Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

2011 Air Monitoring and Sampling Addendum to the Sampling and Analysis Plan

Prepared for United States Environmental Protection Agency

Enbridge Energy, Limited Partnership

Submitted: June 15, 2011

Approved: June 21, 2011

ATTACHMENTS

Approved

LIST OF ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
COC	Chain of Custody
COPC	Contaminate of Potential Concern
Enbridge	Enbridge Energy, Limited Partnership
D/T	dilution-to-threshold
GPS	global positioning system
Line 6B	The pipeline owned by Enbridge Energy, Limited Partnership that runs just south of Marshall, Michigan
MIOSHA	Michigan Occupational Safety and Health Administration
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety and Health Administration
OVM	Organic Vapor Monitoring
PEL	Permissible Exposure Limit
ppm	parts per million
ppmv	Parts per million by volume
QAPP	Quality Assurance Project Plan
SEG	Similar Exposure Group
STEL	Short Term Exposure Limit
Supplemental Order	Supplement to Order for Compliance Under Section 311(c) of the Clean Water Act, issued by U.S. EPA Region 5 on September 23, 2010 to Enbridge Energy Partners, L.P. *et al*., Respondents, Docket No: CWA 1321-5-10-001
U.S. EPA	United States Environmental Protection Agency
U.S. EPA Order	U.S. EPA Removal Administrative Order Under Section 311(c) of the Clean Water Act, issued on July 27, 2010 to Enbridge Energy Partners, L.P., Docket Number: CWA 1321-5-10-001
TICs	Tentatively Identified Compounds
TWA	Time Weighted Average
VOCs	Volatile Organic Compounds

Approved

1.0 INTRODUCTION AND PURPOSE

Enbridge will conduct air sampling and air monitoring to protect worker safety and public health during assessment and recovery operations. Enbridge has been directed to conduct real-time air monitoring and air sampling in the following areas:

- Surrounding communities including Baker Estates and Ceresco;
- Work areas where impacted soil and/or sediment is being disturbed from removal activities,
- Work areas where submerged oil is being removed,
- Other areas in response to odor concerns, and
- Real-time monitoring in Communities along impacted shorelines.

The air monitoring will include volatile organic compounds (VOCs), hydrogen sulfide (H_2S), sulfur dioxide (SO_2), and benzene. Air sampling will only be conducted for VOCs.

Data gathered in the above mentioned areas will be used to assess the potential for community and worker exposures. All field work and data collection will be conducted in accordance with approved work plans and standard operating procedures (SOPs). More detailed discussions of air sampling and real-time air monitoring can be found in the following sections.

2.0 AIR SAMPLING METHODS

Air samples for VOCs will be collected by subatmospheric sampling using evacuated canisters. The collected whole-air samples will be analyzed according to modified U.S. EPA Method TO-15 and OSHA PV-2120. Attachment E presents the laboratory SOP for this sampling. The list of target compounds (with detection limits) is presented in Attachment A . The laboratory will also provide a report of all Tentatively Identified Compounds (TICs) detected in each canister sample.

Canister samples will consist of either grab (instantaneous), 8-hour, or 24-hour collections. The collection time will be based on monitoring objectives. For instance, a grab sample will be collected in response to odor reports, 8-hour collection for work shift related monitoring, and 24-hour sampling for evaluating the potential for long-term exposure at community and/or residential sites. All extended duration samples will be collected using critical flow orifices calibrated by the laboratory to collect a specified target volume into the canister over the desired period. Details of the flow rate settings and pressure limits of the flow controllers are contained in the applicable SOP.

All air samples will be sent to Galson Laboratories, an American Industrial Hygiene Association (AIHA) accredited laboratory, in Syracuse, NY. Samples will be expedited for shipping and analysis. Initial samples will be on a one-day turnaround time for sample results. If approved by U.S. EPA, the turnaround time may be extended to a three to 10 day period.

3.0 METEOROLOGICAL DATA

Meteorological data is an important consideration for deploying canisters and for interpreting air sampling results. A combination of portable meteorological stations and National Weather Service (NWS) data will be used to support air sampling and monitoring.

Two portable meteorological stations will be deployed to provide more time-resolved meteorological data than the once-hourly NWS observations. The stations will include sensors for wind speed, wind direction, air temperature, relative humidity, barometric pressure, and precipitation (precipitation gauge). The meteorological station clocks (or SAFER computer, if it assigns the 5-minute data timestamp) should be maintained in reference to a National Institute of Standards and Technology (NIST) clock source. The stations will be mounted on tripod-based masts. The stations will operate on battery power. Specifications for the meteorological stations are presented in Attachment C.

Specific station locations will be determined to the extent possible based on U.S. EPA guidance for instrument exposure. Primary consideration will be placing the stations in open areas with unobstructed wind flow. The wind direction sensors will be aligned to within 5 degrees of true north, and have a measurement accuracy of 5 degrees or better. Data will be recorded, and downloaded from the stations on a daily basis. The station clocks will be set to Eastern Standard Time. Station locations will be documented with global positioning system (GPS) devices.

One meteorological station will be set up near Ceresco Dam, and the other will be placed near Baker Estates (MP 12.1). Data from these two sources will be used to create daily wind roses for the areas of concern, and identify samples collected as being upwind or downwind of the contaminated areas.

In other areas potentially impacted by the removal, NWS data from Battle Creek (call sign KBTL) or Kalamazoo (call sign KAZO) will be used to produce wind roses and classify upwind/downwind samples. The observations will be downloaded from the internet daily, and placed into a database. In the event portable weather station data are not available for a period, representative NWS data will be used in its place.

Forecasts issued by the NWS, accessed via the NWS web site, will be used to plan sampler deployment. Samplers will be placed in patterns so as to capture (as best possible) conditions both upwind and downwind of a contaminated area based on these forecasts. Predicted shifts in winds due to frontal passages will be taken into consideration in sample placement.

4.0 COMMUNITY EVALUATIONS

Community evaluations will initially be conducted in the Baker Estates and Village of Ceresco communities. U.S. EPA may request evaluation of these or other communities in the future, if changing removal conditions warrant. The evaluations will be performed using both sampling and real-time monitoring.

Real-time air monitors will collect data for total VOCs, H_2S, SO_2, and benzene using the equipment listed in Table 1.

Table 1 Summary of Real-Time Air Monitoring Equipment

Instrument	Analyte	Detection Limit
MultiRAE PID	Total VOCs	0.1 ppm
MultiRAE H_2S electrochemical sensor	H_2S	1 ppm
MultiRAE SO_2 electrochemical sensor	SO_2	0.1 ppm
UltraRAE PID with benzene sep filters	Benzene	0.05 ppm
Gastec Pump w/Benzene Colorimetric Tubes	Benzene	0.05 ppm

One MultiRAE (5 gas instrument) and one UltraRAE benzene monitor will be utilized to take snapshot readings of air quality in the vicinity of the community, during work activity periods each day. The instruments will be used in a mobile mode, covering areas between the contaminated areas and the community (or within the community), based on forecasted prevailing wind directions. Each monitoring location will be documented with GPS equipment, along with the time of the reading.

In addition to real-time air monitoring, analytical air samples will also be collected in or adjacent to select community areas. Three canister samples will be collected simultaneously over contiguous 24-hour periods in the vicinity of the communities being evaluated. The target compound list for community sampling is the same as the list presented in Attachment A. Multiple canisters in each community area allow for better evaluation of the presence or absence of crude oil related chemicals and can capture vapors as changes in wind direction occur. The samplers will be deployed based on forecast wind directions, so as to capture a representative sample of air flowing from contaminated areas into the community. All sampling locations will be documented with GPS devices.

Air monitoring and sampling will be conducted for a minimum period of 14 24-hour periods. Based on the review of the data collected during the initial period, sampling and/or monitoring may be reduced in frequency or discontinued at the discretion of U.S. EPA.

Results from the initial 14-day period will be compared to the screening concentrations found in Attachment B. Enbridge and U.S. EPA will evaluate this comparison to determine the need for ongoing sampling and/or monitoring. If results from the initial 14-day time period yield no detections above applicable screening values, then sampling operations may be reduced or discontinued. In the event that results should exceed a screening level, additional sampling, monitoring, or protective measures may be required.

5.0 WORK AREA PERIMETER EVALUATIONS

5.1 Work Zone Perimeter Sampling

Perimeter samples will be collected at all work sites involving the submerged oil, dredged sediment, and overbank excavation. Three canister samples will be collected simultaneously over an 8-hour period along the perimeter work areas, coinciding with work activity. Sample locations will be selected based on anticipated activities and forecast wind directions. The purpose is to select locations with the greatest opportunity to detect volatile organic compounds, if any, that are released during recovery activities. Work area samples will be positioned to ensure both upwind (1 sample) and downwind (2 samples) capture zones from work operations to evaluate VOC vapors on-site and as background. Sample canisters will be placed as close as practical to the actual removal activities, without compromising site safety or work efforts. All sample locations will be documented using GPS devices.

Perimeter sampling will be conducted at all work locations for a minimum period of 14 days, or until results can be evaluated for that time period. Enbridge and U.S. EPA will review all sampling results from the initial 14-day period, and determine the perimeter sampling frequency and strategy needed for ongoing operations.

5.2 Work Zone Real-time Monitoring

Real-time air monitoring for VOCs, H_2S, SO_2, and benzene, will be conducted using a MultiRAE and UltraRAE/Gastec Pump with benzene colorimetric tubes (Table 1) by Health and Safety (H&S) personnel within and along the perimeter of all the work zones, including the tar patty recovery work zones. If the H&S monitoring indicates a VOC alarm above applicable action levels, benzene checks will be initiated with a real-time benzene monitor along with appropriate protective action as described in the HASP. The benzene checks will be recorded in air monitoring log books or by entry into a handheld data collection device.

6.0 WORKER EXPOSURE MONITORING

Enbridge will evaluate worker exposure to benzene, toluene, ethylbenzene, xylenes, and n-haxane(COPCs) by collecting breathing zone samples representative of each worker population associated with the oil recovery operations. Each oil recovery workgroup consist of two to four workers conducting similar tasks within close proximity to one another and at similar distances to potentially contaminated sediment for the duration of their respective work shifts. Each workgroup will be evaluated to identify the “maximum risk employee” based on the work task and their proximity to contaminated material. The maximum risk employee(s) from each work group, collectively, will represent the sample population from which exposure samples should be collected.

Worker exposure monitoring for the COPCs will be conducted using both real-time and analytical methods. Worker exposure real-time data for VOCs will be collected using a data-logging MultiRAE PID equipped with a Teflon tubing inlet positioned in the worker's breathing zone. Prior to each work shift, the MultiRAE plus PID will be calibrated using 100 ppm isobutylene calibration gas. The real-time data collected form the data-logging MultiRAE will be downloaded at the conclusion of the work shift. The data will be downloaded via ProRAE Suite software and incorporated into the air monitoring database. The worker's TWA concentration for VOCs will be calculated for each sampled worker.

In addition to the MultiRAE plus PID personal monitor, Enbridge may elect to co-locate an organic vapor monitor (OVM) badge in the worker's breathing zone. These analytical samples will be collected on the 3M 3500/3520 organic vapor monitor (OVM) badge and analyzed for benzene, ethyl benzene, n-hexane, toluene, and xylene using gas chromatography flame ionizing detection (GC/FID) in accordance with the National Institute for Occupational Safety and Health (NIOSH) air sampling method 1500/1501. The OVM badge is a passive dosimeter, composed of a permeation membrane and activated charcoal which collects air samples at a flow rate controlled by the physical process of diffusion. Collected samples will be properly logged and shipped to an AIHA accredited laboratory for subsequent analysis. Table 2 summarizes the analytical detection levels for the OVM badges.

Table 2 OVM badge limit of detection (LOD) for COPCs.

COPCs	**Collection Media**	**Flow Rate (cc/min)**	**Sample Duration* (min)**	**Laboratory LOQ (ug)**	**Limit of Detection (ppm)**
Benzene	3M 3520	35.5	600	2.0	0.029
Ethyl benzene	3M 3520	27.3	600	5.0	0.070
n-Hexane	3M 3520	32.0	600	5.0	0.074
Toluene	3M 3520	31.4	600	5.0	0.070
Xylene	3M 3520	27.3	600	15.0	0.211

*Sample duration may vary

Once analyzed, a time-weighted average (TWA) concentration will be calculated to determine if the worker's exposure meets or exceeds the COPC's site action levels referenced in the Enbridge Health and Safety Plan and/or applicable occupational exposure limits (OELs). Table 3 displays the applicable OELs including standards established by OSHA. The Michigan Department of Labor and Economic Growth Director's Office Occupational Health Standards for benzene are also referenced in Table 3.

Table 3 Occupational Exposure Limits

COPCs	OSHA PEL-TWA(a)	OSHA PEL-STEL(b)	OSHA PEL-Ceiling(c)	ACGIH TLV-TWA(d)	ACGIH TLV-STEL(e)	MIOSHA PEL-TWA(f)	MIOSHA PEL-STEL(g)
Benzene	1	5	NE(h)	0.5	2.5	1	5
Ethyl Benzene	100	NE	NE	20	125	NE	NE
n-Hexane	500	NE	NE	50	NE	NE	NE
Toluene	200	NE	300	20	NE	NE	NE
Xylene	100	NE	NE	100	NE	NE	NE

a. OSHA PEL-TWA = The permissible concentration in air of a substance that shall not be exceeded in an 8-hour work shift or a 40-hour work week (OSHA, 1989).

b. OSHA PEL-STEL = The time-weighted average exposure that should not be exceeded for any 15-minute period (OSHA, 1989).

c. OSHA PEL-Ceiling = The exposure limit that shall at no time be exceeded. If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15-minute timw-weighted average exposure, which shall not be exceeded at any time during the work day (OSHA, 1989).

d. ACGIH TLV-TWA = The Threshold Limit Value-TWA is the concentration for a normal 8-hour workday and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect (ACGIH, 2011).

e. ACGIH TLV-STEL = The time-weighted average exposure that should not be exceeded for any 15-minute period (ACGIH, 2011).

f. MIOSHA PEL-TWA = The permissible concentration in air of a substance that shall not be exceeded in an 8-hour work shift or a 40-hour work week (R 325.77103 Rule 3 (1) MIOSHA Reference of OSHA Permissible Exposure Limits).

g. MIOSHA PEL-STEL = The time-weighted average exposure that should not be exceeded for any 15-minute period (R 325.77103 Rule 3 (2) MIOSHA Reference of OSHA Permissible Exposure Limits).

h. NE = Not Established.

If sample results indicate an exceedance of the site action level and/or OELs for the COPCs, additional measures will be taken to protect worker health. If the monitoring required by paragraph (e)(2)(i) of the OSHA benzene standard 1910.1028 and R 325.77102 (B) of the MIOSHA benzene standard R 325.77102 section reveals employee exposure at or above the action level of 0.5 ppm but at or below the TWA, the employer shall repeat such monitoring for each such employee at least every year. Specifically, if OVM sample results indicate a benzene exceedance in excess of the OSHA Permissible Exposure Limit (PEL-TWA), a regulated area will be established wherever the airborne concentration of benzene exceeds or can reasonably be expected to exceed the permissible exposure limits (1910.1028(d)(1)) (MIOSHA R 325.77104 Rule 4). If a regulated area is established based on detections of elevated benzene , access will be limited to authorized persons with appropriate personal protective equipment (PPE) (1910.1028(d)(2).

7.0 ODOR INVESTIGATIONS

Enbridge will provide an Odor Response Team. The Odor Response Team will be deployed within 30 minutes (maximum) after receiving odor complaints/concerns. Responses will be conducted 24 hours a day, 7 days a week. Enbridge will immediately relay all initial odor reports to U.S. EPA Air Monitoring Operations Section and MDEQ. The MDEQ will notify Michigan Department of Public Health staff of the odor complaints.

Personnel responding to the odor event will travel to the location where the report originated. Real-time air monitoring data and analytical “grab” canister sample data will be collected at the reported location. Short-term real-time readings will be taken for VOCs, H_2S, and SO2 using a MultiRAE monitor and benzene using an UltraRAE monitor or Gastec pump with benzene specific colorimetric tubes. These readings will be reported to the complainant immediately, and recorded in log books. At least one canister sample will be obtained, with additional canisters possible depending on the situation encountered. The canister samples will be analyzed using the same analytical approach and target compound list as routine samples (Attachment A). In addition, at the time of sampling, the Odor Response Team will document the presence or absence of odors and the subjective quality of the odors. The odor event location will also be documented using GPS.

After completion of the field visit, the Odor Response Team will relay the collected information to Enbridge. Enbridge will provide U.S. EPA with daily summaries of all Odor Response Team activities. Upon receipt of canister sampling results, Enbridge contractor will prepare a follow-up letter report, to be transmitted to Enbridge Safety, the complainant, and U.S. EPA.

8.0 TAR PATTY STUDY

The potential for fugitive VOCs from tar patties will be evaluated using a bagging technique. Several tar patties will be enclosed in a mylar or equivalent bag, and allow to warm in direct sunlight. The air inside the bag (headspace) will then be sampled and analyzed.

At 10% of the tar patty removal sites, headspace samples will be collected. At all of the selected sites, one bag of material will be sampled by directly pulling headspace air into a MultiRAE instrument and an UltraRAE benzene-specific monitor. At half of the selected sites, an additional bag of material will be collected and the headspace air sampled by extracting to a Tedlar bag for TO-15 analysis (Attachment A).

The results of these results will be obtained on rapid turnaround from the laboratory, and submitted by Enbridge to U.S.EPA. Enbridge and U.S. EPA will determine the need for monitoring and/or sampling during tar patty removals based on the results.

9.0 DATA QUALITY AND MANAGEMENT

Air samples will be sent to Galson Laboratories located in Syracuse, N.Y or other approved laboratory. Preliminary results will be provided to Enbridge Energy's designated representative and to any other designated representative or organization within one to two days of receipt by the laboratory. Analytical results will be flagged in instances where the contaminant is also detected in the laboratory blanks. The expedited turnaround time for Galson can be as little as one business day, upon laboratory receipt. All data will be submitted to the U.S. EPA Scribe database through Enbridge data management system. In addition, Enbridge will provide daily monitoring summary reports to U.S. EPA (by end of following day).

Collocated duplicate samples will be collected at a frequency of 1 per 10 (10%). Trip blank analysis will be conducted once per week as directed by U.S. EPA.

10.0 AIR SAMPLING AND MONITORING REPORTING

Enbridge will provide on a daily basis the following deliverables:

An overview of air sampling and monitoring activities conducted the previous day. The overview will consist of a map of the area between the spill site and Morrow Lake, or the geographical extent of air sampling and monitoring activities, whichever is smaller. The map will include the following layers:

- Locations of discrete analytical samples collected the previous day. Labels will include a common name (e.g. Ceresco) or project marker name (e.g. MP 24.75), count of discrete sampling locations, and count of samples collected.
- Locations of instantaneous readings collected the previous day. The symbols will be color-coded by analyte. Benzene readings will be colored differently from the other analytes.
- Summary table of instantaneous readings collected the previous day. The table will list counts of readings collected by location category (e.g. Work Area, Community), as well as counts of any detections.
- Windrose(s) generated from meteorological data collected the previous day.

An overview of the latest full day of air sampling laboratory analysis results received. The overview will consist of one or more maps of the area(s) encompassing all locations where any compounds were detected. The map(s) will include the following layers:

- Locations of all discrete analytical samples. Labels will include a unique location code for each symbol, as well as common name or project marker name.

Approved

- Chart listing concentrations and applicable screening levels of all analytes detected in the locations included in the extent of the map.
- Windrose(s) generated from meteorological data collected the day of sampling.

- The daily report package will also contain tabular summaries of hourly meteorological data. This shall be a set of tables that show air monitoring parameters for each day (by hour), as recorded from each portable weather and NWS station. The summaries shall also include a daily average for each parameter.

These deliverables are provided following an internal QA/QC process. The analytical data is received and reviewed by a qualified individual (project manager/industrial hygienist and/or toxicologist). The data will be reviewed on a daily basis to ensure that necessary actions are implemented if required (such as additional canister placement and/or real-time monitoring). Data is then uploaded to the Sharefile site for dissemination. An email notice will be sent informing participating regulatory agencies that the information for that day is available for viewing or download.

The final report will be produced upon completion of air monitoring/sampling activities detailed in this plan. The final report will consist of a compilation of real-time and analytical data, physical parameters such as wind direction, and geographical area. An evaluation of the results will be conducted to determine if COPCs were present during the oil recovery operations and if those COPC concentrations exceeded applicable human health air screening levels.

11.0 PROJECT ORGANIZATION

Enbridge Consultants will be responsible for the following:

- Toxicological support;
- Air monitoring;
- Air sampling;
- Air data quality assurance/quality control, and
- Data evaluation and reporting

Mr. Chase Selby, Environmental Scientist Project Manager, will serve as the Project Manager and Dr. Phillip T. Goad (Principal Toxicologist) will serve as the Project Director and Mr. Brett Yokom, Project Engineer, will serve as Enbridge's Task Manager for this scope of work.

12.0 CALIBRATION AND MAINTENANCE OF FIELD INSTRUMENTS

The calibration and maintenance of field equipment and instrumentation will be in accordance with each manufacturer's specifications or applicable test/method specifications, and will be recorded in Enbridge's Consultant calibration logs.

13.0 CHAIN OF CUSTODY (COC)

Each sample will be identified on a chain of custody record. The air sample numbering system will include site name, date, analyte, and identification code unique to each sample.

14.0 SAMPLE LABELS

Sample labels will be securely affixed to the sample container. They will clearly identify the particular sample and should include the following information:

- Sampling location;
- Date the sample was collected, and
- Unique identifier.

15.0 PACKAGING AND SHIPPING

Packaging and shipping of air samples will be conducted following method recommendations. Canisters will be shipped in a box via carrier service (ex. FedEx). Air samples do not require sample preservation in the field. However, caps will be placed on canisters and regulators or critical orifices will be detached during shipment. The person packaging the samples is responsible to ensure that the sample packaging is in suitable condition for shipping.

Attachment A

Compounds Detected by TO-15 Analysis

Attachment A

Table 1 Predominant Crude Oil VOCs Detect by TO-15 Analysis[1]

Analyte	Laboratory LOQ	Analyte	Laboratory LOQ
Benzene	5.0	Heptane, n-	5.0
Butane, 2-methyl-*		Hexane, n-	5.0
Cyclohexane	5.0	Naphthalene	5.0
Cyclohexane, 1,3-dimethyl-*		Nonane*	
Cyclopentane, methyl-*		Hexane, 2-methyl*	
Cyclohexane, 1,3-dimethyl-, cis-*		Octane*	
Cyclohexane, butyl-*		Octane, 3-methyl-*	
Cyclohexane, ethyl-*		Pentane, 2-methyl-*	
Cyclohexane, methyl-*		Toluene	5.0
Cyclohexane, propyl-*		Benzene, 1,2,4-trimethyl	5.0
Cyclopentane, 1,1 -dimethyl*		Hexane, 3-methyl*	
Cyclopentane, 1,3-dimethyl-, trans *		Hexane, 3-methyl*	
Cyclopentane, 1,2-dimethyl-, trans *		Heptane, 2-methyl-*	
Heptane, 3-methyl-*		Cyclohexane- 1,1,3-trimethyl*	
2-Octene, 2,6-dimethyl-*		Benzene, 1,3,5-trimethyl	5.0
Decane*		Undecane*	
Dodecane*		Xylene, m&p-	10
Ethylbenzene	5.0	Xylene, o-	5.0
Ethyltoluene, 4-	5.0		

1 – The laboratory will also be asked to report on all analytes included in their TO-15 method standard analyte list.

*- Tentatively identified compound (TIC)

Attachment B

Enbridge Oil Spill Human Health Screening Levels

Attachment B

Enbridge Oil Spill
Human Health Air Screening Levels
August 13, 2010

Chemical Name	Chemical Abstract Service Number	Screening Level in parts per billion by volume (ppbv)	Source of Screening Level
1,1,1-trichloroethane	71-55-6	700	ATSDR Int. MRL
1,1,2,2-Tetrachloroethane	79-34-5	0.006	EPA RSL
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	4,000	EPA RSL
1,1,2-Trichloroethane	79-00-5	100	Chronic MRL or RfC
1,1-Dichloroethane	75-34-3	100	Chronic MRL or RfC
1,1-Dichloroethene	75-35-4	20	ATSDR Int. MRL
1,2,4-Trichlorobenzene	120-82-1	30	Chronic MRL or RfC
1,2,4-Trimethylbenzene	95-63-6	1.5	EPA RSL
1,2-Dibromoethane	106-93-4	1	Chronic MRL or RfC
1,2-Dichloro-1,1,2,2-Tetrafluoroethane	76-14-2	9,900	EPA RSL
1,2-Dichlorobenzene	95-50-1	30	Chronic MRL or RfC
1,2-Dichloroethane	107-06-2	1,000	Chronic MRL or RfC
1,2-Dichloropropane	78-87-5	7	ATSDR Int. MRL
1,3-Butadiene	106-99-0	1	Chronic MRL or RfC
1,3,5-Trimethylbenzene	108-67-8	45	MDNRE
1,3-Dichlorobenzene	541-73-1	0.5	MDNRE
1,4-Dichlorobenzene	106-46-7	200	ATSDR Int. MRL
1,4-Dioxane	123-91-1	1,000	ATSDR Int. MRL
2,2,4-Trimethylpentane	540-84-1	750	MDNRE
2-Chloro-1,3-butadiene	126-99-8	2.1	EPA RSL
2-Propanol	67-63-0	3,000	EPA RSL
3-Chloropropene	107-05-1	0.3	Chronic MRL or RfC
Acetone	67-64-1	13,000	ATSDR Int. MRL
Acetonitrile	75-05-8	38	EPA RSL
Acrylonitrile	107-13-1	1	Chronic MRL or RfC
Benzene	71-43-2	6	ATSDR Int. MRL
Benzyl chloride	100-44-7	0.01	EPA RSL
Bromodichloromethane	75-27-4	0.01	EPA RSL
Bromoform	75-25-2	0.21	EPA RSL
Bromomethane	74-83-9	50	ATSDR Int. MRL
Butane	106-97-8	10,000	MDNRE
Carbon disulfide	75-15-0	200	Chronic MRL or RfC
Carbon tetrachloride	56-23-5	30	ATSDR Int. MRL
Chlorobenzene	108-90-7	200	Chronic MRL or RfC
Chloroethane	75-00-3	4,000	Chronic MRL or RfC
Chloroform	67-66-3	50	ATSDR Int. MRL
Chloromethane	74-87-3	200	ATSDR Int. MRL
cis-1,2-dichloroethene	156-59-2	8.6	MDNRE
cis-1,3-Dichloropropene*	10061-02-6	4.4	MDNRE
Cumene	98-82-8	100	Chronic MRL or RfC
Cyclohexane	110-82-7	2,000	Chronic MRL or RfC

Cyclohexane,methyl	108-87-2	4,000	MDNRE
Chemical Name	**Chemical Abstract Service Number**	**Screening Level in parts per billion by volume (ppbv)**	**Source of Screening Level**
Cyclopentane	287-92-3	6,000	MDNRE
Dibromochloromethane	124-48-1	0.01	EPA RSL
Dichlorodifluoromethane	75-71-8	42	EPA RSL
Ethyl Acetate	141-78-6	890	MDNRE
Ethyl benzene	100-41-4	700	ATSDR Int. MRL
Heptane	142-82-5	850	MDNRE
Hexachlorobutadiene	87-68-3	10	Chronic MRL or RfC
Hexane	110-54-3	200	Chronic MRL or RfC
Isobutane	75-28-5	10,000	MDNRE
Methyl butyl ketone	591-78-6	10	Chronic MRL or RfC
Methyl ethyl ketone	78-93-3	2,000	Chronic MRL or RfC
Methyl isobutyl ketone	108-10-1	700	Chronic MRL or RfC
Methyl tert-butyl ether	1634-04-4	700	ATSDR Int. MRL
Methylene chloride	75-09-2	300	ATSDR Int. MRL
Napthalene	91-20-3	1	Chronic MRL or RfC
Nonane	111-84-2	100	MDNRE
Pentane	109-66-0	6,000	MDNRE
Propene	115-07-1	2,000	Chronic MRL or RfC
Styrene	100-42-5	200	Chronic MRL or RfC
Tetrachloroethene	127-18-4	40	Chronic MRL or RfC
Tetrahydrofuran	109-99-9	6.1	MDNRE
Toluene	108-88-3	1,000	Chronic MRL or RfC
trans-1,2-Dichloroethene	156-60-5	200	ATSDR Int. MRL
trans-1,3-Dichloropropene*	10061-01-5	0.5	MDNRE
Trichloroethene	79-01-6	100	ATSDR Int. MRL
Trichlorofluoromethane	75-69-4	130	EPA RSL
Vinyl acetate	108-05-4	10	ATSDR Int. MRL
Vinyl bromide	593-60-2	1	Chronic MRL or RfC
Vinyl chloride	75-01-4	30	ATSDR Int. MRL
Xylenes	1330-20-7	2,000	ATSDR Int. MRL

* MDNRE provisional screening value for Dichloropropene based on a 1 in 100,000 cancer risk

ATSDR Int. MRL - The Agency for Toxic Substances and Disease Registry Intermediate Minimal Risk Level (MRL) is the preferred screening level. The MRL is protective of daily human inhalation exposure for up to a year, including sensitive individuals such as children, the elderly, and those with pre-existing illnesses.

ATSDR Chronic MRL or EPA RfC - If no Intermediate MRL is available, the screening level is the ATSDR Chronic MRL or the EPA Reference Concentration (RfC). The chronic MRL and the RfC are protective of daily human inhalation exposure over a lifetime, including sensitive individuals.

EPA RSL - If none of the above are available, the EPA Regional Screening Level (RSL) is the screening level. The RSLs are protective of daily human inhalation exposure over a lifetime, including sensitive individuals.

MDNRE - If none of the above are available, the Michigan DNRE Air Quality Division, Air Toxics Screening Level is the screening level. The MDNRE screening levels are protective of daily human inhalation exposure over a lifetime, including sensitive individuals.

