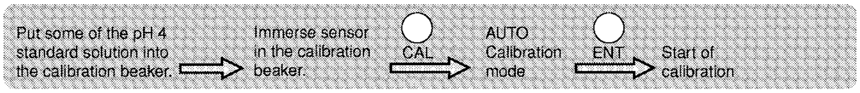
Note

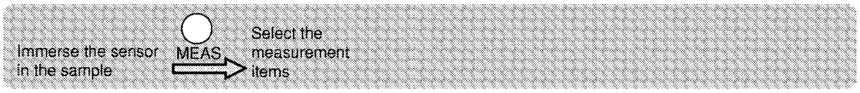
- The battery on the main unit is used up first allowing up to 30 hours use at room temperature. (When using alkaline batteries.)
- Life is reduced by approximately one half when manganese batteries are used.

3. Basic operation

The pH, conductivity (COND), turbidity (TURB), dissolved-oxygen (DO) and water depth (DEP) sensors can be calibrated automatically. Upon completion of this chapter, even beginners should be able to make measurements easily.





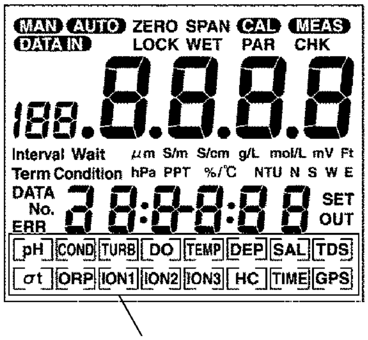


3.1 Key operations and mode switching

Measuring items and displays which are switched with the MEAS key

The items measurable with individual models are displayed. The items selected with the MEAS key will be indicated with [ ].

Example: In the pH Measurement mode: [pH]



The symbols displayed and their meanings are as follows:

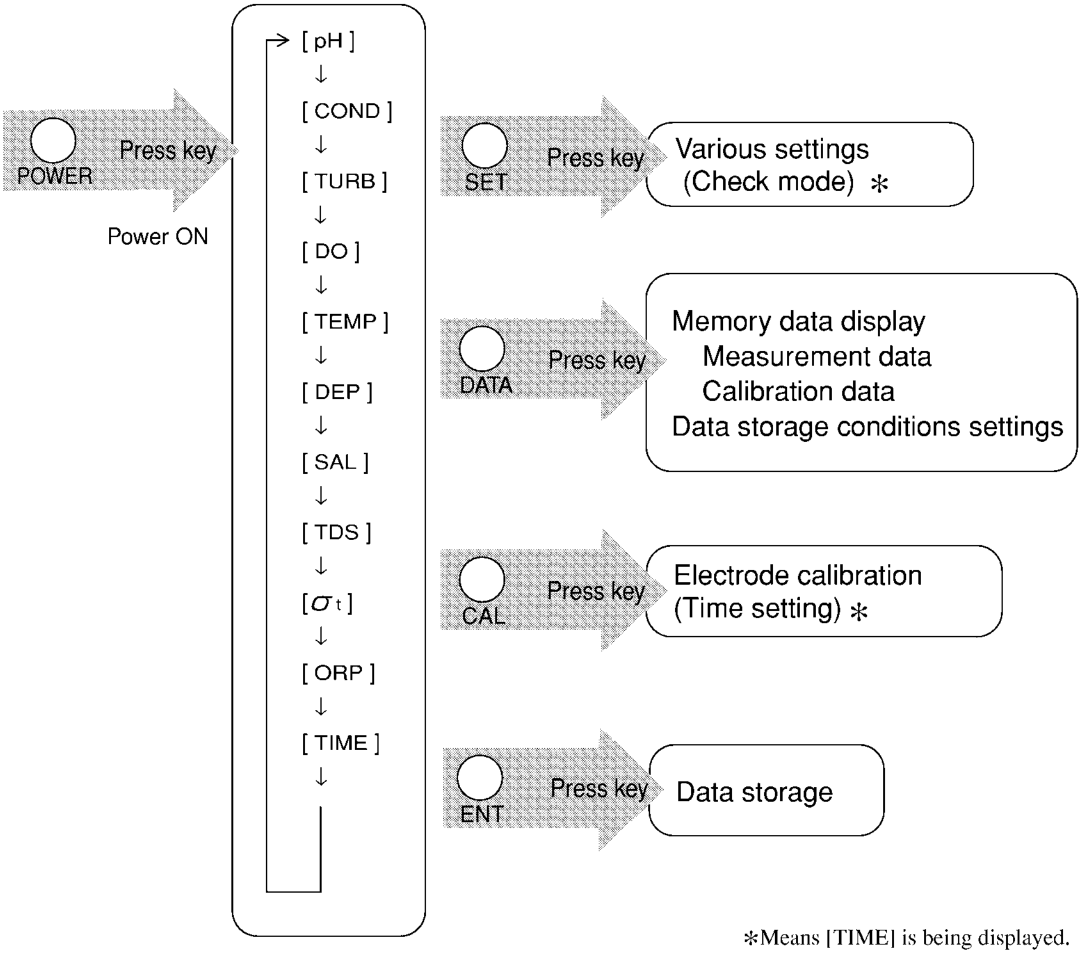
pH	pH
COND	Conductivity
TURB	Turbidity
DO	Dissolved-Oxygen
TEMP	Temperature
DEP	Depth
SAL	Salinity
TDS	Total dissolved solids
σ_t	Specific gravity of seawater
ORP	Oxidation-reduction potential
TIME	Display of date and time
GPS	G.P.S. (Global Positioning System) for imformation of position

Note

- [GPS] lights up when the optional G.P.S. sensor has been connected to the instrument and position information is received from the G.P.S. sensor during the measurement. For more information, refer to the instruction manual for the expansion units.

Measurement mode

MEAS When the MEAS key is pressed,
the next measurement item appears.



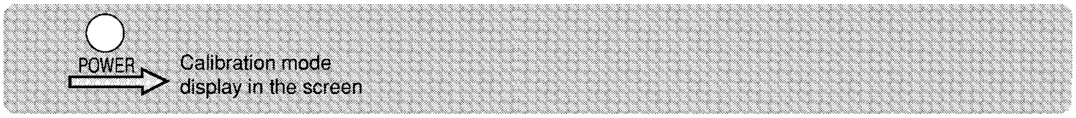
∗Means [TIME] is being displayed.

Note

- "*Measurement item setting*" on page 76 explains how to set the display so items are not displayed.

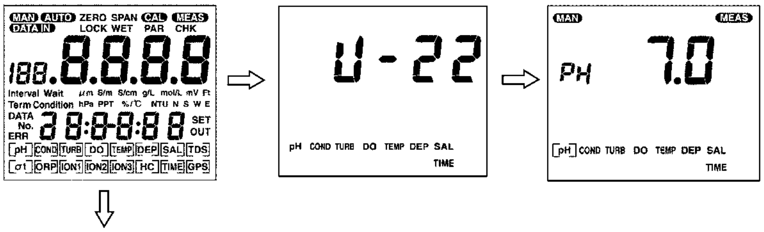
3.2 Operation procedure

3.2.1 Power ON

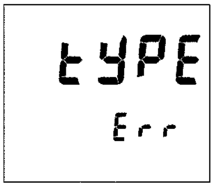


1. Press the **POWER** key.

The display will change in the order of All segment display → Sensor detector display → pH Measurement mode.



With the sensor probe is not connected,



is displayed.

Before turning ON the instrument, connect the sensor probe properly.

3.2.2 AUTO calibration method

To obtain correct measurement, it is necessary to calibrate the sensor using the standard solution before performing measurement. Previous calibration records shown in calibration log.
(☞ 4.3.2 *Calling up The calibration log*, page 43.)

Note

- In the AUTO calibration mode, the pH, COND, and TURB sensors are calibrated in the pH 4 standard solution, and the DO and DEP sensors in the atmosphere simultaneously.
  Calibrate contents at 25°C are as follows:

pH:	set at 4.01 (zero calibration) and the Span is the adjustment value at the factory when shipping.
COND:	0.449 S/m (Span calibration), the Zero is the adjustment value at the factory when shipping.
TURB:	0 NTU (zero calibration), the Span is the adjustment value at the factory when shipping.
DO:	8.52 mg/L (Span calibration), the Zero is the adjustment value at the factory when shipping.
DEP:	0 m (Zero calibration), the Span is the adjustment value at the factory when shipping.

- Values may be unstable if there is temperature fluctuation. Calibrate after waiting for about an hour.

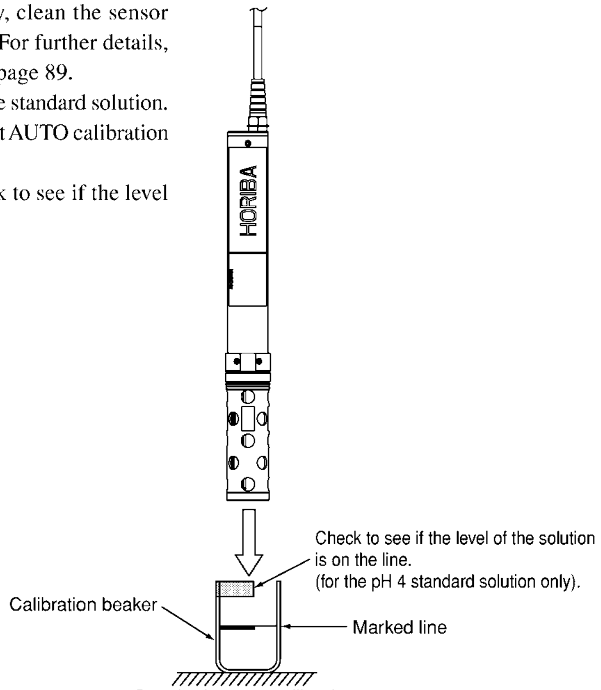
Put some of the pH 4 standard solution into the calibration beaker. ⇒ Immerse sensor in the calibration beaker. ○ CAL ⇒ AUTO Calibration mode ○ ENT ⇒ Start of calibration

Calibrate using the following procedure.

1. Wash the sensor in distilled water a few times and put some of the pH 4 standard solution into the calibration beaker to the marked line. Then immerse the sensor in it.

Important

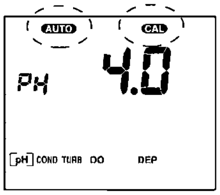
- To carry out calibration for turbidity accurately, clean the sensor surface that will be soaked in standard solution. For further details, see "Troubleshooting for the TURB sensor" on page 89.
- Use the "100-4" manufactured by HORIBA for the standard solution. With other standard solutions, you cannot carry out AUTO calibration correctly.
- Use the label on the calibration beaker and check to see if the level of the calibration solution is on the label line.



Standard sensor calibration

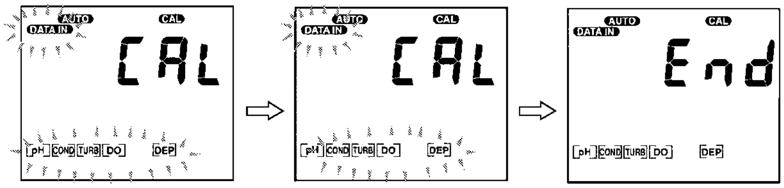
2. Press the **CAL** key in one of the Measurement modes pH, COND, TURB, DO and DEP.

AUTO and **CAL** appear and the instrument enters the AUTO Calibration mode.



3. Press the **ENT** key to start AUTO Calibration.

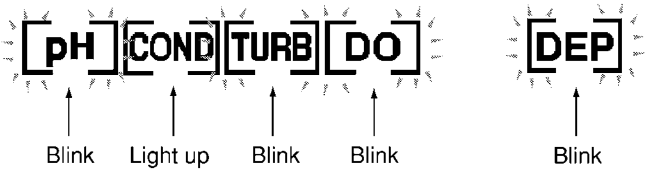
Upon completion of all of the pH, COND, TURB, DO, and DEP modes, End will be displayed.
During calibration, **DATA IN** and [ ] for the selected measurement item blink. [ ] light up for the item of which calibration is finished.



End of calibration

With DATA IN is blinking
To stop calibrating the sensor .... press the CAL key.
To establish the calibration .... press the ENT key.

Example: When COND calibration is finished:
[ ] for [COND] stops blinking and light up steadily.



Note

- [ ] continues to blink because calibration is not performed for the item for which an error has happened. If two or more errors happen, an error with a smaller number appears. (See pages 85 to 88 for these errors and ways to solve them.) These calibration errors disappear when the sensor is calibrated properly again, or when the instrument is turned ON again.
- Calibration should be performed for maximum three minutes. When the indications become stable, calibration should be finished.

4. Press the **MEAS** key to return to the Measurement mode.

Important

- Neutralize any basic pH 4 fluids before disposal.

3.2.3 Measurement

Immerse the sensor in the sample
MEAS
⇨ Select the measurement items

1. Immerse the sensor in the sample.

2. Select the measurement item.

Use the MEAS key to switch measurement items in the following order:

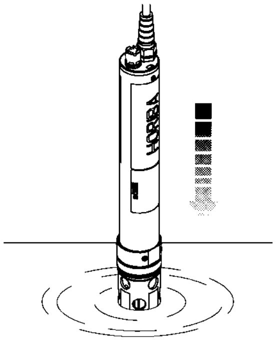
pH → COND → TURB → DO → TEMP → DEP → SAL → TDS → σ_t → ORP → TIME → then back to pH.

Note

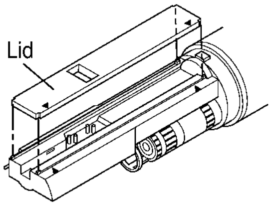
- [GPS] lights up when the optional G.P.S. sensor is connected to the instrument and position information is received from the G.P.S. sensor.
- The above measurement items can be changed by setting “”*Measurement item setting*” described on page 76.

Important

- When immersing the sensor probe in the sample, slowly lower the sensor probe into the sample.
- Dropping it from a height of 1m or more may cause damage to the sensor.



- Don't remove the COND/TURB lid during calibration or measurement.
- Attach the lid to the cell with fitting four corners and facing ▲ marks each other.



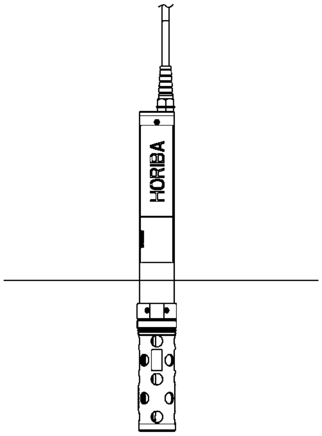
- Perform AUTO calibration after attaching the lid again, when the lid has been removed for the cleaning. A slight difference of the fitting position of the lid causes the difference of the indicated value for turbidity.
- Contacting with a different kind of metal, protection cover of the sensor probe may cause an error in measurement. Be careful not to let protection cover touch with any metal in measurement.

Two useful uses of the U-20XD Series models

Making measurements

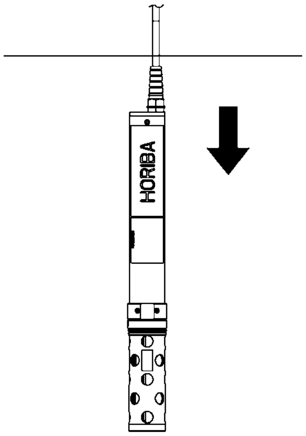
1. Manually storing the measurement data after checking the indication becomes stable

Example: After switching measurement items with the MEAS key, you can then store the measurement data after checking the indication becomes stable.
(☞ 4.1 *Manual storage of data while monitoring the measurement data*, page 34.)



2. Storing data

Example: Data can be stored continuously at constant intervals from the start of the automatic data storage.
This function is useful in obtaining data in depth direction and in storing data continuously.
(☞ 4.2 *Automatic data storage*, page 36.)



Notes in obtaining data on depth

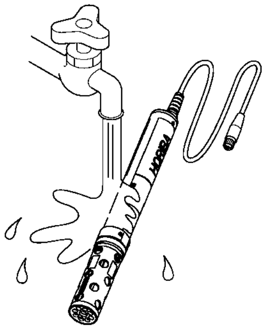
- When the instrument is placed at a depth of 100 m or more, the instrument may be broken.

Notes for reliable measurements

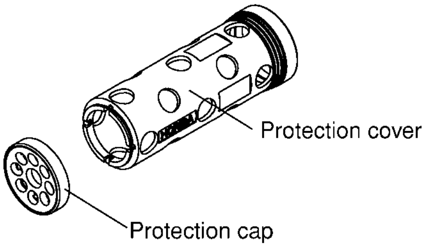
- Any sensor contamination may affect measurements. Use the AUTO calibration mode to check for contamination on sensors about once a week for measurements.

3.2.4 After completion of measurement

1. Turn the power to the instrument off.
2. Use tap water to completely wash off the sample on the sensor and then wipe waterdrops.



Remove the protection cover once and completely wash out with tap water the left over sample on the screws. Reinstall the cover after having wiped off the drops of water. If there is any sample (especially sea water) left over on the screws, rust may form which may prevent the protection cover from being removed. (☞ Installation procedure, page 18.)
Depending on the level of contamination, remove the rubber protection cap from the tip of the protection cover and wash out with tap water. Reinstall it after wiping off the drops of water.



3. Pour about 20 mL (about 2 cm from the bottom)of pure water in the probe cap and install it on the sensor probe. Place the rubber cap on the connector and store the instrument in the carrying case. (☞ 2.2.2 Sensor probe names, page 10.)

When storing with the ph/ORP and DO sensors attached to the probe, make sure to install the probe cap after having poured pure water into it.
Letting the ph/ORP and DO sensors get dry may cause deterioration of the instrument's performance. Should the sponge inside the probe cap be contaminated, replace it with a clean sponge (included).

Now you have read the description for performing measurements. For further information on how to use the instrument, refer to the chapters hereafter.

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MEMO

4. Using the data memory function

The data memory function can be used to store manualy measurement values with associated data numbers and to store automatically measurement values at fixed intervals (data logger).

Make sure MAN is displayed on the measurement screen. ENT ⇒ Start data storage.

Measurement mode DATA ⇒ SET ⇒ DATA IN is displayed. ▲ UP/DOWN ▼ keys ⇒ AUTO is displayed. SET ⇒ Data storage interval ENT ⇒

Switch the hour, minute, second. ▲ UP/DOWN ▼ keys ⇒ Value setting SET ⇒ Waiting time for data storage ENT ⇒ Switch the hour, minute, second. ▲ UP/DOWN ▼ keys ⇒ Value setting

SET ⇒ Data storage measurement interval ▲ UP/DOWN ▼ keys ⇒ Number of days setting MEAS ⇒ Setting completed to the Measurement mode

Measurement mode ENT ⇒ Automatic data storage confirmation screen ENT ⇒ Automatic data storage starts. ⇒ After the specified measurement period, return to the Measurement mode.

Measurement mode DATA ⇒ Data mode DATA ⇒ Measurement data display

Measurement mode DATA ⇒ Data Display mode CAL ⇒ Displays the calibration log.

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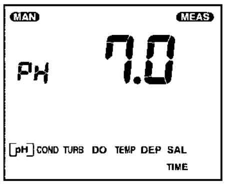
4.1 Manual storage of data while monitoring the measurement data

Make sure MAN is displayed on the measurement screen. ○ ENT ⇨ Start data storage.

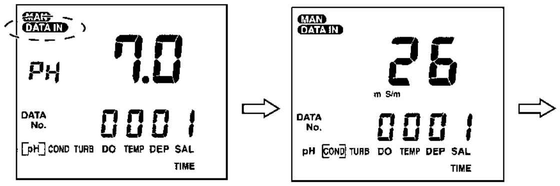
1. Make sure that MAN is displayed on the Measurement mode.

If AUTO is displayed, switch to MAN display.
(☞ page 35, Switch to MAN display on the measurement mode)



2. Press the **ENT** key.

Data storage starts, DATA IN and the data No. are displayed on the screen, and the measured value to be stored and the measurement item are displayed in order at approximately 0.5 second intervals.



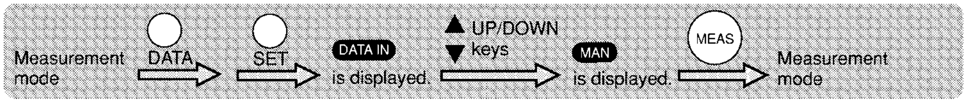
All measurement items and times are stored in sequence.

After the data is stored in memory, the screen returns to the original Measurement mode.

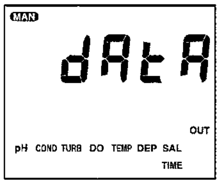
Note

- Up to 2880 sets of data can be stored in the memory.
  When 2880 sets of data have been stored in the memory, ERR 9 appears and no more data can be stored. In this case, "*Data memory clear*" while referring to page 78, and you can store new data in the memory.

When AUTO is displayed
Switch to MAN display on the measurement mode

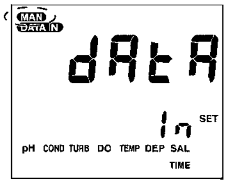


1. Press the **DATA** key in the Measurement mode.



2. Press the **SET** key.
DATA IN is displayed.

3. Press the **UP/DOWN** (▲ ▼) keys to display MAN.

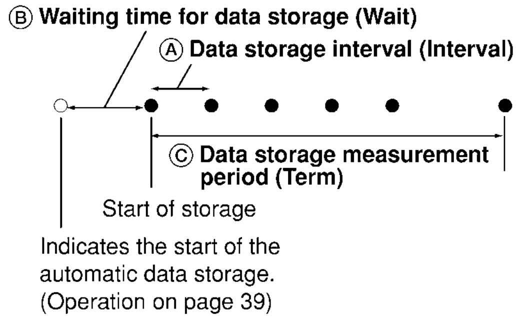


4. Press the **MEAS** key to return to the Measurement mode.

4.2 Automatic data storage

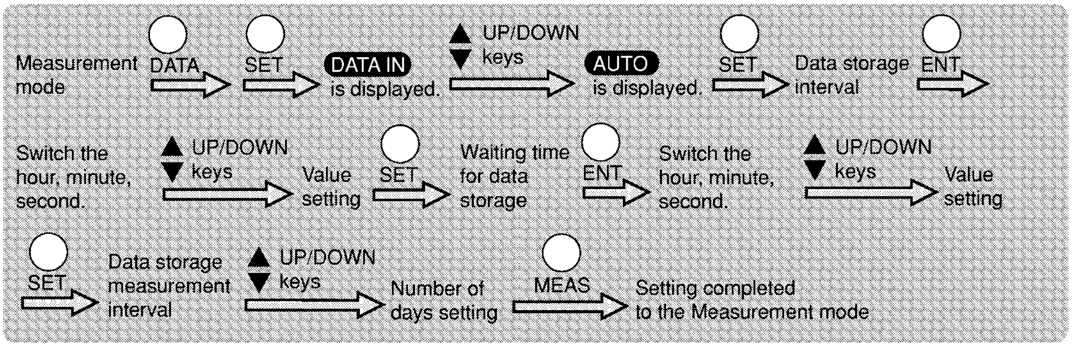
Measured values are stored automatically at constant time intervals. Before using the automatic storage, the following condition settings are required:

- Setting of data storage interval (4.2.1, step 4)
- Setting of waiting time for data storage (4.2.1, step 6)
- Setting of the data storage measurement period (4.2.1, step 8)

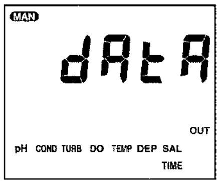


● indicates a storage point.

4.2.1 Data memory conditions settings



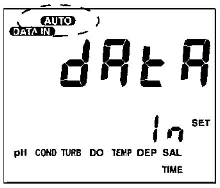
1. Press the **DATA** key in the Measurement mode.



2. Press the **SET** key.

   DATA IN is displayed.

3. Press the **UP/DOWN** (▲ ▼) keys to display AUTO.

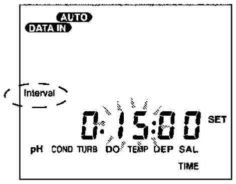


4. Press the **SET** key to display the screen for setting the data storage interval Ⓐ.

"**Interval** " is displayed.

5. Press the **ENT** key to switch the among "hour", "minute" and "second" and set the value using the **UP/DOWN** (▲ ▼) keys.

(Data storage intervals can be set to 2 seconds to 24 hours.)
The current setting location will blink.



6. Press the **SET** key to display the screen for setting the waiting time for data storage Ⓑ.

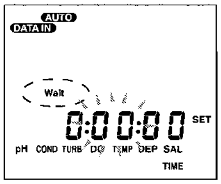
"**Wait** " is displayed.

7. Press the **ENT** key to switch among "hour", "minute" and "second" and set the value using the **UP/DOWN** (▲ ▼) keys.

(The waiting time for data storage can be set to 2 seconds to 24 hours.)
The current setting location will blink.

Important

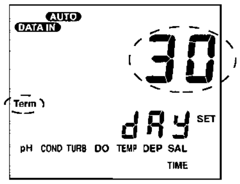
- If wait time is set to "0", note that data is not stored in a memory the first time.



8. Press the **SET** key to display the screen for setting the data storage measurement period Ⓒ (number of days).

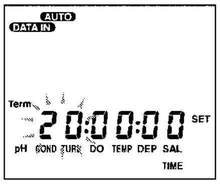
"**Term** " is displayed.

9. Use the **UP/DOWN** (▲ ▼) keys to set the value (number of days).



Setting of less than 24 hours

First set the number of days to 00 then press ENT key to select the "hour/minute/second" setting. Use the UP/ DOWN (▲ ▼) keys to set the hour, the minute and second. During setting, the number to be set blinks.



Note

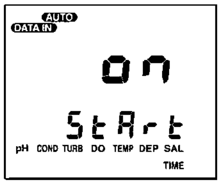
- Press the SET key to return to step 4.

10. When the **MEAS** key is pressed, setting will be completed and the instrument will return to the Measurement mode.

4.2.2 Start of automatic data storage

Measurement mode ○ ENT ⟹ Automatic data storage confirmation screen ○ ENT ⟹ Automatic data storage starts. ⟹ After the specified measurement period, return to the Measurement mode.

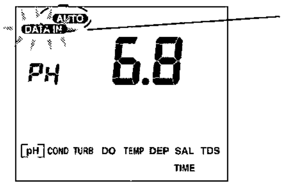
1. Make sure that **AUTO** is displayed on the Measurement mode.
2. Press the **ENT** key. A confirmation screen will be displayed asking if you wish to start automatic data storage.



Note

- If you do not wish to proceed with automatic data storage, press the CAL key to return to the Masurement mode.

3. Press the **ENT** key to start automatic data storage.



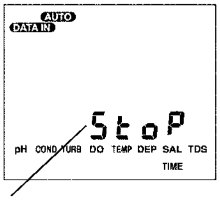
While **DATA IN** is blinking, the automatic data storage is being executed.

Note

- During the automatic data storage, measurement items can be switched by pressing the MEAS key.

Important

- During the automatic data storage, the ENT, SET, and DATA keys do not function and therefore calibration, setting change and stored data display cannot be performed.
- To stop automatic data storage, press the CAL key.



Confirmation display for canceling automatic data storage appears.
To stop the automatic data storage .... Press the ENT key.
To return to the screen for the automatic data storage ... Press the DATA key.

4. After the specified measurement period, DATA IN disappears and the instrument returns to the normal Measurement mode.

Note

- When the instrument is turned on, AUTO lights up and DATA IN blink if automatic data storage is being performed with the sensor probe.

Notes for automatic data storage

- For long-term data storage, replace the sensor probe battery with a new one.
- You can remove the connector from the main unit. It can still be used for up to 60 hours at room temperature with the battery in the sensor probe (alkaline battery). Life is reduced by approximately one half when manganese batteries are used.
- If the sensor probe is connected to the instrument for monitoring, the instrument battery is first consumed to protect the memory of the sensor.
- When 2880 sets of data have been stored in the memory, ERR 9 appears and no more data can be stored. The automatic data storage is automatically ended and the instrument returns to the normal Measurement mode.

4.3 Calling up data from the memory

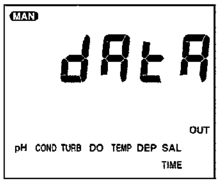
4.3.1 Calling up measurement data

Reading out data that has been stored manually or automatically.

Measurement mode —DATA→ Data mode —DATA→ Measurement data display

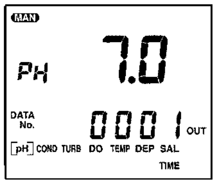
1. Press the **DATA** key in the Measurement mode.

The instrument goes to the DATA mode.



2. Press the **DATA** key.

The measurement data is displayed.
Data you want to call can be displayed by selecting a measurement item and data No.



DATA key .... Selects switching of measurement item or memory data No.

When switching measurement items: Measurement item blinks.
When switching data No. : Data No. blinks.

UP/DOWN (▲▼) keys .... Switch measurement item or No. which has been selected with the DATA key.

Note

- If you push the CAL key, only the data numbers will be displayed, allowing rapid changing of the numbers. Push the UP/DOWN (▲▼)keys to find the number, then press the SET key to display the data.

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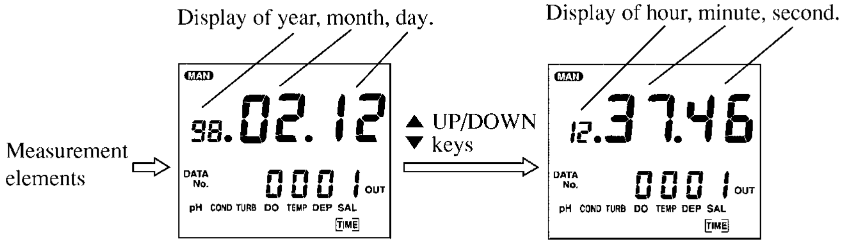
3. Press the **DATA** key.

TIME data

Use the UP/DOWN (▲▼) keys to switch between “Yer, Month, Day” and “Hour, Minute, Second”.

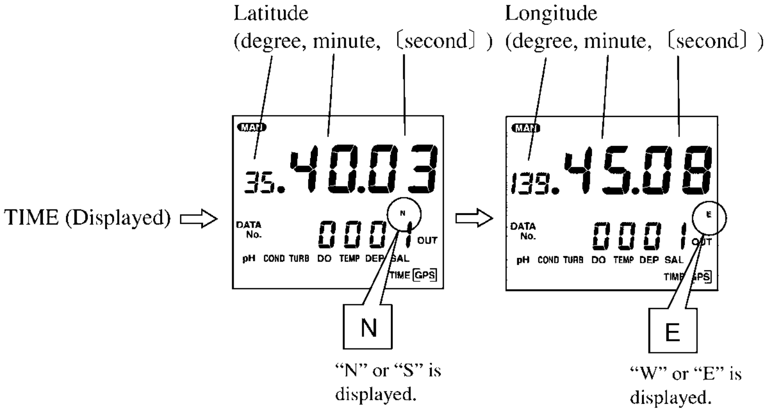


◖Note◗

- The time in the automatic memory can be out by about 2 seconds.

G.P.S. data (only when G.P.S. data is present)

Use the UP/DOWN (▲ ▼) keys to switch between “Latitude” and “Longitude”.



Latitude	N → The North latitude	S → The South latitude
Longitude	E → The East longitude	W → The West longitude

ENT key .... Prints all measurement data for the displayed memory data item. (when the printer is connected to the instrument)

Useful uses of keys in automatic storage

SET + UP (▲) key .... Displays the first part of the next data automatically stored.
SET + DOWN (▼) key .... Displays the first part of the previous data automatically stored.

If there is manual data, then the previous or next manual data is shown.

Display for automatic storage

For the first and last data in one session of automatic storage the following identification marks are displayed in front of the values representing the data Nos.:

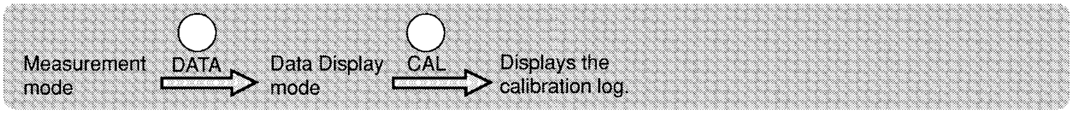
[: displayed for the first data in automatic storage.
] : displayed for the last data in automatic storage.

◖Note◗

- When the MEAS key is pressed, data calling is stopped and the instrument returns to the Measurement mode.
- Data is called from the sensor probe so to get one piece of data takes about one second.

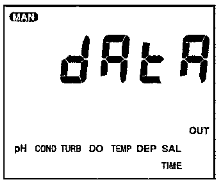
4.3.2 Calling up the calibration log

A calibration log is a record containing the "year, month, day" and "hour and minute" of the last calibration of individual measurement items and their calibration method. The instrument automatically stores the calibration log.



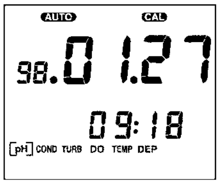
1. Press the **DATA** key in the Measurement mode.

The instrument goes to the DATA Display mode.



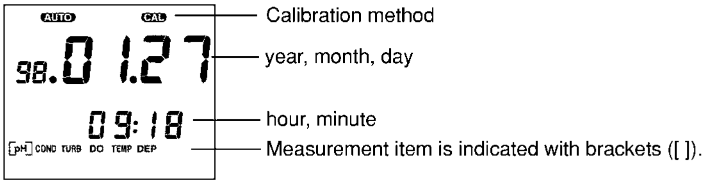
2. Press the **CAL** key.

The calibration log is displayed.



UP/DOWN (▲▼) keys: Switch the measurement item.
ENT key: Prints the entire calibration log. (when the printer is connected to the instrument)

Calibration log.



Calibration method

AUTO CAL : AUTO calibration
MAN ZERO CAL : Manual zero calibration
MAN SPAN CAL : Manual span calibration
MAN ZERO SPAN CAL : Manual zero calibration and span calibration

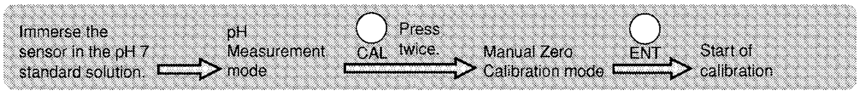
Note

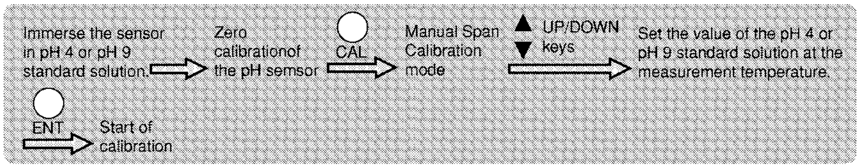
- Press the MEAS key to abort the data calling and return to the Measurement mode.

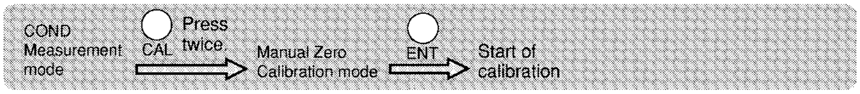
MEMO

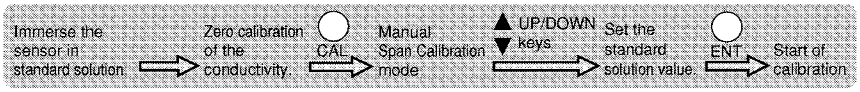
5. Techniques for more accurate measurement

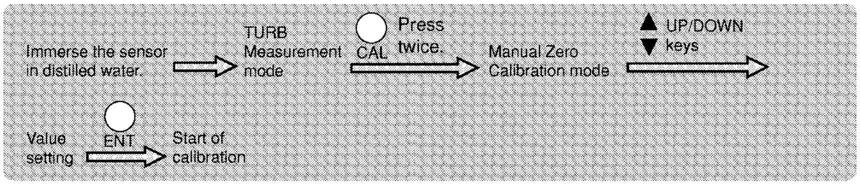
In normal operation, calibration using the AUTO Calibration mode described earlier in the basic operation section provides sufficient accuracy. However, **for more accurate measurement, manual calibration is effective.** When measurement with high-accuracy extended display is needed, be sure to perform manual calibration. Attention: The extended display mode is entered automatically when manual calibration is selected.