Attachment C

Meteorological Station Specifications

Datalogging Specs:

The Coastal WeatherPak outputs data every 30 seconds. SAFER reads this stream as the data comes in and compiles 5 five minute average of the data for use with its model. The data is logged internally to the computer in the SAFER STAR file structure and can be accessed through dbf format by opening the file in Excel. It can also be accessed for further analysis by using the Meteorological analysis application that is a part of the SAFER STAR program suite. Because the data is stored on the hard drive, it is never deleted (no FIFO buffer) and the only way the data can be erased is by manually deleting the files or a hard drive crash.

Technical specs of the instruments:

Wind Speed:
Range: 0 to 60 m/s (130 mph)
Survival: 100 m/s (220 mph)
Threshold: 1.0 m/s (2.2 mph)

Wind Direction
Range: 360° mechanical, 355° electrical
Survival: 100 m/s (220 mph)
Threshold: 0.9 m/s (2.0 mph)

Temperature
Operational Range: -40°C to 50°C (-40°F to 122°F)
Accuracy: ±0.2°C over full range (0.36°F)
Resolution: 0.5°C (1.0°F)

Humidity
Operating Temperature Range: -40°C to +80°C
Measuring Range: 0 to 100% RH
Accuracy at +20°C: +/- 2% RH (0 to 90% RH)
+/- 3% RH (90 to 100% RH)
Temperature Dependence: +/- 0.05% RH/°C

Compass
Accuracy: ±1.0°
Resolution: 1°
Tilt Limit: ±45°

Mechanical Specs

Size: 4" x 22.5" (10.3 cm x 57.2 cm) (base unit without wind monitor)
Weight: 8 lbs (3.6 kg) (base unit without wind monitor)
Carry Weight: ABS Carry Case w/WEATHERPAK® 24 lbs. (10.9 Kg)
Canvas Tripod Bag 30 lbs. (13.6 Kg)
Material: 6061-T6 aluminum, 316SS hardware, O-Ring sealed Mil-Spec connector,thermoplastic resin coated
Set-up Time: 60 seconds, from carry case to full operation

Operating Specs

Temperature: Operation from -40°C to 70°C (-40°F to 160°F)
Pressure: Operation from 800 to 1100 mBar
Humidity: 10 day exposure with 100% RH
Rain: 20 in/hr
Shock/Vibration: Survival of 6 ft drop

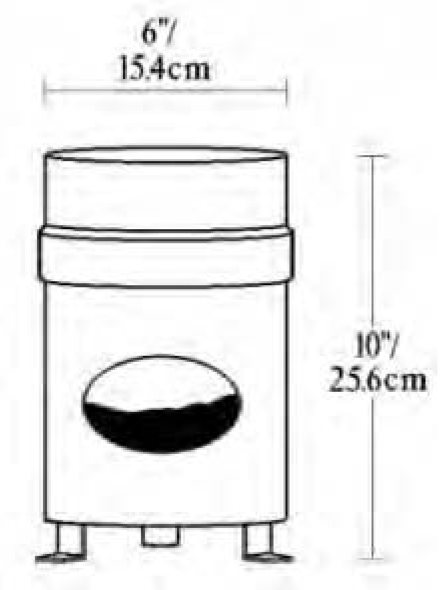
Tipping Bucket / Rain Gauge

S1068W / S1068Z

- **Rugged aluminum housing**
- **Completely automatic**
- **0.01” Accuracy**

This sensor consists of a gold anodized aluminum collector funnel with a knife edge that diverts the water to a tipping bucket mechanism. The mechanism is so designed that one alternate tip of the bucket occurs for each 0.01 inch of rainfall. Connecting the sensor to the ZENO® 3200 data logger, or to the WEATHERPAK® will allow record keeping of accumulated rainfall.

The spent water drains out of the bottom of the housing, so the sensor requires no attention or servicing of any kind. The aluminum housing is covered with a white baked enamel surface to withstand years of exposure to the environment. This sensor is factory calibrated, and due to the nature of its operation, should not require field calibration. Occasional cleaning of debris from the filter screen may be required.



Technical Specifications

S1068W / S1068Z

Resolution:	0.01” (0.25 mm)
Accuracy:	1.0% at 2”/hr. or less
Average Switch Closure Time:	135 ms
Maximum Bounce Settling Time:	0.75 ms
Maximum Bounce Closure Time:	0.25 ms
Maximum Switch Rating:	30 VDC @ 2 A, 115 VAC @ 1 A
Temperature Limits:	0°C to +52°C (+32°F to +125°F)
Humidity Limits:	0 to 100%

PHYSICAL

Height:	10” (25.6 cm)
Weight:	2.5 lbs (1.13 kg)
Receiving Orifice Diameter:	6” (15.4 cm)
Cable:	15 ft, 2-conductor

Attachment D

Field Standard Operating Procedures

CTEH QA/QC and Data Validation Procedures for Real-Time Air Monitoring and Air Sampling

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures are conducted following the collection of real-time air monitoring and analytical sampling to ensure that air monitoring and sampling results are defensible. Analytical sampling can be performed to verify real-time air monitoring results or to provide quantifiable data. The following sections describe QA/QC actions taken to ensure completeness and correctness of data.

1.0 Real-Time Air Monitoring

The term “real–time” refers to data collected using direct reading instruments that allow nearly instantaneous determinations of airborne chemical concentrations. Real-time measurements provide immediate information for worker and community exposure scenarios and, with the use of appropriate site safety measures, help prevent overexposures. Real-time air monitoring follows methods and procedures that are similar to analytical sampling. The following sections describes these actions.

1.1 Field Calibration

All field real-time air monitoring instruments or equipment will be calibrated prior to use in the field. Real-time instruments will be calibrated daily or as needed, according to manufacturer recommendations. Specifically, photo ionization detectors (PIDs) will be calibrated with a known concentration of isobutylene gas or zeroed using zero-grade air or at background site locations. Particulate matter monitors will be zeroed using manufacturer supplied zero filters. Gastec chemical specific colorimetric detector tubes are hermetically sealed and are calibrated by the manufacturer, and therefore, do not require field calibration.

1.2 Field Documentation

During the sampling events, all applicable notes, calibrations, sample locations, and sampling periods will be maintained in either various field books, portable handheld devices, or site logs. All instrument calibrations are to be documented on the field calibration log. The serial number of the instrument, gas applied, concentration, lot number of the gas, and expiration date of the gas are all documented.

All real-time readings will be documented either in bound notebooks, on CTEH field forms, in portable handheld devices, or by using radio telemetry systems combined with computer databasing capabilities. Each real-time record will have a description of the location, global positioning system (GPS) data, sampling date and time, sampler's initials, concentration, analyte, and proper unit of measurement.

1.3 Verification of Real-Time Readings

Direct reading instruments perform sampling and analyses within the instrument and concentration readings can usually be obtained immediately. These instruments have fast response times and can follow rapid changes in concentration. Many are capable of storing continuous readings and displaying averages for selected time intervals. However, the presence of humidity, temperature extremes, and other atmospheric conditions may produce a phenomenon known as instrument drift. A second real-time instrument is often used to verify readings when drift is suspected or to confirm detections.

1.4 Data Management

All real-time data will be entered manually into a database or downloaded from the instrument source and imported into a database. This includes air data that were collected utilizing RAE System's Inc.'s instruments (AreaRAE, MultiRAE, ppbRAE, UltraRAE, MiniRAE), Lumex mercury monitor, Gastec colorimetric tubes, and TSI's aerosol monitors. All real-time manually-logged readings will undergo 100 percent QA/QC by field personnel. Data entered into databases will be reviewed electronically and manually by personnel.

2.0 Analytical Sampling

Steps are performed to ensure analytical samples are identified and handled properly in the field. The following sections describe these steps.

2.1 Sample Media Inspection

Analytical sampling media is shipped by a vendor and are prepared by the manufacturer. Upon receipt by CTEH, sampling media are inspected prior to use in the field and during time of preparation by field personnel. If sampling media appear to be damaged, broken, or incorrectly labeled, the media is discarded. Field personnel inspect to ensure media has not expired. Furthermore, field personnel inspect media to ensure that sample integrity will not be compromised prior to the sampling event. When samples are collected after a sampling event, they are inspected again before shipment to the analytical laboratory.

2.2 Integrated Sample Flow Rate Calibration

Integrated air sampling will be conducted utilizing a sample collection device that that pulls air across a medium and stabilizes chemicals for subsequent laboratory analysis. Sampling devices will be calibrated with a DryCal primary flow meter before and after each use. Pre-calibration and post-calibration of devices are recorded on CTEH field forms.

2.3 Sample Documentation

During the sampling events, all applicable notes, calibrations, sample locations, and sampling periods will be maintained in either field books, handheld devices, or site logs. All analytical sample documentation for samples collected in the field will be in compliance with the procedures outlined in this section, regardless of the sample media.

2.4 Sample Identification and Labels

Each analytical sample prepared and collected will be allocated a unique CTEH identifier (sample ID). This sample ID will be labeled on its assigned sample. All sample labels used on sample containers will include, at a minimum, a sample identification code, the date of the sample, site name, and an indication of the chemical sampled. The label will adhere to the media and the writing on it will be in indelible ink. The label will be secondarily affixed to the media with clear adhesive tape completely covering the label.

2.5 Field Blanks

Field blanks are designed to determine whether samples have been contaminated prior to or during the sampling event. The blank media are submitted to the laboratory without having air pulled through them. At least one field blank will be collected, for each different method, for each set of samples. The number of field blanks collected will be dependent upon method recommendations. If field blanks are not sent with analytical samples, the laboratory will prepare a method blank per QC batch and analyzed with samples. All samples analyzed at the laboratory will have a method blank prepared and analyzed with samples.

2.6 Field QA/QC Samples

Field blank samples will be collected as field QC checks for the samples. There are no known sources of QC samples for industrial hygiene sampling. Therefore, duplicates and matrix spike samples cannot be collected and sent to the laboratory for analysis. Laboratory QC samples will be analyzed concurrently with the analytical batch to which they are assigned.

2.7 Packaging and Shipping

Packaging and shipping of samples will vary depending upon sample media, contaminant concentration, preservation technique, and sample container. Packing and shipping samples should follow recommendations or requirements of analytical method. The person packaging the samples is responsible to ensure that the sample packaging is in suitable condition for shipping.

2.8 Chain of Custody

Chain of Custody (COC) is a legal term (a concept in jurisprudence) that refers to the ability to guarantee the identity and integrity of the sample and provides a chronological history of the sample from the time of collection through to reporting of the test results for the production of legally defensible data. Each sample will be identified on a COC record. Information recorded will include, at a minimum, sample collection date, time, sampler's initials, identification of sample matrix, sample volume, number of containers, analyses requested, preservation method, and signature blocks for each individual who has custody for the sample(s).

2.9 Custody Seals

Custody seals are placed on either the sample container or the sample or both. Custody seals are signed by the sampler with date and time. This is done to ensure that samples are not tampered with until received by the laboratory.

3.0 Laboratory Analytical Procedures

The most current versions of NIOSH, OSHA, or EPA methods will be used by the contract laboratory for the analyses of chemicals sampled for. Each contract laboratory is selected to comply with local, state, or federal regulations. Laboratories are either dictated by governing agency, by accreditation, or due to limitations on who can perform prescribed analysis. When options are available, CTEH chooses AIHA accredited laboratories who are also certified locally for analytical method. The following sections describe procedures to ensure data quality and usability.

3.1 Sample Containers, Preservation, and Holding Times

All sample media will be provided by the analytical laboratories or media manufacturers. Sample preservation and temperature, if necessary, shall be checked immediately upon receipt of samples at the laboratory. The results of these checks will be recorded on the chain-of-custody form submitted with the sample. This is performed to ensure sample integrity.

3.2 Sample Handling in the Laboratory

Upon receipt, all samples will proceed through an orderly processing sequence (as defined in the laboratory QA/QC Plan) specifically designed to ensure continuous integrity of both the sample and other pertinent information to the analysis. All samples will be carefully checked and verified for proper chain-of-custody (COC) records, proper label identification, and any associated discrepancies. These items will be documented by use of a laboratory receipt form.

If no discrepancies are identified, the sample COC record will be signed, and the samples will subsequently be assigned a unique laboratory identification number by the laboratory for tracking and filing. The laboratory QA system and the use of an internal COC procedure will ensure that the samples are appropriately tracked from storage through the laboratory until the analytical process is complete.

Analytical and procedural information and activities will be documented with the use of Standard Operating Procedures (SOPs), a laboratory data management system, laboratory bench sheets, laboratory notebooks, and orderly project files containing any information pertinent to the analysis or integrity of the results.

The contracted laboratory will provide a written QA/QC program that discusses rules and guidelines to ensure the reliability and validity of all analytical work conducted in their laboratory. Compliance with the QA/QC program is coordinated and monitored by designated laboratory quality assurance personnel.

The laboratory will document, in each data package provided, that both initial and ongoing instrument and analytical QC functions have been met. Corrective action will be initiated on any samples analyzed in non-conformance with the QC criteria.

3.3 QA/QC Samples Prepared at the Laboratory

Method quality control checks will be analyzed as outlined in the individual method for each analysis performed. Furthermore, laboratories will prepare at minimum, one method blank per analytical batch. The method blank is carried through each step of the analytical method to examine the potential for cross-contamination. In addition or at the request of clients, laboratories will prepare a laboratory control sample (LCS). The primary purpose of the LCS is to demonstrate that the laboratory can perform the overall analytical approach in a matrix free of interferences (e.g, in reagent water, clean sand, or another suitable reference matrix). The LCS is a blank sample that is spiked with a known concentration of analyte. The LCS is prepared and analyzed with samples. Since there are no known sources for duplicate or matrix spike samples, a laboratory control sample duplicate (LCSD) is often prepared and analyzed. This should be accomplished at a frequency of 1 in every 20 samples analyzed or as necessary, whichever is more frequent.

3.4 Data Reduction

The laboratory will perform in-house analytical data reduction and review of chemical analyses under the direction of the laboratory's technical staff, QA Officer, and Project Manager for this project. These individuals are responsible for evaluating the quality of the data and indicating which, if any, data may be listed as "unacceptable" and/or which should be considered potentially unreliable. A report by the personnel assessing data quality will be submitted to the Laboratory Project Manager or designee with every data package prior to transmittal to the client.

Data reduction, review, and reporting by the laboratory will be conducted as detailed as necessary in the laboratory Quality Assurance Project Plan (QAPP).

3.5 Data Reporting

The specific data items in each analytical data set submitted to CTEH will include, but will not be limited to, the following items:

- Cover sheet listing the samples included in the report and narrative comments describing problems encountered during analysis;
- Copies of signed COC records;
- Tabulated results of the compounds identified and quantified;
- Analytical results for QC field blanks;
- Calculations of detection (reporting) limits;
- Raw electronic data files

3.6 Preventive Maintenance and Calibration

The approved laboratory will be responsible for the maintenance of laboratory instruments and equipment. Instruments and measurements made as part of the analytical methodology will be as specified in the method, without modification. The laboratory's QA program ensures that only trained personnel perform routine maintenance on all major instruments and that repairs are performed by trained laboratory personnel or service technicians employed by the instrument manufacturer or representative. Instrument maintenance will be appropriately documented through the use of instrument logs that will be included in the laboratory project file.

3.7 Corrective Measures

When errors, deficiencies, or out-of-control situations exist, the laboratory QA program provides systematic procedures, called corrective actions, to resolve problems and restore proper functioning to the analytical system.

3.8 Laboratory Data Report

Laboratory data reports will be issued for each work order generated by the laboratory. A work order is generated for a single client's samples, received by the laboratory on the same day. The deliverable components of the data report are listed below:

- Data Report (analyte, method, detection limit, date and time of analysis and results for each sample)
- Field and Laboratory Blank Summaries
- Dilution Factors
- Chain-of-Custody Records
- Cooler Receipt Forms
- Laboratory Sample Preparation Data Sheets
- Extraction/Digestion Logs

As appropriate, each of these deliverable components is given for each of the types of analyses that are conducted.

4.0 Data Validation/Verification

Prior to reporting and submittal to client, CTEH conducts data verification or data validation procedures on analytical data. A CTEH Environmental Chemist will conduct data verification on the analytical data at the request of the client. Frequency and methods are chosen to best represent the intended use of the data. Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. The analytical data will be evaluated to determine whether the reported laboratory results are compliant with the requirements of the sampling and analysis methods and procedures used to generate results.

The following parameters will be evaluated:

- Data Completeness

- Holding Times
- Sample Preservation
- Sample Receipt
- Sample Analysis

At the completion of the data verification process, the reviewer will prepare a summary of the results and note data usability.

Furthermore, data validation is a systematic procedure of reviewing a body of data against a set of established criteria to provide a specified level of assurance of its validity prior to use. The validation process will include checks for internal consistency, checks for transmittal errors, and checks for verification of laboratory capability. Evaluation of these criteria will involve review of parameters listed above and:

- Evaluation of Holding Times
- Review of Surrogate Recoveries
- A review of all QA/QC samples
- Detection limit records
- Instrument calibration records
- Continuing calibration records
- Internal standard records
- Target compound results
- Sample results

At the completion of the data validation process, the reviewer will prepare a summary of the results, validate sampling results, and specify the uses for which the data are suitable.

CENTER FOR TOXICOLOGY AND ENVIRONMENTAL HEALTH, L.L.C.

Toxicology Emergency Response Program (6/3/2008)
STANDARD OPERATING PROCEDURE NO. (Version 1.1)

SUBJECT: Gastec GV-100 and Colorimetric Detector Tubes

Description of the SOP: This procedure is intended to provide instruction on the proper use of the Gastec piston pump (GV-100) with real-time colorimetric detector tubes for a wide range of analytes.

Calibration Instructions: **Factory Calibrated.**

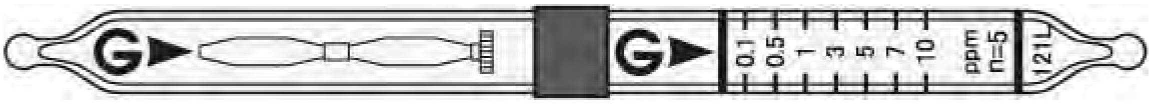
<u>Equipment Use Instructions (step by step)</u>

1) Determine your analyte of concern.
2) Pick out a box of detector tubes and insure the following items (The following instructions assume you have picked out a previously un-opened box)
    a) The box of detector tubes are not expired (Expiration date is printed on the top of the box).
    b) The measuring range is appropriate for the sampling you are performing.
3) Determine if the analyte you are sampling for is a single tube method or a dual tube method. To determine this, look on the front of the detector tube box and look at the number of tests. If it says 10 tests, it is a single tube method, if it says 5 tests; it is a dual tube method (example: Benzene 121L).
4) Assuming it is a single tube method:
    a) Break off both ends of the glass detector tube in the tip breaker located on the Gastec pump.
    b) Insert the glass tube in the end of the Gastec pump with the arrow on the glass detector tube pointing towards the pump.
5) Assuming it is a dual tube method:
    a) There will be ten glass tubes in the box, 5 pre-treatment tubes and 5 detector tubes.
    b) Locate a pre-treatment tube (usually in the back row of the box and is identified as a tube with no measuring scale printed on it), a detector tube (usually in the front row of the box and is identified as a glass tube with a measuring range printed on it), and a pink piece of tubing located between the two rows of tubes.

c) Break off both ends of both tubes using the tip breaker on the side of the Gastec pump.

d) The pretreatment tube should be placed in-line with the measuring tube using the pink piece of tubing. The pretreatment tube should be in front of the detector tube for sampling. The detector tube has the measuring range delineated on it, and should be the one inserted into the pump while the other, pretreatment tube, filters the air before it reaches it.

NOTE: The arrows on both glass tubes should be pointing towards the Gastec pump.



e) Insert the measuring tube in the Gastec pump.

6) To determine the appropriate number of pump strokes, look at the instructions located in the detector tube box. There are two types of pump strokes, a full stroke (100 mL) and a half stroke (50 mL). To pull a full stroke or a half stroke line up the arrow on the Gastec pump handle with the appropriate volume (either 100 mL or 50 mL). Every analyte has a different measuring range, but generally the more pump strokes that are pulled, the lower the detection limits.

NOTE: Insure that you are pulling enough pump strokes to get below the particular standard or guideline with which you are comparing your results. Also, the “number of pump strokes” in the directions refers to full (100 mL) pump strokes.

7) The pump stroke is complete when the “Flow Finish Indicator” is visible on the end of the pump handle. The “Flow Finish Indicator” is a white disc that becomes visible after pulling the pump stroke anywhere from 30 seconds to 5 minutes depending on the analyte.

8) To read the airborne concentration of the analyte of concern, look at the measuring scale on the detector tube. Consult the instructions for the appropriate reagent color change that you should expect if the analyte is present in the air at detectable levels. There is a statement on every detector tube such as “n=X”, this indicates the number of full pump strokes that you must pull to read the concentration directly from the detector tube. If you pull more or less than

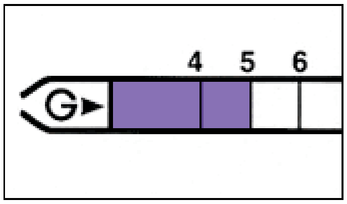
this number, you must apply a correction factor that you will find in the instructions.

9) Note that all colorimetric detector tubes have chemical interferences as well as corrections for humidity, pressure, and temperature. Consult the instructions for details.

10) Do not re-use a detector tube or pretreatment tube if you have a color change in the reagent (a detection).

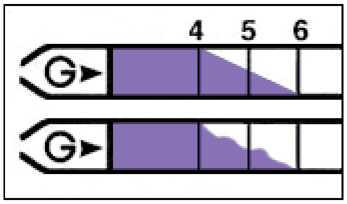
Tips for detector tube reading

When the end of the color change layer is flat, simply read the value at the end.



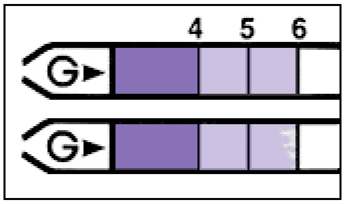
In this case, the reading would be 5%.

When the end of the color change layer is slanted, read the value in the middle of the slant.



In this exaggerated case, the reading would be 5%.

When the demarcation of the color change layer is pale, the mean value between the dark and the pale layer ends is taken.



In this exaggerated case, the reading would be 5%.

Tip for easier reading

When you mark the color change with a pen as soon as the sampling is complete, it is more convenient to read.

NOTE: It is possible to have a positive detection that is not measurable. This occurs when there is a positive color change, but it is not within the marked, measurable part of the tube. To record this properly you would state that the reading was above the detection limit, but below the measuring range. Example, >1 ppm ,<5 ppm.

11) Dispose of the pretreatment and detector tube according to local governmental standards.

***Additional media needed for this equipment*:**

Detector tubes are available for a wide variety of analytes. We have at least one box of most of the detector tubes that are manufactured by Gastec.

***Notification Procedures for Equipment Failure*:**

Notify: Equipment Room Manager

***Specialized Training Required or Recommended*:**

None

***References and Further Assistance*:**

1) Refer to the Gastec Handbook 2nd Edition or later

2) Nextteq, LLC
8406 Benjamin Road, Suite J
Tampa, FL 33634
Phone: 877-312-2333
Fax: 877-312-2444
http://www.nextteq.com/

3) http://www.gastec.co.jp/english/index.php

***Review Date for this SOP*:**

Nathan Williams 4_12_2011

CENTER FOR TOXICOLOGY AND ENVIRONMENTAL HEALTH, L.L.C.

Toxicology Emergency Response Program 04-19-2011
STANDARD OPERATING PROCEDURE NO. (Version 1.0)

SUBJECT: *Motorola MC-55 Handheld*

Description of the SOP. The purpose of this document is to provide the reader with a thorough understanding of the general capabilities, proper usage and maintenance, and field data collection procedures with the Motorola MC-55.

Motorola MC 55 EPA (PDA/Handheld)

General notes

The Motorola MC 55 is an Enterprise Personal Assistant (EPA) device that runs Windows Mobile 6 operating system. The models that CTEH owns have the following amenities:

Touch screen	**Blue Tooth**	**Mobile Broadband**	**Barcode Scanner**
Barcode Scanner	**Camera**	**Key pad**	**Phone/Text**

**Note: as of this writing we do not have a means to have the barcode scanner and the camera enabled at the same time.

Proper usage

- The elastic strap on the back is there for you to put your off hand through while using the device. It makes holding the device easier.
- The stylus on the right side of the device is for use with the touch screen. While not *required* to use the touch screen, the stylus provides greater control and precision.
- If you take good care of your unit it will be more reliable than one that is mishandled or used improperly. Taking the battery out is the only way to turn the unit off. Even if the red power button is pressed and the screen goes black the unit is still on.

Section 1 Battery

The charge of one battery on a MC 55 will last 100 hours in standby mode and 6 hours of talk time (most units won't have phone feature on). For data entry purposes this translates to a couple of days. In the case of a failing or worn out battery it may not last a whole day of regular data entry. As is the case with any rechargeable battery, life and function will be optimized if the following is done:

- The battery is charged only if it is very low and not left charging after the battery has been fully charged.
- Extreme heat and cold temperatures are avoided. Battery is kept in a dry environment and not submerged in water. If the battery or the unit manages to get wet remove the battery immediately and allow the unit and the battery to dry separately. If the battery gets wet and the small white rectangle (on the right) turns pink or red, discontinue use of battery and dispose of it at a facility that recycles batteries.

- **Note:** The battery will not work as well if the battery gets excessively hot; which can happen if the unit is charged and used non-stop, is used intensely or is left in the sun. If the performance has degraded significantly due to overheating it might be beneficial to take the battery out and let the battery cool off.
- **Removing or replacing battery:** Figures 1.1 and 1.2 demonstrate the proper procedures for removing and replacing the unit's battery.

Figure 1.1: Procedure for removing battery from unit.

STEP 1 Flip the unit over so that the screen is facing down. 	**STEP 2** Pull up on the strap to let the strap down. 
STEP 3 On the gray metal piece there is a black battery lock. Slide the lock to the Right (it will take some oompf). The battery should pop up a little but it might not. 	**STEP 4** Pull the battery off of the unit. 

Figure 1.2: Procedure for replacing battery in unit.

STEP 1

(If the elastic band has already been taken down then continue to step one otherwise do step three from Figure 1.1 first)

Slide the bottom of the battery into the back of the unit.

STEPS 2 & 3

Hold the unit with both hands so your fingers are on the battery and your palms are on the sides of the screen.

STEP 4

Reattach the elastic band by sliding the metal clip on the end of the band onto the top of the unit. The unit should come on as soon as the battery is installed. If not you may need to press the red power button once to turn it on.

Section 2 General Hand Held Unit Practices and Guidelines

Following is a list of best practices and guidelines which should ensure optimal usage of the MC 55 unit.

- Do not drop or subject unit to sudden impacts.
- Avoid getting the unit wet. If the unit does get wet remove the battery immediately.
- For general transport, make sure that the unit is secured in a closeable pouch or container when not in use. Failure to secure the unit in a closable pouch or container may result in the unit getting dropped or left behind.
- This MC 55 has **not** been certified for usage in volatile or flammable environments. Make sure the unit is off if before entering a flammable or volatile environment.
- Do not use a writing pen or sharp objects on the touchscreen.

Section 3 Windows Mobile 6 OS Basics

3.1 Resetting the device:

A lot of the problems that you might encounter with your device can be solved by resetting the device. This is done by pressing and holding the red power button until the screen goes white or about 5 seconds.

3.2 Volume

The rocker arm on the left of the unit is the volume control

3.3 Keyboards

Some units have a full QWERTY keyboard below the screen while some have a numerical keypad that is similar to a cell phone. The shift, orange and blue button have two modes: single and lock. Pressing the shift key ⇧ once will only capitalize the very next letter pressed, while pressing shift ⇧ twice will essentially turn caps lock on. Inputting text with the numerical pad is similar to texting with a phone. With the orange button enabled press the number that has the letter you want until the letter you want


ut


e 12 key style

appears. For the letter C this means pressing the 2 button three times. After a brief pause pressing 2 again (with orange locked) will result in an ‘a’ (or ‘A’).

3.3.1 On Screen Keyboard

Of course all devices have an onscreen keyboard that is fairly easy to use.
When you are at a point that you can input text on the device, press the keyboard button to bring up the onscreen keyboard. The stylus will be very helpful in typing the correct keys. However, the screen can occasionally get out of line making using the onscreen keyboard very difficult. In the case of bad screen alignment follow the **Screen Alignment** section.

3.3.2 Other input modes

There are other ways to input characters into the device, which you can see if you press the up arrow next to the keyboard. You might find that your keyboard is gone in place of something else, in which case use the up arrow and select Keyboard.

3.4 GPS:

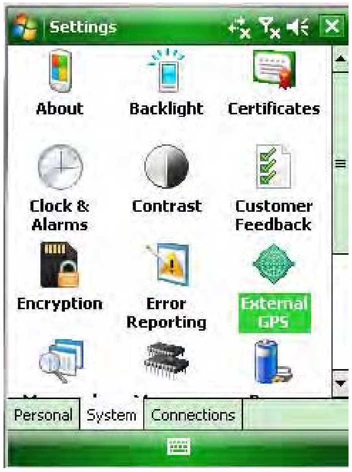
Figure 3.1 shows the steps for setting up the GPS on the MC-55.

- You should only manipulate the settings of the GPS after you have tried troubleshooting the problem. Your handheld shouldbe set up for GPS by the time you get it. However, in some rare cases it seems that the device loses the saved values for the GPS settings. There is also a different setup that works that your unit might be set up with, where the Pocket PC GPS settings uses COM:8 instead of COM:3.
- The GPS locator works off of satellites, which means that a clear line of sight with the sky is critical. Being indoors or under large structures will block the GPS signal.
- The first satellite synch can take 10-20 minutes or longer on occasion. Staying in one place will help your device find its location during this period. After the first synch the GPS location should be more responsive.