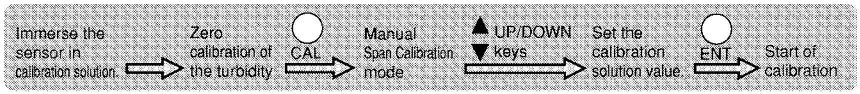


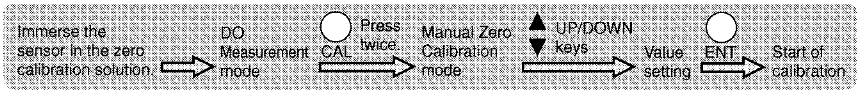


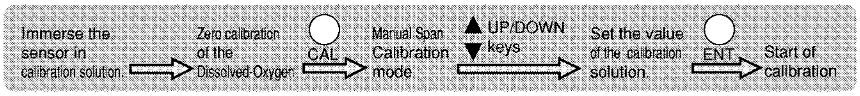


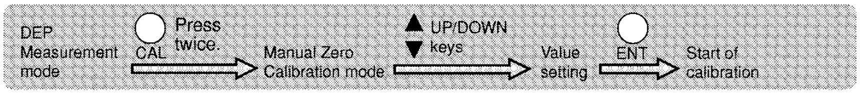


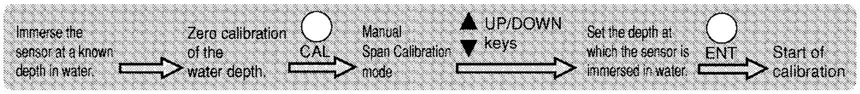


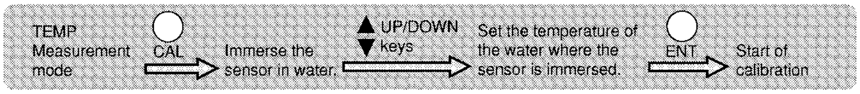

Immerse the sensor in calibration solution.
Zero calibration of the turbidity
CAL
Manual Span Calibration mode
UP/DOWN keys
Set the calibration solution value.
ENT
Start of calibration


Immerse the sensor in the zero calibration solution.
DO Measurement mode
CAL
Press twice.
Manual Zero Calibration mode
UP/DOWN keys
Value setting
ENT
Start of calibration


Immerse the sensor in calibration solution.
Zero calibration of the Dissolved-Oxygen
CAL
Manual Span Calibration mode
UP/DOWN keys
Set the value of the calibration solution.
ENT
Start of calibration


DEP Measurement mode
CAL
Press twice.
Manual Zero Calibration mode
UP/DOWN keys
Value setting
ENT
Start of calibration


Immerse the sensor at a known depth in water.
Zero calibration of the water depth.
CAL
Manual Span Calibration mode
UP/DOWN keys
Set the depth at which the sensor is immersed in water.
ENT
Start of calibration


TEMP Measurement mode
CAL
Immerse the sensor in water.
UP/DOWN keys
Set the temperature of the water where the sensor is immersed.
ENT
Start of calibration

5.1 Manual pH calibration

5.1.1 Zero calibration

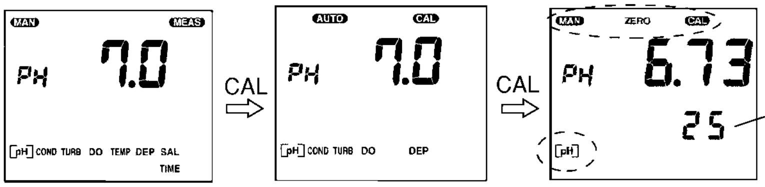
Immerse the sensor in the pH 7 standard solution. ⇨ pH Measurement mode ⇨ CAL ○ Press twice. ⇨ Manual Zero Calibration mode ⇨ ENT ○ ⇨ Start of calibration

Key operations and mode switching (☞ Page 25)

1. Wash the sensor two or three times using distilled water, then pour some pH 7 standard solution into the calibration beaker, and immerse the sensor in it.

2. Press the **CAL** key twice in the pH Measurement mode.

When the instrument enters the Manual Zero Calibration mode, **MAN**, **ZERO** and **CAL** light up.

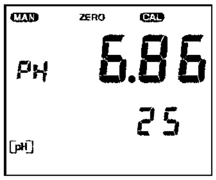


The measurement temperature is displayed.

Manual Zero Calibration mode

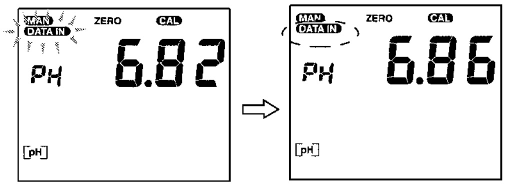
3. Use the **UP/DOWN** (▲ ▼) keys to input the value for the pH 7 standard solution at the measurement temperature.

(☞ *8. Reference data*, page 96.)



4. Press the **ENT** key.

The manual zero calibration starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

With DATA IN is blinking

To stop calibrating the sensor .... Press the CAL key.

To establish the calibration .... Press the ENT key.

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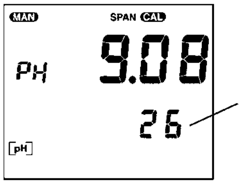
5.1.2 Span calibration

Immerse the sensor in pH 4 or pH 9 standard solution. ⇨ Zero calibrationof the pH semsor ⇨ CAL ⇨ Manual Span Calibration mode ⇨ ▲▼ UP/DOWN keys ⇨ Set the value of the pH 4 or pH 9 standard solution at the measurement temperature. ⇨ ENT ⇨ Start of calibration

1. Wash the sensor two or three times using distilled water, then pour some pH 4 or pH 9 standard solution into the calibration beaker, and immerse the sensor in it.

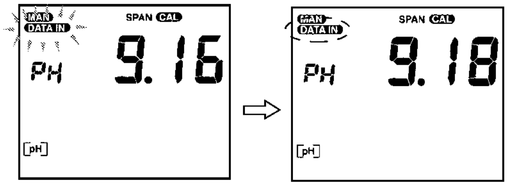
2. After the zero calibration of the pH sensor, press the **CAL** key to make sure that the instrument is in the Manual Span Calibration mode.
   MAN, **SPAN** and **CAL** light up.

3. Use the **UP/DOWN** (▲ ▼) keys to set the value for the pH 4 or pH 9 standard solution at the measurement temperature.



The measurement temperature is displayed.

4. Press the **ENT** key.
   The manual span calibration starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

With DATA IN is blinking
To stop calibrating the sensor .... Press the CAL key.
To establish the calibration .... Press the ENT key.

5. Press the **MEAS** key to return to the Measurement mode.

Note

- When the SET and CAL keys are pressed during the manual pH calibration mode, the calibration data for the pH sensor can be deleted.

5.2 Manual conductivity (COND) calibration

The U-20XD series models can measure conductivity (COND) in the range from 0.90 to 9.99 S/m. Depending on the concentration of the sample, these models automatically select the most suitable measuring range from three ranges: 0.0 to 99.9 mS/m, 0.090 to 0.999 S/m, and 0.90 to 9.99 S/m. The zero point is common to the three measuring ranges.

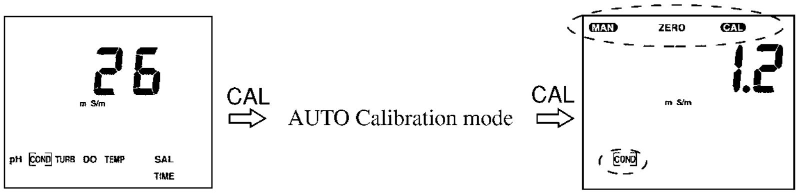
5.2.1 Zero calibration

COND Measurement mode ○ CAL Press twice. ⇒ Manual Zero Calibration mode ○ ENT ⇒ Start of calibration

Key operations and mode switching (☞ Page 25)

1. Wash the conductivity (COND) sensor two or three times using distilled water. Completely remove the water on the sensor and calibrate the instrument in the atmosphere.
2. Press the **CAL** key twice in the Conductivity (COND) Measurement mode.

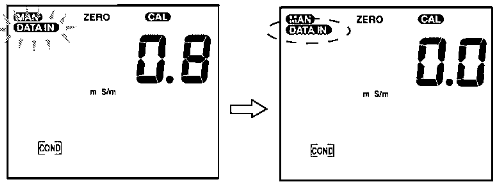
When the instrument enters the Manual Zero Calibration mode, **MAN**, **ZERO** and **CAL** light up.



Manual Zero Calibration mode

3. Use the **UP/DOWN** (▲ ▼) keys to set the value to 0.0.
4. Press the **ENT** key.

The manual zero calibration is starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

With DATA IN is blinking

To stop calibrating the sensor .... Press the CAL key.

To establish the calibration .... Press the ENT key.

5.2.2 Span calibration

Preparation of calibration solution (Potassium chloride (KCl) 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.

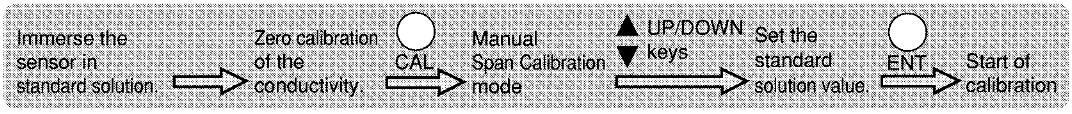
Consult the following table and measure a portion of potassium chloride (KC1), then prepare standard potassium chloride (KC1) solution following the procedure below.

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	0.373	0.0 to 99.9 mS/m
0.050 mol/L	0.667 S/m	3.73	0.090 to 0.999 S/m
0.500 mol/L	5.87 S/m	37.2	0.90 to 9.99 S/m

1. Dissolve the weighed Potassium Chloride (KCl) in distilled water.
2. Put the dissolved Potassium Chloride (KCl) into a 1 L measuring flask, and fill to the 1 L mark with distilled water.

Calibration procedure

Perform the span calibration using the three types of standard solution as follows.

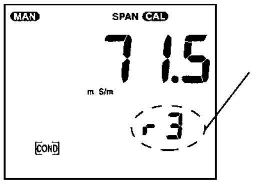


Important

- Set the temperature of the span standard solution to 25 ± 5 °C.
- The sensor should be calibrated in the three standard solutions in the order of increasing concentration.

1. Wash the sensor two or three times using distilled water, then pour some standard solution into the calibration beaker, and immerse the sensor in it.
2. After the zero calibration of the conductivity (COND) sensor, press the **CAL** key to make sure that the instrument is in the Manual Span Calibration mode.
   MAN, **SPAN** and **CAL** light up.

3. Use the **UP/DOWN** (▲ ▼) keys to set the standard solution value.



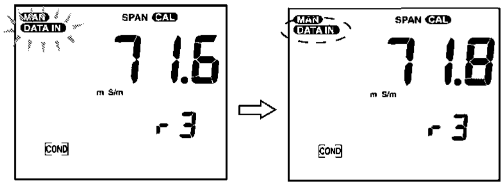
The calibration range is displayed.

Note

- The sensor automatically identifies the calibration solution and the relevant calibration range is displayed.
  r 1 : 0.90 to 9.99 S/m
  r 2 : 0.090 to 0.999 S/m
  r 3 : 0.0 to 99.9 mS/m

4. Press the **ENT** key.

The manual span calibration is starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

With DATA IN is blinking
To stop calibrating the sensor .... Press the CAL key.
To establish the calibration .... Press the ENT key.

5. Press the **CAL** key and use each standard solution and perform steps 1 to 4 above for calibration.

6. Press the **MEAS** key to return to the Measurement mode.

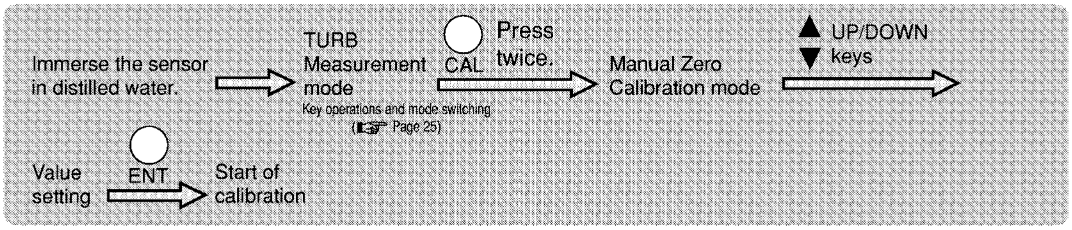
Note

- When the SET and CAL keys are pressed during the manual Conductivity (COND) Calibration mode, the calibration data for the conductivity (COND) sensor can be deleted.
- Perform the calibration again after deleting the present calibration data when calibration error occurs and the calibration cannot be performed.
- Perform the calibration again after deleting the present calibration data when the value cannot be read off because of unsettled digit of the measurement value.

5.3 Manual turbidity (TURB) calibration

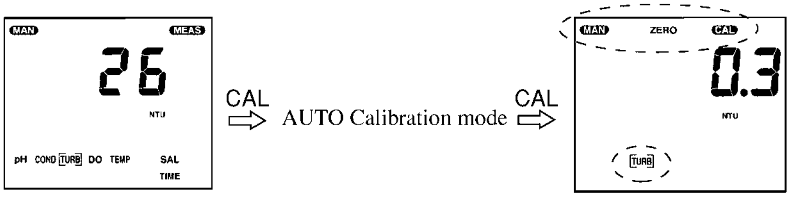
5.3.1 Zero calibration

In zero calibration, distilled water is used as a calibration solution. If you cannot obtain distilled water, you may use ion exchange water, which can be considered to have a turbidity of zero.
When the turbidity (TURB) sensor is calibrated, it is particularly important that the probe is completely contamination-free. Do not use a contaminated probe. Otherwise unreliable calibration will result.



1. Wash the sensor two or three times using distilled water, then place some distilled water into the calibration beaker, and immerse the sensor in it.
2. Press the **CAL** key twice in the Turbidity (TURB) Measurement mode.

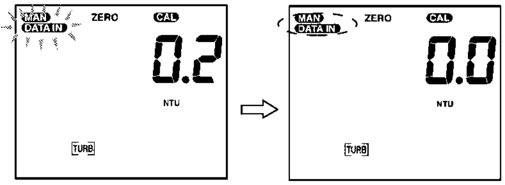
When the instrument enters the Manual Zero Calibration mode, **MAN**, **ZERO** and **CAL** light up.



Manual Zero Calibration mode

3. Use the **UP/DOWN** (▲ ▼) keys to set the value to 0.0.
4. Press the **ENT** key.

The manual zero calibration is started.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

With DATA IN is blinking
To stop calibrating the sensor .... Press the CAL key.
To establish the calibration .... Press the ENT key.

5.3.2 Span calibration

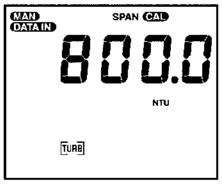
Preparation of calibration solution

Weigh out 5.0 g of hydrazine sulfate, and dissolve it in 400 mL of distilled water. Next dissolve 50 g of hexamethylene tetramine in 400 mL of distilled water, and mix the two solutions together. Finally add distilled water until the total solution volume is 1000 mL, and mix well. Store this solution at a temperature of 25 ± 3 °C for 48 hours. The turbidity value (TURB) of this solution is equivalent to 4000 NTU.
Use the solution as span calibration solution for turbidity (TURB) of 800 NTU by diluting this solution by a factor of 5 (use a pipette to measure 50 mL of the 4000 NTU solution and pour it into a 250 mL measuring flask, and add 200 mL of distilled water).

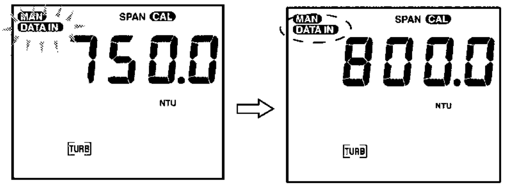
Calibration procedure

Immerse the sensor in calibration solution. ⇨ Zero calibration of the turbidity ⇨ ○ CAL ⇨ Manual Span Calibration mode ⇨ ▲ ▼ UP/DOWN keys ⇨ Set the calibration solution value. ⇨ ○ ENT ⇨ Start of calibration

1. Wash the sensor two or three times using distilled water, then pour standard solution into a calibration beaker, and immerse the sensor in it.
2. After the zero calibration of the turbidity (TURB) sensor, press the **CAL** key to make sure that the instrument is in the Manual Span Calibration mode.
   MAN, **SPAN** and **CAL** light up.
3. Use the **UP/DOWN** (▲ ▼) keys to set the value to 800.0.



4. Press the **ENT** key.
   The manual span calibration is starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

With DATA IN is blinking

To stop calibrating the sensor .... Press the CAL key.
To establish the calibration .... Press the ENT key.

5. Press the **MEAS** key to return to the Measurement mode.

Important

- When it is known beforehand that the solution for measurement has a low turbidity (0 to 100 NTU), calibrate the sensor in the span calibration solution of 80 NTU. To prepare an 80 NTU calibration solution, dilute the 4,000 NTU calibration solution with distilled water by a factor of 50.

Note

- When the SET and CAL keys are pressed during the manual Turbidity (TURB) Calibration mode, the calibration data for the turbidity (TURB) sensor can be deleted.

5.4 Manual Dissolved-Oxygen (DO) calibration

It is necessary to prepare a new calibration solution each time directly before calibration of the Dissolved-Oxygen (DO) sensor.

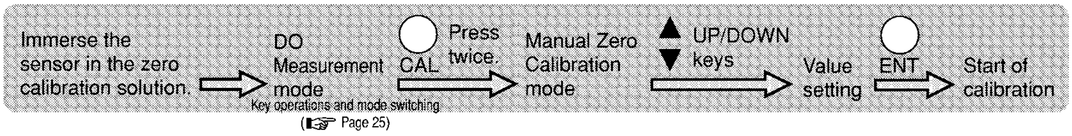
5.4.1 Zero calibration

Use ion exchange water or tap water with sodium sulfite dissolved in it.

Preparation of calibration solution

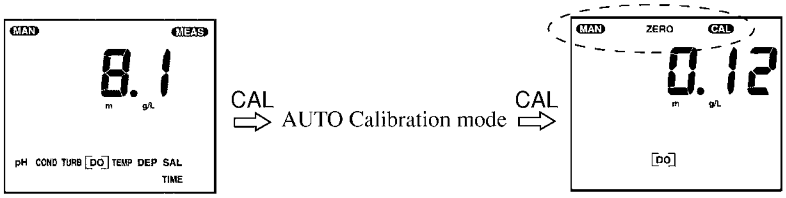
Add approximately 50 g of sodium sulfite to 1,000 mL of water (either ion exchange water or tap water) and stir the mixture to dissolve the sodium sulfite in it.
The calibration beaker (included) cannot be used to manually calibrate the DO sensor. Use a container that can immerse the DO sensor.

Calibration procedure



1. Wash the sensors 2 to 3 times with pure water and immerse the DO sensor completely in zero calibrated liquid.
2. Press the **CAL** key twice in the Dissolved-Oxygen (DO) Measurement mode.

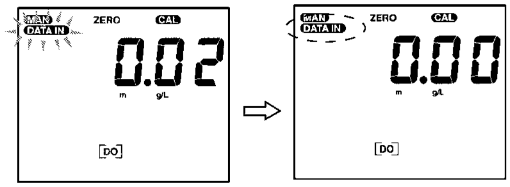
   When the instrument enters the Manual Zero Calibration mode, **MAN**, **ZERO** and **CAL** light up.



Manual Zero Caliburation mode

3. After the display has stabilized, use the **UP/DOWN** (▲ ▼) keys to set the value to 0.0.
4. Press the **ENT** key.

   The manual zero calibration is starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

With DATA IN is blinking

To stop calibrating the sensor .... Press the CAL key.

To establish the calibration .... Press the ENT key.

Important

- After calibration, use tap water to clean the sensor.

5.4.2 Span calibration

Use ion exchange water or tap water with saturated dissolved oxygen as the span calibration liquid.

Preparation of standard solution for span calibration

Pour 1 to 2 liters of water into a container (either ion exchange water or tap water).
Using a pneumatic pump, feed air into the water and froth up the solution until oxygen is saturated.
The calibration beaker (included) cannot be used to manually calibrate the DO sensor.
Use a container that can immerse the DO sensor.

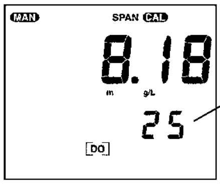
Calibration procedure

Immerse the sensor in calibration solution. ⇒ Zero calibration of the Dissolved-Oxygen ⇒ ○ CAL ⇒ Manual Span Calibration mode ⇒ ▲ UP/DOWN ▼ keys ⇒ Set the value of the calibration solution. ⇒ ○ ENT ⇒ Start of calibration

1. Wash the sensors 2 to 3 times with pure water and immerse the DO sensor completely in span calibrated liquid.

2. After the zero calibration of the Dissolved-Oxygen (DO) sensor, press the **CAL** key to make sure that the instrument is in the Manual Span Calibration mode.
MAN, **SPAN** and **CAL** light up.

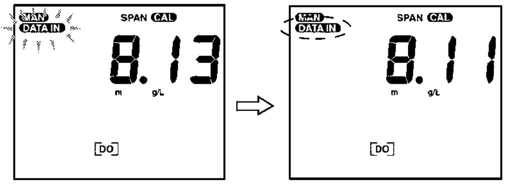
3. After the display has stabilized, use the **UP/DOWN** (▲ ▼) keys to set the amount of saturated dissolved oxygen in water at the temperature.



The temperature setting is displayed.
Refer to the table given on page 56 and set a value equivalent to the amount of saturated dissolved oxygen at the temperature.

4. Press the **ENT** key.

The manual span calibration is starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

With DATA IN is blinking
To stop calibrating the sensor .... Press the CAL key.
To establish the calibration .... Press the ENT key.

5. Press the **MEAS** key to return to the Measurement mode.

◖Note◗

- When the SET and CAL keys are pressed during the manual Dissolved-Oxygen (DO) calibration mode, the calibration data for the dissolved-oxygen (DO) sensor can be deleted.

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	12.45	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

AUTO calibration is based on the JIS tables. When you need the measured data based on ISO, calibration should be done according to the procedure of span calibration.

5.5 Water depth (DEP) calibration

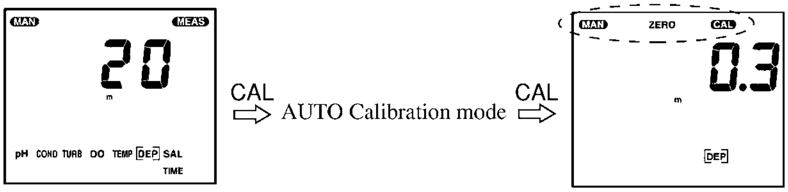
5.5.1 Zero calibration

DEP Measurement mode ○ CAL Press twice. ⇨ Manual Zero Calibration mode ▲ ▼ UP/DOWN keys ⇨ Value setting ○ ENT ⇨ Start of calibration

Key operations and mode switching
(☞ Page 25)

1. Immerse the sensor in the sample water for approximately 30 minutes so that sensor probe and sample temperatures become the same.
2. Press the **CAL** key twice in the Water Depth (DEP) Measurement mode.

When the instrument enters the Manual Zero Calibration mode, **MAN**, **ZERO** and **CAL** light up.



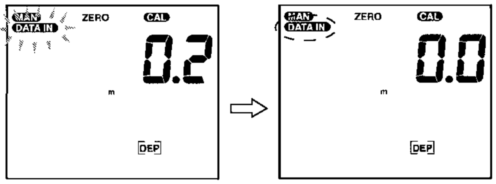
Manual Zero Calibration mode

Important

- Sensor probe should be immersed to the depth where the battery cover comes level with the surface. And the level is uses as 0 m in depth.

3. Use the **UP/DOWN** (▲ ▼) keys to set the value to 0.0.
4. Press the **ENT** key.

The manual zero calibration is starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

With DATA IN is blinking
To stop calibrating the sensor .... Press the CAL key.
To establish the calibration .... Press the ENT key.

Important

- Since the water depth (DEP) sensor depends greatly on temperature, calibrate the sensor at the same temperature as the sample for more accurate measurement.
- Use the AUTO Calibration mode because calibration error becomes large when using in a place with flow velocity or where it is shallow.

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Before use
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Techniques for more accurate measurement
Using the various functions
Instrument specifications
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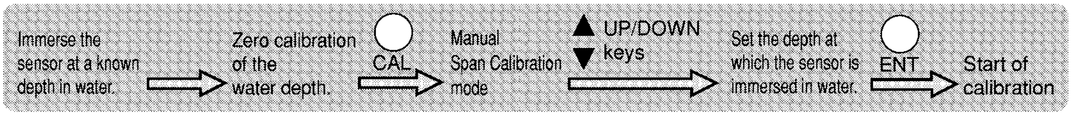
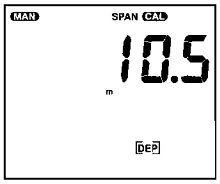
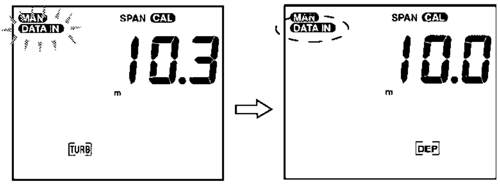
5.5.2 Span calibration



1. Immerse the sensor at a known depth in water. (Set the depth of the lid for memory backup battery as the depth setting.)
2. After the zero calibration of the water depth (DEP) sensor, press the **CAL** key to make sure that the instrument is in the Manual Span Calibration mode.
   MAN, **SPAN** and **CAL** light up.
3. Use the **UP/DOWN** (▲ ▼) keys to set the depth at which the sensor is immersed in water.



4. Press the **ENT** key.
   The manual span calibration is starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

With DATA IN is blinking
To stop calibrating the sensor .... Press the CAL key.
To establish the calibration .... Press the ENT key.

5. Press the **MEAS** key to return to the Measurement mode.

◖Note◗

- When the SET and CAL keys are pressed during the manual Water depth (DEP) Calibration mode, the calibration data for the water depth (DEP) sensor can be deleted.

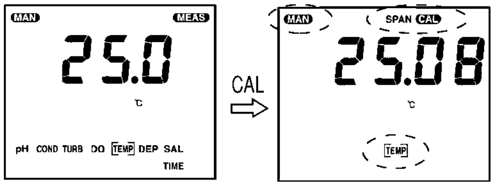
5.6 Temperature (TEMP) calibration

TEMP Measurement mode ○ CAL ⇒ Immerse the sensor in water. ⇒ ▲ UP/DOWN ▼ keys ⇒ Set the temperature of the water where the sensor is immersed. ○ ENT ⇒ Start of calibration

Key operations and mode switching
(☞ Page 25)

1. Press the **CAL** key in the Temperature (TEMP) Measurement mode.

Select the manual calibration mode.

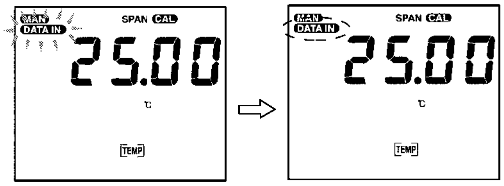


2. Immerse the sensor in water at a known temperature.

3. Use the **UP/DOWN** (▲ ▼) keys to set the temperature of the water where the sensor is immersed as a calibration value.

4. Press the **ENT** key.

The manual calibration is starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

With DATA IN is blinking

To stop calibrating the sensor .... Press the CAL key.

To establish the calibration .... Press the ENT key.

5. Press the **MEAS** key to return to the Measurement mode.

Note

- When the SET and CAL keys are pressed during the manual Temperature (TEMP) calibration mode, the calibration data for the temperature (TEMP) sensor can be deleted.

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5.7 Operation check using ORP standard solution

Note

- Standard solution is not used only for calibration of the meter, but to confirm whether or not the condition of electrodes is good.

1. Add 250 mL pure (ion exchange) water to one packet of any of the below listed standard solutions and mix well.
   When mixing, the excess quinhydrone (a black powder) will float to the surface of the solution.
2. Immerse a washed and dried ORP electrode in the ORP standard solution and measure the mV value.
3. If the electrode and the meter, itself, are working correctly, numerical values within 15 mV or less of those listed in Table 1 should be obtained.
4. If measurements that fall within 15 mV of the values listed above are not obtained using this method, measure the solution again after replacing the reference electrode internal solution and removing the dirt from the surface of the metal electrode by moistening a cotton swab with alcohol or a neutral cleaning agent and lightly rubbing the electrode or by soaking the electrode in diluted nitric acid (1:1 nitric acid).
5. If measurements within 15 mV of the values listed above are still not obtained after re-measuring, the reference electrode or the meter may be faulty. Either replace the electrode or have the meter inspected.

Important

- If the prepared ORP standard solution is allowed to stand in open air for one hour or more, it may undergo transformation. For this reasons ORP standard solution that has finished being prepared cannot be stored.
- When measuring a solution that has 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, use the meter after immersing the electrodes in the solution again and mixing it thoroughly.

Precautions when measuring actual samples

- Note that when measuring the ORP of solution that has 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 water is allowed to stand, its ORP undergoes big changes. Always measure alkaline ion water promptly.

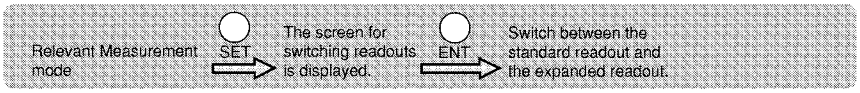
ORP standard solution

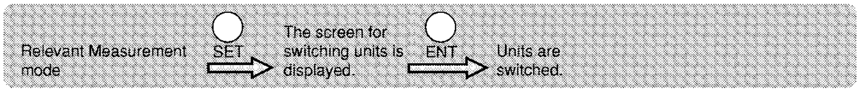
There are two kinds of standards substances. Under normal circumstances, it is sufficient to use only the one type of substance that is closest to the measured value.

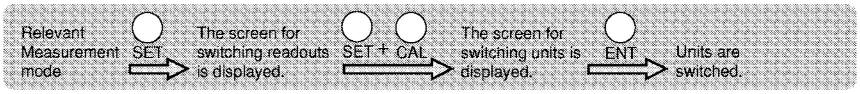
Indicated value of ORP standard solution at various temperatures

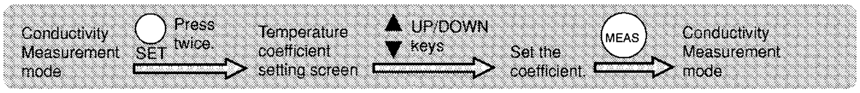
Standard solution ℃	160-22	160-51
	Phthalic-acid chloride + quinhydrone	Neutral phosphate + quinhydrone
5	+274.2	+111.9
10	+270.9	+106.9
15	+266.8	+101.0
20	+262.5	+95.0
25	+257.6	+89.0
30	+253.5	+82.7
35	+248.6	+76.2
40	+243.6	+69.0

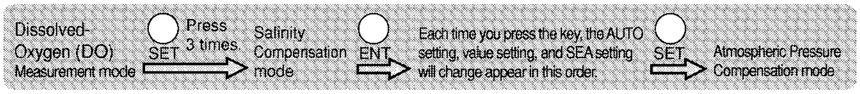
6. Using the various functions

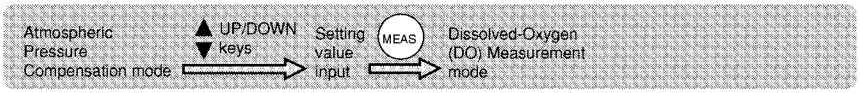


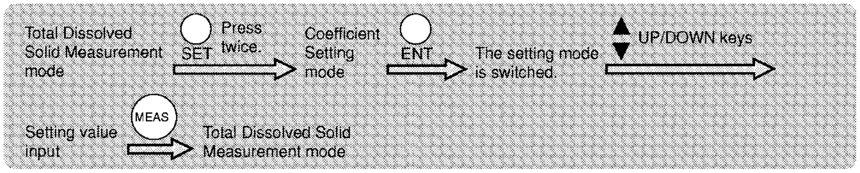


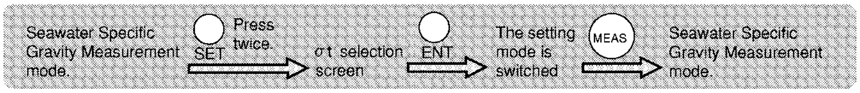


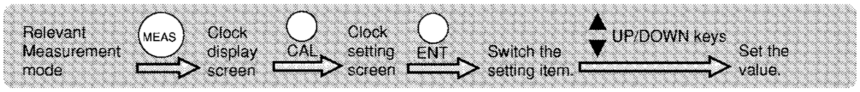


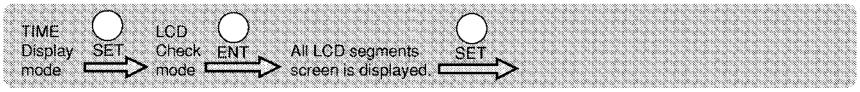


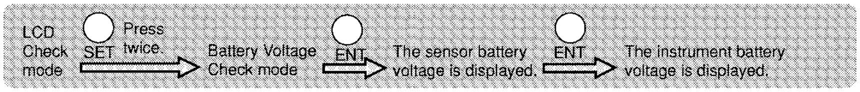


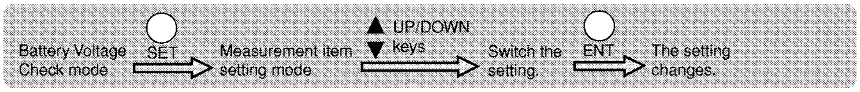


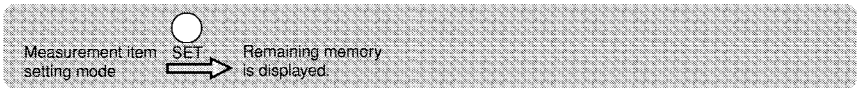

Seawater Specific Gravity Measurement mode.
SET
Press twice.
σt selection screen
ENT
The setting mode is switched
MEAS
Seawater Specific Gravity Measurement mode.

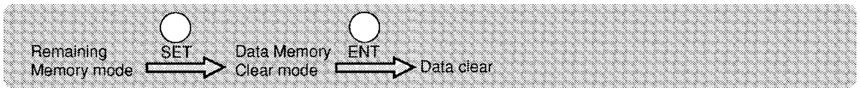

Relevant Measurement mode
MEAS
Clock display screen
CAL
Clock setting screen
ENT
Switch the setting item.
▲▼ UP/DOWN keys
Set the value.

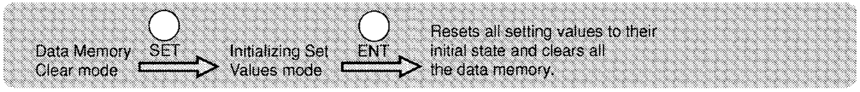

TIME Display mode
SET
LCD Check mode
ENT
All LCD segments screen is displayed.
SET

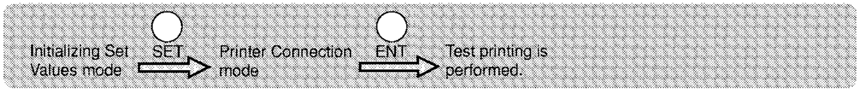

LCD Check mode
SET
Press twice.
Battery Voltage Check mode
ENT
The sensor battery voltage is displayed.
ENT
The instrument battery voltage is displayed.


Battery Voltage Check mode
SET
Measurement item setting mode
▲▼ UP/DOWN keys
Switch the setting.
ENT
The setting changes.


Measurement item setting mode
SET
Remaining memory is displayed.


Remaining Memory mode
SET
Data Memory Clear mode
ENT
Data clear


Data Memory Clear mode
SET
Initializing Set Values mode
ENT
Resets all setting values to their initial state and clears all the data memory.


Initializing Set Values mode
SET
Printer Connection mode
ENT
Test printing is performed.

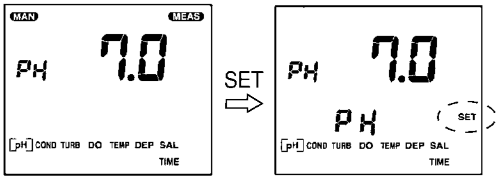
6.1 Switching to Expanded readout (High-accuracy display)

With the exception of oxidation-reduction potential (ORP), it is possible to switch between the Standard readout and the Expanded readout for the measurement value.

Relevant Measurement mode
Key operations and mode switching
(☞ Page 25)
○ SET ⇨ The screen for switching readouts is displayed.
○ ENT ⇨ Switch between the standard readout and the expanded readout.

1. Press the **SET** key in the relevant Measurement mode.

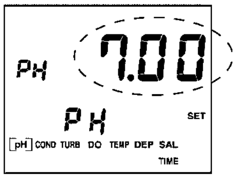
The screen for switching readouts is displayed.



Standard readout

2. Press the **ENT** key.

The screen can be switched between the standard readout and the expanded readout (High-accuracy display).



Expanded readout (High-accuracy display)

◖Note◗

- Switch readouts for each measurement items.
- Use the manual 2-point calibration (zero and span) when high accuracy is required for expanded readout (High-accuracy display).
- The expanded readout mode is automatically activated when the manual 2-point calibration mode is chosen.

3. Press the **MEAS** key to return to the Measurement mode.

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6.2 Switching measurement units

It is possible to switch between measurement units.

The units which can be switched are as follows:

pH	pH or mV
Conductivity (COND)	S/m or mS/cm
Water depth (DEP)	m or ft
Turbidity (TURB)	NTU or mg/L
Dissolved Oxygen (DO)	mg/L or % (Oxygen saturation ratio)

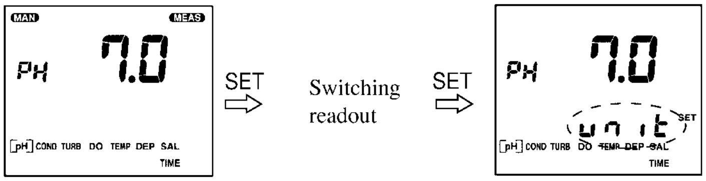
In the case of pH, TURB, DO

Relevant Measurement mode ○ SET ⇒ The screen for switching units is displayed. ○ ENT ⇒ Units are switched.