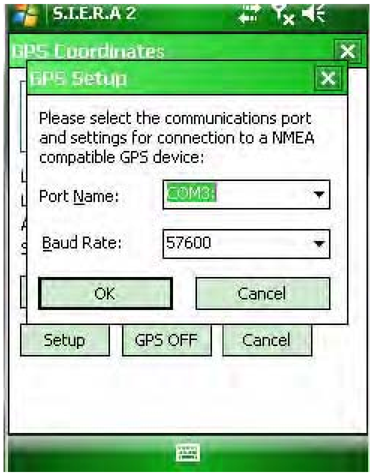
Figure 3.1: Steps for setting up GPS on the MC-55

STEP 1

STEP 2



STEP 3

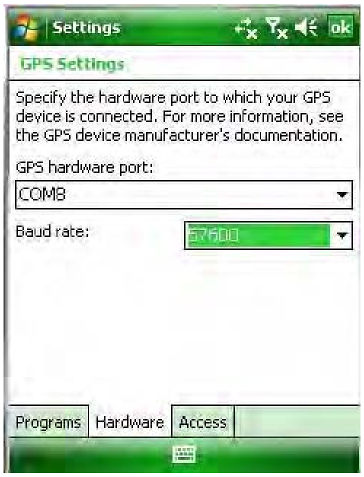


Please select the communications port and settings for connection to a NMEA compatible GPS device:

Port Name: COM3:

Baud Rate: 57600

STEP 4



Specify the hardware port to which your GPS device is connected. For more information, see the GPS device manufacturer's documentation.

GPS hardware port: COM8

Baud rate: 57600

STEP 5

Windows Mobile manages access to your GPS device and allows multiple programs to obtain GPS data simultaneously. If you clear this check box, some programs may not be able to obtain GPS data.

☑ Manage GPS automatically (recommended)

STEP 6

Choose the port that programs will use to obtain GPS data. Any program that uses GPS will need to communicate with this port.

GPS program port: COM3

In my personal experience (Matt Reed) I have seen very few GPS radios fail in the MC55. However, if after thoroughly troubleshooting your GPS issues without success call your equipment or IT tech for help.

1. Press |⊞ Start| -> |Settings|
2. Click the |System| tab on the bottom and select External GPS
3. In the Programs tab the GPS program port should be COM3
4. In the Hardware tab the GPS Hardware Port should be COM8 and the baud rate set to 57600
5. In the Access tab Check the box Manage GPS Automatically
6. When you are getting your latitude and longitude for a data point in a Pocket PC Creations app (like S.I.E.R.A. 2, Personnel Sampling, Real Time 2.2 etc.) and you choose automatic, a window should pop up saying “Connecting to GPS…” from there click “Setup”. The Port Name should be COM3 (the same as the GPS program port) and the Baud Rate should be 57600.

Section 4 Screen Alignment

The MC55 touch screen translates where you press the screen with your finger or stylus into coordinates in the operating system. Sometimes the translation is off. Pressing on top of the item that you want to press translate to a different spot in the OS.

For example: If you press the ‘g’ on the onscreen keyboard and the ‘x’ is what gets highlighted then the translation is off and you have a screen alignment problem.

You can fix this by

1. Pressing the blue button followed by
2. Pressing the backspace button.

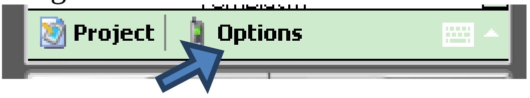
Then follow the onscreen directions. There has been one instance (out of 200 +) that I am aware of where the screen would not stay aligned after doing a software screen alignment. In these cases report the problem and get a replacement.

Section 5 Pocket PC Creations (PPCC)

Each application in Pocket PC Creations is project specific. If you have questions regarding how to use it or what to put into a certain app ask your supervisor or site lead.

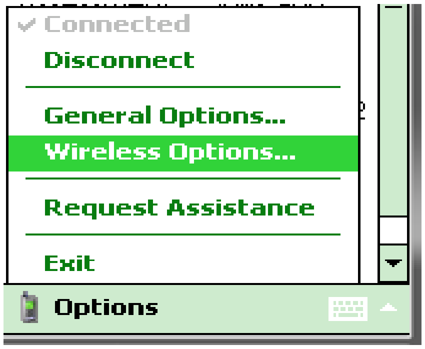
If you don’t have the Pocket PC Apps that you need to do your function you will need to call your site lead or IT tech to get it.

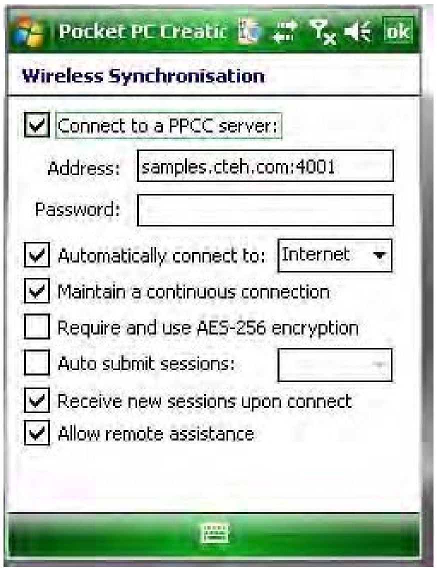
The settings for Pocket PC Creations can be found under the “Options” menu.



5.1 Wireless Options

First let’s go over the Wireless Options.





Wireless Synchronisation

☑ Connect to a PPCC server:

Address: samples.cteh.com:4001

Password:

☑ Automatically connect to: Internet

☑ Maintain a continuous connection

☐ Require and use AES-256 encryption

☐ Auto submit sessions:

☑ Receive new sessions upon connect

☑ Allow remote assistance

[✓] (checked) Connect to a PPCC server: The top check box often gets unchecked if a recent connection attempt was unsuccessful (more on this later)
The Address: is |samples.cteh.com:4001|
note the colon between “com” and “4001”
There isn’t a password.
[✓] (checked) Automatically connect to: |Internet|.
[✓] (checked) Maintain a continuous connection,
[ ] (unchecked) Require and use AES-256 encryption.
[ ] (unchecked) Auto submit sessions:
[✓] (checked) Receive new sessions upon connect.
[✓] (checked) Allow remote assistance

If your unit is having trouble connecting contact Matt Reed, Brady Davis, or Anton Avguchenko at 501-801-8500.

Section 6   Real-time Readings

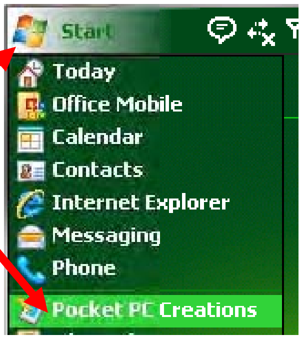
Basic:
Use the stylus to enter data for each required field. Navigate through the pages by using "Next" at the bottom and the scroll bar on the right side of the screen.

A good rule-of-thumb is to think about what information would be helpful to someone looking at this data several months/years from now if they were trying to get a good idea of what happened and where you were.

You can navigate between different Pocket PC Creations using the **"Back"** button inside each program.

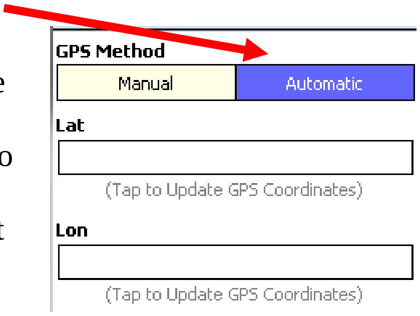
Detailed:

1) Turn on the hand held unit by pushing the small **red** button at the bottom front of the handheld. Handhelds are notoriously hard to actually turn off, so you may also be able to just tap the screen.



2) After a couple of minutes it will come to a **green** screen with start at the top left corner of the screen. Press Start.
3) The next screen will be **a green** screen. Go to **Pocket PC Creations**.
4) The next screen will be white with several files. Pick **RealTime 2.2.** (or the most recent version of RealTime)

5) Your next screen will be a white screen, go to the bottom and pick **new.**
6) You can enter text and numbers using the physical keys on the handheld or by tapping the small keyboard icon in the bottom right of the screen with the stylus. This will bring a keyboard up on the screen that you can type with using the stylus.
7) Fill in the correct **date** (this should be automatically filled in when you start a new reading), **project number**, and **region**.
8) Next enter your name, choose indoor or outdoor sampling, and select the appropriate **"Location Category"**.
9) Hit **"Next"** to move on to the next page when you've completed the current one.

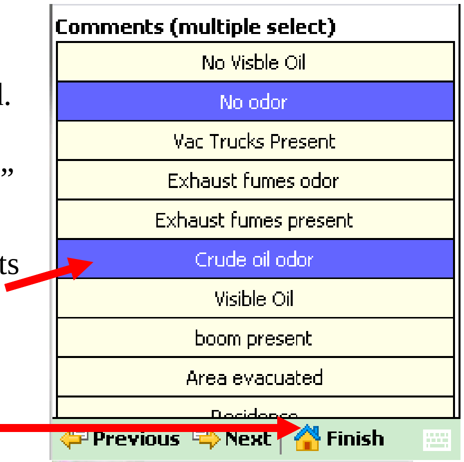


10) Make sure you enter coordinates whenever possible. If outside, you should be able to choose "Automatic" and just tap the box(es) for Latitude/Longitude. It can take several minutes to acquire satellites and provide a reading the first time you do this after powering on the MC55, but after that it should be fairly instantaneous. If the GPS isn't working, you can often get coordinates from your cellphone or Google Earth, Google Maps, etc. and enter them by choosing "Manual".

11) Enter the address if known and be concise, specific, but also detailed in the **"Location Description"** and later **"Additional Comments"**.

12) Next enter the matrix (what you measured for: air, water surface, soil), the instrument used, its barcode number, the analyte that you measured for (H2S, LEL, O2, SO2, VOC, etc), result flag either non-detect or detect, reading that your instrument gave you, detection limit of the analyte, units measured (%, ppm), instrument details (was there fog, rain, elevated humidity, moisture interferer, drift of areaRAE, battery low, 100ml, 200ml, 300ml).

    a. ***NOTE** If entering a Gastec reading, indicate how many pump strokes here by choosing the volume of air pumped. Be sure to enter the Gastec Tube Number in the "Additional Comments" field.

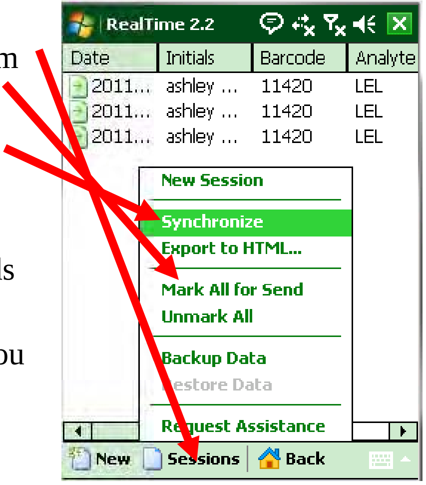


13) On the next two screens, choose any comments that apply, and concisely provide any other details that might be useful in **"Additional Comments"**

14) Then hit "**Finish".**

15) To synchronize and send data to main computer on site, tap "**Sessions"** at the bottom of the screen, touch **"Mark All for Send"**, touch **"Synchronize"**.

16) You should synchronize your data regularly. Don't use the "duplicate" feature unless expressly told you can do so. This often leads to errors that invalidate the data you are collecting and costs CTEH more time than you will save.



Date	Initials	Barcode	Analyte
2011...	ashley ...	11420	LEL
2011...	ashley ...	11420	LEL
2011...	ashley ...	11420	LEL

Section 7 SIERA Points

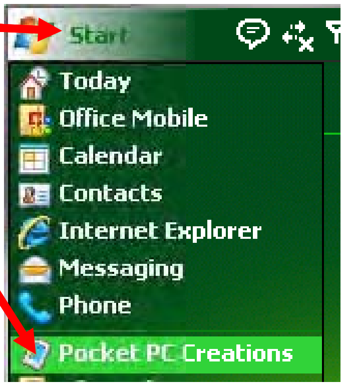
Basics:

SIERA Points are used to record samples, monitoring stations, and events. The SIERA2 program works a lot like RealTime described above. Navigate through the pages using **“Next”** and the scroll bar on the right of the screen.

Details:

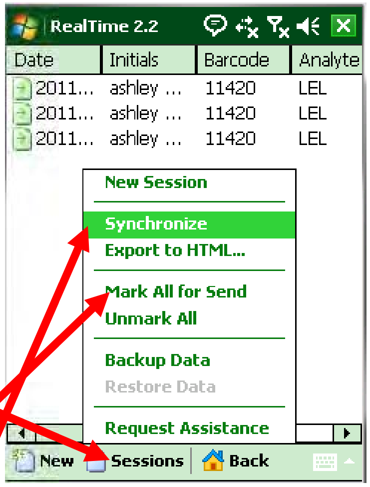
1) Turn on the hand held unit by pushing the small **red** button at the bottom front of the handheld.

2) After a couple of minutes it will come to a **green** screen with start at the top left corner of the screen. Press **“Start”**.



3) The next screen will be a **green** screen. Go to “**Pocket PC Creations**” and press it.
4) The next screen will be white with several files. Pick “**SIERA 2**”.
5) Your next screen will be a white screen, go to the bottom and pick “New”.

6) Fill in the **Project**, **DateTime** (should be automatic), GPS method (pick automatic if outside), **region** or state that you are in, **Location Description**, your **initials**, **SIERA Type** (sample, survey, tar ball, safety, source, instrument, event, receptor), **SIERA subtype**, **Primary identifier** (the Sample ID), **Other identifier** (Station Name), comments, touch “tap to attach image”, push **yellow** button on front of handheld (or tap the screen) to take picture, back out of screen by pushing “**Back**” at bottom of screen, touch “**Finish**”.
7) To synchronize and send data to main computer on site, tap **sessions** at the bottom of the screen, touch “**Mark all for send**”, hit **“Sessions”** again, touch “**Synchronize**”.



Date	Initials	Barcode	Analyte
2011...	ashley ...	11420	LEL
2011...	ashley ...	11420	LEL
2011...	ashley ...	11420	LEL

Additional media needed for this equipment:

A/C adapter (necessary for charging battery)

Car charger (necessary for charging battery in the field)

Docking station (for both charging and synchronizing directly to computer)

SIM Card

Notification Procedures for Equipment Failure:

CTEH-Matthias “Papa Lemur Finkelstein” Reed – (501) 801-8652

References and Further Assistance

Motorola MC-55 User’s Guide

Call Anton Avguchenko, Matt Reed, or Brady Davis if you need help.

CTEH Main Number: 501-801-8500

Created by

Matthias Reed April 19, 2011
David Quibell April 25, 2011
Johnnie Chamberlin April 27, 2011

Attachments:
none

CENTER FOR TOXICOLOGY AND ENVIRONMENTAL HEALTH, L.L.C.

Toxicology Emergency Response Program April 14, 2009
STANDARD OPERATING PROCEDURE NO. (1)

SUBJECT: MiniCan or Mini-canister

Description of the SOP: The purpose of this SOP is to instruct the user about proper methods and operation for collecting a Mini-Can air sample. Upon completion of this manual the user should be able to collect both a grab sample and a time released air sample using a Mini-Can air sampling instrument.

Calibration Instructions

1. All cleaning and calibration should be conducted at the laboratory by authorized personnel.

Grab Sample Equipment Use Instructions (step by step)

1. Ensure that the sampler is not wearing any of perfume, cologne, or aerosol. These products may affect the sample.

2. Remove protective cap from the Mini-Can sampler tip..

3. Using a grab sample regulator, slide the connection collar back.

4. Position the canister on its side in the direction of the area intended to sample.

5. Insert the sampler tip into the regulator and release the collar.

NOTE: There should not be a gap between the regulator and the canister.

6. Allow the canister ample time to fill (20-30 seconds)

7. Once the canister has been successfully filled with sample air pull back on the connection collar to release the regulator.

8. Place protective cap on sampler tip.

9. Complete a Chain of Custody form and ship sample in accordance to laboratories shipment instruction.

Additional media needed for this equipment:

Quick Grab Sample Regulator

Time Released Equipment Use Instructions (step by step)

1. Ensure the sampler is not wearing any sort of perfume, cologne, or aerosol. These products may affect the sample.

2. Remove protective cap from the Mini-Can sampler tip.

3. Using a time release regulator, slide the connection collar back.

4. Place canister in area intended for sampling and insert sampler tip into regulator. **NOTE: For stationary sampling the canister should be placed on its side. For personnel sampling the canister should be fastened using a holster belt with a sampling tube attached to the regulator and clipped to the collar of the individual that is being sampled.**

5. Release the connection collar.

Note: There should not be any gap between the regulator and the canister.

6. Allow the sample canister ample time to fill.

NOTE: Progress can be monitored by checking the vacuum gauge located on the regulator. The pressure should decrease over time.

7. Once sample time is complete and canister has been successfully filled with sample air pull back the connection collar to release the regulator.

8. Place protective cap back on the Mini-Can sampler tip.

9. Complete a Chain of Custody form and ship sample in accordance to laboratories shipment instruction.

Additional media needed for this equipment:

Time Released Grab Sample Regulator

Belt holster (depending on sample)

Sample tubing (depending on sample)

Notification Procedures for Equipment Failure

Galson Laboratories
6601 Kirkville Road
East Syracuse, NY 13057
Phone: 315-432-LABS (5227)
Toll Free: 888-432-LABS (5227)
www.galsonlabs.com
mail@galsonlabs.com

Center for Toxicology and Environmental Health (CTEH)
5120 North Shore Drive
North Little Rock, AR 72118
Phone: 501-801-8500
Emergency: 1-866-TOX-CTEH (869-2834)
Fax: 501-801-8501
www.cteh.com

References and Further Assistance.

Centek Laboratories, LLC
143 Midler Park Drive
Syracuse, New York 13206
Phone: 315-431-9730
Fax: 315-431-9731

Review Date for this SOP

Nathan Williams 4_12_2011

UltraRAE 3000 User's Guide

Rev. A
May 2008
P/N 059-4023-000

FCC Information

Contains FCC ID: S22BTMODULE-CL2

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

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.

ATEX WARNING!

To reduce the risk of electrostatic ignition, do not use the instrument without the rubber boot in place.

The instrument is classified as to intrinsic safety for use in Class I, Division 1, groups A, B, C, D, and ATEX II 2G EEx ia IIC T4, or non-hazardous locations.

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 the 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 équipement doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d'instructions en entier avant d'utiliser, d'entretenir ou de réparer l'équipement.

Utiliser seulement l'ensemble de batterie RAE Systems, référence 059-3051-000 ou 059-3052-000. Cet instrument n'a pas été testé dans une atmosphère de gaz/air explosive ayant une concentration d'oxygène plus élevée que 21%. La substitution de composants peut compromettre la sécurité intrinsèque. Ne charger les batteries que dans des emplacements désignés non-dangereux.

Ne pas mélanger les anciennes et les nouvelles batteries, ou bien encore les batteries de différents fabricants.

L'étalonnage de tout instrument de RAE Systems doit être testé en exposant l'instrument à une concentration de gaz connue avant de mettre en service l'instrument pour la première fois.

Pour une sécurité maximale, la sensibilité de l'instrument doit être vérifiée en exposant l'instrument à une concentration de gaz connue avant chaque utilisation journalière.

Ne pas utiliser de connexion USB/PC en zone dangereuse.

1 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

2 General Information

The UltraRAE 3000 is a hand-held, programmable compound specific PID monitor designed to provide instantaneous exposure monitoring of a specific organic gas. It monitors a specific gas by utilizing a gas separation tube and the photoionization detector (PID) with a 9.8 eV gas discharge lamp. It also can be used to measure total volatile organic compound (VOC) as a broadband monitor by utilizing the PID with a 9.8 eV, 10.6 eV, or 11.7 eV lamp.

Features include:

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

- 260,000-point datalogging storage capacity for data download to PC

The UltraRAE 3000 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.

3 Physical Description

The main components of the portable compound-specific and VOC monitoring instrument include:

- Three 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
- Easy-to-use separation tube holder
- USB communication port for PC interface
- Protective rubber cover

4 Specifications

Size:	10" L x 3" W x 2.5" H (25.5 cm x 7.6 cm x 6.4 cm)
Weight:	26 oz (738 g) with battery pack
Detector:	Photoionization sensor with 9.8, 10.6, or 11.7 eV UV lamp
Battery:	A 4.2V/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	50 ppb to 10,000 ppm (VOC mode)	50 ppb
9.8 eV	50 ppb to 200 ppm, for benzene and butadiene; 50 ppb to 5,000 ppm (VOC mode)	50 ppb
11.7 eV	50 ppb to 2,000 ppm (VOC mode)	50 ppb

Response time (T_{90}):	2 seconds
Accuracy (Isobutylene):	3% at calibration point
PID Detector:	Easy access to lamp and sensor for cleaning and replacement
Correction Factors:	Over 200 VOC gases built in (based on RAE Systems Technical Note TN-106)
Calibration:	Two-point field calibration of zero and standard reference gases
Calibration Reference:	Store up to 8 sets of calibration data, alarm limits and span values
Inlet Probe:	Flexible 5" tubing (a short tube is also available) Separation tube housing with permanent VOC tube
Radio module:	Bluetooth (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

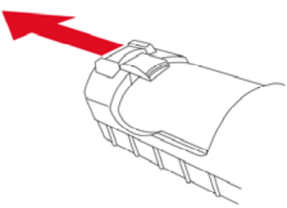
Intrinsic Safety:	US and Canada: Class I, Division 1, Group A, B, C, D Europe: ATEX (II 2G EEx ia IIC T4)
EM Interference:	Highly resistant to EMI/RFI. Compliant with EMC R&TTE (RF Modules)
Alarm Setting:	Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode:	Hygiene or Search mode
Alarm:	Buzzer 95dB at 12″ (30cm) and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure
Alarm Type:	Latching or automatic reset
Real-time Clock:	Automatic date and time stamps on datalogged information
Datalogging:	260,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC via USB on charging station.
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.

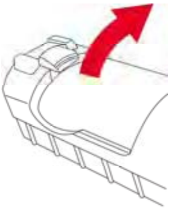
5 Replacing Alkaline Batteries

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. (An optional rechargeable lithium-ion battery pack, part number 059-3051-000, is also available.)

To install the adapter in the instrument:

1. Remove the alkaline battery adapter from the instrument by sliding the tab and tilting out the adapter.

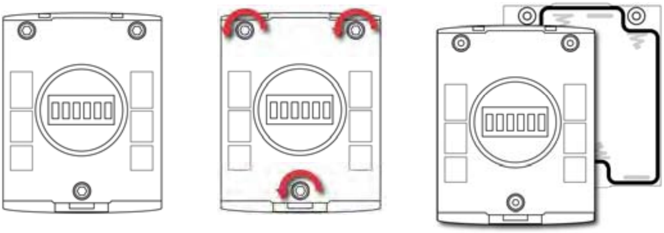




2. Replace the batteries (follow the procedure below).
3. Tilt the alkaline battery adapter and put it into the instrument.
4. Slide the tab back into place to secure the battery adapter.

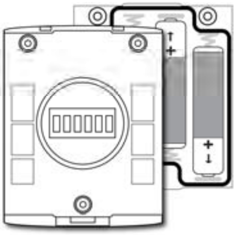
To insert batteries into the adapter:

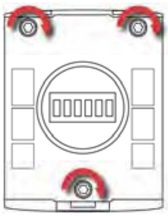
1. Remove the three hex-socket screws to open the compartment in the adapter.



2. Insert four fresh AA batteries as indicated by the polarity (+/-) markings.

3. Replace the cover. Replace the three screws.





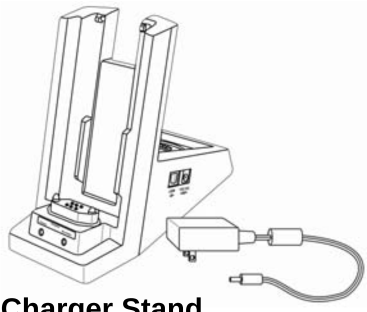
IMPORTANT!

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 Travel Charger or Charger Stand, 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 Charging Cradle or Travel Charger’s charging LED does not glow, indicating that it will not charge the alkaline batteries.

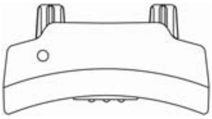
Note: When replacing alkaline batteries, dispose of old ones properly.

6 Charging A Lithium-Ion Battery

Always fully charge the battery before using the instrument. The instrument's Li-ion battery is charged by attaching the instrument to the Travel Charger (or by placing the instrument in the optional Charger Stand). Contacts on the bottom of the instrument meet the Travel Charger's (or Charger Stand's) contacts, transferring power without other connections.



Charger Stand

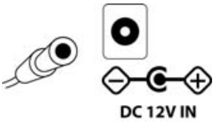


Travel Charger

Note: Before connecting the charger to the instrument, visually inspect the contacts to make sure they are clean. If they are not, wipe them with a soft cloth. Do not use solvents or cleaners.

Follow this procedure to charge the instrument:

1. Plug the AC/DC adapter's barrel connector into the instrument's Charger Stand or Travel Charger.



2. Plug the AC/DC adapter into the wall outlet.
3. Connect the AC/DC adapter to the Travel Charger (or Charger Stand).

4. Place the instrument into the Travel Charger or Charger Stand. The LED in the Travel Charger (or Charger Stand) should glow.

The instrument begins charging automatically. (If the optional Charger Stand is used, the "Primary" LED blinks green to indicate charging.) During charging, the diagonal lines in the battery icon on the instrument's display are animated and you see the message "Charging..."

Note: If the Li-ion battery has been discharged below a certain threshold, the "Charging..." message does not display immediately. The charging LED blinks to indicate that it is charging, and after it has been charging for a while, the "Charging..." message appears.

When the instrument's battery is fully charged, the battery icon is no longer animated and shows a full battery. The message "Fully charged!" is shown. (If the Charger Stand or Travel Charger is used, its LED glows continuously green.)

Note: If you see the "Battery Charging Error" icon (a battery outline with an exclamation mark inside), check that the instrument or rechargeable battery has been properly set into the Travel Charger (or Charger Stand). If you still receive the message, check the Troubleshooting section of this guide.

Note: If the instrument or battery has been charging for more than 10 hours and you see the "Battery Charging Error" icon and a message that says, "Charging Too Long," this indicates that the battery is not reaching a full charge. Try changing the battery and make sure the contacts on the instrument are meeting the Travel Charger's (or Charger Stand's) contacts. If the message is still shown, consult your distributor or RAE Systems Technical Services.

6.1 Charging A Spare Rechargeable Battery (Optional Charger Stand Only)

A rechargeable Li-ion battery can be charged when it is not inside the monitor. The Charger Stand is designed to accommodate both types of charging. Contacts on the bottom of the battery meet the contacts on the Charger Stand, 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 Charger Stand.
2. Place the battery into the Charger Stand, 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 Charger Stand blinks green. When charging is complete, it glows steady green.

Release the battery from the Charger Stand by pulling it back toward the rear of the Charger Stand 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.

WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge and replace batteries only in areas known to be non-hazardous.

6.2 Low Voltage Warning

When the battery's charge falls below a preset voltage, the instrument warns you by beeping once and flashing once every minute, and the "empty battery" icon blinks on and off once per second. You should turn off the instrument within 10 minutes and either recharge the battery by placing the instrument in its cradle, or replace the battery with a fresh one with a full charge.

6.3 Clock Battery

An internal clock battery is mounted on one of the instrument’s printed circuit boards. This long-life battery keeps settings in memory from being lost whenever the Li-ion battery or alkaline batteries are removed. This backup battery should last approximately five years, and must be replaced by an authorized RAE Systems service technician. It is not user-replaceable.

6.4 Data Protection While Power Is Off

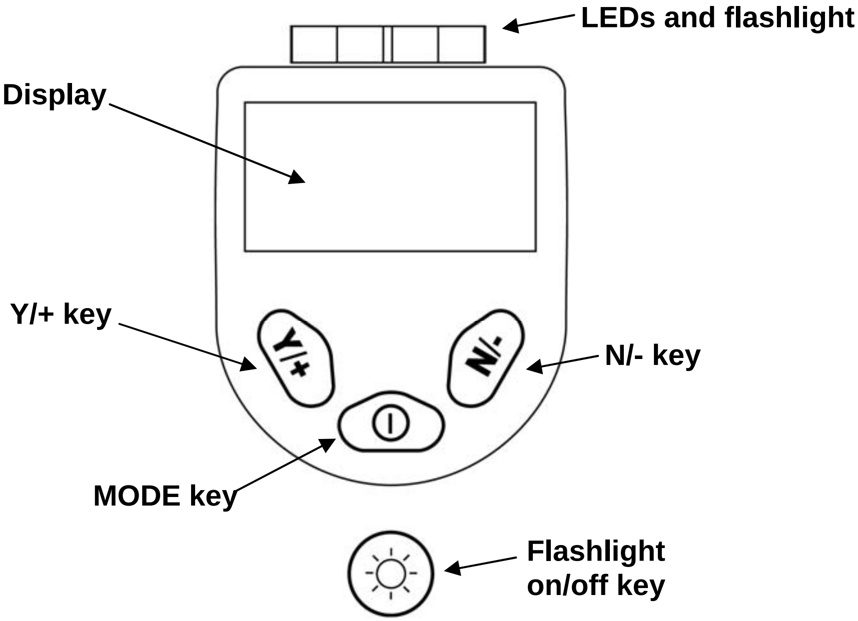
When the instrument is turned off, all the current real-time data including last measured values are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost.

7 User Interface

The instrument's user interface consists of the display, LEDs, an alarm transducer, and four keys. The keys are:

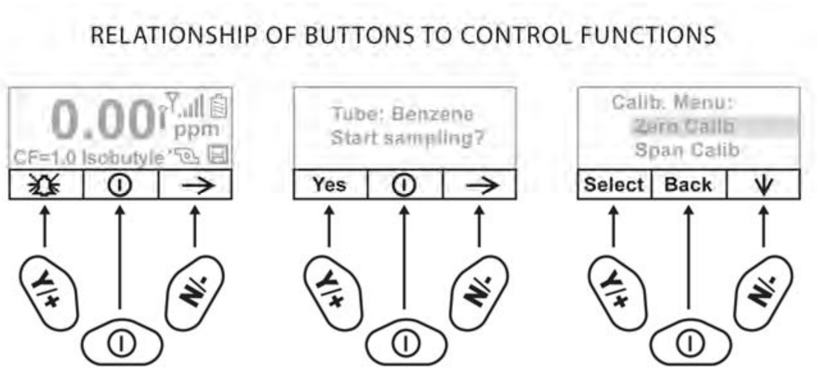
Y/+
MODE
N/-
Flashlight on/off

The LCD display provides visual feedback that includes the reading, time, battery condition, and other functions.



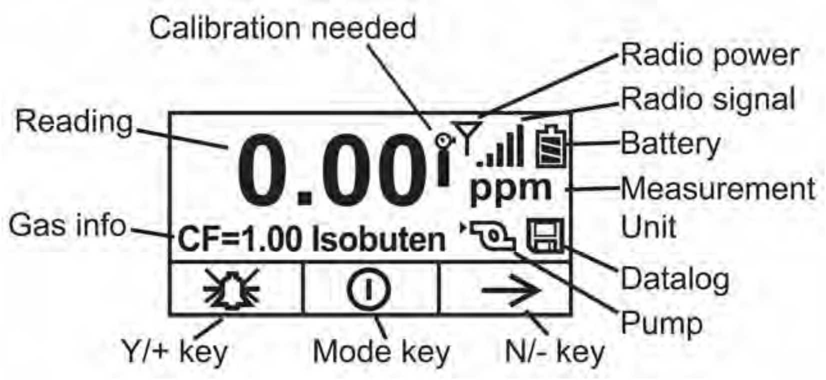
In addition to their labeled functions, the keys labeled Y/+, MODE, and N/- act as "soft keys" that control different parameters and make different selections within the instrument's menus. From menu to menu, each key controls a different parameter or makes a different selection.

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:



7.1 Display

The display shows the following information:



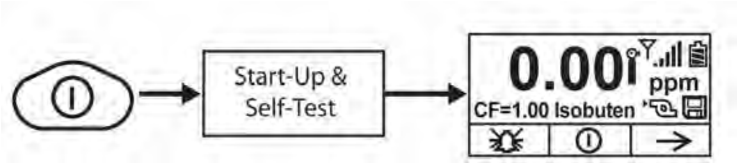
Gas info	Tells the Correction Factor and type of calibration gas
Reading	Concentration of gas as measured by the instrument
Calibration needed	Indicates that calibration should be performed
Radio power	Indicates whether radio connection is on or off
Radio signal	Indicates signal strength in 5-bar bargraph
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

8 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.

8.1 Turning The Instrument On (Simple)

1. With the instrument turned off, press and hold [MODE].
2. When the display turns on, release the [MODE] key.

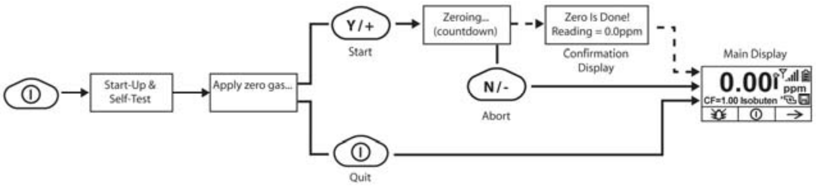


The RAE Systems logo should appear first. (If the logo does not appear, there is likely a problem and you should contact your distributor or RAE Systems Technical Support.) The instrument is now operating and performs self tests. If any tests (including sensor and memory tests) fail, refer to the Troubleshooting 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.

8.2 Turning The Instrument On (Power On Zero)

If your UltraRAE 3000 has been configured to perform a zero (fresh air) calibration upon startup, called Power On Zero, then the startup routine is interrupted so that you can perform a fresh air calibration. (See page 85 for details on turning this feature on or off.)



If you do not want to perform a zero calibration, press [MODE] to bypass it. If you start a zero calibration and want to abort it, press [N/-], and the calibration stops and the main display is shown.

8.3 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.

8.4 Operating The Built-In Flashlight

The instrument has a built-in flashlight that helps you point the probe in dark places. Press the flashlight key to turn it on. Press it again to turn it off.

Note: Using the flashlight for extended periods shortens the battery’s operating time before it needs recharging.

8.5 Pump Status

IMPORTANT!

During operation, make sure the probe inlet and the gas outlet are free of obstructions. Obstructions can cause premature wear on the pump, false readings, or pump stalling. During normal operation, the pump icon alternately shows inflow and outflow as shown here:

During duty cycling (PID lamp cleaning), the display shows these icons in alternation:

If there is a pump failure or obstruction that disrupts the pump, the alarm sounds and you see this icon blinking on and off:

If you see this blinking icon, consult the Troubleshooting section of this guide.

8.6 Calibration Status

The instrument displays this icon if it requires calibration:

Calibration is required (and indicated by this icon) if:

- The lamp type has been changed (for example, from 10.6 eV to 9.8 eV).
- The sensor module 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.

9 Operating Modes

The UltraRAE is actually two monitors in one:

- Compound-specific monitor
- VOC monitor

As a compound-specific monitor, it takes timed measurements and uses a separation tube in conjunction with software that enables the UltraRAE 3000 to give specific readings on one particular type of compound, such as benzene or butadiene.

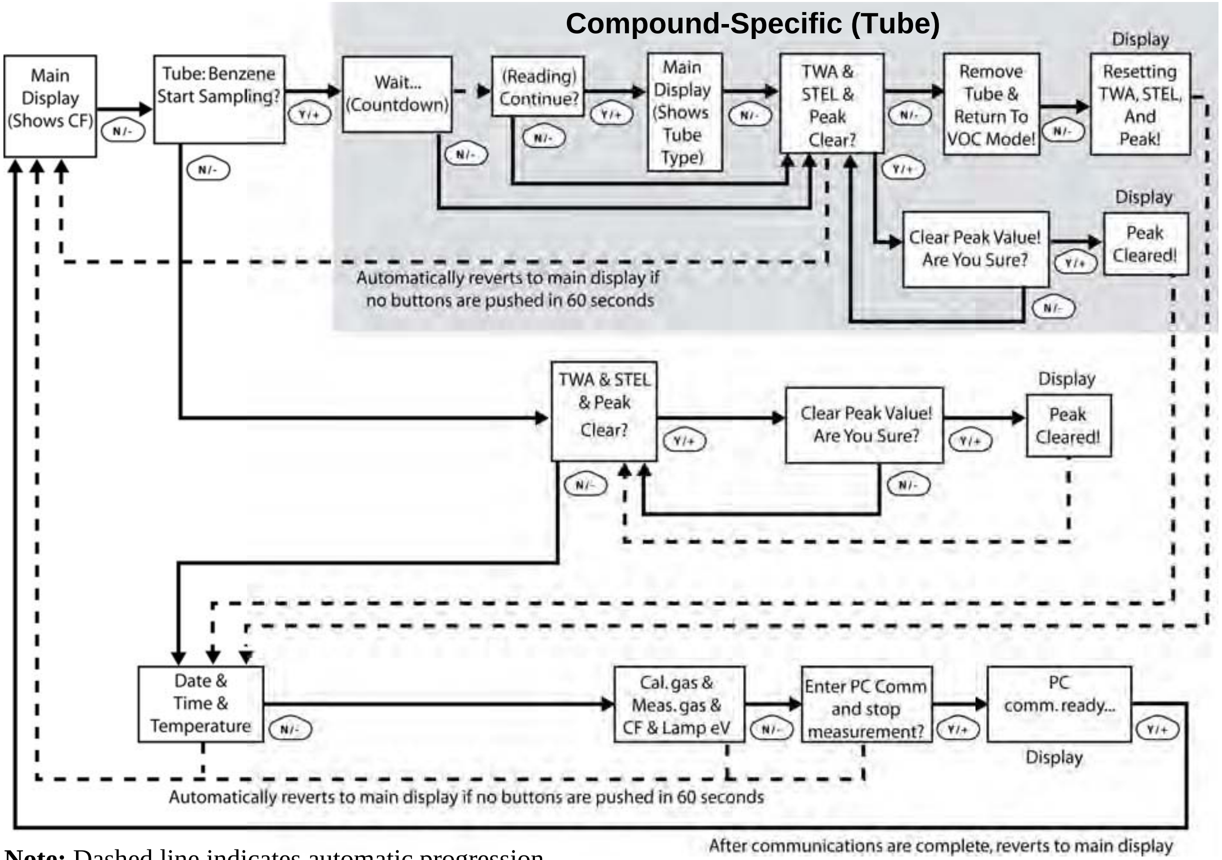
As a VOC monitor, the UltraRAE 3000 operates in different modes. In some cases, you can change modes using a password and using the instrument's navigation. In other cases, you must use ProRAE Studio software.

The following two sections cover operation in the two modes.

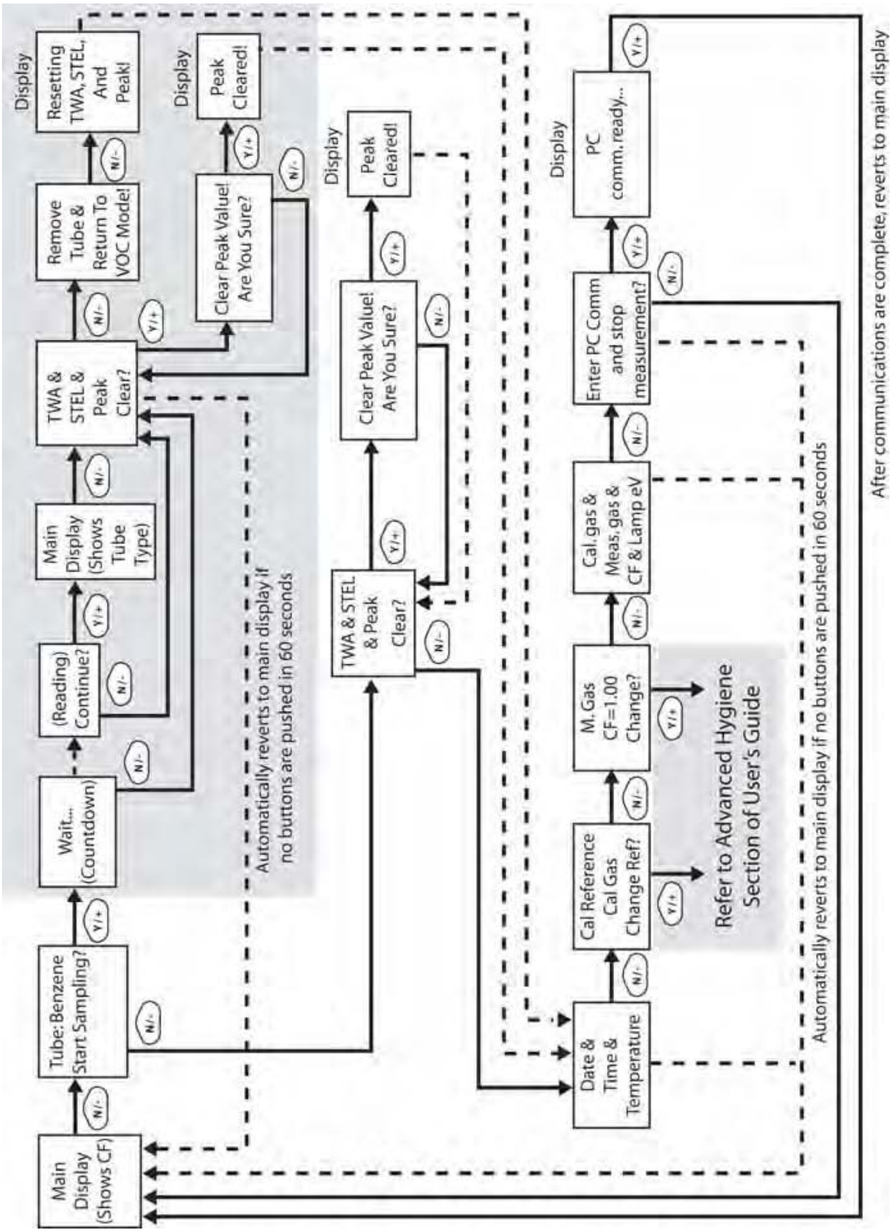
- Compound Specific, 31.
- VOC, page 38.

The diagram on the next page shows the basic flow of the UltraRAE 3000's functions. The area with the gray field is the compound-specific (tube) mode, while the rest shows VOC mode. Navigate through the steps by using the [Y/+] and [N/-] keys as shown in the diagram.

Note: If you use a password to access Programming Mode (see page 60), then the navigation changes slightly, entering part of Advanced Hygiene Mode's settings, as shown on page 29.



Note: Dashed line indicates automatic progression.


Main Display (Shows CF)
N/-
Tube: Benzene Start Sampling?
Y/+
Wait... (Countdown)
(Reading) Continue?
Y/+
Main Display (Shows Tube Type)
N/-
N/-
N/-
TWA & STEL & Peak Clear?
N/-
Remove Tube & Return To VOC Mode!
N/-
Display
Resetting TWA, STEL, And Peak!
Y/+
Clear Peak Value! Are You Sure?
Y/+
Display
Peak Cleared!
N/-
Automatically reverts to main display if no buttons are pushed in 60 seconds
N/-
TWA & STEL & Peak Clear?
Y/+
N/-
Clear Peak Value! Are You Sure?
Y/+
N/-
Display
Peak Cleared!
Date & Time & Temperature
N/-
Cal Reference Cal Gas Change Ref?
Y/+
N/-
M. Gas CF=1.00 Change?
Y/+
Refer to Advanced Hygiene Section of User's Guide
N/-
Cal. gas & Meas. gas & CF & Lamp eV
N/-
Enter PC Comm and stop measurement?
Y/+
N/-
Display
PC comm. ready...
Y/+
Automatically reverts to main display if no buttons are pushed in 60 seconds
After communications are complete, reverts to main display

The default setting for your instrument is:

User Mode: Basic
Operation Mode: Hygiene

This is outlined in detail on page 88.

The other options, covered later in this guide, are:

User Mode: Advanced (page 92)
Operation Mode: Hygiene

User Mode: Advanced (page 96)
Operation Mode: Search

Using ProRAE Studio allows access to other options. In addition, Diagnostic Mode (page 97) is available for service technicians.

10 Compound-Specific Operation

10.1 Compound-Specific Measurement

The UltraRAE 3000 can perform compound-specific measurement in addition to general VOC measurement. This requires using a RAE-Sep separation tube (butadiene or benzene) and having the UltraRAE 3000 in Tube Mode, operating with a 9.8eV lamp.

10.2 Measurement Phases

To perform a compound-specific measurement, follow this order:

1. UltraRAE 3000 is ready for sampling
2. Prepare the separation tube
3. Insert the separation tube
4. Start measurement
5. UltraRAE 3000 displays and logs measurement
6. Remove the separation tube

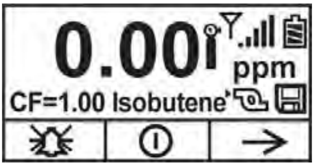
10.3 Performing A Measurement

Before performing a compound-specific measurement for Benzene or Butadiene using a RAE-Sep separation tube, make sure the UltraRAE 3000 is in Tube Mode and that the appropriate tube type is selected. The UltraRAE 3000 only acts as a compound-specific measurement device when it is equipped with a 9.8eV lamp. The UltraRAE 3000 is designed to auto-sense the lamp type. It can also be manually set to default to a 9.8eV lamp type.

Make sure the UltraRAE 3000 is set to operate with your selected tube:

1. Enter Programming Mode.
2. Select Measurement.
3. Select Tube Selection.
4. Make a choice of Benzene or Butadiene.
5. Save your choice.

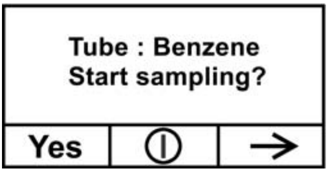
To begin measuring, turn on the UltraRAE 3000. This screen is shown, which includes the CF (correction factor) and measurement gas type for calibration reference:



0.00 ppm

CF=1.00 Isobutene

Press [N/-] to advance. You will see this screen:



Tube : Benzene
Start sampling?

Do not begin sampling yet!

Before you start sampling, you must insert a RAE-Sep separation tube into the inlet/holder. Follow the Separation Tube Preparation and Placing A Tube Into The UltraRAE 3000 instructions before pressing any buttons on the UltraRAE 3000. Once the tube is in place, then proceed to measuring.

IMPORTANT!

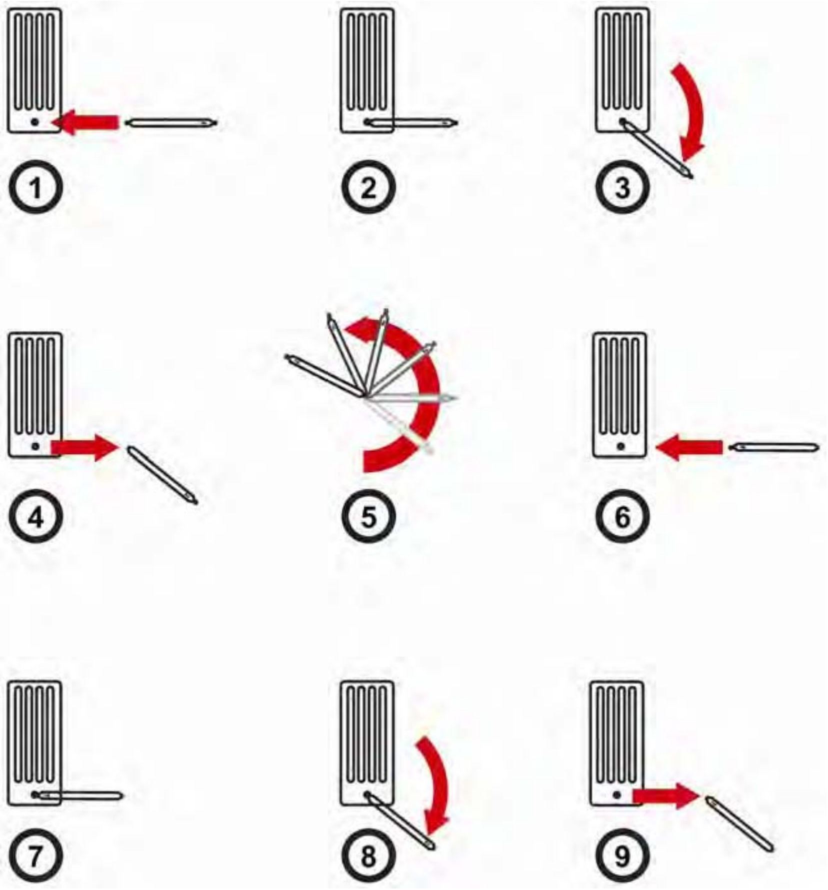
Once a tube's ends are broken off, the material inside is exposed. Therefore, use the tube for sampling as soon as possible.

10.4 Separation Tube Preparation

CAUTION!

Wear hand and eye protection when breaking tube tips. Use caution in handling tubes with broken ends. Keep away from children. RAE-Sep tubes should be disposed of according to local regulations. See footnotes of data sheets for disposal information.

1. Open a package of RAE-Sep separation tubes and remove one.
2. Place the tip in the package’s tube tip breaker (the small hole on the front) and snap off the tip.
3. Turn the tube around and snap off the other end.

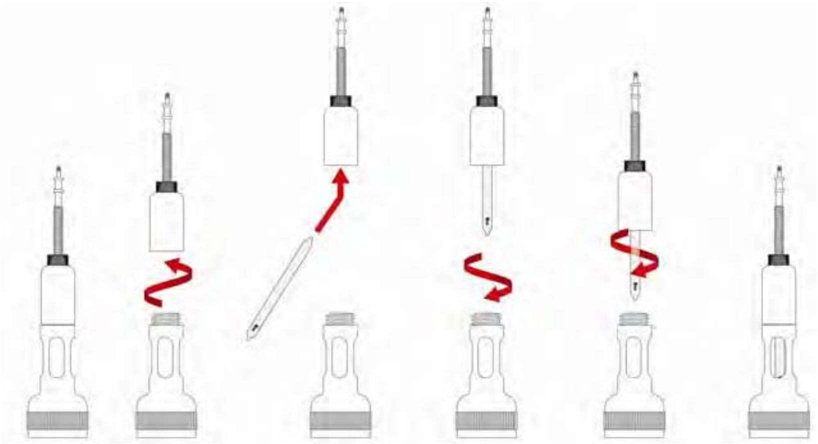


CAUTION!

Handle tubes with care. Tube ends are sharp after ends are broken off.

10.5 Inserting The Separation Tube

1. Unscrew the front of the sampling probe from the base.
2. Slip the tube into the rubber holder in the front portion. Make sure the arrow on the side of the tube points toward the instrument.
3. Insert the other end of the tube into the middle of the base while turning the front portion to tighten it onto the base's threads.



IMPORTANT!

Do not overtighten any portion of the sampling assembly.

Note: When the UltraRAE 3000 is used for VOC monitoring, no tube is inserted.

IMPORTANT!

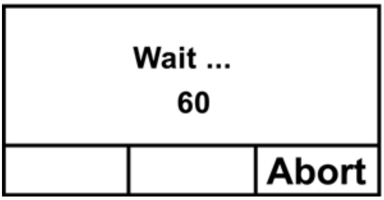
To ensure that there are no leaks, periodically test the seals:

With the UltraRAE 3000 running, place your finger over the end of the inlet probe. The alarm should sound and the pump-stall icon should flash on the display. This indicates that all seals are good. Stop the alarm by pressing [Y/+]. If the pump does not alarm or show the stalled-pump icon, then check that all inlet parts are tight and inspect the O-ring for damage (replace it if necessary).

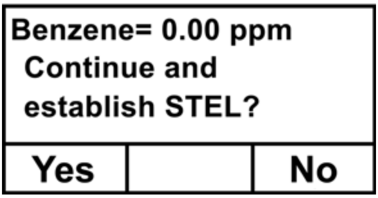
10.6 Measuring

Once the tube is in place, begin measuring by pressing [Y/+].

The display shows a countdown (60 seconds is shown here, but sampling time depends on the type of separation tube selected and the temperature):


Wait ...
60

Note: You can abort the sampling by pressing [N/-] at any time. Once the countdown is complete, the reading is shown:

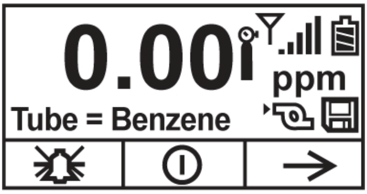

Benzene= 0.00 ppm
Continue and
establish STEL?

Press [Y/+] to continue sampling with the tube for 15 minutes to establish a STEL reading, or press [N/-] to return to the main menu.

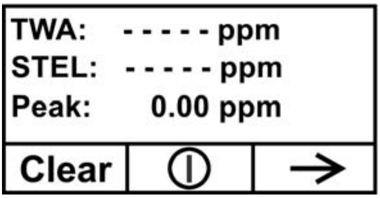
WARNING!

At least 1/4 of the tube should still be yellow-orange at the bottom. If not, the STEL value is not valid. Abort the measurement and change the tube. Then do a snapshot test instead of a STEL test. **Note:** If the STEL is exceeded, the UltraRAE 3000 goes into alarm.

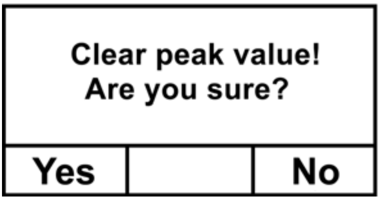
If you press [N/-] to return to the main menu, which shows the tube type instead of the CF (correction factor):


0.00 ppm
Tube = Benzene

Press [N/-] to advance to this screen:

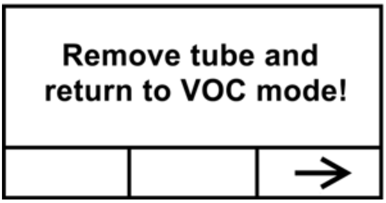

TWA: - - - - - ppm
STEL: - - - - - ppm
Peak: 0.00 ppm

If you press [Y/+], you are asked, "Clear peak value! Are You Sure?" to confirm:

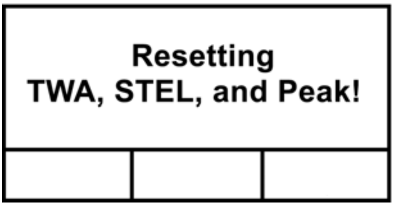

Clear peak value!
Are you sure?

Press [Y/+] to clear the Peak value and exit to VOC operation.

If you press [N/-], this display is shown:

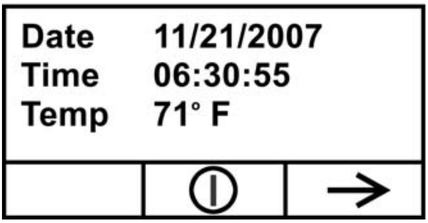

Remove tube and
return to VOC mode!

Remove the tube and put the inlet back together. Then press [N/-]. This display is shown:



Resetting
TWA, STEL, and Peak!

After a few seconds, the UltraRAE 3000 enters VOC mode and shows this display:



Date 11/21/2007
Time 06:30:55
Temp 71° F

You can step through the rest of the steps by pressing [N/-] repeatedly until you reach the main menu again.

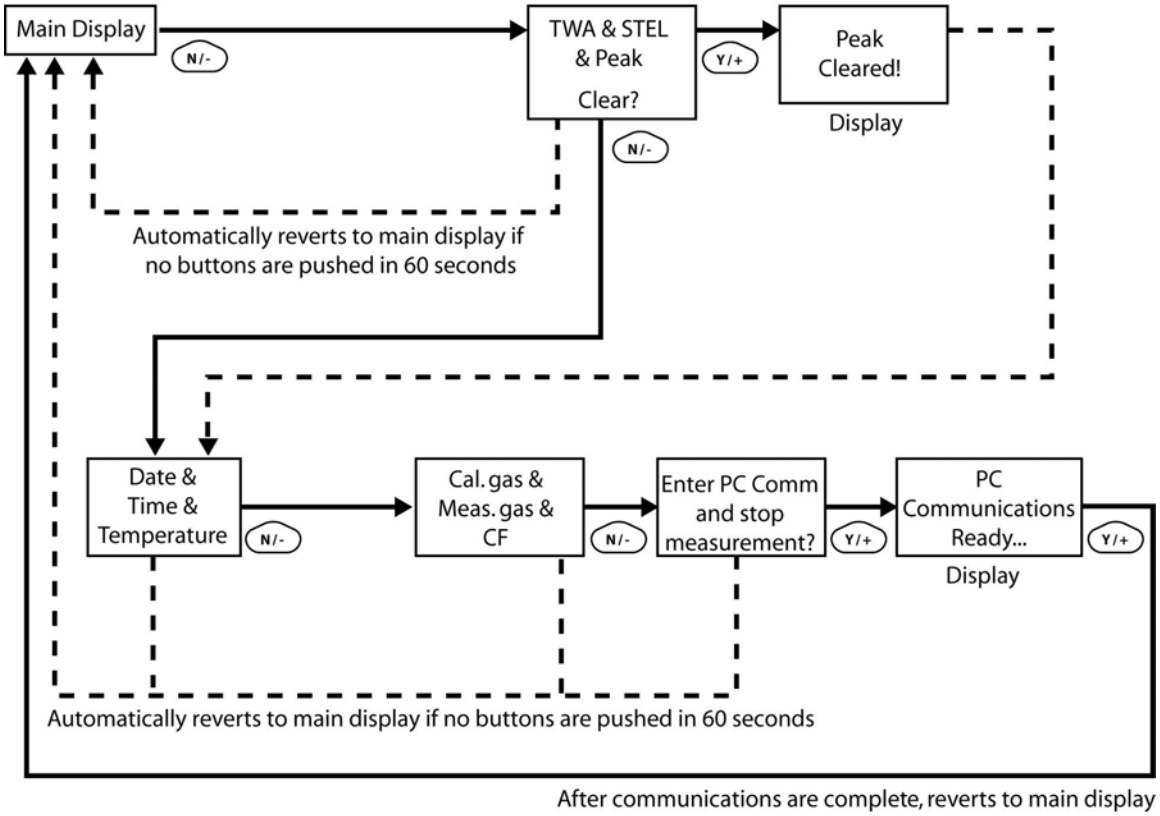
11 VOC Operation

11.1 Basic User Level/Hygiene Mode (Default Settings)

The instrument is programmed to operate in Basic User Level/Hygiene Mode as its default. This gives you the most commonly needed features while requiring the fewest parameter adjustments.

Pressing [N/-] steps you from one screen to the next, and eventually return to the main display. If you do not press a key within 60 seconds after entering a display, the instrument reverts to its main display.

Note: While viewing any of these screens, you can shut off your instrument by pressing [MODE].



Note: Dashed line indicates automatic progression.

After the instrument is turned on, it runs through the start-up menu. If the UltraRAE 3000 is set for "Power On Zero," then the message "**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 51 for a more detailed description of zero calibration.

Start zero calibration by pressing Start [Y/+]. 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 = 0.0 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.

12 Alarm Signals

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn you of the alarm condition.

In addition, the instrument alarms if one of the following conditions occurs: battery voltage falls below a preset voltage level, failure of the UV lamp, or pump stall.

12.1 Alarm Signal Summary

Message	Condition	Alarm Signal
HIGH	Gas exceeds "High Alarm" limit	3 beeps/flashes per second*
OVR	Gas exceeds measurement range	3 beeps/flashes per second*
MAX	Gas exceeds electronics' maximum range	3 beeps/flashes per second*
LOW	Gas exceeds "Low Alarm" limit	2 beeps/flashes per second*
TWA	Gas exceeds "TWA" limit	1 Beep/flash per second*
STEL	Gas exceeds "STEL" limit	1 Beep/flash per second*
Pump icon flashes	Pump failure	3 beeps/flashes per second
Lamp	PID lamp failure	3 beeps/flashes per second plus "Lamp" message on display
Battery icon flashes	Low battery	1 flash, 1 beep per minute plus battery icon flashes on display
CAL	Calibration failed, or needs calibration	1 beep/flash per second
NEG	Gas reading measures less than number stored in calibration	1 beep/flash per second

* Hygiene mode only. In Search mode, the number of beeps per second (1 to 7) depends upon the concentration of the sampled gas. Faster rates indicate higher concentrations.

12.2 Preset Alarm Limits & Calibration

The instrument is factory calibrated with standard calibration gas, and is programmed with default alarm limits.

Cal Gas	Cal Span	unit	Low	High	TWA	STEL
Isobutylene	100	ppm	50	100	10	25
Benzene	5	ppm	2	5	0.5	2.5
Butadiene	10	ppm	10	5	2	5

12.3 Testing The Alarm

You can test the alarm whenever the main (Reading) display is shown. Press [Y/+], and the audible and visible alarms are tested.

13 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.