Key operations and mode switching
(☞ Page 25)

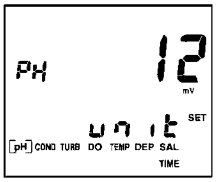
1. Press the **SET** key twice in the relevant Measurement mode.

Confirm that unit is displayed on the screen for switching units.



2. Press the **ENT** key.

Units are switched.



3. Press the **MEAS** key to return to the Measurement mode.

In the case of COND and DEP

Relevant Measurement mode ○ SET ⇒ The screen for switching readouts is displayed. ○ CAL + ○ SET ⇒ The screen for switching units is displayed. ○ ENT ⇒ Units are switched.

1. Press the **SET** key in the Relevant Measurement mode.

   The screen for switching readout is displayed.

2. Press the **SET** key while holding down the **CAL** key.

   Confirm that unit is displayed on the screen for switching units.

3. Press the **ENT** key.

   Units are switched.

4. Press the **MEAS** key to return to the Measurement mode.

Measurement range

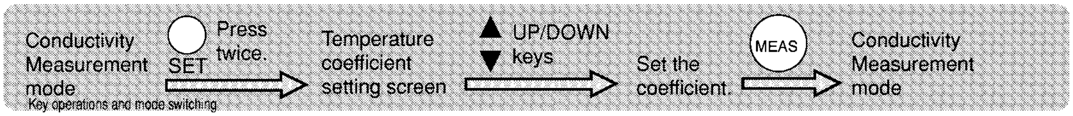
Measurement item		Measurement range		Measurement units
		Expanded	Standard	
pH		0.00 to 14.00	0.0 to 14.0	pH
		—	−1999 to 1999	mV in pH measurement
Conductivity (COND)	Range 1	0.90 to 9.99	0.9 to 9.9	S/m
		9.0 to 99.9	9 to 99	mS/cm
	Range 2	0.090 to 0.999	0.09 to 0.99	S/m
		0.90 to 9.99	0.9 to 9.9	mS/cm
	Range 3	0.0 to 99.9	0 to 99	mS/m
		0.000 to 0.999	0.00 to 0.99	mS/cm
Turbidity (TURB) *1		0.0 to 800.0	0 to 800	NTU (nephelometric turbidity units) or mg/L
Dissolved-oxygen (DO)		0.00 to 19.99	0.0 to 19.9	mg/L
		0.0 to 199.9	0 to 199	%
Temperature (TEMP)		0.00 to 55.00	0.0 to 55.0	°C
Water depth (DEP)		0.0 to 100.0	0 to 100	m
		0.0 to 330.0	0 to 330	ft
Salinity (SAL)		0.00 to 4.00	0.0 to 4.0	%
Total dissolved solids (TDS) *2	Range 1	5.5 to 65.0	5 to 65	g/L
	Range 2	0.55 to 6.50	0.5 to 6.5	g/L
	Range 3	0.000 to 0.650	0.00 to 0.65	g/L
Seawater specific gravity (σ_t)		0.0 to 50.0	0 to 50	–
Oxygen-reduction potential (ORP)		—	−1999 to 1999	mV

*1: Depending on the concentration range, the minimum turbidity is displayed as follows:
0 to 100 NTU ... 1 NTU for standard readout, 0.1 NTU for expanded readout.
100 to 800 NTU ... 10 NTU for standard readout, 1 NTU for expanded readout.

*2: The TDS range depends on the TDS factor settings. (Above ranges are given for a TDS coefficient of 0.65.)

6.3 Temperature conversion for conductivity (COND)

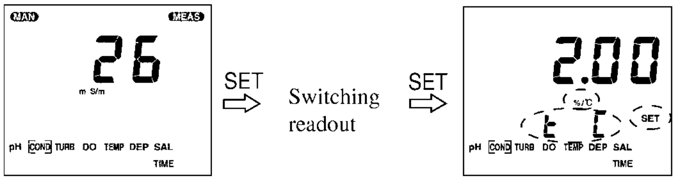
Sample conductivity (COND) varies with temperature, and this instrument uses a temperature conversion coefficient to automatically standardize the conductivity (COND) to the value at 25 °C. The initial setting value is 2 %/°C, which is the generally used value.



Key operations and mode switching
(☞ Page 25)

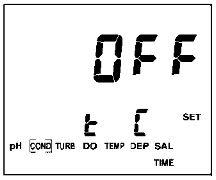
1. **Press the SET key twice in the Conductivity (COND) Measurement mode.**

   The screen for setting temperature coefficients is displayed.



2. **Use the UP/DOWN (▲ ▼) keys to set the coefficient.**

   The setting range is 0.00 to 3.00 %/°C.



   With the ENT key, the temperature conversion is switched between ON and OFF.
   The temperature conversion OFF mode is not a 25°C coefficient but a coefficient at the temperature of the sample.

3. **Press the MEAS key.**

   The instrument returns to the Conductivity (COND) Measurement mode.

◖Note◗

- For temperature coefficients, refer to *Reference data*, page 98 to 99.

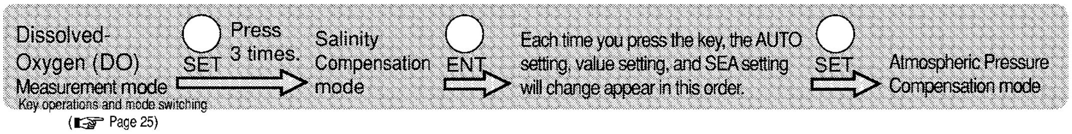
6.4 Dissolved-Oxygen (DO) environmental influence compensation

6.4.1 Salinity compensation

The indicated dissolved oxygen (DO) value can go over the actual value if salinity compensation isn't added because of the increase in salinity in the sample. To obtain a correct measured value for dissolved oxygen (DO) in the sample containing salinity, therefore, salinity compensation is needed. The following modes are available for calculation of salinity compensation.

AUTO........ Salinity compensation is performed automatically with salinity converted from a measured value for conductivity.

SEA .... Compensation value appropriate for normal seawater is used.



1. Press the **SET** key 3 times in the Dissolved-Oxygen (DO) Measurement mode.

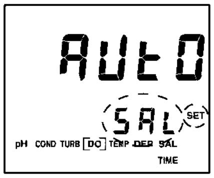
The salinity compensation mode currently set is displayed.

Important

- If you do not change the salinity compensation mode currently set, press the MEAS key to return to the Dissolved-Oxygen (DO) Measurement mode or press the SET key to select the Pressure Compensation mode.

2. Press the **ENT** key.

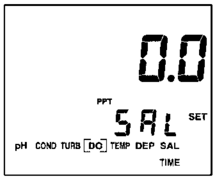
The following screens are displayed in sequence each time the ENT key is pressed: AUTO setting, value setting, SEA setting and AUTO setting.



3. From the screen on which the value is displayed, use the **UP/DOWN** (▲ ▼) keys to enter the setting value if the salinity is known.

For AUTO and SEA setting, this step need not be performed.

The setting range is 0.0 to 40.0 ppt (parts per thousand).



4. When the **SET** key is pressed, setting will be completed and the instrument will enter the Pressure Compensation mode.

5. Press the **MEAS** key to return to the Dissolved-Oxygen (DO) Measurement mode.

6.4.2 Atmospheric pressure compensation

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 instrument, it is possible to standardize the measured Dissolved-Oxygen (DO) value to a value at the standard atmospheric pressure (1013 hPa).

Atmospheric Pressure Compensation mode ▲▼ UP/DOWN keys ⇒ Setting value input (MEAS) ⇒ Dissolved-Oxygen (DO) Measurement mode

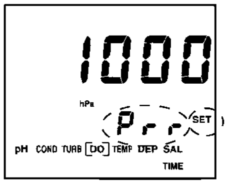
1. When the **SET** key is pressed on the salinity compensation screen, setting will be completed and the instrument will enter the Pressure Compensation mode.

Important

- If you do not change the Pressure Compensation mode currently set, press the MEAS key to enter the Dissolved-Oxygen (DO) Measurement mode.

2. Use the **UP/DOWN** (▲ ▼) keys to input a setting value.

The setting range is 100 to 1999 hPa.



3. When the **MEAS** key is pressed, setting will be completed and the instrument will enter the Dissolved-Oxygen (DO) Measurement mode.

Relation between height (m) and atmospheric pressure (hPa)

Height (m)	0	200	400	600	800	1000	1200	1400	1600	1800	2000	3000	3400
Pressure (hPa)	1013	990	966	943	921	899	877	856	835	815	795	701	666

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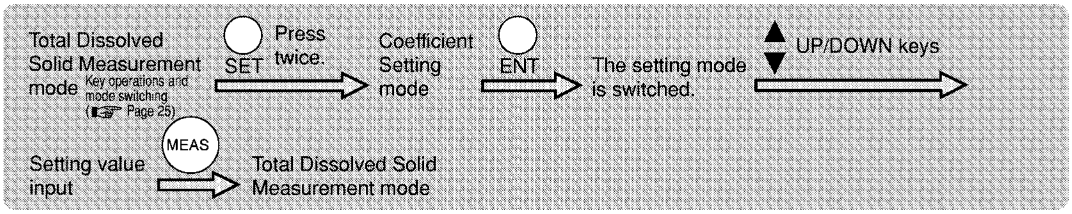
6.5 Setting a total dissolved solid (TDS) coefficient

The total dissolved solid amount (TDS) is a converted value obtained by multiplying the conductivity (COND) value by a known coefficient. Based on a conversion for KCl and $CaCO_3$ solutions, the coefficient initially set for the instrument 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

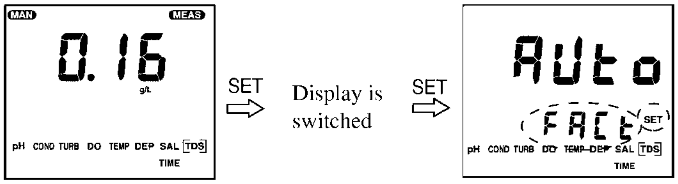
AUTO .... Used to automatically calculate the total dissolved solid (TDS) amount with an initially set coefficient.

Setting value input .... Used to determine the total dissolved solid (TDS) amount by setting any conversion coefficient irrespective of the conductivity (COND) value.



1. Press the **SET** key twice in the Total Dissolved Solid (TDS) Measurement mode.

The Coefficient Setting mode currently set is displayed.

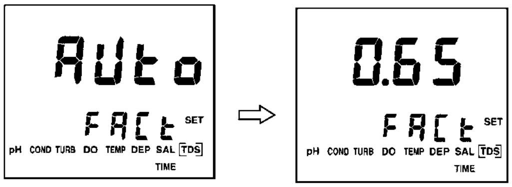


Important

- If you do not change the coefficient currently set, press the MEAS key to enter the Total Dissolved Solid (TDS) Measurement mode.

2. Press the **ENT** key.

The setting mode changes (AUTO/setting value input).



3. Use the **UP/DOWN** (▲ ▼) keys to input a setting value if required.

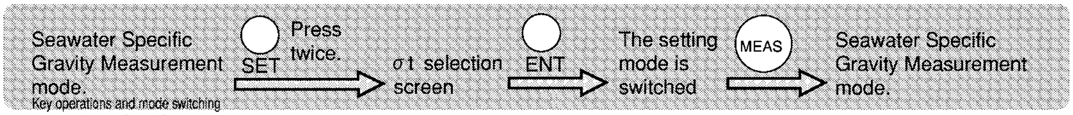
The setting range is 0.50 to 1.00.

4. When the **MEAS** key is pressed, setting will be completed and the instrument will enter the Total Dissolved Solid (TDS) Measurement mode.

6.6 Displaying seawater specific gravity (σ_0, σ_{15})

The specific gravity of seawater varies with temperature. By converting the measured value based on the value for a reference temperature, it is possible to compare sample measurement values at different temperatures.

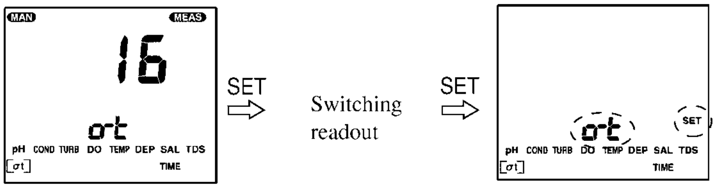
σ_t .... Specific gravity of seawater at the measurement temperature.
σ_0............ Seawater specific gravity at 0 °C.
σ_{15} .... Seawater specific gravity at 15 °C.



Key operations and mode switching
(☞ Page 25)

1. Press the **SET** key twice in the Seawater Specific Gravity (σ_t) Measurement mode.

Seawater specific gravity (σ_t) selection screen is displayed.

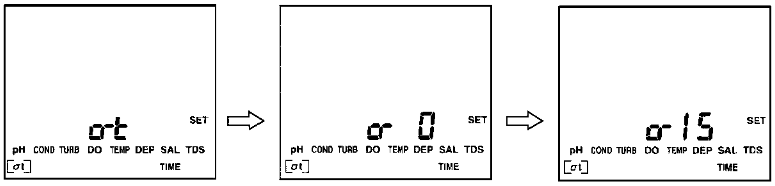


Important

- If you do not change the specific gravity currently set, press the MEAS key to enter the Seawater Specific gravity (σ_t) Measurement mode.

2. Press the **ENT** key.

The setting mode is switched.
($\sigma_0 \rightarrow \sigma_{15} \rightarrow \sigma_t \rightarrow \sigma_0 \ldots$)



3. When the **MEAS** key is pressed, setting will be completed and the instrument will enter the Seawater Specific Gravity (σ_t) Measurement mode.

Note

- See page 100 for more about seawater specific gravity.

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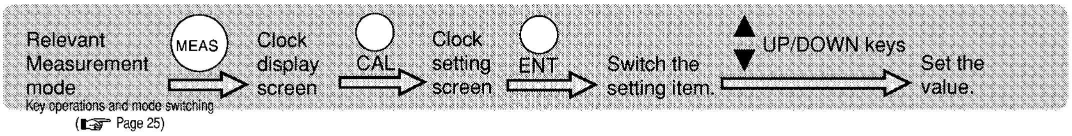
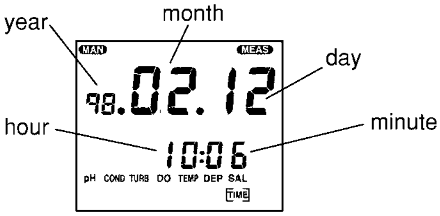
6.7 Setting the clock



1. Use the **MEAS** key in the measurement mode to switch to the clock display screen.

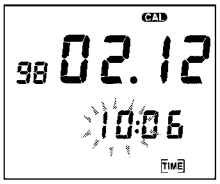


2. Press the **CAL** key.

CAL light up and clock setting screen is displayed.

3. Press the **ENT** key to switch the measuring item.

(year → month → day → hour → minute → year ...). The setting item will blink.



4. Use the **UP/DOWN** (▲ ▼) keys to set the value.

5. Press **SET** key to confirm the setting.

Note

- When the MEAS key is pressed, the instrument will return to the clock display.

Important

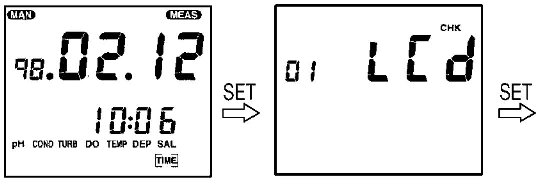
- When the MEAS key is pressed without pressing the SET key and the clock display is displayed again, settings are not changed.

6.8 Key lock setting

If you press the POWER key while pressing the UP (▲) key when the power is off, the instrument is then turned ON with the key locked and the key lock function works.
With the key locked, only the POWER and MEAS keys can be used and [LOCK] is displayed on the screen. To release this function, turn the instrument OFF first and then ON again.

6.9 Check mode

When the SET key is pressed in the measurement mode from the screen where "year, month, day and time" are displayed, the instrument performs self-diagnosis check.



Each time the SET key is pressed, the check mode item is switched sequentially.

Check mode items

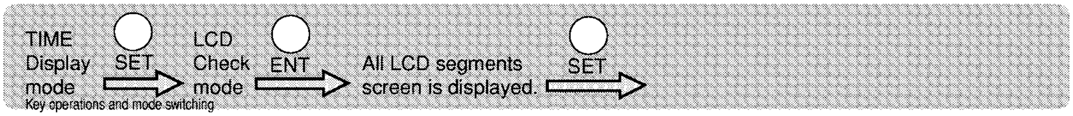
1 :	LCD check	Checks if all LCD segments will be displayed. (☞ Page 74)
2 :	Battery voltage check	Performs a simple battery voltage check for the instrument and sensors. (☞ Page 75)
3 :	Measurement item setting	Can set the measurement item to be stored. (☞ Page 76)
4 :	Remaining memory	Displays the number of data that can be stored now. (☞ Page 77)
5 :	Data memory clear	Clears the data memory. (☞ Page 78)
6 :	Initializing set values	Initializes all memory settings. (☞ Page 79)
7 :	Printer connection, test print	Performs a test print. (☞ Page 80)

◖Note◗

- In the check mode, it is possible to return to the Measurement mode by pressing the MEAS key.

6.9.1 LCD check

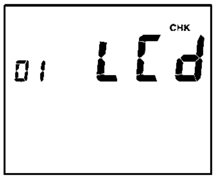
All LCD segments are displayed.



(☞ Page 25)

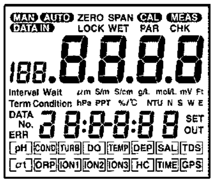
1. Press the **SET** key in the Clock Display mode.

LCD check mode screen is displayed.

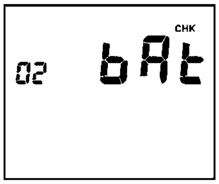


2. Press the **ENT** key.

3. Check to see if all LCD segments are displayed.



4. When the **SET** key is pressed, the instrument goes to the battery voltage check.



Note

- When the MEAS key is pressed, the instrument returns to the Clock Display mode.

6.9.2 Battery voltage check

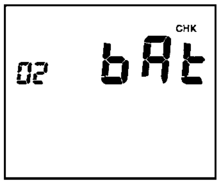
The battery voltage in use is displayed.

LCD Check mode ○ SET Press twice. ⇒ Battery Voltage Check mode ○ ENT ⇒ The sensor battery voltage is displayed. ○ ENT ⇒ The instrument battery voltage is displayed.

Check mode (☞ Page 73)

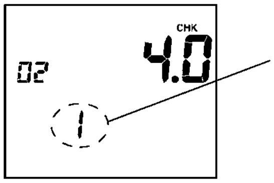
1. Press the **SET** key twice in the LCD Check mode.