14 Backlight

The LCD display is equipped with an LED backlight to assist in reading the display under poor lighting conditions.

15 Datalogging

During datalogging, the instrument displays a disk icon to indicate that datalogging is enabled. The instrument stores the measured gas concentration at the end of every sample period (when data logging is enabled). In addition, the following information is stored: user ID, site ID, serial number, last calibration date, and alarm limits. All data are retained (even after the unit is turned off) in non-volatile memory so that it can be down- loaded at a later time to a PC.

15.1 Datalogging Event

When Datalogging is enabled, measurement readings are being saved. These data are stored in “groups” or “events.” A new event is created and stored each time the instrument is turned on and is set to automatic datalogging, or a configuration parameter is changed, or datalogging is interrupted. The maximum time for one event is 24 hours or 28,800 points. If an event exceeds 24 hours, a new event is automatically created. Information, such as start time, user ID, site ID, gas name, serial number, last calibration date, and alarm limits are recorded.

15.2 Datalogging Sample

After an event is recorded, the unit records a shorter form of the data. When transferred to a PC running ProRAE Studio, this data is arranged with a sample number, time, date, gas concentration, and other related information.

15.3 Auto/Manual/Snapshot Datalogging

The instrument has three datalog types:

Auto	Default mode. Collects datalog information when the instrument is sampling.
Manual	Datalogging occurs only when the instrument's datalogging is manually started (see page 63 for details).
Snapshot	Datalogs only during snapshot (single-event capture, initiated by pressing [MODE]) sampling. See page 65 for details.

Note: You can only choose one datalog type to be active at a time.

16 Accessories

The following accessories are included with the instrument:

- AC Adapter (Battery Charger)
- Travel Charger
- Alkaline battery adapter
- External Filter
- Organic Vapor Zeroing kit

Hard-case kits also include these accessories:

- Calibration gas, if specified
- Calibration adapter
- Calibration regulator and flow controller
- Charging Cradle (instead of Travel Charger)

17 Standard Kit & Accessories

17.1 AC Adapter (Battery Charger)

WARNING

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in area known to be non-hazardous.

Ne charger les batteries que dans emplacements designés non-dangereuses.

A battery charging circuit is built into the instrument cradle. It only needs a regular AC to 12 VDC adapter (wall-mount transformer, part number 500-0114-000) to charge the instrument.

To charge the battery inside the instrument:

1. Power off the instrument.
2. Connect the AC adapter to the DC jack on the instrument's cradle. If the instrument is off, it automatically turns on.
3. While charging, the display message shows "Charging." The Primary LED on the cradle flashes green when charging.
4. When the battery is fully charged, the LED changes to glowing green continuously, and the message "Fully charged" appears on the display. If there is a charging error, the LED glows red continuously.

A completely discharged instrument can be charged to full capacity within 8 hours. Batteries drain slowly even if an instrument is off. Therefore, if the instrument has been in storage or has not been charged for several days or longer, check the charge before using it.

The factory-supplied battery is designed to last for 16 hours of normal operation (no alarm), for a new battery under the optimum circumstances. As the battery becomes older or is subject to adverse conditions (such as cold ambient temperature), its capacity will be significantly reduced.

17.2 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 probe.

18 Optional Accessories

18.1 Calibration Adapter

The calibration adapter for the instrument is a simple 6-inch Tygon tubing with a metal adapter on one end. During calibration, simply insert the metal adapter into the regular gas inlet probe of the instrument and the tubing to the gas regulator on the gas bottle.

18.2 Calibration Regulator

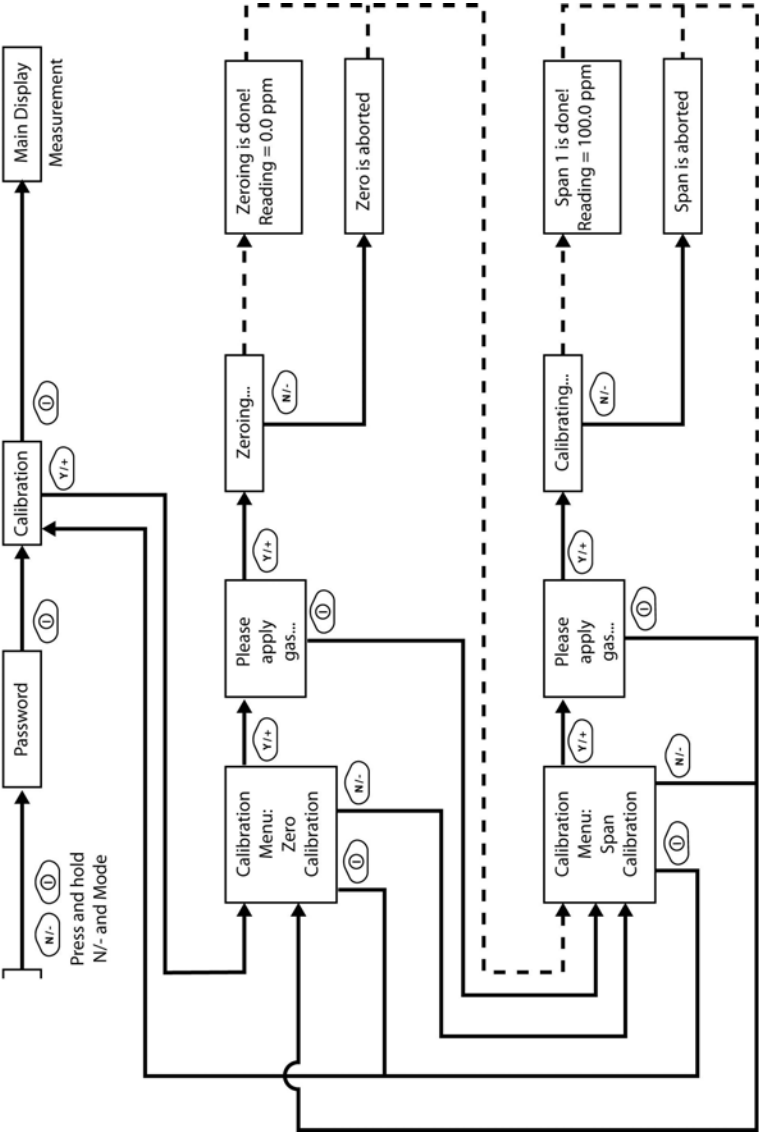
The Calibration Regulator is used in the calibration process. It regulates the gas flow rate from the Span gas cylinder into the gas inlet of the instrument during calibration process. The maximum flow rate allowed by the flow controller is about 0.5L/min (500 cc per min.). Alternatively, a demand-flow regulator or a Tedlar gas bag may be used to match the pump flow precisely.

18.3 Organic Vapor Zeroing Kit

The Organic Vapor Zeroing Kit is used for filtering organic air contaminants that may affect the zero calibration reading. To use the Organic Vapor Zeroing Kit, simply connect the filter to the inlet port of the instrument.

19 Standard Two-Point Calibration (Zero & Span)

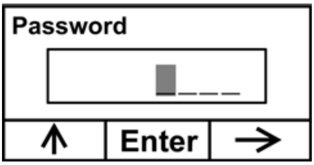
The following diagram shows the instrument's calibrations in Basic/Hygiene mode.



Note: Dashed line indicates automatic progression.

19.1 Entering Calibration

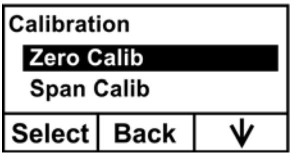
1. Press and hold [MODE] and [N/-] until you see the Password screen.



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.

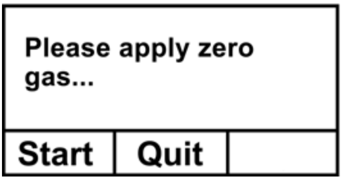
19.2 Zero (Fresh Air) Calibration

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 = 0.0 ppm

The instrument will then show the Calibration menu on its display, with Span Calib highlighted.

19.3 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.

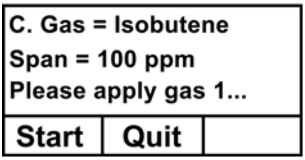
- Press [Y/+] to enter Span calibration.
- Press [N/-] to skip Span calibration and return to Zero calibration.
- Press [MODE] to exit Span calibration and return to the top calibration menu.

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).

IMPORTANT!

If you are using the UltraRAE 3000 to test for benzene, it is recommended that you calibrate with 5 ppm benzene calibration gas from RAE Systems.

You will also see this message that prompts you:



C. Gas = Isobutene
Span = 100 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 = 100.0 ppm

The instrument then exits Span calibration and shows the Zero calibration menu on its display.

Note: The reading should be very close to the span gas value.

19.4 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…

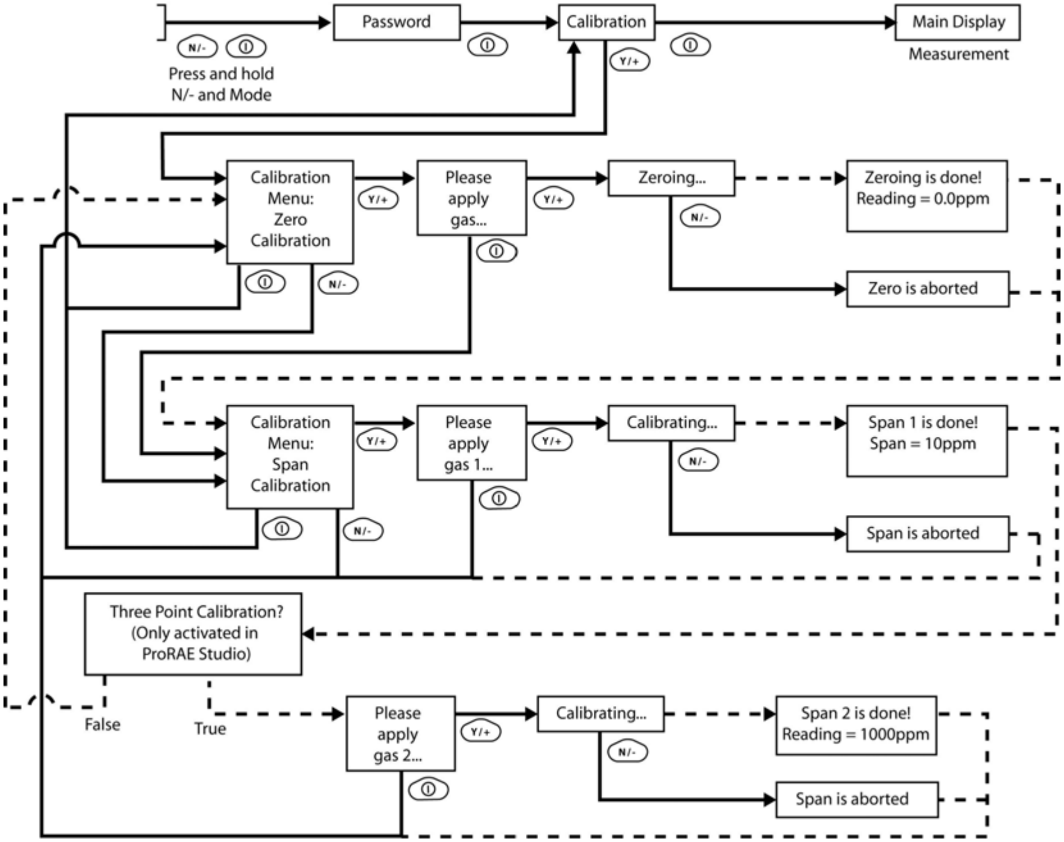
The instrument updates its settings and then returns to the main display. It begins or resumes monitoring.

20 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.

20.1 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.

20.2 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…

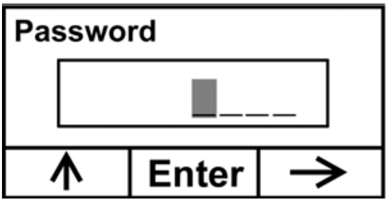
The instrument updates its settings and then returns to the main display. It begins or resumes monitoring.

21 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.

21.1 Entering Programming Mode

1. Press and hold [MODE] and [N/-] until you see the Password screen.



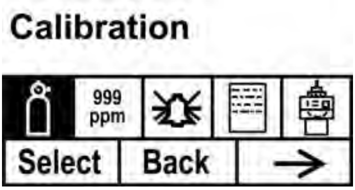
2. Input the 4-digit password:

- Increase the number from 0 through 9 by pressing [Y/+].
- Step from digit to digit using [N/-].
- Press [MODE] when you are done.

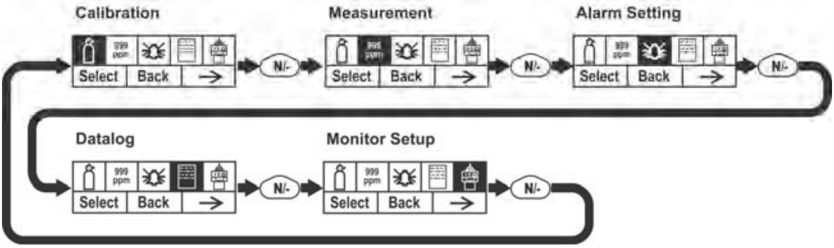
If you make a mistake, you can cycle through the digits by pressing [N/-] and then using [Y/+] to change the number in each position.

Note: The default password is 0000.

When you have successfully entered Programming Mode, you see this screen:



Note: The password can only be changed by connecting the instrument to a PC running ProRAE Studio 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.

22 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	Radio Power
Span Calibration	Meas. Unit	Low Alarm	Interval	Op Mode
	Tube Selection	STEL Alarm	Data Selection	Site ID
		TWA Alarm	Datalog Type	User ID
		Alarm Mode		User Mode
		Buzzer & Light		Date
				Time
				Pump Duty Cycle
				Pump Speed
				Temperature Unit
				Language
				Real Time Protocol
				Power On Zero
				Unit ID
				LCD Contrast
				Lamp ID

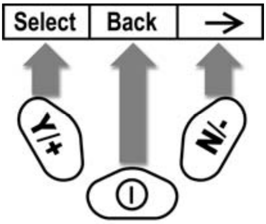
Once you enter Programming Mode, the LCD displays the first menu, Calibration. Each subsequent menu is accessed by pressing [N/-] repeatedly until the desired menu is displayed. To enter a sub-menu of a menu, press [Y/+].

22.1 Exiting Programming Mode

To exit Programming Mode and return to normal operation, press [MODE] once at any of the programming menu displays. You will see "Updating Settings…" as changes are registered and the mode changes.

22.2 Navigating Programming Mode Menus

Navigating through the Programming Mode menus is easy and consistent, using a single interface format of "Select," "Back" and "Next" at the top level. The three control buttons correspond to these choices as shown:



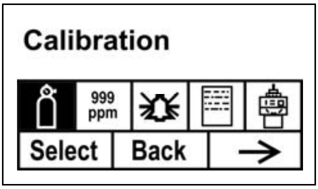
Note: Pressing [MODE] in the Programming Mode's top level causes the instrument to exit Programming Mode and return to monitoring.

The three keys perform the following functions in Programming Mode:

Key	Function in Programming Mode
[MODE]:	Exit menu when pressed momentarily or exit data entry mode
[Y/+]:	Increase alphanumerical value for data entry or confirm (yes) for a question
[N/-]:	Provides a "no" response to a question

22.3 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/+].

22.3.1 Zero Calibration

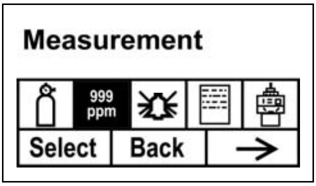
The procedure for performing a zero calibration is covered on page 49.

22.3.2 Span Calibration

The procedure for performing a basic span calibration is covered on page 49.

22.4 Measurement

The sub-menus for Measurement are Measurement Gas and Measurement Unit.



22.4.1 Meas. Gas

Measurement gases are organized in four lists:

- My List is a customized list of gases that you create. It contains a maximum of 10 gases and can only be built in ProRAE Studio 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 many of 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].

22.4.2 Meas. Unit

Standard available measurement units include:

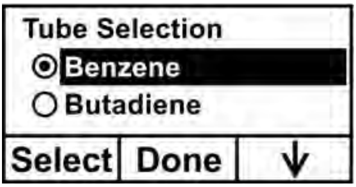
Abbreviation	**Unit**	**UltraRAE 3000**
ppm	parts per million	Yes
ppb	parts per billion	
mg/m3	milligrams per cubic meter	Yes
ug/m3	micrograms per cubic meter	

- 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].

22.4.3 Tube Selection

When operating the UltraRAE 3000 in Compound Specific mode, the internal computer works most effectively when it is told which type of separation tube is being used.



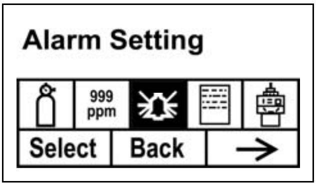
1. Scroll through the menu by pressing [N/-].
2. Press [Y/+] to make a selection.
3. Press [MODE] when you are done.
4. Press [Y/+] to save your choice or [N/-] to undo your selection.

22.5 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 42.

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 µg/m^3 (micrograms 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.

22.5.1 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.

22.5.2 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.

22.5.3 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.

22.5.4 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.

22.5.5 Alarm Mode

There are two selectable alarm modes:

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 mode to the other.
2. Press **[Y/+]** to select an alarm mode.

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.

22.5.6 Buzzer & Light

The buzzer and light alarms can be programmed to be on or off individually or in combination. Your choices are:

- Both on
- Light only
- Buzzer only
- Both off

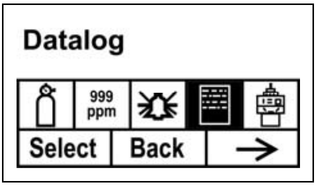
1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates your selection).
3. When you have completed your selections, press [MODE].

   You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

22.6 Datalog

The instrument calculates and stores the concentration and ID of each sample taken. In the datalog sub-menu, a user can perform the tasks and functions shown below.



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.

22.6.1 Clear Datalog

This erases all the data stored in the datalog.

Note: Once the datalog is cleared, the data cannot be recovered.

Press [Y/+] to clear the datalog. The display asks, "Are you sure?"

- Press [Y/+] if you want to clear the datalog. When it has been cleared, the display shows "Datalog Cleared!"
- Press [N/-] if you do not want to clear the datalog.

The display changes, and you are taken to the next sub-menu, Interval.

22.6.2 Interval

Intervals are shown in seconds. The default value is 60 seconds. The maximum interval is 3600 seconds.

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

When you have completed your selections, press [MODE].

You will see two choices: Save and Undo. You 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.

22.6.3 Data Selection

Data Selection allows you to select which types of data are stored and made available when you offload your datalog to a computer via ProRAE Studio 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.

22.6.4 Datalog Type

The instrument has three datalog types:

Auto	Default mode. Collects datalog information when the instrument is sampling.
Manual	Datalogging occurs only when the instrument's datalogging is manually started (see below for details).
Snapshot	Datalogs only during single-event capture sampling.

Note: You can only choose one datalog type to be active at a time.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].

You will see two choices: Save and Undo. You 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.

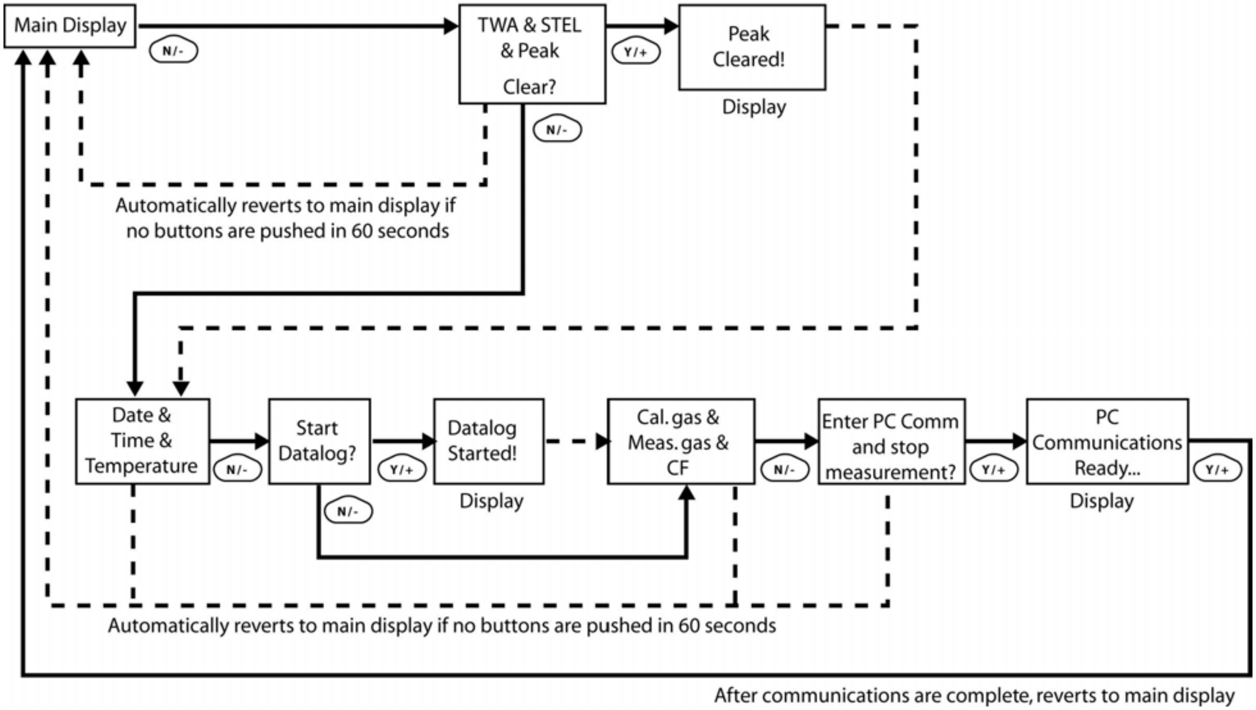
Press [N/-] to undo the changes and revert to the previous settings.

22.6.5 Manual Datalog

When the instrument is set to Manual Datalog, you turn datalogging on and off by stepping through the displays from the Main Display, and then pressing the keys to select datalog on/off functions.

- When you reach the screen that says "Start Datalog?" press [Y/+] to start it. You see "Datalog Started," confirming that datalogging is now on.

When you reach the screen that says "Stop Datalog?" press [Y/+] to stop it. You see "Datalog Stopped," confirming that datalogging is now off.



Note: Dashed line indicates automatic progression.

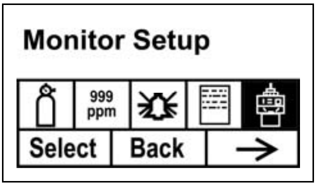
22.6.6 Snapshot Datalog

When the instrument is in Snapshot datalogging mode, it captures a single "snapshot" of the data at the moment of your choosing. Whenever the instrument is on and it is set to Snapshot, all you have to do is press [MODE] each time you want to capture a snapshot of the data at that instant.

When you send the data to a computer using ProRAE Studio, the data snapshots are uniquely identified by time and other parameters.

22.7 Monitor Setup

Many settings can be accessed in this menu, including setting the date and time and adjusting the pump's on/off duty cycle.



22.7.1 Radio Power

The radio connection can be turned on or off. (The default value is off.)

1. Press [N/-] to step from one option to the next (on or off).
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates that the option is selected).
3. When you have completed your selection, press [MODE].

- Press [Y/+] to accept the new radio setting (on or off).
- Press [N/-] to discard the change and move to the next sub-menu.

22.7.2 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).

22.7.3 Site ID

Enter an 8-digit alphanumeric/character Site ID in the programming mode. This Site ID is included in the datalog report.

1. Press [Y/+] and the display shows the current site ID. Example: "RAE00001." Note that the left-most digit flashes to indicate it is the selected one.
2. Press [Y/+] to step through all 26 letters (A to Z) and 10 numerals (0 to 9).
   Note: The last four digits must be numerals.
3. Press [N/-] to advance to the next digit. The next digit to the right flashes.

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.

22.7.4 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.

22.7.5 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.

22.7.6 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.

22.7.7 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.

22.7.8 Duty Cycle

The pump's duty cycle is the ratio of its on time to off time. The duty cycle ranges from 50% to 100% (always on; this is the default value), 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.

22.7.9 Temperature Unit

The temperature display can be switched between Fahrenheit and Celsius units.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the “radio button” indicates “on”).
3. When you have completed your selection, press [MODE].
   - Press [Y/+] to save the new temperature unit.
   - Press [N/-] to undo the change and move to the next sub-menu.

22.7.10 Pump Speed

The pump can operate at two speeds, high and low. Running at low speed is quieter and conserves a small amount of power. There is almost no difference in sampling accuracy.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the “radio button” indicates “on”).
3. When you have completed your selection, press [MODE].
   - Press [Y/+] to save the new temperature unit.
   - Press [N/-] to undo the change and move to the next sub-menu.

22.7.11 Language

English is the default language, but other languages can be selected for the instrument.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].
    - Press [Y/+] to save your new language choice.
    - Press [N/-] to undo it and return to the previous language selection.

22.7.12 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 (default). 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. Use this setting with a RAELink3.

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.

22.7.13 Power On Zero

When Power On Zero is on, the instrument is ready to perform 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.

22.7.14 Unit ID

This three-digit number keeps data separated by instrument when more than one instrument is used in a network. If multiple sensing units are attempting to communicate with the same Host, then the units must all have a different Unit ID.

1. Press [Y/+] to step through all 10 numerals (0 to 9). If you pass the numeral you want, keep pressing [Y/+]. After it counts up to 9, it starts counting up from 0 again.
2. Press [N/-] to advance to the next digit. The next digit to the right flashes.

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.

Note: If you are using an UltraRAE 3000 with a RAELink3, this unit ID is displayed by the RAELink3.

22.7.15 LCD Contrast

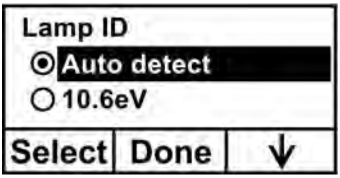
The display's contrast can be increased or decreased from its default setting. You may not need to ever change the default setting, but sometimes you can optimize the display to suit extreme temperature and ambient brightness/darkness conditions.

- The minimum value is 20.
- The maximum value is 60.

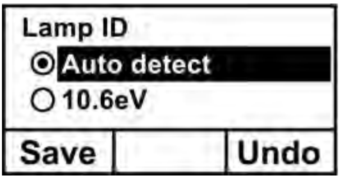
1. Press [Y/+] to increase the value or [N/-] to decrease the value.
2. Press [MODE] to save your selection.
   - Press [Y/+] to save your new contrast value.
   - Press [N/-] to undo it and return to the previous value.

22.7.16 Lamp ID

The UltraRAE can automatically identify the type of lamp, or you can select a lamp type manually.



1. Scroll through the menu by pressing [N/-].
2. Press [Y/+] to make a selection.
3. Press [MODE] when you are done.
4. Press [Y/+] to save your choice or [N/-] to undo your selection.



23 Humidity Compensation

The UltraRAE 3000 has a humidity sensor and humidity compensation circuitry. By default it is on, but it can be turned off or on by using ProRAE Studio software. RAE Systems recommends testing the humidity sensor once a year. See page 99 for the simple procedure.

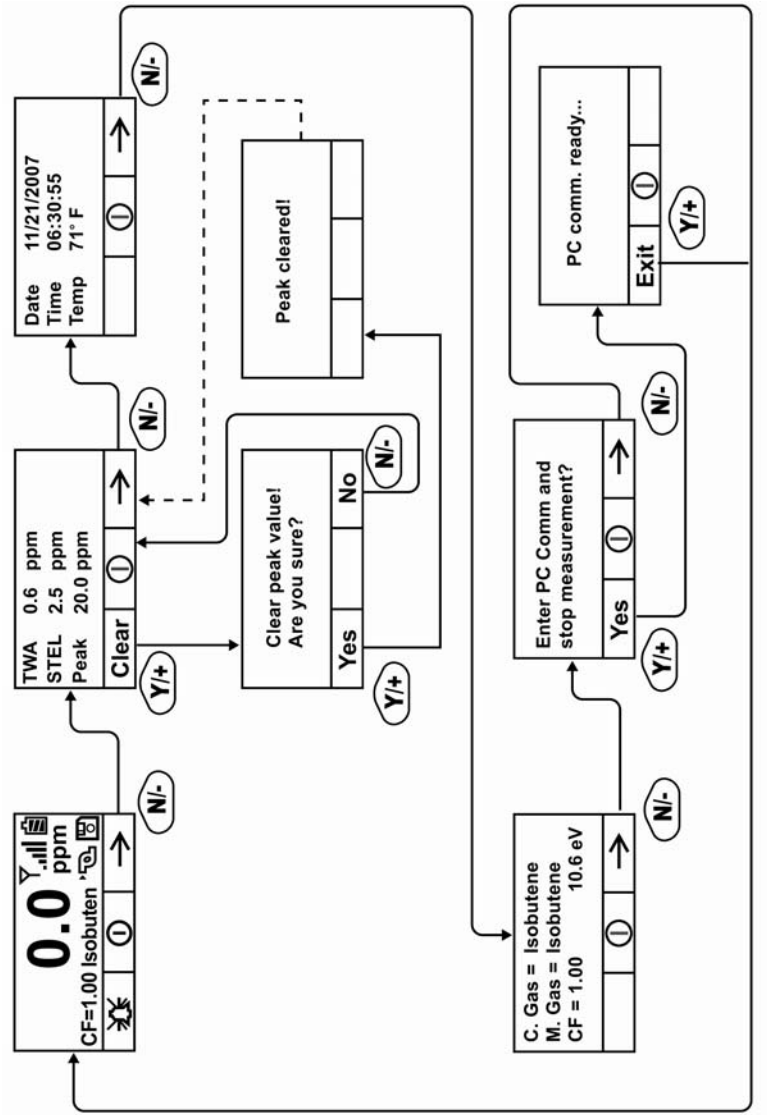
24 Hygiene Mode

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.

24.1 Basic User Level & Hygiene Mode

The default setting is navigated in the following way:



Note: Dashed line indicates automatic progression.

Pressing [N/-] steps you from screen to screen. Options include clearing the Peak value and turning on the instrument's PC Communications for data transfer to a PC.

24.2 Entering Search Mode From Hygiene Mode

In order to change the instrument's operational mode from Hygiene Mode to Search Mode, you must enter the password-protected Programming Mode:

1. Hold [MODE] and [N/-] until you see the password screen.
2. Use [Y/+] to increment to the number you want for the first digit. (If you pass by the desired number, press [Y/+] until it cycles through to 0 again. Then press [Y/+] until you reach the desired number.)
3. Press [N/-] to advance to the next digit.
4. Again press [Y/+] to increment the number.
5. Press [N/-] to advance to the next digit.

Continue the process until all four numbers of the password have been input. Then press [MODE] to proceed.

The screen changes to icons with the label "Calibration."

1. Press [N/-] to advance to "Monitor Setup."
2. Press [Y/+] to select Monitor Setup.

Under Monitor Setup, you will see "Op Mode."

Press [Y/+] to select.

You will see:

Hygiene
Search

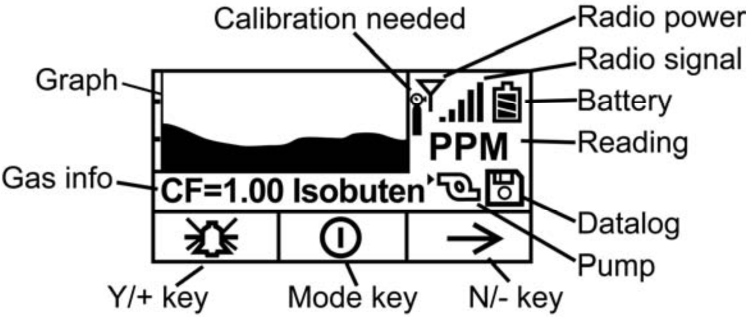
The current mode is indicated by a dark circle within the circle in front of either Hygiene or Search.

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).

24.3 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:

25 Advanced User Level (Hygiene Mode Or Search Mode)

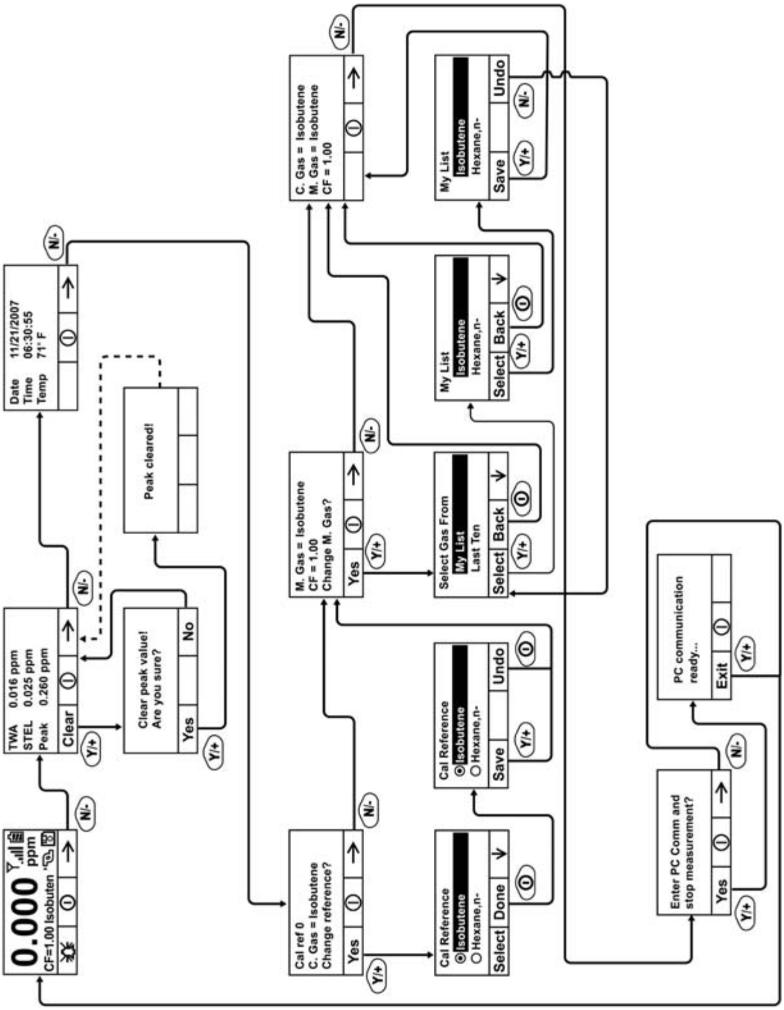
The User Mode called Advanced User Level allows a greater number of parameters to be changed than Basic User Level. It can be used with either of the Operation Modes, Hygiene Mode or Search Mode.

25.1 Advanced User Level & Hygiene Mode

With the instrument in Operation Mode: Hygiene Mode, enter User Mode: Advanced User Level (refer to the section called Monitor Mode for instructions).

Once you are in Advanced User Level and Hygiene Mode together, you can change the calibration reference and measurement gas, in addition to performing normal monitoring functions.

Pressing [N/-] progresses through the screens, while pressing [Y/+] selects options. Pressing [MODE] makes menu choices when it is shown for “Done” or “Back.” Pressing and holding [Mode] whenever the circle with a vertical line in the middle is shown activates the countdown to shutoff.

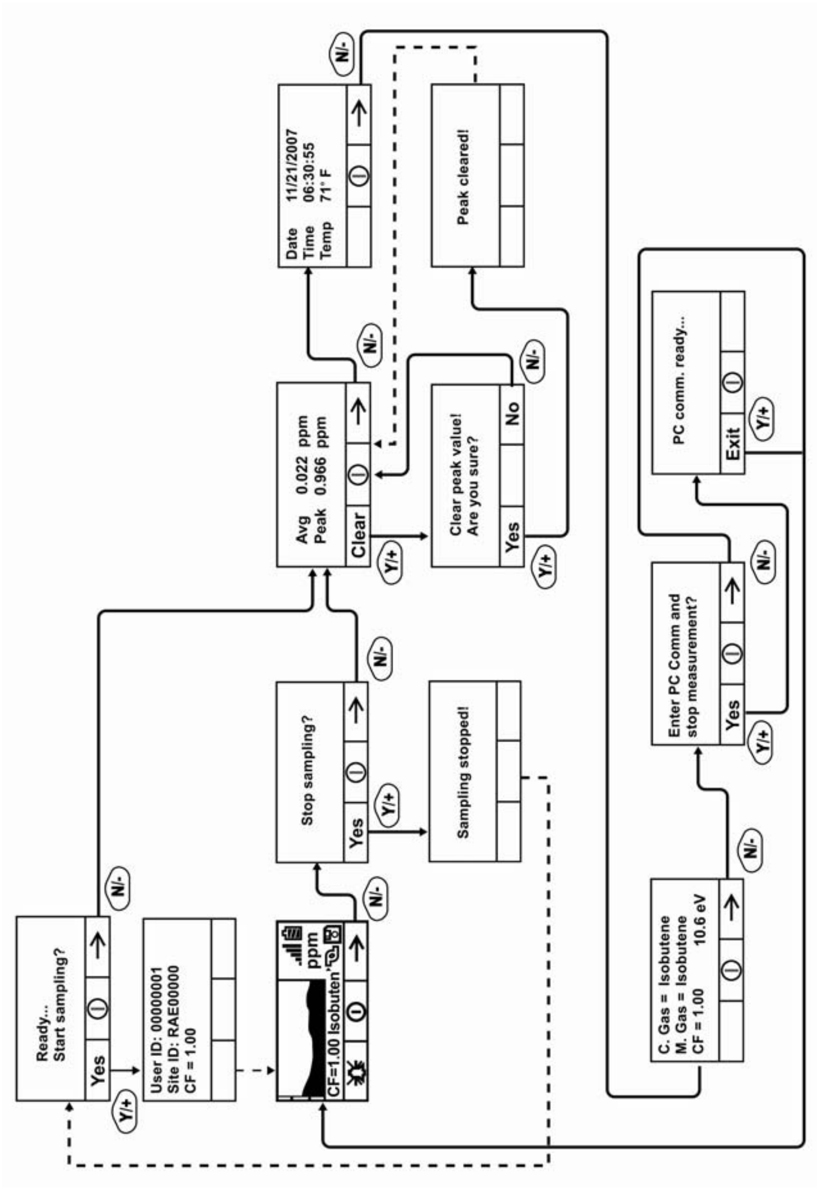


Note: Dashed line indicates automatic progression.

25.2 Basic User Level & Search Mode

With the instrument in Operation Mode: Search Mode, enter User Mode and select Basic User Level (refer to the section called User Mode for instructions).

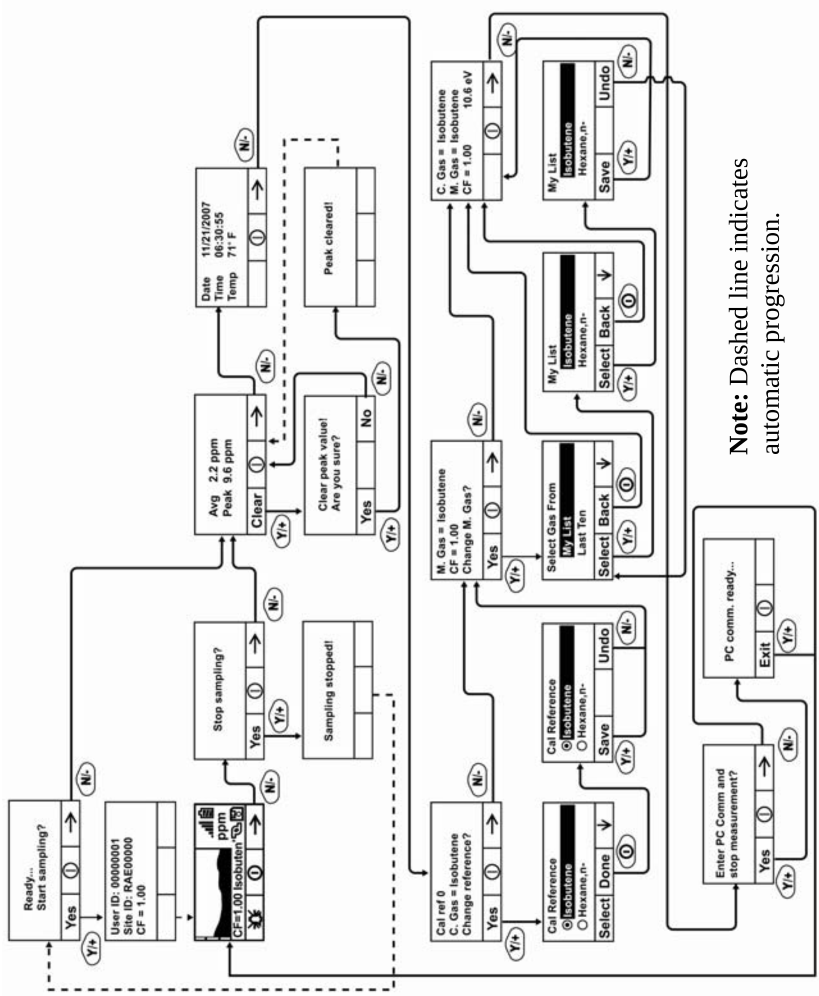
When the instrument is in Search Mode, it only samples when you activate sampling. When you see the display that says, “Ready…Start sampling?” press [Y/+] to start. The pump turns on and the instrument begins collecting data. To stop sampling, press [N/-] while the main display is showing. You will see a new screen that says, “Stop sampling?” Press [Y/+] to stop sampling. Press [N/-] if you want sampling to continue.



Note: Dashed line indicates automatic progression.

25.3 Advanced User Level & Search Mode

With the instrument in Operation Mode: Search Mode, enter User Mode and select Advanced User Level (refer to the section called Monitor Mode for instructions). Operation is similar to Basic User Level & Sampling Mode, but now allows you to change calibration and measurement reference gases. Refer to the section on measurement gases on page 65 for more details.



Note: Dashed line indicates automatic progression.

25.4 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.

25.4.1 Entering Diagnostic Mode

Note: To enter Diagnostic Mode, you must begin with the instrument turned off.

Press and hold [Y/+] and [MODE] until the instrument starts.

The instrument goes through a brief startup, and then displays raw data for the PID sensor. These numbers are raw sensor readings without calibration. The instrument is now in Diagnostic Mode.

Note: In Diagnostic Mode, the pump and lamp are normally on.

You can enter Programming Mode and calibrate the instrument as usual by pressing both [MODE] and [N/-] for three seconds.

You can enter Monitoring Mode by pressing [MODE] and [Y/+] together for three seconds.

Once the instrument is started up in Diagnostic Mode, you can switch between Diagnostic Mode and Monitoring Mode by pressing and holding [MODE] and [Y/+] simultaneously for two seconds.

In Diagnostic mode, you can step through parameter screens by pressing [MODE].

25.4.2 Adjusting The Pump Stall Threshold

If the gas inlet is blocked but the pump does not shut down, or the pump shuts down too easily with a slight blockage, the pump stall threshold value may be set too high or too low.

Use the following steps to adjust the pump stall threshold:

25.4.3 Pump High

In Diagnostic Mode, press the [MODE] key until "Pump High" is displayed. The display shows the maximum, minimum, and stall values for the pump at its high speed. Write down the "Max" reading.

Block the gas inlet and watch the pump current reading (labeled "I") increase. Write down its blocked reading. **Note:** If the pump current reading does not increase significantly (less than 10 counts), then there may be a leak in the gas inlet or the pump is weak or defective.

Add the two readings you wrote down. This is the average of the maximum block count and the maximum idle count. Divide that number by 2. Use the [Y/+] or [N/-] key to increase or decrease the stall value to equal that number.

Press the [MODE] key to exit this display.

25.4.4 Pump Low

In Diagnostic Mode, press the [MODE] key until "Pump Low" is displayed. The display shows the maximum, minimum, and stall values for the pump at its low speed. Write down the "Max" reading.

Block the gas inlet and watch the pump current reading (labeled "I") increase. Write down its blocked reading. **Note:** If the pump current reading does not increase significantly (less than 10 counts), then there may be a leak in the gas inlet or the pump is weak or defective.

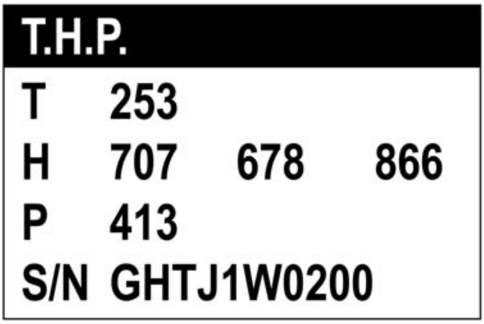
Add the two readings you wrote down. This is the average of the maximum block count and the maximum idle count. Divide that number by 2. Use the [Y/+] or [N/-] key to increase or decrease the stall value to equal that number.

Press the [MODE] key to exit this display.

25.4.5 Testing The Humidity Sensor

1. Press [MODE] to step through the diagnostic screens until you reach a screen that says “T.H.P” (for “temperature, humidity, pressure”) at the top.

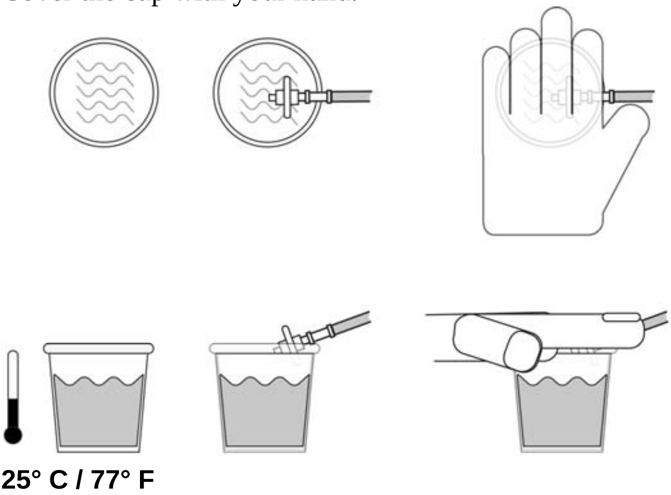
   There are three numbers for the humidity reading (“H”). The first number is the current humidity reading from the sensor. The second is the reference number for 0% humidity, and the third number is the reference for 100% humidity.



```
T.H.P.
T    253
H    707    678    866
P    413
S/N  GHTJ1W0200
```

2. Fill a cup with warm water (>25° C/77° F).
3. Put a filter on the UltraRAE 3000’s inlet probe.
4. Place the inlet probe over the warm water.

5. Cover the cup with your hand.



6. Wait a few seconds and check the high-humidity reading.
7. The humidity reading should be within ±10% of the 100% humidity reading. If it is not, then the THP Sensor (part number 023-3011-000-FRU) should be replaced.
8. Check the low-humidity reading by connecting the inlet probe to a tank of zero gas (air at 0% humidity).
9. Turn on the zero gas and wait a few seconds for the sensor reading to stabilize. It should read within 10% of the low-reference number. If it does not, replace the T.H.P. sensor.
10. Once you have finished testing the humidity sensor, exit Diagnostic Mode by shutting down the UltraRAE 3000 (hold [MODE] through the countdown, and then release when it is off).

25.4.6 Exiting Diagnostic Mode

You can exit Diagnostic Mode and go directly to Programming Mode or Monitor Mode as outlined above, or you can exit Diagnostic Mode completely.

To exit Diagnostic Mode so that it cannot be re-entered without a restart:

Shut down the instrument. When it is off, restart it by holding the [MODE] key. Diagnostic Mode cannot be entered until the instrument is restarted as outlined in “Entering Diagnostic Mode.”

26 Transferring Data To & From 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).

26.1 Downloading The Datalog To A PC

1. Connect the data cable to the PC and the cradle.
2. Place the instrument into its cradle. The charging LED should be illuminated.
3. Start ProRAE Studio 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.

26.2 Uploading Firmware To The instrument From A PC

Uploading new firmware to your instrument requires connecting the instrument and PC. Follow these steps to make the connection:

1. Connect the data cable to the PC and the cradle.
2. Place the instrument into its cradle. The charging LED should be illuminated.
3. Start RAEProgrammer 7000 on your PC.
4. From RAEProgrammer 7000, 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 RAEProgrammer 7000 and the firmware to upload the new firmware to your instrument.

Note: Check for the latest updates to ProRAEProgrammer 7000 at www.raesystems.com.

27 Maintenance

The major maintenance items of the instrument are:

- Battery pack
- Sensor module
- PID lamp
- Sampling pump
- Inlet connectors and filters

In addition, you can test the humidity sensor (this should be done annually, in order to ensure the most accurate operation).

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.**

27.1 Battery Charging & Replacement

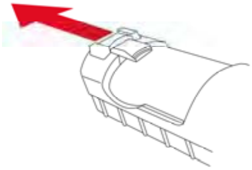
When the display shows a flashing empty battery icon, the battery requires recharging. It is recommended to recharge the instrument upon returning from fieldwork. A fully charged battery runs a instrument for 16 hours continuously. The charging time is less than 8 hours for a fully discharged battery. The battery may be replaced in the field (in areas known to be non-hazardous), if required.

WARNING!

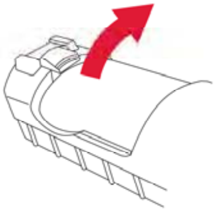
To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. **Remove and replace battery only in areas known to be non-hazardous.**

27.1.1 Replacing The Li-ion Battery

1. Turn off the instrument.
2. Located on the rear of the instrument is a battery tab. Slide it down to unlock the battery.



3. Remove the battery pack from the battery compartment by tilting it out.



4. Replace a fully charged spare battery pack inside the battery compartment. Make sure the battery pack is oriented properly inside the compartment.
5. Slide the capture tab back up to its locked position.

27.1.2 Replacing The Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500 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 hex-socket 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.

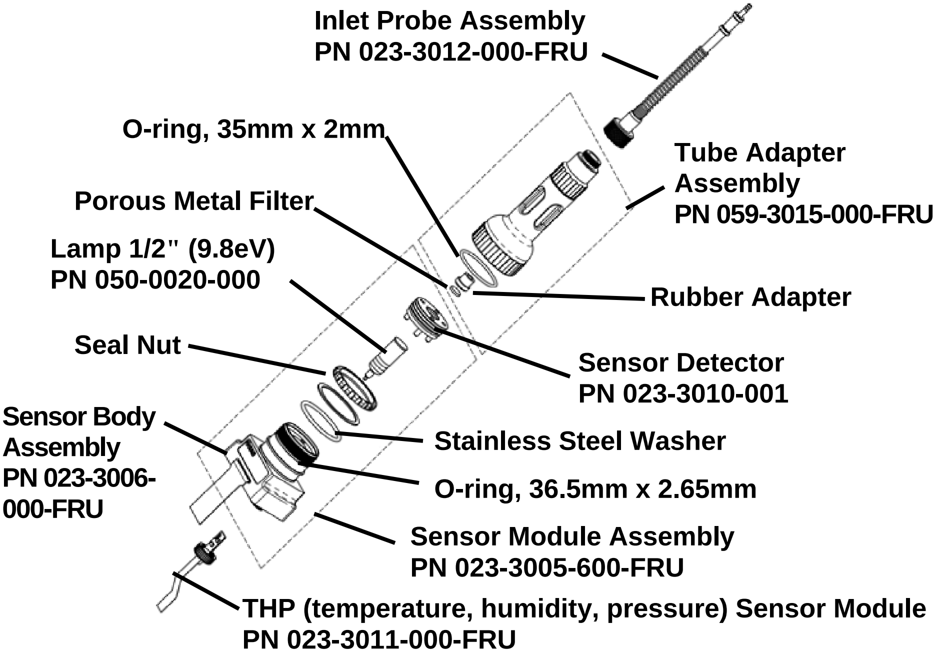
WARNING!

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.

27.2 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 if:

1. The reading is inaccurate even after calibration.
2. The reading is very sensitive to air moisture.
3. A 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.

Note: The 10.6eV lamp requires a Teflon O-ring. The 9.8eV and 11.7eV lamps do not require the O-ring.

27.3 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.

27.3.1 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.

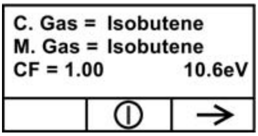
27.3.2 Determining The Lamp Type

The monitor can accommodate three lamp values: 10.6eV (standard), 9.8eV, and 11.7eV. The monitor automatically reads a marking on the side of the lamp to set the proper Correction Factor. There are two ways to determine the lamp type:

Remove the lamp and look for markings (bars) on the side:

- No bars: 10.6eV
- 1 bar: 11.7eV
- 2 bars: 9.8eV

Also, when the monitor is running, the lamp type is shown along with the calibration and measurement gas and Correction Factor:



C. Gas = Isobutene
M. Gas = Isobutene
CF = 1.00 10.6eV

Note: This screen can be accessed from the reading screen by pressing [N/-] four times.

27.3.3 Sampling Pump

When approaching the end of the specified lifetime of the pump, it will consume higher amount of energy and reduce its sample draw capability significantly. When this occurs, it is necessary to replace or rebuild the pump. When checking the pump flow, make sure that the inlet connector is tight and the inlet tubing is in good condition. Connect a flow meter to the gas inlet probe. The flow rate should be above 450 cc/min when there is no air leakage.

If the pump is not working properly, refer the instrument to qualified service personnel for further testing and, if necessary, pump repair or replacement.

27.3.4 Testing The T.H.P. Sensor

It is recommended that you periodically test the humidity sensitivity of the T.H.P. (temperature/humidity/pressure) sensor. See page 99 for a simple procedure.

27.3.5 Cleaning The Instrument

Occasional cleaning with a soft cloth is recommended. Do not use detergents or chemicals.

Visually inspect the contacts at the base of the instrument, on the battery, and on the charging cradle to make sure they are clean. If they are not, wipe them with a soft, dry cloth. Never use solvents or cleaners.

27.3.6 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/

27.4 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.

28 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

29 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

30 RAE Systems Contacts

RAE Systems
World Headquarters
3775 N. First St.
San Jose, CA 95134-1708 USA
Phone: +1 408.952.8200
Fax: +1 408.952.8480

E-mail: customerserv@raesystems.com
Web Site: www.raesystems.com

RAE Systems Technical Support
Monday through Friday, 7:00AM to 5:00PM Pacific Time
Phone: +1.408.952.8461
Email: tech@raesystems.com

Life-critical after-hours support is available:
+1.408.952.8200 select option 8

RAE Systems Europe ApS
Kirstinehøj 23 A
DK-2770 Kastrup
Denmark
Phone: +45 86 52 51 55
Fax: +45 86 52 51 77
orders@raeeurope.com
sales@raeeurope.com
service@raesystems.com
Web: www.raesystems.dk

RAE Systems UK Ltd
D5 Culham Innovation Centre
Culham Science Centre
Abingdon, Oxon OX14 3DB
United Kingdom
Phone: +44 1865408368
Fax: +44 1235531119
Mobile: +44 7841362693
Email: raeuk@raeeurope.com

RAE Systems France
336, rue de la fée des eaux
69390 Vernaison
France
Phone: +33 4 78 46 16 65
Fax: +33 4 78 46 25 98
Email: info-france@raeeurope.com
Web: www.raesystems.fr

RAE BeNeLux BV
Rijndal 20
2904 DC Capelle a/d IJssel
Phone: +31 10 4426149
Fax: +31 10 4426148
Email: info@rae.nl
Web: www.rae.nl

RAE Systems Spain, s.l.
Av. Remolar, 31
08820 El Prat de Llobregat
Spain
Phone: +34 933 788 352
Fax: +34 933 788 353
Mobile: +34 687 491 106
Email: mdelgado@raespain.com
Web: www.raespain.com

RAE Middle East
Lot 7, Ground Floor, Office 19
Jebel Ali Free Zone
Dubai
United Arab Emirates
Phone: +971 4 887 5562
Fax: +971 4 887 5563
Email: mjorgensen@raesystems.com

RAE Systems (Hong Kong) Ltd.
Room 8, 6/F, Hong Leong Plaza
33 Lok Yip Road
Fanling, N.T, Hong Kong
Phone: +852.2669.0828
Fax: +852.2669.0803
Email: hksales@raesystems.com

RAE Systems Japan
403 Plaza Ochanomizu Bldg. 2-1
Surugadai Kanda Chiyoda-Ku
Tokyo, Japan
Phone: 81-3-5283-3268
Fax: 81-3-5283-3275
Email: jpsales@raesystems.com

RAE Systems Korea
#1010, DaeMyungAnsVill First,
Sang-Dong 412-2, Wonmi-Gu, Bucheon,
Kyungki-Do, Korea
Phone: 82-32-328-7123
Fax: 82-32-328-7127
Email: krsales@raesystems.com

31 Regulatory Information

Intrinsic Safety:	US and Canada: Class I, Division 1, Group A, B, C, D Europe: ATEX (II 2G EEx ia IIC T4)
Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)

32 Basic Operation

32.1 Turning The Instrument On

1. With the instrument turned off, press and hold [MODE].
2. When the display turns on, release the [MODE] key.

The instrument is now operating and performs self tests. Once the self tests are complete, the display shows a graph or numerical gas reading. This indicates that the instrument is fully functional and ready to use.

32.2 Turning The Instrument Off

1. Press and hold the Mode key for 3 seconds. A 5-second countdown to shutoff begins.
2. When you see “Unit off...” release your finger from the [MODE] key. The instrument is now off.

Note: You must hold your finger on the key for the entire shutoff process. If you remove your finger from the key during the countdown, the shutoff operation is canceled and the instrument continues normal operation.

33 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.

33.1 Alarm Signal Summary

Message	**Condition**	**Alarm Signal**
HIGH	Gas exceeds "High Alarm" limit	3 beeps/flashes per second*
OVR	Gas exceeds measurement range	3 beeps/flashes per second*
MAX	Gas exceeds electronics' maximum range	3 beeps/flashes per second*
LOW	Gas exceeds "Low Alarm" limit	2 beeps/flashes per second*
TWA	Gas exceeds "TWA" limit	1 Beep/flash per second*
STEL	Gas exceeds "STEL" limit	1 Beep/flash per second*
Pump icon flashes	Pump failure	3 beeps/flashes per second

Lamp	PID lamp failure	3 beeps/flashes per second plus "Lamp" message on display
Battery icon flashes	Low battery	1 flash, 1 beep per minute plus battery icon flashes on display
CAL	Calibration failed, or needs calibration	1 beep/flash per second
NEG	Gas reading measures less than number stored in calibration	1 beep/flash per second

34 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

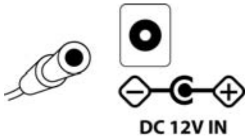
35 Charging The Battery

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.

ATEX WARNING!

To reduce the risk of electrostatic ignition, do not use the instrument without the rubber boot in place.

35.1 Low Voltage Warning

When the battery's charge falls below a preset voltage, the instrument warns you by beeping once and flashing once every minute, and the battery icon blinks once per second. You should turn off the instrument within 10 minutes and either recharge the battery by placing the instrument in its cradle, or replace the battery with a fresh one with a full charge.

35.2 Clock Battery

An internal clock battery is mounted on one of the instrument's printed circuit boards. This long-life battery keeps settings in memory from being lost whenever the Li-ion 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.

35.3 Replacing The Rechargeable Li-Ion Battery

Caution: Turn off the instrument before removing or replacing the battery.

35.4 Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500 or Energizer E91).

Do not mix old and new batteries or batteries from different manufacturers.

36 Troubleshooting

Problem	Possible Reasons & Solutions	
Cannot turn on power after charging the battery	**Reasons:**	Discharged battery. Defective battery.
	Solutions:	Charge or replace battery.
Lost password	**Solutions:**	Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
Reading abnormally High	**Reasons:**	Dirty filter. Dirty sensor module. Excessive moisture and water condensation. Incorrect calibration.
	Solutions:	Replace filter. Blow-dry the sensor module. Calibrate the unit.
Reading abnormally Low	**Reasons:**	Dirty filter. Dirty sensor module. Weak or dirty lamp. Incorrect calibration.
	Solutions:	Replace filter. Remove Calibration Adapter. Calibrate the unit. Check for air leakage.
Buzzer Inoperative	**Reasons:**	Bad buzzer.
	Solutions:	Check that buzzer is not turned off. Call authorized service center.