Battery Voltage Check mode screen is displayed.



2. Press the **ENT** key.

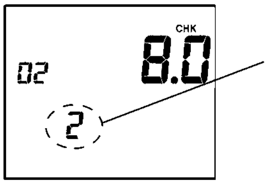
The sensor battery voltage is displayed.



1: Sensor battery voltage
Criteria
3.0 to 5.0 V : Normal
Less than 3.0 V: Replace the battery.
(Error No. 2 will blink.)

3. Press the **ENT** key.

The instrument battery voltage is displayed.



2: Instrument battery voltage
Criteria
5.5 to 11.0 V : Normal
Less than 5.5 V: Replace the battery.
(Error No.3 will blink.)

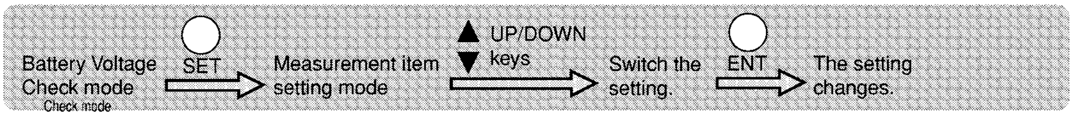
4. When the **SET** key is pressed, the instrument goes to the measurement item setting.

◖Note◗

- When the MEAS key is pressed, the instrument returns to the Clock Display mode.

6.9.3 Measurement item setting

Measuring items can be set.



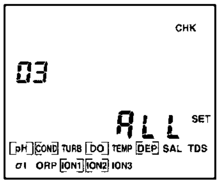
(☞ Page 73)

1. Press the **SET** key in the Battery Voltage Check mode.

Display setting mode screen is displayed.

2. Use the **UP/DOWN** (▲ ▼) keys to switch the measurement item.

The selected item blinks.



3. Press the **ENT** key to switch between [set/ not set] for the blinking item.

An item for which "set" is selected is indicated with [ ].

◖Note◗

- If the temperature is "not set" data for each component is not temperature-compensated and is displayed as data at 25 °C.

4. When the **SET** key is pressed, the instrument goes to the remaining memory display.

◖Note◗

- When the MEAS key is pressed, the instrument returns to the Clock Display mode.

6.9.4 Remaining memory

The number of date that can be stored can be displayed.

Measurement item setting mode ○ SET ⇒ Remaining memory is displayed.

Check mode (☞ Page 73)

Press the **SET** key in the Display Setting mode.

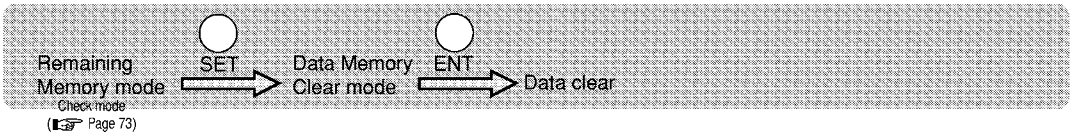
Remaining memory is displayed.

Note

- When the **SET** key is pressed, the instrument goes to the Data Memory Clear mode.
- When the MEAS key is pressed, the instrument returns to the Clock Display mode.

6.9.5 Data memory clear

All the data memory is cleared.

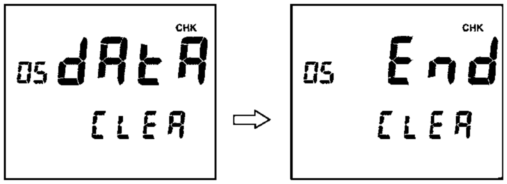


1. Press the **SET** key in the Remaining Memory mode.

   Data memory clear mode screen is displayed.

2. Press the **ENT** key.

   The data is cleared.



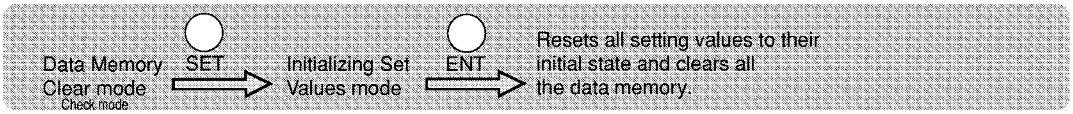
3. When the **SET** key is pressed, the instrument goes to the Memory Initialization mode.

◖Note◗

- When the MEAS key is pressed, the instrument returns to the Clock Display mode.

6.9.6 Initializing set values

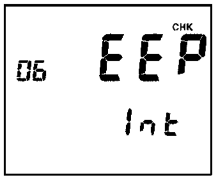
All setting values are reset to their initial state.



(☞ Page 73)

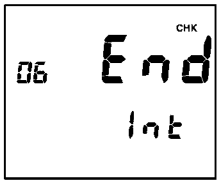
1. Press the **SET** key in the Data Memory Clear mode.

Initializing Set Values mode screen is displayed.



2. Press the **ENT** key.

All setting values are reset to their initial state.



3. When the **SET** key is pressed, the instrument goes to the Printer Connection mode.

Note

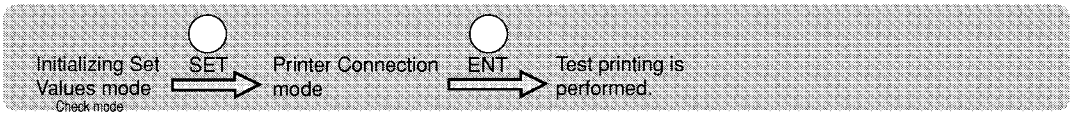
- When the MEAS key is pressed, the instrument return to the Clock Display mode.
- Data stored in the memory remains.

Initial setting

Item	Description	Initial value
Common	Display setting	Standard
	Data storage	Manual
pH	Unit	pH
COND	Unit	S/m
	Temperature coefficient	2.0 %/°C
DO	Salinity setting	AUTO
	Atmospheric pressure setting	1013 hPa
	Unit	mg/L
TURB	Unit	NTU
DEP	Unit	m
TDS	Coefficient	AUTO
σ_t	Unit	σ_t

6.9.7 Printer connection, test print

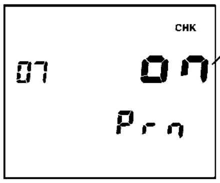
This mode only operates when the function expansion unit is connected. A test print is performed if a printer is connected.



Check mode
(☞ Page 73)

1. **Press the SET key in the Initializing Set Values mode.**

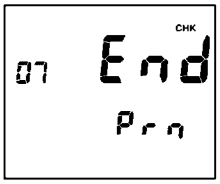
   Printer Connection mode screen is displayed.



Displayed as OFF when not connected.

2. **Press the ENT key to start printing.**

   Normally, "End" is displayed. If an error has occurred, "Err" is displayed.



3. When the **SET** key is pressed, the instrument will return to the first LCD check mode.

Note

- When the MEAS key is pressed, the instrument returns to the Clock Display mode.

7. Instrument specifications

7.1 Daily maintenance

Sensor probe

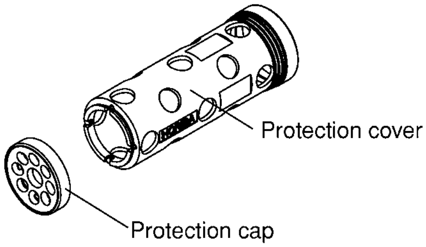
● Storage method

After use, wash out with tap water and wipe off all contamination. Pour about 20 mL of pure water into the probe cap, install it on the sensor probe, and store in the carrying case.

In order to use the instrument regularly for a long time, store it after wiping off all contamination from the cable, sensor probe, and sensors.

Remove the protection cover once and completely wash out with tap water the left over sample on the screws. Reinstall the cover after having wiped off the drops of water. If there is any sample (especially sea water) left over on the screws, rust may form which may prevent the protection cover from being removed. (☞ Installation procedure, page 18.)

Depending on the level of contamination, remove the rubber protection cap from the tip of the protection cover and wash out with tap water. Reinstall it after wiping off the drops of water.



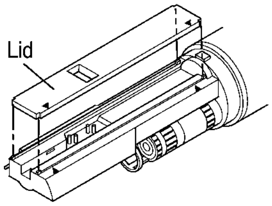
When storing with the pH/ORP and DO sensors attached to the probe, make sure to install the probe cap after having poured pure water into it.

Letting the pH/ORP and DO sensors get dry may cause deterioration of the instrument's performance. Should the sponge inside the probe cap be contaminated, replace it with a clean sponge (included).

TEMP/COND/TURB units

● To remove contamination

1. Remove the lid from the cell.
2. Clean the unit in tap water. If the unit is severely contaminated, use an absorbent cotton to remove contamination.
3. Attach the lid to the cell block before storage. (☞ page 29)



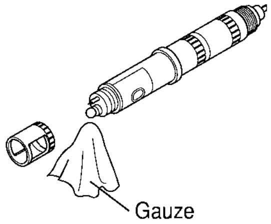
Important

- The cell has a window for turbidity measurement. Be careful to avoid damage to the window.
  In case of measurements, attach the lid to the cell in the correct direction.
- Don't remove the COND/TURB lid during calibration or measurement.
- Attach the lid to the cell with fitting four corners and facing ▲ marks each other.

pH/ORP sensors

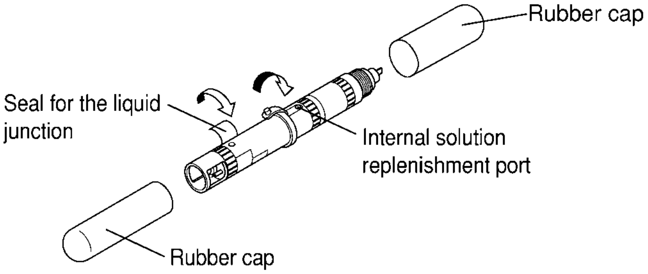
● To remove contamination

Use a piece of gauze dampened with detergent and wipe off contamination.



● Long-term storage

Remove the sensor from the sensor probe and check the internal solution replenishment port is closed. Then, attach a seal to the liquid junction and attach the rubber caps before storage.



● Monthly maintenance

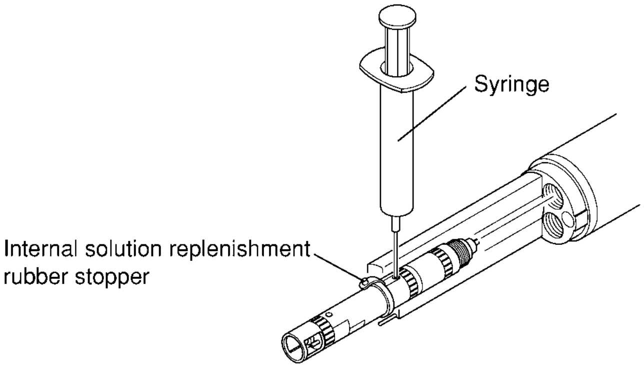
Replace the internal solution as described below:

1. Remove the sensor from the sensor probe using a sensor spanner.
2. Open the internal solution replenishment rubber stopper and remove the internal solution with a syringe.
3. Pour new internal solution (#330) to the level near rubber stopper. Be careful to avoid air bubbles from coming in the solition.
   Air bubbles in the internal solution will impair the sensors' pressure compensation function.

Important

- Shake the sensor to avoid bubbles in the internal solution from remaining at the bottom of the sensor.

4. Attach the sensor to the sensor probe.



DO sensor

● To remove contamination

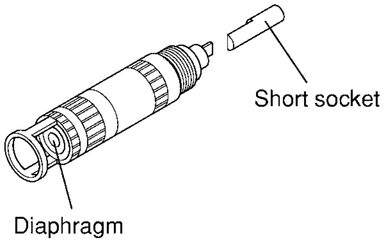
Wipe off contamination with gauze to avoid damage to the diaphragm.

● Long-term storage

Remove the sensor from the sensor probe using a sensor spanner. Set the supplied short socket and store the sensor in a cool(0 to 10℃), dark place.

Important

- Provide the DO sensor with a short socket or connect the sensor to the sensor probe for storage. Otherwise, the sensor may have a shorter life or stable instructions may not be obtained.
- The short socket is used when storing. Do not throw it away.



● Resetting the DO sensor when storing without having installed the short socket.

When leaving the DO sensor unattended for a brief period (1 or 2 days) without the short socket, the DO sensor can be reset by connecting it to the short socket or the probe. However, an amount of time corresponding to the period it was left unattended is necessary. If left unattended without being connected to the short socket or the probe for a long period (1 month), it cannot be reset.

● To replace the diaphragm.

Please read the instruction manual of the DO diaphragm replacement kit. (☞ page 89)

7.2 Troubleshooting

The instrument has a simple error message that informs users of operational errors and failure. Err No. is displayed at the bottom of the screen.

● Error message list

Err No.	Designation	Err No.	Designation
1	Sensor memory failure	6	Span calibration error
2	Sensor battery voltage drop	7	Calibration stability error
3	Instrument battery voltage drop	8	Printer error
4	Communications error	9	DATA IN error
5	Zero calibration error		

● Error and remedy

Important

- For err Nos. 5 to 7, the calibration err display disappears when a proper calibration is performed after the following action, or when the instrument is turned on again. For the other err Nos., the err display disappears after any of the following actions is taken.
- Error Nos. 2 and 3 are displayed even when using the AC adapter if the sensor probe battery voltage or instrument battery voltage drops is low on voltage.

Err NO.	Problem	Cause	Remedy
1	No data can be read from or written into the sensor probe memory.	Internal IC failure	Call your nearest store for sensor probe repair.
2	Sensor probe battery voltage drop	① Battery voltage drop ② Improper installation of the battery	① Replace the sensor probe battery. ② Set the batteries (LR03) in the correct direction.
3	Instrument battery voltage drop	① Battery voltage drop ② Improper installation of the battery	① Replace the instrument battery. ② Set the battery (6LR61) in the correct direction.
4	No communications possible between the instrument and the sensor probe	① Improper connection of the connector to the instrument ② Cable disconnection	① Connect the connector to the instrument properly and turn on the instrument again. ② Call your nearest store for cable repair.
5	No zero calibration possible	pH	pH
		• The standard solution is contaminated.	• Change the standard solution.
		• Contamination on the pH glass membrane	• Clean the pH glass membrane.
		• Change in concentration of the internal solution for the reference electrode	• Replace the internal solution for the reference electrode.
		• Cracks in the pH glass electrode	• Replace the sensor.
		COND	COND
		• The standard solution is contaminated.	• Change the standard solution.
		• The sensor is dirty.	• Clean the sensor.
		• The COND sensor is broken.	• Contact your nearest store.

Introduction
Before use
Basic operation
Using the data memory function
Techniques for more accurate measurement
Using the various functions
Instrument specifications
Reference data

Err NO.	Problem	Cause	Remedy
5	Zero calibration not possible	TURB	TURB
		• Air bubbles in the cell	• Swing the sensor probe while drawing a large arc.
		• Cell contamination	• Clean the cell.
		DO	DO
		• Damage to the diaphragm of the DO sensor	• Check the sensor and replace it if damaged.
		DEP	DEP
		• Contamination on the DEP sensor	• Clean the DEP sensor.
		• Damage to the DEP sensor	• Contact your nearest store.
6	Span calibration not possible	pH	pH
		• Contamination on the pH glass membrane	• Clean the pH glass membrane.
		• Change in concentration of the internal solution for the reference electrode	• Replace the internal solution for the reference electrode.
		• Cracks in the pH glass electrode	• Replace the sensor.
		• Damage to the connector pin	• Replace the sensor.
		COND	COND
		• The standard solution isn't correct.	• Calibrate with correct standard solution.
		• The standard solution value is set uncorrectly.	• Delete the calibration data for the conductivity, then calibrate the sensor again. (☞ Page 50)
		• The COND sensor is broken.	• Contact your nearest store.
		TURB	TURB
		• Air bubbles in the cell	• Swing the sensor probe while drawing a large arc.
		• Cell contamination	• Clean the cell.
		• The lid is attached uncorrectly.	• Confirm if the lid is attached correctly, then calibrate the sensor again. (☞ Page 29)
		DO	DO
		• Damage to DO sensor diaphragm	• Check the DO sensor and replace it if damaged.
		• DO sensor is unstable.	• Connect DO sensor to the sensor probe. Calibrate the sensor again 1 day later.
		• Damage to the connector pin	• Replace the sensor.
		DEP	DEP
		• Contamination on the DEP sensor	• Clean the DEP sensor.
		• Damage to the DEP sensor	• Contact your nearest store.
		TEMP	
		• Damage to the TEMP sensor	• Contact your nearest store.
7	The calibration value does not become stable within approximately three minutes.	① Sensor contamination	① Clean each sensor.
		② Dry sensor surface	② Pour the standard solution into the calibration beaker. Calibrate the sensor again 1 to 2 hours later.
		③ Severe temperature change	③ Calibrate the sensor in a place at a stable temperature or in a thermostatic oven.

Err NO.	Problem	Cause	Remedy
8	Printer unit failure		Turn OFF the instrument and use the remedy described below. Then turn ON the printer again.
		① Paper has jammed in the printer	① Remove the jammed sheet of paper
		② Improper printer unit connection	② Check to see if the printer is properl connected to the instrument.
		③ Printer failure	③ Replace the printer. * Contact your nearest store if the instrument does not recover after replacement of the printer.
9	Data cannot be stored because the memory is full.	No free space in the memory	Delete the data stored in the memory. (☞ Page 78)

● Other troubles

Remedies for various trouble with no Err No. displayed are described below.

Problem	Cause	Remedy
No data display with the power on	• No batteries	• Set new batteries.
	• Improper position of the positive and negative poles	• Set the batteries properly while paying attention to the positive and negative poles.
	• Battery voltage drop	• Replace the batteries with new ones.
	• Improper instrument battery contact	• Use radio pliers to narrow the positive terminal of the battery snap.
No setting change possible	• Automatic data storage is under way	• Press the CAL key to stop the automatic data storage.
No key operation possible	• The key lock function is working	• Turn OFF the instrument. Then turn ON the instrument again. (☞ Page 73)
	• Failure to calibrate the sensor or wrong calibration.	• Calibrate the sensor properly.
Blinking measured value	• Improper measurement sample	• Use a sample that is in the measurement range.
	• Sensor contamination	• Clean each sensor.
	• Poor calibration is possible. (The standard solution is contaminated.)	• Carry out correct calibration.
tYPE Err The Err is displayed and the operation cannot be performed.	• Improper connection of the cable connector to the instrument	• Connect the connector to the instrument properly and turn on the instrument again.
	• Cable disconnection	• Contact your nearest store.
	• Instrument inside failure	• Contact your nearest store.