Inlet flow too low	**Reasons:**	Pump diaphragm damaged or has debris. Flow path leaks.
	Solutions:	Check flow path for leaks; sensor module O-ring, tube connectors, Teflon tube compression fitting. Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
"Lamp" message during operation	**Reasons:**	Lamp drive circuit. Weak or defective PID lamp, defective.
	Solutions:	Turn the unit off and back on. Replace UV lamp

RAE Systems
World Headquarters
3775 N. First St.
San Jose, CA 95134-1708 USA
Phone: 408.952.8200
Fax: 408.952.8480

E-mail: customerserv@raesystems.com
Web Site: www.raesystems.com

Rev. A
May 2008
P/N 059-4023-000

To run SAFER v. 9.0:

Steps 1-2 – only if you are using a removable drive to store your data, but not to run the program

1. Connect the removable drive to PC.
2. Copy the appropriate state folder (they can be identified by their two-letter USPS abbreviation) from the removable drive into C:/GISData/World/USA/. If you wish, you may copy only the counties that you’re interested in. The process is a *little* more involved, but possible with practice.

Steps 3-end – everyone.

3. Open the STAR Site Manager. RTSiteMan.exe
4. Create a new site by selecting the icon.
5. Name the site and proceed by clicking the icon.
6. To locate the site, left-click on the map (the icon should already be selected) near where the incident is located. The coordinates at the location where you click will appear at the bottom left of the screen. It is NOT critical at this stage to locate the site exactly. For best results, shoot for +/- 15 miles.
7. Copy the coordinates obtained in step 3 into the boxes at the top left of the screen. Select the coordinates, then right-click, select ‘copy;’ right-click and select ‘paste’ to paste the coordinates. (If an exact address is known, this may also be entered).
8. Once the coordinates have been selected, click the icon. This will bring up more detailed GIS data around the incident site.
9. Determine the exact location of the incident site by zooming (and icons) and panning (icon). Use the icon to determine names of places. After selecting the icon, simply mouse over the place of interest and hold the left-mouse button
10. After finding the exact incident site location, choose the icon, and select that location as the center of the map.
11. Click the icon.
12. Locate the weather station (the icon should already be selected) by clicking on the map.

13. Click the ➡ icon.
14. Select the surface roughness that you wish to use. Try to match the qualitative surface characteristics of the site. This parameter is most critical in an urban or dense forest environment.
15. Select the ✓ icon.
16. When back to the main screen, select the ✓ icon again. When prompted if you want to collect met/sen data, select "Yes."
17. This will bring you to the Launch Pad. Data Acquisition should start automatically. Start the Emergency Response program and click on the Stoplight icon, and model away!

Manual Met Notes:

a. Maximum solar radiation = 1000 W/. Take a fraction of this based on cloud cover.
b. Stability class can be estimated from wind speed, solar radiation (qualitative), and ceiling height.

FROM EPA's
"Meteorological Monitoring Guidance for Regulatory Modeling Applications"
(EPA-454/R-99-005, February, 2000)

Step 1.
Determine the "Net Radiation Index"

1. If the total cover is 10/10 and the ceiling is less than 7,000 feet, use net radiation index equal to 0 (whether day or night)
2. For **Nighttime**: (from one hour before sunset to one hour after sunrise):
   a. If total cloud cover ≤ 4/10, use net radiation index equal to -2.
   b. If total cloud cover > 4/10, use net radiation index equal to -1.
3. For **Daytime**
   a. Determine the insolation class number as a function of solar altitude from Table 1, below
   b. If total cloud cover ≤ 5/10, use the net radiation index in Table 2 corresponding to the insolation class number.
   c. If cloud cover > 5/10, modify the insolation class number using the following six steps.
      1.) Ceiling < 7,000 ft, subtract 2
      2.) Ceiling ≥ 7,000 ft, but < 160,000 ft, subtract 1
      3.) Total cloud cover equal to 10/10, subtract 1. (This will only apply to ceiling ≥ 7,000 ft since cases with 10/10 coverage below 7,000 ft are considered in item 1

above.)

4.) If insolation class number has not been modified by steps 1.), 2.) or 3.) above, assume modified class number equal to insolation class number.

5.) If modified insolation class number is less than 1, let it equal 1.

6.) Use the net radiation index in Table 6-4 corresponding to the modified insolation class number.

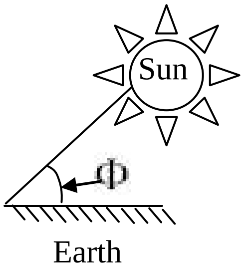


Table 1
Insolation Class as a Function of Solar Altitude

Solar Altitude Φ (degrees)	Insolation	Insolation Class Number
$60 < \Phi$	strong	4
$35 < \Phi \le 60$	moderate	3
$15 < \Phi \le 35$	slight	2
$\Phi \le 15$	weak	1

Table 2.
Turner's Key to the P-G Stability Categories

Wind Speed		Net Radiation Index						
(knots)	*(m/s)*	*4*	*3*	*2*	*1*	*0*	*- 1*	*- 2*
0,1	0 - 0.7	1	1	2	3	4	6	7
2,3	0.8 - 1.8	1	2	2	3	4	6	7
4,5	1.9 - 2.8	1	2	3	4	4	5	6
6	2.9 - 3.3	2	2	3	4	4	5	6
7	3.4 - 3.8	2	2	3	4	4	4	5
8,9	3.9 - 4.8	2	3	3	4	4	4	5
10	4.9 - 5.4	3	3	4	4	4	4	5
11	5.5 - 5.9	3	3	4	4	4	4	4
≥ 12	≥ 6.0	3	4	4	4	4	4	4

CENTER FOR TOXICOLOGY AND ENVIRONMENTAL HEALTH, L.L.C.

Toxicology Emergency Response Program (DATE)
STANDARD OPERATING PROCEDURE NO. ( )

SUBJECT: Data Collection and Management

Description of the SOP. This SOP describes record-keeping processes.

Key Personnel with Responsibility to Manage this Equipment.

Amanda Fincher

Calibration Instructions

1. All instrument calibrations are documented on CTEH Calibration Logs with the following information: date, time instrument identification, calibration gas/filter identification, user initials.

2. Calibration logs are stored together in project file.

Sampling Data Collection and Management Instructions

1. Laboratory Samples

a) Sample collection information is documented on CTEH field forms. Sampling information includes the following: date, time, location, sampler identification, and sample collection device information (if applicable).
   1) Sample collection forms are stored together in project file.
   2) Sample collection information is databased using Microsoft Access and/or summarized on sample collection maps made with ArcGIS.

b) Analysis requests are made on CTEH-prepared chains of custody (COCs). Copies of original COCs sent to the laboratory are stored together in the project file. The original COCs are also stored together in the project file, upon receipt from the laboratory.

c) Laboratory results are received in EDD format, in PDF format, and in hard copy data packets.
   1) EDDs and PDFs are stored in an electronic project folder. Hard copies are stored together in the project file.
   2) Laboratory results are compiled and databased using Microsoft Access and/or summarized on sample collection maps made with ArcGIS. Within the database and/or map summary, laboratory results are associated with sample collection information.

2. Instantaneous "Real-Time" Measurements

a) Manually-logged data
   1) Instantaneous measurements are documented on CTEH field forms or in bound notebooks. Information documented includes: date, time, location, instrument information, sample result, sampler observations, and sampler identification.

    2) Copies of measurements from notebooks are stored with field forms in the "real-time" section of the project file. Notebooks are stored together in the project file.
    3) Information from real-time forms and notebooks are databased using Microsoft Access.

b) Instrument-logged data
    1) Instrument information, location information, and general observations associated with instrument-logged data are documented either on CTEH real-time field forms or in bound notebooks. This information is filed in the same manner as manually-logged data.
    2) Instrument-logged data are downloaded from the instrument using the appropriate software. These data are then databased using Microsoft Access. Within the database, instrument-logged data are associated with sample collection information.
    3) Sample collection information is mapped using ArcGIS, and associated data are configured into graphs using SigmaPlot.

c) Radio-telemeted data
    1) Instrument information, location information, and observations are documented on CTEH field forms or in bound notebooks. This information is filed in the same manner as manually-logged data.
    2) Telemeted data are recorded using software associated with the transmitters. Stored data are backed up on a daily basis. These data are then databased using Microsoft Access. Within the database, instrument-logged data are associated with sample collection information.
    3) Sample collection information is mapped using ArcGIS, and associated data are configured into graphs using SigmaPlot.

CENTER FOR TOXICOLOGY AND ENVIRONMENTAL HEALTH, L.L.C.

Toxicology Emergency Response Program (June 15, 2011)
STANDARD OPERATING PROCEDURE NO. (1.0)

SUBJECT: MultiRAE Worker Exposure Monitoring

Description of the SOP. This SOP describes the use of the MultiRAE plus PID as a personal monitoring device for the collection of real-time worker exposure data.

Key Personnel with Responsibility to Manage this Operation.

Any environmental scientist or IH technician responsible for the collection of real-time worker exposure data using the MultiRAE plus PID.

MultiRAE Worker Exposure Preparation Instructions

1. Calibration

a) Please follow the CTEH MultiRAE plus PID Standard Operating Procedures Version 1.1, latest version.

2. Equipment Preparation

a) Connect a 3-4 ft piece of Teflon® tubing using RAE approved connectors to the MultiRAE inlet. Connect the Teflon® tubing directly to the MultiRAE, do not connect to the water-trap.
b) Install a water-trap to the inlet end of the Teflon® tubing. Ensure that the inlet of the Teflon® tubing is equipped with a connection device that can be clipped to the worker's lapel or clothing in the breathing zone.

3. Instrument Set-Up

a) Ensure that the MultiRAE is ***NOT*** *in Diagnostics Mode.*
b) Set up the MultiRAE to data-log at the appropriate data-log interval. If no specific data-log interval is desired, use the ***5-minute interval****.*
c) Ensure that the MultiRAE reflects the correct ***DATE and Time (time zone where sample will be collected).***
d) Ensure that the appropriate sensors are enabled for data-log. Additionally, ensure that irrelevant sensors are disabled.

4. Instrument Installation on Worker

a) Clip the calibrated MultiRAE onto the belt of the worker. If no belt is available or the worker is wearing chemical or flame-resistant protective clothing, use an auxiliary belt on the outside of the chemical or flame-resistant protective clothing.
b) Going across the worker's back, locate the Teflon® tubing inlet in the worker's breathing zone, clipping the inlet to the worker's lapel or clothing.
c) Ensure that the inlet is located on the outside of any clothing, vest, or other material that may block the inlet from drawing air from the worker's breathing zone.

Sampling Data Sheet Instructions

1. Use an appropriate field data sheet prior to deploying the MultiRAE to collect worker exposure data. The data sheet should capture the following information:

a) CTEH Project Number
b) MultiRAE Instrument Serial Number
c) Calibration Information (specifically the: calibration date, calibration gas type, calibration gas lot number, calibration gas expiration date.)
d) Worker's Full Name, Contact Information, and Company Information,
e) Worker's Job Task,
f) Worker's Work Site Location Information,
g) Sample Information for Co-located samples (i.e. 3M 3500 badge information, sample ID, etc…),
h) Start Date and Time,
i) Stop Date and Time,
j) Worker's Smoking Habit,
k) Other Potential Cross-Contamination Sources (i.e. bug spray, cologne, hand sanitizer etc…)
l) Sampler's Name and Contact Information

Post-Sampling Event Collection of MultiRAE and Data Processing

1.At the end of the worker's job task or work shift, collect the MultiRAE from the worker:

2.Conduct an end of shift interview with the employee to gather information related to work shift activities

3. Immediately download the MultiRAEs data-logged data using ProRAE suite. Save the data file in the appropriate project folder location.

4. Replace the MultiRAEs batteries and prepare the instrument for subsequent use of the device.

CENTER FOR TOXICOLOGY AND ENVIRONMENTAL HEALTH, L.L.C.

Toxicology Emergency Response Program (6/17/08)
STANDARD OPERATING PROCEDURE NO. (Version 1.1)

SUBJECT: MultiRAE Plus

Description of the SOP. This SOP describes the set-up and use of the MultiRAE Plus.

Calibration Instructions: Calibration should be done at least once a shift.

To get to Calibration Screen

1) Turn on MultiRAE by pressing and holding the MODE button. Wait for the instrument to warm up.
2) To get to the calibration screen press the MODE and "No" buttons at the same time. Hold until screen says "Calibrate Monitor", press Y/+.
3) When the message "Fresh Air Calibration?" appears, make sure before pressing Y/+ you have either a fresh air environment or are using zero grade air. When calibrating sensors for the first time, do not Fresh Air calibrate.

For Multiple Sensor Calibration

1) To calibrate multiple sensors at the same time in the MulitRAE, select Y/+ at the multiple sensor calibration screen.
2) To accept these chemicals for multiple sensor calibration, press Y/+
3) To change the chemicals for the multiple sensor calibration, press N/- at the "OK?" screen
4) The "Pick" screen will appear. To choose other sensors, press MODE scroll from one sensor to the next and press Y/+ to select a sensor and N/- to deselect a sensor.
5) An asterisk (*****) will appear by the sensors that are selected to be calibrated with the multiple sensor calibration.
6) The instrument will recognize the Calibration gas and begin counting down from 59 seconds.
7) After 59 seconds, the instrument will show "Calibration Complete"

NOTE: Quad gas allows for the calibration of CO, H_2S, O_2, and LEL.

For Single Sensor Calibration

1) To calibrate single sensors, select y/+ at the single sensor calibration screen.
2) Use the MODE button to navigate between sensors. Press Y/+ to select the sensor.

3) After pressing Y/+ on the VOC sensor, the MultiRAE will ask you to Apply Gas = Isobutylene.
4) When you apply the calibration gas to MultiRae, it will begin a countdown from 59 sec.
5) At the end of the 59 sec., the instrument will show “Calibration Complete, Turn off cal gas”

NOTE: The MultiRae is set to calibrate to a specific concentration of calibration gas. For each sensor, the calibration gas and concentration will be different.

Using a Different Calibration Gas: If you need to calibrate your instrument with a calibration gas that is not sold to you by Rae Systems, you will need to check the span gas value which should equal concentration of the calibration gas.

1) To modify span gas value, press Y/+ when the “Modify Span Gas Value” screen appears.
2) Use the MODE button to scroll from digit to digit and the Y/+ and N/- buttons to adjust values.
3) Before calibration, the span gas values need to represent the calibration gas concentrations.

Bump Calibration: This is done to check a sensor’s function; this does not take the place of a standard calibration.

1) Can be done in either diagnostic mode in the raw screen or in standard mode in the readings screen.

2) Attach the calibration gas that coincides with that sensor to the MultiRAE

3) Expose the instrument to the gas (example: isobutylene to check VOCs)

4) Watch the readings and make sure they reach the correct value. (RAW values have an acceptable range. The ranges for the most commonly used sensors will be provided at the end of the SOP)

NOTE: Always record a calibration in the calibration log, there will be an example form at the end of the SOP.

NOTE: Always calibrate the instrument in the environment it will be used in. If there is too large a change in humidity and temperature, the instrument will not react properly

NOTE: There are special case calibrations for some sensors.
Example: HCl and HF sensors. These sensors have a 4 minute calibration time.

NOTE: Some sensors need to be “burned in” for a period before fully operable.
Example: Cl2, HCL, HF, NO, NH3 sensors: There “burn in” periods are recommended to be between 12-24 hours.

Equipment Use Instructions (step by step)

Battery Replacement and Monitor Start Up

1) Remove the water trap, if applicable, from the inlet. (replace water trap if there is visible dirt or it has been in humid environment)
2) Remove the instrument from its casing.
3) Loosen the screws on the backside of the instrument and remove the front cover.
4) Replace the batteries, and screw the cover back on.
5) Press and hold the mode button until the monitor comes on.
6) Place the instrument back into its protective cover and put the water trap back on unless you are using chemical sensors which call for the water trap to be left off (see MultiRAE handbook for list of sensors).
7) Allow the MultiRAE to go through its startup procedures.

User Mode- Main Screen Menus

1) While the Instrument is showing readings, press MODE to scroll through the main screens.
2) Press MODE once to view the PEAK value.
3) Press MODE again to view the MINIMUM value.
4) Press MODE again for the STEL values. STEL values are only shown for TOX1, VOC, and TOX2.
5) Press MODE again for TWA values. TWA values are also only shown for TOX1, VOC, and TOX2.
6) Press MODE again to view the Battery Power screen.
7) Press Mode once again to view the Date, Time, Temperature, and Time the instrument was turned on.
8) Pressing MODE again will take you to the “Start Datalog?” Screen. Press Y/+ to Start Datalog then the screen will display Stop Datalog. When you stop the datalog, this will complete one event.
9) Press mode once to view the LEL gas= screen. This tells you what calibration gas your LEL is set.
10) Press MODE once more to view the calibration gas to which the PID is set.
11) Press MODE again for the “Print Reading?” Screen.
12) Press MODE again for the “Communicate with PC?” screen. To download information off of the Multi Rae to your computer, press Y/+.

Program Mode - to go into Program Mode, PRESS and HOLD MODE and N/- for 5 seconds. (It is sometimes easier to hold the N/- button first then hold MODE)

Change Alarm Limits

1) All sensors come from Rae Systems with a default alarm limit.
2) These limits can be found in the “Change Alarm Limits” screen on the Multi Rae.
3) Press mode and no at the same time. Use the mode button to scroll through the menu.
4) When the “Change Alarm Limits” screen appears, select Y/+.
5) You will have the option of changing the High alarm, Low alarm, STEL alarm, and the Average alarm limits.
6) Press N/- to scroll to the Alarm limit that you would like to change.
7) Select Y/+ on the alarm limit that you intend to change.
8) Use the MODE button to scroll from digit to digit and the Y/+ and N/- buttons to select digits.
9) To save your changes, hold down the MODE button.

Change Real Time Clock

1) Hit MODE when the command Monitor Setup? appears on the screen.
2) Select “Change Real Time Clock?” to adjust the date and time showing on the MultiRae, then use Y/+ and N/- to adjust the time.

NOTE: ALWAYS do this, and double check it, before you start a datalog.

View or Change Datalog

1) Press MODE and N+/ at the same time. Scroll through the menu by pressing the MODE button.
2) To view or change the Datalog function, press Y/+ at the “View or Change Datalog?” screen.
3) The first option will be to “Clear all Data?”
4) Select Y/+ to clear all of the data in the datalog memory.
5) The next option is to “Reset the Peak and Minimum?”
6) When you select Y/+ to “Reset the Peak and Minimum?” the Multi Rae will prompt “Are you sure?”
7) Select Y/+ to reset your values that you see when scrolling the main menu.
8) The next option is to Enable/Disable datalog? If a * is displayed next to a sensor name, data will be recorded. Use mode to move from sensor to sensor. An asterisk (*) means

the sensor is enabled; no asterisk means the sensor is disabled. Press Y/+ to select, and N/- to deselect. To save changes, press MODE until Save? appears. Then press Y/+ to accept. Otherwise, hold MODE to escape and cancel changes.

NOTE: Do not datalog an instrument that is in diagnostic mode, it will record RAW values. Always restart first then begin datalog.

Change Backlight

1) You can change the backlight mode by pressing Y/+ at the "Change Backlight Mode?" screen.
2) To turn on the backlight, hold the N/- button down.

Change Pump Speed

1) To change Pump Speed continue until Change Pump Speed? appears on screen. Press Y+/ or N+/ to change speed different than what it is previously set. Once you determine which speed you prefer then hold the Y+/ to save.
2) Low pump speed- (default) used when operating conditions that are slow to change, prolongs pump motor life, LEL sensor life and battery run time.
3) High pump speed- use for long lengths of tubing or when rapid changes in input conditions are expected, such as HazMat response or when used for measuring heavy, low vapor pressure compounds like jet fuel.

NOTE: Make sure to note it somewhere on an equipment tag when you have changed the pump speed from a default setting, include your initials and date

NOTE: When using tubing as an extension, we must use Teflon tubing. Tygon tubing readily absorbs volatiles, especially benzene.

Sensor Configuration

1) Hit MODE and N/+ at the same time.
2) Change LEL/VOC Gas Selection?
3) Enable/Disable Sensors?
4) Sensors have assigned sockets. These are identified on the PCB. High bias toxic in socket 1/A.
5) Change PID Lamp Type? This only applies to PID monitors. The PID sensor can utilize either a 10.6 eV or an 11.7 eV UV. Since each lamp type has a different correction factor table, it is important to select the correct lamp type.

NOTE: 11.7 lamps have a much shorter lifespan, be aware of the expiration date and leave Tiffani a note when you mobilize with them.

Using the MultiRAE

1) After recognizing your chemical of concern, look in the technical and application notes and locate the correction factor for that chemical that corresponds with the lamp in your MultiRAE
2) When two or more chemicals of concern need to be monitored, a general rule of thumb is to use the highest correction factor and the chemical with the lowest PEL for action level purposes.

NOTE: Correction factors are very important, for both the VOC and LEL sensors. Look through both TN-106 (PID) and TN-156 (LEL).

NOTE: The new NH3 sensors are un-biased. However the NO sensors are still high-bias.

How to clean a lamp

1) Acquire a lamp cleaning kit. Make sure it includes cotton swabs, methanol, tweezers. Gloves can be found in the ER GO BAG if there are none in the kit.
2) Remove the front cover from the instrument.
3) Remove the metal casing from the PID using the tweezers and wearing gloves. Set it aside.
4) Using the tweezers carefully remove the top of the PID housing, it is usually fairly secure, do not use too much force. Set it aside.
5) Carefully remove the lamp from the base, and securely hold it while you swab with cotton soaked in the methanol. Be careful not to allow cotton fibers to stick to the lamp.
6) Give the lamp a few seconds to dry, then place back into base.
7) Carefully swab the metal screen in the top of the PID housing, and give it a few seconds to dry before replacing.
8) Replace metal casing. If it appears dirty, swab with methanol also.
9) Replace cover on the instrument.

NOTE: If replacing an expired or faulty lamp, please place the old lamp in box the new lamp came out of. Mark the box with the serial number and date removed, and return to Tiffani. It may not have expired yet and be available for replacement.

NOTE: Other than lamp cleaning/replacement or sensor changes, do not manipulate the other components within the instrument. Red tag the unit and return to Tiffani.

Additional media needed for this equipment: (i.e. calibration gas or chemcassettes)

MultiRAE technical and application notes; MultiRAE users manual

Calibration gases appropriate to the sensors being used.

Lamp cleaning kit.

Notification Procedures for Equipment Failure (i.e. Rae Systems tech support number and CTEH contact)

RAE Systems 408.723.4800 CTEH- Equipment Room Manager 801.501.8580

RED TAG inoperable equipment properly, example following SOP

References and Further Assistance

Review Date for this SOP

Nathan Williams 4/12/2011

Attachments

Excerpt from TN-123
Calibration Log example
Red Equipment Tag example

CENTER FOR TOXICOLOGY AND ENVIRONMENTAL HEALTH, L.L.C.

Toxicology Emergency Response Program (June 15, 2011)
STANDARD OPERATING PROCEDURE NO. (1.0)

SUBJECT: MultiRAE Worker Exposure Monitoring

Description of the SOP. This SOP describes the use of the MultiRAE plus PID as a personal monitoring device for the collection of real-time worker exposure data.

Key Personnel with Responsibility to Manage this Operation.

Any environmental scientist or IH technician responsible for the collection of real-time worker exposure data using the MultiRAE plus PID.

MultiRAE Worker Exposure Preparation Instructions

1. Calibration

a) Please follow the CTEH MultiRAE plus PID Standard Operating Procedures Version 1.1, latest version.

2. Equipment Preparation

a) Connect a 3-4 ft piece of Teflon® tubing using RAE approved connectors to the MultiRAE inlet. Connect the Teflon® tubing directly to the MultiRAE, do not connect to the water-trap.
b) Install a water-trap to the inlet end of the Teflon® tubing. Ensure that the inlet of the Teflon® tubing is equipped with a connection device that can be clipped to the worker's lapel or clothing in the breathing zone.

3. Instrument Set-Up

a) Ensure that the MultiRAE is ***NOT*** *in Diagnostics Mode.*
b) Set up the MultiRAE to data-log at the appropriate data-log interval. If no specific data-log interval is desired, use the ***5-minute interval****.*
c) Ensure that the MultiRAE reflects the correct ***DATE and Time (time zone where sample will be collected).***
d) Ensure that the appropriate sensors are enabled for data-log. Additionally, ensure that irrelevant sensors are disabled.

4. Instrument Installation on Worker

a) Clip the calibrated MultiRAE onto the belt of the worker. If no belt is available or the worker is wearing chemical or flame-resistant protective clothing, use an auxiliary belt on the outside of the chemical or flame-resistant protective clothing.
b) Going across the worker's back, locate the Teflon® tubing inlet in the worker's breathing zone, clipping the inlet to the worker's lapel or clothing.
c) Ensure that the inlet is located on the outside of any clothing, vest, or other material that may block the inlet from drawing air from the worker's breathing zone.

Sampling Data Sheet Instructions

1. Use an appropriate field data sheet prior to deploying the MultiRAE to collect worker exposure data. The data sheet should capture the following information:

- *a)* CTEH Project Number
- *b)* MultiRAE Instrument Serial Number
- *c)* Calibration Information (specifically the: calibration date, calibration gas type, calibration gas lot number, calibration gas expiration date.)
- *d)* Worker's Full Name, Contact Information, and Company Information,
- *e)* Worker's Job Task,
- *f)* Worker's Work Site Location Information,
- *g)* Sample Information for Co-located samples (i.e. 3M 3500 badge information, sample ID, etc…),
- *h)* Start Date and Time,
- *i)* Stop Date and Time,
- *j)* Worker's Smoking Habit,
- *k)* Other Potential Cross-Contamination Sources (i.e. bug spray, cologne, hand sanitizer etc…)
- *l)* Sampler's Name and Contact Information

Post-Sampling Event Collection of MultiRAE and Data Processing

1.At the end of the worker's job task or work shift, collect the MultiRAE from the worker:

2.Conduct an end of shift interview with the employee to gather information related to work shift activities

3. Immediately download the MultiRAEs data-logged data using ProRAE suite. Save the data file in the appropriate project folder location.

4. Replace the MultiRAEs batteries and prepare the instrument for subsequent use of the device.

CENTER FOR TOXICOLOGY AND ENVIRONMENTAL HEALTH, L.L.C.

Toxicology Emergency Response Program (6/17/08)
STANDARD OPERATING PROCEDURE NO. (Version 1.1)

SUBJECT: MultiRAE Plus

Description of the SOP. This SOP describes the set-up and use of the MultiRAE Plus.

Calibration Instructions: Calibration should be done at least once a shift.

To get to Calibration Screen

1) Turn on MultiRAE by pressing and holding the MODE button. Wait for the instrument to warm up.
2) To get to the calibration screen press the MODE and "No" buttons at the same time. Hold until screen says "Calibrate Monitor", press Y/+.
3) When the message "Fresh Air Calibration?" appears, make sure before pressing Y/+ you have either a fresh air environment or are using zero grade air. When calibrating sensors for the first time, do not Fresh Air calibrate.

For Multiple Sensor Calibration

1) To calibrate multiple sensors at the same time in the MulitRAE, select Y/+ at the multiple sensor calibration screen.
2) To accept these chemicals for multiple sensor calibration, press Y/+
3) To change the chemicals for the multiple sensor calibration, press N/- at the "OK?" screen
4) The "Pick" screen will appear. To choose other sensors, press MODE scroll from one sensor to the next and press Y/+ to select a sensor and N/- to deselect a sensor.
5) An asterisk (*****) will appear by the sensors that are selected to be calibrated with the multiple sensor calibration.
6) The instrument will recognize the Calibration gas and begin counting down from 59 seconds.
7) After 59 seconds, the instrument will show "Calibration Complete"

NOTE: Quad gas allows for the calibration of CO, H_2S, O_2, and LEL.

For Single Sensor Calibration

1) To calibrate single sensors, select y/+ at the single sensor calibration screen.
2) Use the MODE button to navigate between sensors. Press Y/+ to select the sensor.

3) After pressing Y/+ on the VOC sensor, the MultiRAE will ask you to Apply Gas = Isobutylene.
4) When you apply the calibration gas to MultiRae, it will begin a countdown from 59 sec.
5) At the end of the 59 sec., the instrument will show “Calibration Complete, Turn off cal gas”

<u>NOTE:</u> The MultiRae is set to calibrate to a specific concentration of calibration gas. For each sensor, the calibration gas and concentration will be different.

<u>Using a Different Calibration Gas:</u> If you need to calibrate your instrument with a calibration gas that is not sold to you by Rae Systems, you will need to check the span gas value which should equal concentration of the calibration gas.

1) To modify span gas value, press Y/+ when the “Modify Span Gas Value” screen appears.
2) Use the MODE button to scroll from digit to digit and the Y/+ and N/- buttons to adjust values.
3) Before calibration, the span gas values need to represent the calibration gas concentrations.

<u>Bump Calibration:</u> This is done to check a sensor’s function; this does not take the place of a standard calibration.

1) Can be done in either diagnostic mode in the raw screen or in standard mode in the readings screen.

2) Attach the calibration gas that coincides with that sensor to the MultiRAE

3) Expose the instrument to the gas (example: isobutylene to check VOCs)

4) Watch the readings and make sure they reach the correct value. (RAW values have an acceptable range. The ranges for the most commonly used sensors will be provided at the end of the SOP)

<u>NOTE:</u> Always record a calibration in the calibration log, there will be an example form at the end of the SOP.

<u>NOTE:</u> Always calibrate the instrument in the environment it will be used in. If there is too large a change in humidity and temperature, the instrument will not react properly

<u>NOTE:</u> There are special case calibrations for some sensors.
Example: HCl and HF sensors. These sensors have a 4 minute calibration time.

<u>NOTE:</u> Some sensors need to be “burned in” for a period before fully operable.
Example: Cl2, HCL, HF, NO, NH3 sensors: There “burn in” periods are recommended to be between 12-24 hours.

Equipment Use Instructions (step by step)

Battery Replacement and Monitor Start Up

1) Remove the water trap, if applicable, from the inlet. (replace water trap if there is visible dirt or it has been in humid environment)
2) Remove the instrument from its casing.
3) Loosen the screws on the backside of the instrument and remove the front cover.
4) Replace the batteries, and screw the cover back on.
5) Press and hold the mode button until the monitor comes on.
6) Place the instrument back into its protective cover and put the water trap back on unless you are using chemical sensors which call for the water trap to be left off (see MultiRAE handbook for list of sensors).
7) Allow the MultiRAE to go through its startup procedures.