● Troubleshooting for the TURB sensor

If an abnormal value such as -10, 800 or more is indicated, or indication does not become stable, follow as below instructions.

Remove the contamination of the sensor

Remove the cover of the turbidity (TURB) sensor, and clean the sensor with cotton swab.
Contamination or bubbles on the sensor may cause fluctuation of TURB values.

Remove bubbles around the sensor

When immersing sensor in the calibration cup, be sure lower it slowly. Quick immersion may cause bubbles on the sensor, which can have bad influence on calibration accuracy to give abnormal value indication.

Use of new standard solution

When calibration, clean the sensor before immersing it in the new standard solution. In case of zero calibration, when the standard solution is turbid or contaminated, calibrate again with the new standard one.

Points to be noted in making measurement

Immerse the sensor slowly in the sample. In case of abnormal measurement value observed, contamination or bubbles adhering may be suspected. So, shake greatly the sensor. Since immersion of the sensor in the sludge layer at the bottom of the sample can prohibit accurate measurement, shake greatly enough to remove the sludge.

● Maintenance of DO sensor

Durable life of DO sensor is generally one year, however, it may vary depending on the using condition. In case of the failure of calibration or breakage of the diaphragm, take either of the following steps according to the using period.

Within one year after purchasing :

Obtain diaphragm replacement kit (optional) to replace the used diaphragm and replenish the internal solution for restoration.

When exceeding one year after purchasing :

Replace by the new DO sensor.

● Materials

#5460 DO Sensor Diaphragm Replacement Kit Operation Manual

This operation manual explains how to replace the DO Sensor (#5460) Diaphragm.

1 This kit comes with the following.

● Diaphragm sheets	10 sheets
● Diaphragm retaining ring	5 pcs.
● O−ring (S9)	5 pcs.
● Internal solution #305 (50 mL)	1 bottle
● Diaphragm retaining plate	1 pc.
● Replacement stand	1 pc.
● Syringe and needle	1 set
● Operation manual	1 sheet

2 Diaphragm Replacement

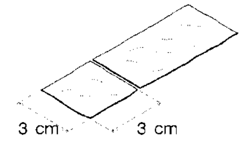
Chemical solution

Caution

The internal solution contains pottasium hydroxide (KOH) solution of high concentration.
If the solution comes in contact with hands or skin, wash immediately with water. If the solution comes in contact with the eyes, flush with ample amounts of water, then seek medical assistance.

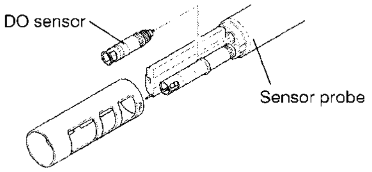
1 Cut a diaphragm sheet to about 3 x 3 cm in size.

Note▶▶▶ Don't get any fingerprints or dust on the center part of the square.

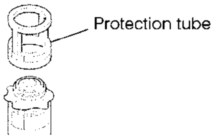


2 Detach the DO sensor from the sensor probe.

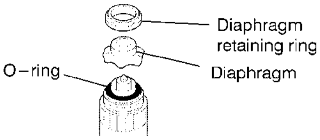
Ref ▶▶▶ Refer to the U−21.22.23 Operation Manual, section 2.3.2 "Sensor Installation".
Note▶▶▶ If the short socket is not attached, instability may be seen when the sensor is used again.
Wear vinyl work gloves when handling the sensor. The KOH inside it is a strong alkaline and can irritate skin.



3 Detach the protection tube that holds the diaphragm in place. If it is difficult to remove, use some spanner, etc. to remove it.

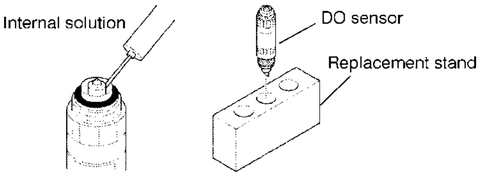


4 Detach the diaphragm retaining ring and diaphragm. Detach the diaphragm retaining ring and diaphragm if damaged or no longer functional.

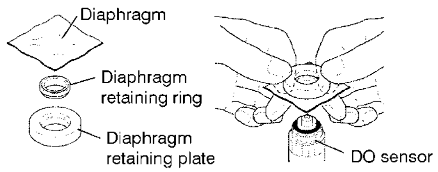


5 Set the sensor in the replacement stand ,and fill the internal solution with the attached syringe until the sensor tip is soaked with the solution.

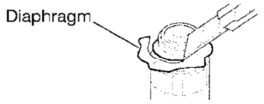
Note▶▶▶ Use the internal solution included in the kit for best performance.
In case some white crystals are seen, wipe them out completely with a Kimwipe®, etc.
In case the internal solution includes white crystals, remove the internal solution and fill up again. If the white crystals cannot be seen, just fill up.



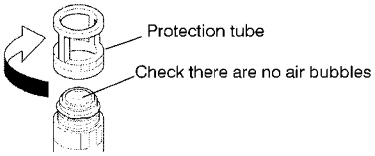
6 Fit the diaphragm retaining ring into the diaphragm retaining plate. Then, lay the diaphragm over the sensor and carefully cover with the ring and plate so that the diaphragm does not wrinkle. Finally, remove the retaining plate.



7 Cut the draped edge of the diaphragm to the shape of the sensor.

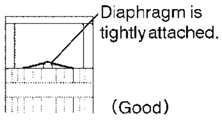


8 Check there are no air bubbles inside the sensor and tighten the protection tube securely.

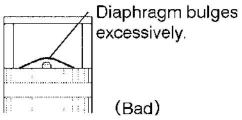


9 Check the diaphragm bulges upward as shown on the below left and that it is not wrinkled.

Note▶▶▶ Check that span calibration can be made correctly. Sensitivity lowers and response speed slows if the diaphragm does not bulge sufficiently.



(Good)



(Bad)

For any question regarding this product, please contact your local agency, or inquire from the Customer Registration website (www.horiba.co.jp/register).

HORIBA, Ltd.

7.3 Specifications

NOTE ○: Applicable
—: Unapplicable

		U-22XD
Instrument	Water-proof construction	IP67
	Mass	Approximately 500 g (including the grip holder)
Sensor *1	Use in 2-inch well	○
	Measurement temperature	0 to 55 °C
	Storage temperature	-5 to 60 °C
	Measurement depth	to 100 m
	Maximum sensor outside diameter	47 mm
	Sensor length	380 mm
	Continuous use available *2	30 days
	Automatic data gathering at set time	○
	Mass (Cable10 m)	Approximately 1.9 kg
pH	Measuring principle	Glass electrode method
● Two-point calibration	Range	pH0 to 14
● Automatic temperature compensation	Resolution	0.01 pH
	Repeatability	±0.05 pH
	Accuracy	±0.1 pH
Dissolved-Oxygen	Measuring principle	Diaphragm galvanic battery method
● Salinity conversion (0 to 40 ppt/Auto)	Range	0 to 19.99 mg/L
● Automatic temperature compensation	Resolution	0.01 mg/L
	Repeatability	±0.1 mg/L
	Accuracy	±0.2 mg/L
Conductivity	Measuring principle	4 AC electrode method
● Auto range	Range	0 to 9.99 S/m
● Automatic temperature conversion (25 °C)	Resolution	0.1 % of full scale
	Repeatability	±1 %
	Accuracy	±3 %
Salinity	Measuring principle	Conductivity conversion
	Range	0 to 4 %
	Resolution	0.01 %
	Repeatability	±0.1 %
	Accuracy	±0.3 %
Total Dissolved Solid(TDS)	Measuring principle	Conductivity conversion
● Conversion factor setting	Range	0 to 99.9 g/L
	Resolution	0.1 % of full scale
	Repeatability	±2 g/L
	Accuracy	±5 g/L
Seawater specific gravity	Measuring principle	Conductivity conversion
● Display σ_t, σ_0, σ_{15}	Range	0 to 50 σ_t
	Resolution	0.1 σ_t
	Repeatability	±2 σ_t
	Accuracy	±5 σ_t
Temperature	Measuring principle	Thermistor method
	Range	0 to 55 °C
	Resolution	0.01 °C
	Repeatability	±0.3 °C
	Accuracy	±1.0 °C

		U-22XD
Turbidity (TURB)	Measuring principle	Penetration and scattering method
● Unit selection	Range (NTU or mg/L)	0 to 800 NTU
	Resolution	0.1 NTU
	Repetability	±3 %
	Accuracy	±5 %
Water depth	Measuring principle	Pressure method
	Range	0 to 100 m
	Resolution	0.1 m
	Repetability	±3 %
	Accuracy	±5 %
Oxidation-reduction potential (ORP)	Measuring principle	Platinum electrode method
	Range	± 1999 mV
	Resolution	1 mV
	Repetability	± 5 mV
	Accuracy	±15 mV
Simultaneous measurement items		10

Note: The accuracy rating value is obtained from measurements at intermediate point of the standard solution after two-point calibration (at room temperature and pressure). The repeatability and accuracy rating percentages are based on the full scale (except for salinity).

*1: Organic solvents, strong acids, and strong alkaline solvents cannot be measured.

*2: Based on the data measured automatically at 15 minutes intervals. The battery life taken into account.
Periodical maintenance and calibration is necessary when a lot of shellfishes and seaweeds exist at the measurement point.

7.4 Spare parts

Sensors

Sensor	Model	Spare part number
pH sensor	6230	9037-0056-00
pH/ORP sensor	6280	9037-0057-00
DO sensor	5460	9037-0058-00

Standard and internal solutions

Solution	Model	Spare part number	Remark
pH 4 standard solution (500 mL)	100-4	9003-0016-00	Standard solution for AUTO calibration, which is in addition used for manual pH span calibration.
pH 7 standard solution (500 mL)	100-7	9003-0017-00	Standard solution for pH zero calibration
pH 9 standard solution (500 mL)	100-9	9003-0018-00	Standard solution for manual pH span calibration
Powder for ORP standard solution (250 mL × 10)	160-51	9003-0031-00	Powdered standard solution to be used for checking ORP behavior
Powder for ORP standard solution (250 mL × 10)	160-22	9003-0030-00	
pH reference internal solution (250 mL)	330	9037-0052-00	Replenishment internal solution for pH reference electrode

Others

	Model	Spare part number	Remark
Calibration beaker XD	–	9037-0086-00	This is similar to the standard accessory, and used for sensor calibration.
Connector plug for the prove	–	9037-0071-00	When using the probe separately from the instrument, this is used to maintain waterproof of the connector.
Sensor spanner	–	9037-0088-00	This is used to connect the sensor to the probe. Similar to the standard accessory.
DO diaphragm replacement kit	–	9037-0074-00	In case of breakage of the DO sensor diaphragm, it is used in the replacement of the diaphragm to restore the sensor.
Battery cover packing	–	9096-0013-00	Replacement packing to be used for battery box of the main unit.
System unit cover O-ring	–	9096-0014-00	Replacement packing to be used for EXT cover of the main unit.
Sensor O-ring	–	9037-0076-00	Replacement O-ring to be used for connector of pH/ORP sensor and Do sensor.
Probe cap XD	–	9037-0087-00	This cap is to be used when storing the sensor probe.
Battery caver O-ring	–	9037-0084-00	This replacement O-ring is used for the sensor probe's battery cover.
Silicon grease	–	9037-0085-00	This silicon grease is applied on the sensors' O-rings. Similar to the standard accessory.
Protection cover packing	–	9037-0091-00	This is packing for when taking off the probe cap and seal after installing the protection cover. (board packing and O-ring set)
Sponge	–	9037-0089-00	This replacement sponge is used for the probe cap XD.
Protection cap	–	9037-0090-00	This cap is to be attached to the protection cover.

* The spare parts above are prepared by dealers.
Order the part by designating the parts name, model and spare parts number.

7.5 Option

Parts name	Model	Remark
Expansion adaptor	U-2001	This is applicable to AC adapter connection, RS-232C communication, GPS connection, printer output, and data-collecting software.
System unit *	U-2002-100V U-2002-110V U-2002-220V	This is applicable to AC adapter connection, RS-232C communication, GPS connection, printer output, and data-collecting software. GPS and printer are included in a complete set.
AC adaptor (for 100 V)	AC-10	AC adapter intended to drive the U-20 series by AC power supply. This should be used together with U-2001 and U-2002.
Carrying case	W-2010	Compact carrying case for cable below 10 m in length . Not large enough to hold flow cell or guard.
Carrying case	W-2030	Bigger-sized carrying case for cable exceeding 30 m in length. Large enough to hold flow cell.
Flow cell	W-2100	To be used for measurement at a pumping up sample.
Probe guard	W-2200	To be used for measurement at a location where there is a flow or a location with a thick sludge layer residing at the bottom.
PC connection cable	—	Nine-pin connection cable to PC.

* Specify the power source and voltage of the printer when ordering.

8. Reference Data

● pH measurement

1. Principle of pH measurement

U-20XD 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 comparison electrode. For more information, refer to JIS Z 8802 pH measurement method.

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 when the pH is measured must be recorded along with that pH value, even if a meter that has automatic temperature compensation is used. If the solution temperature is not recorded, the results of the pH measurement may be meaningless.

3. Types of standard solutions

When measuring pH, the pH meter must be calibrated using a standard solution. There are five kinds of standard solutions specified in "JIS 28802 pH measurement". For normal measurement, two of standard solutions with a 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 .... 0.05 mol/L potassium hydrogen phthalate aqueous solution
(Phthalate)
pH 7 standard solution .... 0.025 mol/L potassium dihydrogenphosphate, 0.025 mol/L sodium phospate aqueous solution
(Neutral phosphate)
pH 9 standard solution .... 0.01 mol/L tetra-sodium boric acid aqueous solution
(Borate)

pH values of pH standard solutions at various temperatures settings.

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

4. Supplements for pH measurement

Pressure compensation diaphragm

U-20XD series can measure pH with high accuracy through the pressure compensation diaphragm without being affected by hydraulic pressure. Attention should be paid to the following points so that the diaphragm may function fully.
Before measurement, use a syringe and fill the reference electrode up to the replenish port with the internal solution. When injecting the polarity reference internal solution, be careful that air bubbles do not get into the solution.

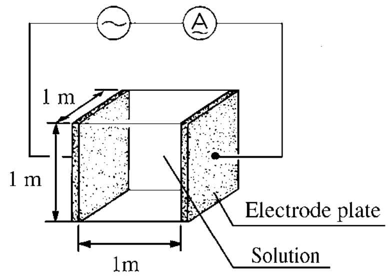
● COND measurement

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.

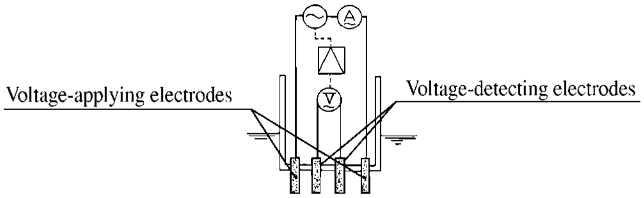
A cube with 1 m on each side, as shown in Fig. 1, is used to demonstrate an electrolytic solution. Two electrode plates are placed on opposite sides, and the cube is filled with a solution. If the resistance between these two electrode plates is represented by r (Ω), the conductivity of the solution L ($S.m^{-1}$) is represented as $L=1/r$. S stands for Siemens, a unit of measurement of conductance.



(Fig. 1 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-20XD series has adopted the 4-electrode method to overcome these disadvantages of the the 2-electrode method. As shown in Fig. 2, the U-20XD 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. 2 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 conductivity, 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.

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2. SI units

New measurement units, called SI units, have been in use from 1996. Accordingly, the U-20XD 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 units
Measurement value	0.1 mS/cm	→	0.01 S/m
	1 mS/cm	→	0.1 S/m
	100 mS/cm	→	10 S/m

3. Temperature coeffcient

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 tempreture 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-20XD 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-20XD 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
(value displayed on U-20XD series)
t : Temperature of solution at time of measurement (°C)
L_t : Conductivity of solution at t (°C)
K : Temperature coeffcient (%/°C)

Conductivity and temperature coefficient for various types of solutions

Conductivity and related temperature coefficients of representative substances (at 25 °C) are shown in the table below.

Substance	Concentration wt%	Conductivity S/m	Temperature coeffcient %/°C	Temperature °C
NaOH	5	19.69	2.01	15
	10	31.24	2.17	
	15	34.63	2.49	
	20	32.70	2.99	
KOH	25.2	54.03	2.09	15
	29.4	54.34	2.21	
	33.6	52.21	2.36	
	42	42.12	2.83	
NH_3	0.1	0.0251	2.46	15
	1.6	0.0867	2.38	
	4.01	0.1095	2.50	
	8.03	0.1038	2.62	
HCl	5	39.48	1.58	18
	10	63.2	1.56	
	20	76.15	1.54	
	30	66.20	1.54	
H_2SO_4	5	20.85	1.21	18
	10	39.15	1.28	
	20	65.27	1.45	
	40	68.00	1.78	
	50	54.05	1.93	
	60	37.26	2.13	
	100.14	1.87	0.30	
HNO_3	6.2	31.23	1.47	18
	12.4	54.18	1.42	
	31	78.19	1.39	
	49.6	63.41	1.57	
H_3PO_4	10	5.68	1.04	15
	20	11.29	1.14	
	40	20.70	1.50	
	45	20.87	1.61	
	50	20.73	1.74	
NaCl	5	6.72	2.17	18
	10	12.11	2.14	
	15	16.42	2.12	
	20	19.57	2.16	
	25	21.5	2.27	

Substance	Concentration wt%	Conductivity S/m	Temperature coeffcient %/°C	Temperature °C
Na_2SO_4	5	4.09	2.36	18
	10	6.87	2.49	
	15	8.86	2.56	
Na_2CO_3	5	4.56	2.52	18
	10	7.05	2.71	
	15	8.36	2.94	
KCl	5	6.90	2.01	18
	10	13.59	1.88	
	15	20.20	1.79	
	20	26.77	1.68	
	21	28.10	1.66	
KBr	5	4.65	2.06	15
	10	9.28	1.94	
	20	19.07	1.77	
KCN	3.25	5.07	2.07	15
	6.5	10.26	1.93	
NH_4Cl	5	9.18	1.98	18
	10	17.76	1.86	
	15	25.86	1.71	
	20	33.65	1.61	
	25	40.25	1.54	
NH_4NO_3	5	5.90	2.03	15
	10	11.17	1.94	
	30	28.41	1.68	
	50	36.22	1.56	
$CuSO_4$	2.5	10.90	2.13	18
	5	18.90	2.16	
	10	32.00	2.18	
	15	42.10	2.31	
CH_3COOH	10	15.26	1.69	18
	15	16.19	1.74	
	20	16.05	1.79	
	30	14.01	1.86	
	40	10.81	1.96	
	60	4.56	2.06	

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● SAL conversion

The U-20XD series is designed to measure salinity as well as the other parameters.
Note that the "salinity" referred to 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 is known. In other words, the salinity measurement of the U-20XD 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, for example, hydrochloric acid (HCl).

● 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) × K × 10
TDS(g/L) = L (mS/m) × K ÷ 100
Conductivity in the old units (mS/cm) .... TDS(g/L) = L (mS/cm) × K
K = TDS coefficient

Initial settings use the values listed in the table (☞ Page 70) 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.

● σ_t 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.

$$\sigma = (\rho - 1) \times 1000$$

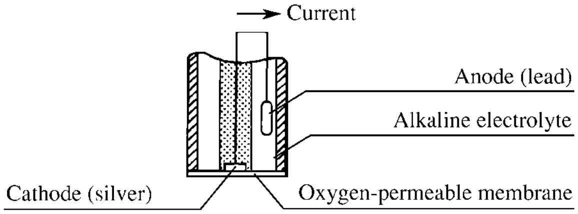
The density of seawater ρ is expressed by temperature, hydraulic pressure, and salinity functions. The density of seawater σ under the atmospheric pressure is expressed as σ_t. The density of seawater under the atmospheric pressure is determined by temperature and salinity.
The U-20XD series models make 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-20XD series models, newly added as measurement components.

● DO measurement

1. Principle of measurement

The "DO" referred to here means the concentration of oxygen dissolved in water. DO is essential to self-purification of river and sea and to water creatures such as fish. DO measurement is also essential to drainage and water quality control.

Fig. 3 shows the principle of measurement using a DO sensor.



(Fig. 3 Principle of DO sensor)

A noble metal (silver) is fitted closely to an oxygen-permeable membrane to make the cathode; a base metal (lead) is used as the anode. Both are immersed in an alkaline electrolyte with the anode-to-cathode external circuit closed. Oxygen diffusing through the oxygen-permeable membrane causes a reduction reaction at the cathode; this allows flow of current in the external circuit:

$$O_2 + 2H_2O + 4e^{-} \rightarrow 4OH^{-}$$

At the anode, oxidation reaction occur as follows:

$$2Pb \rightarrow 2Pb2^{+} + 4e^{-}$$

The current is proportional to the quantity of oxygen diffusing through the oxygen-permeable membrane. Accordingly, measurement of the current makes the DO in a sample known.

The DO measuring method based on this principle is called the membrane-electrode method. This method allows convenient measurement of DO, especially when compared with chemical-analysis method, which needs complicated pre-treatment to eliminate the effects of oxidizing or reducing substances.

2. DO correction for salinity

When a solution and air are in contact and in complete equilibrium (saturated), DO: C [mg/L] in the solution, and the oxygen partial-pressure: Ps [MPa] in air are in the following relation:

$$C = Ps/H$$

H [MPa/ (mg/L)] is referred to as Henry's constant, which depends on the composition of the solution. In general, C becomes smaller as the salinity in the solution increases, since H becomes larger.

A DO sensor is intended to detect Ps in the above expression. Therefore, the DO measurement would be in error if the DO sensor were immersed either in air-saturated pure water or in solution with salt. To settle this problem, it is necessary to correct the DO reading based on the salinity of the sample using salinity correction.

Conventional DO meters make this salinity correction by inputting a known salinity value. This poses no problems if the salinity of the sample is known. In general, however, the salinity of the sample is usually not known, and the method is not practical even if the DO meters are equipped with the salinity correction function.

The U-20XD series is capable of measuring the salinity of a sample and automatically correcting the using this function.

3. Features of the U-20XD series DO sensors

In conventional DO measurements, it was necessary to keep the velocity of the flow constant because the velocity of flow led to fluctuation in indicated values. In our U-20XD series models, improvements in sensors have made it possible to make measurements with stable indications and with little influence of the velocity of flow.

● Turbidity (TURB) measurement

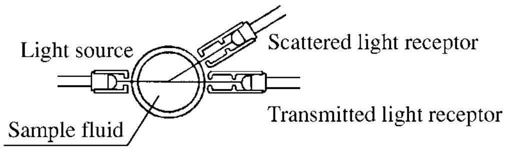
1. Principle of measurement

From among several types of turbidity-measuring methods available, the U-20XD series uses the light-transmission-scattering method, shown in Fig. 4.

Irradiation of a beam of light onto a sample brings about separation of the beam into (1) the light transmitted through the solution and (2) the light scattered by turbidity components in the sample. In the light-transmission-scattering method, the intensity of both transmitted light and the scattered light are measured using separate receptors, and the turbidity is obtained based on the ratio of the two.

With the U-20XD series, the light source is a pulse-lighting infrared-emission diode. The scattered light is measured at a point 60° offset from the light source. This light-absorption-scattering method has several advantages, including the fact that (1) the actual color of the sample fluid has little effect on the measurement of turbidity, (2) fluctuations in light quantity from the light source are easily compensated for, and (3) it allow the U-20XD series to be operated with relatively low-power consumption.

The turbidity value differs with the structure of the cell so changes with the instrument.



(Fig. 4 Principle of the light-transmission-scattering method)

2. Standard solution

U-20XD 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.

● DEP measurement

1. Depth (DEP) measurement

For the U-22XD model, 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.

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:

Immerse the depth sensor of the sensor probe into the sample.

Keep the sensor immersed in the sample for approximately 30 minutes until the temperatures of the sensor and the sample are the same.

Then make the zero calibration of the sensor manually. (☞ Page 57)

● Measuring mV (oxidation-reduction potential (ORP))

ORP principles

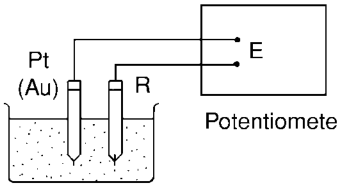
ORP (or "redox potential") is an abbreviation for oxidation-reduction potential. ORP is the energy level (potential) determined according to the state of equilibrium between the oxidants (M^{Z+}) and reductants $M^{(Z-N)+}$) that coexist within a solution.

$M^{z+} + ne^- \Leftrightarrow M^{(z-n)+}$...........①

If only ① exists within a solution, a metal electrode (platinum, gold, etc.) and a reference electrode are inserted into the solution, forming the ORP measuring system shown in Fig. 5. Measuring the potential (ORP) that exists between the two electrodes enables the potential to generally be expressed by the following equation.

$$E = E_0 - \frac{RT}{nF}\ ln\ \frac{a_{M^{(z-n)+}}}{a_{M^{z+}}} \text{ .....②}$$

E: Electric potential
E_0 : Constant
R : Gas constant
T : Absolute temperature
n : Electron count
F : Faraday constant
a : Activity



(Fig. 5 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.

$Fe^{3+} + e^- \Leftrightarrow Fe^{2+}$..............①

$$E = E_0 - \frac{RT}{F}\ ln\ \frac{a_{Fe^{2+}}}{a_{Fe^{3+}}} \text{ .....②}$$

When only one type of state of equilibrium 1 exists in the solution, the ORP of the solution can be determined uniquely by equation 2. What is important here is that ORP is determined by the ratio of activity between the oxidant (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 (potentiametric titration) and in the disposal and treatment of solutions.

Recently, there have appeared various claims regarding this matter, such as that a high degree of ORP is effective in sterilization or that drinking water that has a low ORP reduces the chance of illness by reacting with the activated oxygen in the cells of the body. ORP is used as an index for alkaline drinking water.

Standard electrode (reference electrode) types and ORP

The ORP of a solution that is obtained through measurement is a value that corresponds to the 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 uses Ag/AgCl with 3.33 mol/L KCl as the reference solution for reference electrodes. According to general technical literature, standard 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.

$E_{\text{N.H.E.}} = E + 206 - 0.7\,(t - 25)\text{mV} \qquad t = 0 - 60\ ℃$

$E_{\text{N.H.E.}}$: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 $Li^{+} + e^{-} \rightarrow Li$

E0=-3.024 V VS N.H.E.

However, in some literature, the "+" and "-" signs are reversed.

B $Li \rightarrow Li^{+} + e^{-}$

E0=+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.

表 3

For any question regarding this product,
please contact your local agency,
or inquire from the Customer Registration
website (www.horiba.co.jp/register).

HORIBA, Ltd.

First edition: November 2001
CODE : I1000908000

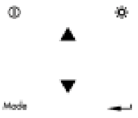
FIELD OPERATION GUIDE
YSI 550 DO INSTRUMENT

TURNING THE INSTRUMENT ON

The YSI 550 DO keypad consists of six keys. There are four function keys, and one up and one down arrow keys. The top left key that has a green circle and line is the ON/OFF key. The top right key is the back light. The bottom left is the Mode key, and the bottom right is the Enter key.

Turn the instrument on by pressing and releasing the **ON/OFF** button on the front of the instrument.

NOTE: Since the probe has not yet been prepared, the data on the display will be inaccurate.



The light key is at the top right of the keypad. Pushing the **LIGHT** key will turn on or off the back light. The light will power off automatically after two minutes of non-use.

CHANGING THE TEMPERATURE UNITS

The YSI 550 DO Instrument can display the temperature units in either Fahrenheit or Celsius. To change the units that are displayed, turn the instrument on. Pressing both the down arrow keys and the mode key at the same time will switch the units between C or F.

CHOOSING THE RIGHT MEMBRANE

The YSI 5906 Standard Membrane Kit is supplied with the YSI 550 DO Instrument. This kit contains six cap membranes and a bottle of electrolyte solution. YSI recommends the 5906 membranes for all applications.

MEMBRANE CAP INSTALLATION

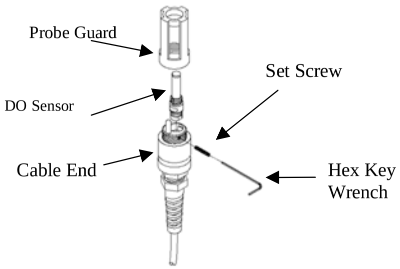
To install a new membrane cap on your YSI 550 dissolved oxygen probe:

Unscrew and remove the probe sensor guard.
1. Unscrew and remove the old membrane cap.
2. Thoroughly rinse the sensor tip with distilled or DI water.
3. xPrepare the electrolyte according to the directions on the solution bottle.Hold the membrane cap and fill it at least 1/2 full with the electrolyte solution.
4. Screw the membrane cap onto the probe moderately tight. A small amount of electrolyte should overflow.
5. Screw the probe sensor guard on moderately tight.

CAUTION: **Do not touch the membrane surface.**

HOW TO REPLACE THE DO PROBE TIP

In the YSI 559 dissolved oxygen module replacement kit YSI supplies a YSI 559 DO Sensor, a YSI 5906 membrane kit, the set screw that holds the sensor in place, a hex key wrench to help install the probe, and an instruction sheet.



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 module. Turn the wrench counter clockwise and remove the screw. (You do not have to remove the screw all the way to release the sensor.)

4. Pull the DO sensor out of the module. The DO sensor is keyed, or has a flat side, so that it can not be removed improperly.

5. Insert the new probe. Make sure that the inside of the module, and the o-ring of 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 can not be installed improperly.

6a. **IF you did not remove the screw all the way in Step 3:** Use the hex key wrench to tighten the screw in properly, making sure that the screw does not stick out on either side of the DO sensor module.

6b. **IF you removed the screw all the way in Step 3:** Insert the set screw into the small hole in the side of the DO sensor module, and turn clockwise to rethread.

7. The YSI 559 DO module is shipped dry. **Before using the YSI 550 with a new YSI 559 sensor, the protective membrane on the probe tip must be removed, the membrane cap must be filled with electrolyte solution and a new membrane must be installed.** Follow the instructions below to install the electrolyte solution and membrane.

8. Insert the new probe. Make sure that the inside of the module, and the o-ring of 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 can not be installed improperly.

CAUTION: Make sure that you do not cross-thread the screw. Use the hex key wrench to tighten the screw in properly, making sure that the screw does not stick out on either side of the cable end. The probe guard will not thread on properly and damage may result if the screw is allowed to stick out on either side of the cable end.

THE CALIBRATION PROCESS

Before you calibrate the YSI 550 DO Instrument complete the procedures discussed **in Section 2, Preparing the YSI 550** and **Section 3, Preparing the Probe**.

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 550 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.

To accurately calibrate the YSI 550, 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, use a YSI 30 Salinity-Conductivity-Temperature instrument to determine salinity.

- IF you are going to calibrate in % saturation mode, you need to know the approximate altitude of the region where you are located.

1. Ensure that the sponge inside the instrument's calibration chamber is moist. Insert the probe into the calibration chamber.

2. Turn the instrument on by pressing the **ON/OFF** button on the front of the instrument. Wait for the dissolved oxygen and temperature readings to stabilize (usually 15 minutes is required after turning the instrument on).

3. To enter the calibration menu, use two fingers to press and release both the **UP ARROW** and **DOWN ARROW** keys at the same time.

TO CALIBRATE IN MG/L:

To switch between mg/L and percent saturation to be displayed as the oxygen readings units, press the Mode key. Either a “mg/L” or “%” will be displayed on the right side of the screen.

4. Make sure that the DO reading (large display) is stable, then press the **ENTER** button. The YSI 550 DO instrument should now display **CAL** in the lower left of the display, the calibration value should be displayed in the lower right of the display and the current DO reading (before calibration) should be on the main display.

5. Make sure that the DO reading (large display) is stable, then press the **ENTER** button. 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 40 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 (zero for fresh water), press the **ENTER** key. The instrument will return to normal operation.

Once the calibration process is complete, the only keys that will remain operational are the **MODE** key, the **LIGHT** key and the **ON/OFF** key. You can move back and forth from reading dissolved oxygen in the mg/L mode or the % air saturation mode by pressing the **MODE** key. If you are working in a dark area and have difficulty reading the LCD, press the **LIGHT** key to activate the back-light of the YSI 550. The **ON/OFF** key turns the instrument on or off.

For best results:

- Each time the YSI 550 DO Instrument is turned off, re-calibrate before taking measurements.
- Calibrate at a temperature within ±10°C of the sample temperature.

TO CALIBRATE IN % SATURATION:

To switch between mg/L and percent saturation to be displayed as the oxygen readings units, press the Mode key. Either a “mg/L” or “%” will be displayed on the right side of the screen.

4. IF you are calibrating in % saturation mode, the LCD will prompt you to enter the local altitude in hundreds of feet. Use the arrow keys to increase or decrease the altitude.

EXAMPLE: Entering the number 12 here indicates 1200 feet.

6. When the proper altitude appears on the LCD, press the **ENTER** key. The YSI 550 DO Instrument should now display **CAL** in the lower left of the display, the calibration value should be displayed in the lower right of the display and the current DO reading (before calibration) should be on the main display.

7. Make sure that the DO reading (large display) is stable, then press the **ENTER** button. 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 40 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 (zero for fresh water), press the **ENTER** key. The instrument will return to normal operation.

Once the calibration process is complete, the only keys that will remain operational are the **MODE** key, the **LIGHT** key and the **ON/OFF** key. You can move back and forth from reading dissolved oxygen in the mg/L mode or the % air saturation mode by pressing the **MODE** key. If you are working in a dark area and have difficulty reading the LCD, press and hold the **LIGHT** key to activate the back-light of the YSI 550. The **ON/OFF** key turns the instrument on or off.

For best results:

- Each time the YSI 550 DO Instrument is turned off, re-calibrate before taking measurements.
- Calibrate at a temperature within ±10°C of the sample temperature.

CONVERSION CHART

To Convert From	To	Equation
Feet	Meter	Multiply by 0.3048
Meter	Feet	Multiply by 3.2808399
Degrees Celsius	Degrees Fahrenheit	(°C × 9/5) + 32
Degrees Fahrenheit	Degrees Celsius	(°F - 32) × 5/9
Milligrams per liter (mg/L)	Parts per million (ppm)	Multiply by 1

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Item #655127
Drawing #A655127
Revision A
March 2000

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.

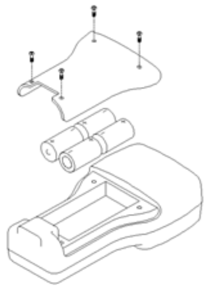
FEATURES OF THE YSI 550A

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.

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.

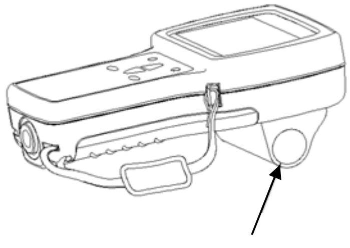


INSTRUMENT CASE

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.

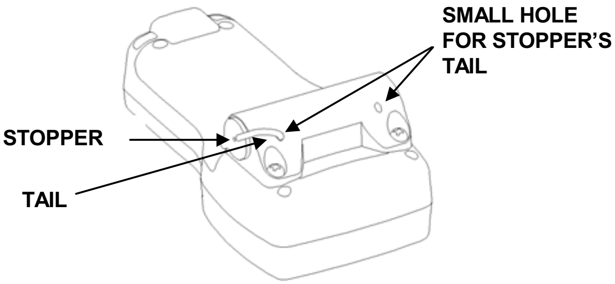
CALIBRATION/STORAGE CHAMBER



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.

- Calibrate at a temperature within ±10°C of the sample temperature.

CALIBRATION IN % SATURATION

1. Ensure that the sponge inside the instrument's calibration chamber is moist. Insert the probe into the calibration chamber.

2. Turn the instrument on. Allow it to warm up and readings to stabilize for about 15-20 minutes.

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. Turn the instrument on. Allow it to warm up and readings to stabilize for about 15-20 minutes.

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.

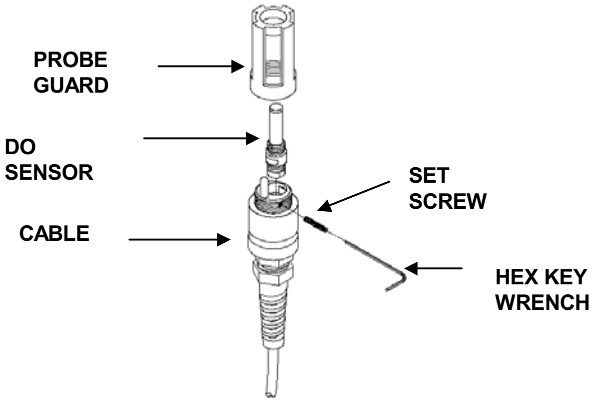
GOLD CATHODE

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.

SYMPTOM	POSSIBLE SOLUTION
7. Secondary display reads "Ovr" or "Undr".	A. Sample temperature is less than -5° C (23°F) or more than +45°C (122°F). Increase or decrease the sample temperature to bring within the allowable range. B. Return system for service.
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.