User Mode- Main Screen Menus

1) While the Instrument is showing readings, press MODE to scroll through the main screens.
2) Press MODE once to view the PEAK value.
3) Press MODE again to view the MINIMUM value.
4) Press MODE again for the STEL values. STEL values are only shown for TOX1, VOC, and TOX2.
5) Press MODE again for TWA values. TWA values are also only shown for TOX1, VOC, and TOX2.
6) Press MODE again to view the Battery Power screen.
7) Press Mode once again to view the Date, Time, Temperature, and Time the instrument was turned on.
8) Pressing MODE again will take you to the “Start Datalog?” Screen. Press Y/+ to Start Datalog then the screen will display Stop Datalog. When you stop the datalog, this will complete one event.
9) Press mode once to view the LEL gas= screen. This tells you what calibration gas your LEL is set.
10) Press MODE once more to view the calibration gas to which the PID is set.
11) Press MODE again for the “Print Reading?” Screen.
12) Press MODE again for the “Communicate with PC?” screen. To download information off of the Multi Rae to your computer, press Y/+.

Program Mode - to go into Program Mode, PRESS and HOLD MODE and N/- for 5 seconds. (It is sometimes easier to hold the N/- button first then hold MODE)

Change Alarm Limits

1) All sensors come from Rae Systems with a default alarm limit.
2) These limits can be found in the “Change Alarm Limits” screen on the Multi Rae.
3) Press mode and no at the same time. Use the mode button to scroll through the menu.
4) When the “Change Alarm Limits” screen appears, select Y/+.
5) You will have the option of changing the High alarm, Low alarm, STEL alarm, and the Average alarm limits.
6) Press N/- to scroll to the Alarm limit that you would like to change.
7) Select Y/+ on the alarm limit that you intend to change.
8) Use the MODE button to scroll from digit to digit and the Y/+ and N/- buttons to select digits.
9) To save your changes, hold down the MODE button.

Change Real Time Clock

1) Hit MODE when the command Monitor Setup? appears on the screen.
2) Select “Change Real Time Clock?” to adjust the date and time showing on the MultiRae, then use Y/+ and N/- to adjust the time.

NOTE: ALWAYS do this, and double check it, before you start a datalog.

View or Change Datalog

1) Press MODE and N+/ at the same time. Scroll through the menu by pressing the MODE button.
2) To view or change the Datalog function, press Y/+ at the “View or Change Datalog?” screen.
3) The first option will be to “Clear all Data?”
4) Select Y/+ to clear all of the data in the datalog memory.
5) The next option is to “Reset the Peak and Minimum?”
6) When you select Y/+ to “Reset the Peak and Minimum?” the Multi Rae will prompt “Are you sure?”
7) Select Y/+ to reset your values that you see when scrolling the main menu.
8) The next option is to Enable/Disable datalog? If a * is displayed next to a sensor name, data will be recorded. Use mode to move from sensor to sensor. An asterisk (*) means

the sensor is enabled; no asterisk means the sensor is disabled. Press Y/+ to select, and N/- to deselect. To save changes, press MODE until Save? appears. Then press Y/+ to accept. Otherwise, hold MODE to escape and cancel changes.

NOTE: Do not datalog an instrument that is in diagnostic mode, it will record RAW values. Always restart first then begin datalog.

Change Backlight

1) You can change the backlight mode by pressing Y/+ at the "Change Backlight Mode?" screen.
2) To turn on the backlight, hold the N/- button down.

Change Pump Speed

1) To change Pump Speed continue until Change Pump Speed? appears on screen. Press Y+/ or N+/ to change speed different than what it is previously set. Once you determine which speed you prefer then hold the Y+/ to save.
2) Low pump speed- (default) used when operating conditions that are slow to change, prolongs pump motor life, LEL sensor life and battery run time.
3) High pump speed- use for long lengths of tubing or when rapid changes in input conditions are expected, such as HazMat response or when used for measuring heavy, low vapor pressure compounds like jet fuel.

NOTE: Make sure to note it somewhere on an equipment tag when you have changed the pump speed from a default setting, include your initials and date

NOTE: When using tubing as an extension, we must use Teflon tubing. Tygon tubing readily absorbs volatiles, especially benzene.

Sensor Configuration

1) Hit MODE and N/+ at the same time.
2) Change LEL/VOC Gas Selection?
3) Enable/Disable Sensors?
4) Sensors have assigned sockets. These are identified on the PCB. High bias toxic in socket 1/A.
5) Change PID Lamp Type? This only applies to PID monitors. The PID sensor can utilize either a 10.6 eV or an 11.7 eV UV. Since each lamp type has a different correction factor table, it is important to select the correct lamp type.

NOTE: 11.7 lamps have a much shorter lifespan, be aware of the expiration date and leave Tiffani a note when you mobilize with them.

Using the MultiRAE

1) After recognizing your chemical of concern, look in the technical and application notes and locate the correction factor for that chemical that corresponds with the lamp in your MultiRAE
2) When two or more chemicals of concern need to be monitored, a general rule of thumb is to use the highest correction factor and the chemical with the lowest PEL for action level purposes.

NOTE: Correction factors are very important, for both the VOC and LEL sensors. Look through both TN-106 (PID) and TN-156 (LEL).

NOTE: The new NH3 sensors are un-biased. However the NO sensors are still high-bias.

How to clean a lamp

1) Acquire a lamp cleaning kit. Make sure it includes cotton swabs, methanol, tweezers. Gloves can be found in the ER GO BAG if there are none in the kit.
2) Remove the front cover from the instrument.
3) Remove the metal casing from the PID using the tweezers and wearing gloves. Set it aside.
4) Using the tweezers carefully remove the top of the PID housing, it is usually fairly secure, do not use too much force. Set it aside.
5) Carefully remove the lamp from the base, and securely hold it while you swab with cotton soaked in the methanol. Be careful not to allow cotton fibers to stick to the lamp.
6) Give the lamp a few seconds to dry, then place back into base.
7) Carefully swab the metal screen in the top of the PID housing, and give it a few seconds to dry before replacing.
8) Replace metal casing. If it appears dirty, swab with methanol also.
9) Replace cover on the instrument.

NOTE: If replacing an expired or faulty lamp, please place the old lamp in box the new lamp came out of. Mark the box with the serial number and date removed, and return to Tiffani. It may not have expired yet and be available for replacement.

NOTE: Other than lamp cleaning/replacement or sensor changes, do not manipulate the other components within the instrument. Red tag the unit and return to Tiffani.

Additional media needed for this equipment: (i.e. calibration gas or chemcassettes)

MultiRAE technical and application notes; MultiRAE users manual

Calibration gases appropriate to the sensors being used.

Lamp cleaning kit.

Notification Procedures for Equipment Failure (i.e. Rae Systems tech support number and CTEH contact)

RAE Systems 408.723.4800	CTEH- Equipment Room Manager 801.501.8580

RED TAG inoperable equipment properly, example following SOP

References and Further Assistance

Review Date for this SOP

Nathan Williams 4/12/2011

Attachments

Excerpt from TN-123
Calibration Log example
Red Equipment Tag example

Attachment E

Galson Laboratories SOP for VOCs by OSHA PV-2120 & EPA TO-15

CENTER FOR TOXICOLOGY AND ENVIRONMENTAL HEALTH, L.L.C.

Toxicology Emergency Response Program (June 15, 2011)
STANDARD OPERATING PROCEDURE NO. (1.0)

SUBJECT: 3M 3500_3520 OVM Badge SOP

Description of the SOP. This SOP describes the use of the 3M 3500/3520 Organic Vapor Monitor (OVM) badge as a passive dosimeter for the collection of analytical worker exposure data.

Key Personnel with Responsibility to Manage this Operation.

Any environmental scientist or IH technician responsible for the collection of real-time worker exposure data using the 3M 3500/3520 OVM badge.

3M 3500/3520 OVM Badge Preparation Instructions

1. Calibration

a) Neither calibration, nor flow calibration is required.

2. OVM Badge Preparation

NOTE: While handling un-exposed and/or exposed OVM badges, please consider using proper media handling techniques. Sample handling should take place in a location, removed from any areas of contamination or potential sources of cross-contamination. The researcher should use clean/covered hands, surfaces, and tools when working with OVM badges.

a) Inspect the badge container to identify potential tampering or un-intentional disturbances to the OVM badge prior to use. An un-used OVM badge should be housed in a sealed aluminum canister as sent from the manufacturer or laboratory.
b) Remove the badge from the canister only at the time of sample deployment.

3. OVM Badge Deployment

a) Place the OVM badge on the worker's lapel or clothing within the breathing zone (i.e. within 10 inches from the nose or mouth as per NIOSH recommendations).
b) Ensure that the OVM badge is located on the outside of any clothing, vest, or other material that may block the inlet from drawing air from the worker's breathing zone.
c) Instruct the worker to avoid covering the OVM badge with clothing, vests, PPE, etc…
d) Instruct the worker to avoid introducing cross-contamination across the surface of the OVM badge (i.e. bug spray, cologne, hand sanitizer, etc…)

Sampling Data Sheet Instructions

1. Use an appropriate field data sheet prior to deploying the OVM badge. The data sheet should capture the following information:

a) CTEH Project Number
b) Sample Identification Number

c) Worker's Full Name, Contact Information, and Company Information,
d) Worker's Job Task,
e) Worker's Work Site Location Information,
f) Sample Information for Co-located samples (i.e. 3M 3500 badge information, sample ID, etc…),
g) Start Date and Time,
h) Stop Date and Time,
i) Worker's Smoking Habit,
j) Other Potential Cross-Contamination Sources (i.e. bug spray, cologne, hand sanitizer etc…)
k) Sampler's Name and Contact Information

Post-Sampling OVM Badge Collection and Data Processing

1. At the end of the worker's job task or work shift:

a) collect the exposed OVM badge from the worker,
b) remove the OVM badge's outer ring and permeation membrane,
c) and, place the clear plastic lid over the OVM badge. Ensure that the clear plastic lid closely firmly.

2. Place the exposed, sealed OVM badge back into the original canister and complete the canister's label with the appropriate sample information.

3. Conduct the post-sample interview with the sampled worker to identify problems and/or potential cross contamination to the sample. This information should be entered onto the Sampling Data Sheet.

4. Document the stop time and date of the sampling event.

5. Place the canister and corresponding OVM badge with the appropriate sample lot and prepare COC for shipment to the laboratory.

SUBJECT: WHOLE AIR AND SUMMA CAN REGULATOR CALIBRATION AND CLEANING

SOP ID:	AUTHOR: Anthony Marchetti
IN-AIRREG	SECTION SUPERVISOR: ***Gale S. Peterson***
	QA OFFICER: Wendy Ferro
COPYRIGHT	LABORATORY DIRECTOR: Mary Unangst

1.0 PURPOSE

This SOP describes the calibration and cleaning procedure for flow controllers and the regulators used to collect samples in 400cc, *450cc,* ***1000cc MiniCans or Summa Cans.***

2.0 RESPONSIBILITIES

2.1 All technicians performing this procedure are required to read and understand the SOP as written.

2.2 The Section Supervisor is required to read and understand the SOP as written in addition to assuming responsibility for the training and continued education of technicians performing this procedure.

3.0 DEFINITIONS

3.1 SOP – Standard Operation Procedure

3.2 PSI: pounds/sq. inch

3.3 QC: Quality Control

3.4 "Hg: inches of Mercury

3.5 UHP: Ultra High Purity (Nitrogen Grade 4.8 or higher)

3.6 Psig: pounds/sq. inch gauge

3.7 Mini Can: metal canister with valve

3.8 Summa Can: Round Metal Canister with Valve

3.9 Flow controller or regulator: mechanism used to fill Mini can

3.10 LP: Low Pressure

4.0 METHOD SUMMARY

4.1 The Mini Can regulator is a high purity flow regulation system used to fill canisters

(Mini Cans or ***Summa Cans***) at a constant rate from vacuum to within 1 psi of atmospheric pressure, without requiring power.

4.2 The regulator consists of two main parts; the vacuum controller body and an interchangeable sapphire restrictor. The vacuum controller maintains a –0.3 to –1 psi atmospheric pressure regardless of what the vacuum is on the outlet. By changing the value of the restrictor on the inlet, different flow rates (corresponding to canister fill times) can be achieved. For any given restrictor, the flow rate can only be changed by a factor of 2-3x. This is done by adjusting the hex head set screw on the center of the vacuum controller body. Refer to MS-FORM-1 for restrictor settings for various applications.

4.3 In the laboratory, regulators are cleaned between each use and set to the flow rate requested by the client.

4.4 Canisters are leak-checked in the following manner: when can-cleaning has been completed, each canister is put under full vacuum and the vacuum reading (usually 30" of Mercury) is recorded in the Can-Cleaning Logbook along with the date/time and analyst's initials. The prep group will check and record the vacuum reading for each canister before shipping to a client and place a full vacuum sticker along with a date/sample label. Acceptance criteria are +/- 2" of Hg variance for a >= 24 hour leak check.

5.0 INTERFERENCES

Not Applicable

6.0 SAFETY

6.1 Safety glasses with side shields are required when working in the laboratory.

7.0 MATERIALS AND APPARATUS

7.1 UHP nitrogen for the cleaning gas.

7.2 Regulators, with a selection of #2 through #5 restrictors. Restek requlators have a #8 restrictor which are comparable to a #5 restrictor.

7.3 Alicat Scientific flow meters: Model #01-39-20035.01 and Model #01-03-200020.

7.4 1/2" and 9/16" open end wrenches and a 1/8" hex key.

8.0 REAGENTS AND STANDARDS

8.1 Nitrogen @ 99.9999% purity (UHP N2)

9.0 PROCEDURE

9.1 For Flow Settings

9.1.1 Select a flow controller with the correct restrictor code. See MS-FORM-1 for guidelines.

9.1.2 Ensure all possible leak points are tightened prior to calibration.

9.1.3 The Regulator Calibration Data Sheet located in P:\Prep Group\Pump Loan\Approved Forms\ Regulator Cal Sheet and update to reflect calibration results.

9.1.4 Connect the appropriate Alicat Scientific flow calibrator to the inlet of the regulator. Alicat Model #01-39-20035.01 is used with restrictors coded 2 and 3, Model #01-03-20020 is used with restrictors coded 4 and 5. Verify the gauge is functioning.

9.1.5 Connect an evacuated calibration canister that is between 10 & 30 inches of Hg (gauge) to the outlet of the flow controller body to start flow.

9.1.6 Allow about 1 minute for the flow to equilibrate, then note the inches of Hg regulator is reading. Visually observe regulator dial for 30 seconds to verify the regulator is not leaking (i.e. the inches of Hg is dropping very quickly). Recheck what regulator is reading when the regulator is calibrated, prior to removing from Alicat, to ensure it has not leaked. If there is a drastic drop in pressure, place regulator in repair bin.

9.1.7 Verify that the Alicat is reading 0 when the regulator is removed. If it is not reading 0, press the reset button and repeat 9.1.3 - 9.1.5. Change the battery if abnormal fluctuation is noticed on the display of the Alicat during calibration. ***The battery of the Alicat should be changed every six months. Attach a label with the date of battery change and check that it is not past six months before each use. Replace the label with the correct date anytime the battery is changed.***

9.1.8 Remove the hex screw cover located in the center of the regulator body using a 1/8” hex key.

9.1.9 Adjust the set screw using the hex wrench so that the flows agree with MS-FORM-1 ***(Figure 1)***, enter this data into the cells that correspond to the regulator you are calibrating. Turning the screw clockwise will result in a lower flow rate; turning the screw counterclockwise raises the flow rate. The adjustment must be done slowly (1/4 of full turn intervals), allowing the regulator body adequate time to “equalize” with any adjustments made. Add a label with the appropriate hours on it for what the regulator was calibrated to. Print out “Regulator Calibration Data Sheet”and include in paperwork that goes to client.

9.1.10 CAUTION: If 1-2 turns do not result in a change of flow rate, STOP and check the flow calibrator for proper operation or blockages in the inlet plenum. The internal diaphragm of the regulator may be damaged by over tightening. If flow readings are unsteady or erratic, select another regulator.

9.2 PROCEDURE FOR CLEANING

9.2.1 Remove all tape or labels added to the regulators. Be sure not to remove the barcode label or the label containing the serial number.

9.2.2 Remove back flush port screw from the body of the regulator. This is located to the right center of the diaphragm housing, it is a 1/8" hex screw.

9.2.3 Remove the restrictor and particulate filter located on the inlet side of the regulator.

9.2.4 The regulator can be cleaned, by connecting LP UHP N2 hose at 5-10 psi at the flush port and back flush for about 20 seconds.

9.2.5 The restrictors can be cleaned by using UHP N2 at 30-40 psig to remove any solid particulate caught in the sapphire orifice (use the dilution manifold). Be sure to connect the restrictors with the flat side (inlet side) facing out so any blockages will be blown out.

9.2.6 Clean the particulate filter with UHP N2 by same method as above. Ensuring positive air flow through the filter.

9.2.7 Reassemble the unit taking great care not to over tighten any screws. Check the gap between the restrictor and the ferrule nut using the nogo gap gauge at the 1/4"/ 6mm setting.

9.2.8 Grab regulators must also be flushed briefly with UHP N2 to ensure cleanliness using the dilution manifold.

10.0 DOCUMENTATION

Not Applicable

11.0 CALCULATIONS

Not Applicable

12.0 QUALITY CONTROL CHECKS AND CRITERIA

Not Applicable

13.0 CORRECTIVE ACTION PLAN

Not Applicable

14.0 WASTE DISPOSAL

Not Applicable

15.0 REFERENCES

15.1 MS-FORM-1

16.0 METHOD MODIFICATIONS

Not Applicable

Minican Regulator	**Setting Guidelines**							
	400 cc Minican							
2	Time (minutes)	5	10	15	30			
	Flow (cc/minute)	***72***	***36***	***24***	***12***			
3	Time (minutes)	15	30	45	60	90	120	
	Flow (cc/minute)	***24***	***12***	***8***	***6***	***4***	***3***	
4	Time (hours)	1	1.5	2	3	4**		
	Flow (cc/minute)	***6***	***4***	***3***	***2***	***1.5***		
5	Time (hours)	4**	6	8	10	12	14	16
	Flow (cc/minute)	***1.5***	***1***	***0.75***	***0.6***	***0.5***	***0.43***	***0.37***

	450 cc Minican							
2	Time (minutes)	5	10	15	30			
	Flow (cc/minute)	***81***	***40.5***	***27***	***13.5***			
3	Time (minutes)	15	30	45	60	90	120	
	Flow (cc/minute)	***27***	***13.5***	***9***	***6.8***	***4.5***	***3.4***	
4	Time (hours)	1	1.5	2	3	4**		
	Flow (cc/minute)	***6.75***	***4.5***	***3.38***	***2.25***	***1.69***		
5	Time (hours)	4**	6	8	10	12	14	16
	Flow (cc/minute)	***1.69***	***1.13***	***0.84***	***0.68***	***0.56***	***0.48***	***0.42***

	1 Liter Minican						
4	Time (hours)	1	2	3	4	5	6
	Flow (cc/minute)	***15***	***7.5***	***5***	***3.75***	***3***	***2.5***
5	Time (hours)	8	12	16	18	24	
	Flow (cc/minute)	***1.87***	***1.25***	***0.94***	***0.83***	***0.62***	

Minican Regulator	**Setting Guidelines**	
	6 Liter Canister	
3	Time (hours)	24
	Flow (cc/minute)	***3.8***
4	Time (hours)	24
	Flow (cc/minute)	***3.75***
5	Time (days)	7
	Flow (cc/minute)	***0.54***

Note: Minimum vacuum allowable for acceptable minican/canister is ***-28" Hg***

Note: Flow rate as read from the Alicat Scientific flow calibrator

Note: Regulator setting determined by using this formula

$$\frac{\text{Target Volume (cc)}}{\text{Total Time (minutes)}} \times .9$$

Note: When using a 1 Liter can for under 8 hours you need to use a #4 restrictor.

**Preferable to use #4 restrictor for 4 hour setting

(Figure 1)

SUBJECT: **VOLATILE ORGANIC COMPOUNDS BY OSHA PV2120 & EPA TO-15**

SOP ID:	AUTHOR: Justin Palmer/ Rob Wilson
IN-VOCS	SECTION SUPERVISOR: Justin Palmer
	QA OFFICER: Wendy Ferro
COPYRIGHT	LABORATORY DIRECTOR: Mary Unangst

1.0 PURPOSE

1.1 This SOP describes the procedure for determining contaminants in whole air samples collected in a fused silica-lined stainless steel canister (following OSHA method PV2120 and Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (Method TO-15). This method utilizes GC/MS for the determination of a wide range of volatile and semi-volatile organic compounds (as listed in Table 1).

2.0 RESPONSIBILITIES

2.1 All GC/MS analysts performing this method are required to read and understand the method as written in OSHA PV2120, and are required to meet all QC requirements (as described in EPA TO-15) before attempting analysis of samples.

2.2 The section supervisor is required to read and understand the method as written, but is also responsible for the training and continued education of technicians performing this method.

2.3 The section supervisor is required to review reports and packages to ensure that all data are valid prior to client receipt.

3.0 DEFINITIONS

3.1 GC/MS: Gas Chromatography/Mass Spectrometry

3.2 Capillary: Analytical column with an internal diameter less than or equal to 0.32 mm

3.3 EICP: Extracted ion current profile: Plot of ion abundance vs. GC retention time for a single characteristic mass (amu)/charge ratio.

3.4 AMU: Atomic Mass Unit

3.5 ppbv: part per billion by volume for component concentration in the gas phase.

3.6 Mini Can: Canisters ranging from 400mL to 1000mL in volume; these are associated with an injection volume of 100mL.

3.7 Summa Canisters: Canisters with a 6L volume; these are associated with an injection volumes of ***500 to 1000-cc.***

3.8 SCAN: Normal MS acquisition mode where mass ranges from 35 to 300 amu are scanned to produce a Total Ion Chromatogram.

3.9 SIM: Selective Ion Mode; only scans certain ions per sample to increase sensitivity. Used for only certain projects that require low level analysis.

4.0 METHOD SUMMARY

4.1 The sample is prepared for analysis by pre-concentration, which removes potential interference and dries the sample. After the pre-concentration and drying steps are completed, the analytes are cryo-focused onto the head of the GC column via reduced temperature trapping, followed by rapid thermal desorption.

4.2 Separation of the analytes is achieved by temperature programming of the GC oven.

4.3 The eluent from the capillary column is introduced directly to the mass spectrometer, which is operated in the electron impact mode. Identification of target analytes is accomplished by comparing sample mass spectra with reference spectra generated from purchased standards on the GC/MS system used to analyze the samples. Quantitation is achieved using the internal standard technique. The response of a selected quantitation ion for each analyte relative to the quantitation ion of the designated internal standard (relative response factor, or RRF) is determined over a minimum five-point calibration range.

5.0 INTERFERENCES

5.1 Raw GC/MS data from all samples and blanks must be evaluated for interference. Determine if the source of interference is in the sample introduction system. If so, take corrective action to eliminate the problem.

5.2 Contamination by carryover can occur whenever high-concentration and low-concentration samples are sequentially analyzed. Each auto-sampler port is flushed with nitrogen after use (prior to set-up of the next batch of samples).

5.3 Interferences are minimal by GC/MS as this type of detector allows the determination if compounds are co-eluting in the chromatographic system. Quantification can be done on alternate ions so interferences are eliminated in most cases. In other instances, a dilution may be performed to allow better separation or results may be considered estimated if the interference cannot be removed.

6.0 SAFETY

6.1 Most volatile compounds are considered hazardous. Always wear gloves and a lab coat when handling stock standards.

6.2 Safety glasses with side-shields are required whenever working in the laboratory.

6.3 It is very important that special precaution be used when working with liquid nitrogen, as it can cause serious burns.

6.4 Be sure that only radiation worker trained personnel handle Mini Cans that have been screened for radiation. These cans will have an orange dot on them.

7.0 MATERIALS AND APPARATUS

7.1 Agilent (previously Hewlett Packard (HP)- may be used interchangeably) 5890, 6890, or 7890 Series GC, in conjunction with an HP model 5972, 5973, or 5975 mass spectrometer (capable of scanning from 35 to 300 amu every 1-second or less using 70 volts (nominal) electron energy in the electron impact ionization mode).

7.2 Entech 7032, 7032L, 7032A, or 7016CA autosampler models with the Entech 7100 or 7100A three stage Preconcentrator.

7.2.1 Microscale Purge and Trap (MPT) analysis is performed by utilizing a glass bead trap in module 1 and a Tenax sorbent trap in module 2. Module 3 contains an empty trap.

7.2.2 Cold Trap Dehydration analysis (CTD) employs an empty trap in module 1 and a Tenax trap in module 2. Module 3 contains an empty trap.

7.3 Analytical Chromatography column: 0.32mm ID x 60m length silicone-coated capillary column with a 1 um film thickness – Restek RTX-1 or equivalent.

7.4 GC/MS Interface - The GC column is directly coupled to the mass spectrometer ion source. Acceptable tuning and calibration performance must be demonstrated on a daily basis.

7.5 Data System – The data system used is the HP Chemstation G1701BA with (at minimum) Revision B.01.00 software package for the HP5972, 5973, or 5975 MS. This system allows continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program. The software allows for searching any GC/MS data file for ions of a specific mass, and plotting such ion abundance versus time or scan number. This type of plot is defined as an Extracted Ion Current Profile. The software allows integration of the abundance in any EICP between specified time or scan number limits. The NIST 129K version mass spectral library is being used for a reference library.

8.0 REAGENTS AND STANDARDS

8.1 Helium @ 99.9999% purity

8.2 Liquid nitrogen

8.3 Stock standards

8.3.1 Stock standard solutions are purchased as certified solutions.

8.3.1.1 TO-15 Subset standard is purchased from Spectra gases

8.3.1.1.1 (Catalogue # ENT15-25S-6A-1M*)* or Scott gases (item# 0104AZ00025).

8.3.1.2 TO-14 standard is purchased from Spectra gases

8.3.1.2.1 (Catalogue # ENT14/39S/6A1M) or Scott gases (item# 01049Z90001).

8.3.1.3 Ethylene oxide standard is purchased from Spectra gases

8.3.1.3.1 (ETOX/CGA3501M) or Scott gases (item# 08020001310PAL).

8.3.1.4 4-Phenylcyclohexene standard is purchased from Scott gases (item# 0104P200046).

8.3.1.5 TO-15 100-ppbv 75 compound standard

8.3.1.6 TO-15 10-ppbv project specific compound list

8.3.1.6.1 Used for ultra low level SIM analysis.

8.3.2 Stock standard solutions must be stored at room temperature, or as recommended by the manufacturer.

8.3.3 Stock standard solutions must be replaced after 1 year, or sooner depending on manufacturer's expiration date.

8.4 Internal Standard and Surrogate

8.4.1 The internal standards are Bromochloromethane, 1,4-Difluorobenzene, and Chlorobenzene-d5.

8.4.2 The surrogate is Bromofluorobenzene.

8.4.3 Each sample undergoing analysis, as well as all calibration standards must be spiked with 50-ppbv of each internal standard and surrogate.

8.4.4 A certified stock internal and surrogate standard mixture must be purchased every 12 months (or sooner, if degradation is observed). (Spectra Gases, TO-14 IS/Surr. mix, catalogue # ENT14ITS-6A-1M) or (Scott Gases, TO-14 IS/Surr. Mix, P/N 24087828)

8.4.5 Store the internal/surrogate standard at room temperature.

8.5 GC/MS Tuning standard

8.5.1 In a 6L Summa canister, prepare a 100-ppbv standard of Bromofluorobenzene (BFB). This standard contains the internal standard compounds as well.

8.5.2 The tuning standard is stored at room temperature when not in use. When using premixed certified gases, store according to the manufacturer's documented holding time and storage temperature recommendations.

8.6 Intermediate (working) standards

8.6.1 A working standard of the target compounds is prepared at 5-ppbv, 25-ppbv, and 100-ppbv for both 100cc and 500cc injection methods. This is used to generate the instrument calibration curve. The working standard must contain all of the analytes of interest. Target compound working standards expire one month after preparation.

8.6.2 The internal / surrogate working standard is prepared at 100 ppbv. This is also used as the tuning standard. Working internal standards expire two months from preparation date.

8.7 Calibration standards

8.7.1 Calibration standards must be analyzed at a minimum of five different concentrations. One of the calibration standards must correspond to a sample concentration at or below that necessary to meet the data quality objectives of the project. The remaining standards must correspond to the range of concentrations expected to be found in the actual samples. The typical calibration curve range for TO15 (Minican) list is 5-ppbv to 150-ppbv for most analytes. TO-15 (6L Summa can) list is from 1-ppbv to 30-ppbv. ***TO-15 low level list is from 0.2-ppbv to 30-ppbv. TO-15 SIM is dependent on project specific reporting limits.*** Ethylene Oxide ranges from 20-400-ppbv and 4-Phenylcyclohexene ranges from 1-20-ppbv.

8.7.2 Internal standards and surrogate are added to all calibration standards during analysis.

9.0 PROCEDURES

9.1 Sample collection, preservation and handling

9.1.1 Whole air samples are collected in 400cc or 1000cc fused silica lined stainless steel canisters (Mini Cans) or 6-liter Summa canisters that are stored at room temperature until analysis. Sample stability is unknown, therefore samples should be analyzed as soon as possible.

9.2 Sample Preparation

9.2.1 Once the GCMS group has received the samples, the vacuum in the can is measured to verify the amount of sample collected. If the vacuum reading is > 5 inches of Hg, the project manager must notify the customer. This can be caused by either improper sample collection or a malfunction of the regulator. A full canister will read < 5 inches of Mercury. ***There should be a partial vacuum remaining (@ 1 to < 5 inches of Mercury) to evidence that a full sampling event took place. No measurable vacuum may be an indication that the canister was not collecting the sample over the full duration of the sampling***

period or that the canister was leaking during sampling. The customer must be notified if there is no measurable vacuum. Pump group will set regulators to leave a partial vacuum for the specified sampling time (8 hrs, 24 hrs, or week). A volume of Nitrogen can be added to bring the volume above 5" Mercury with the use of the Entech 7100 sample diluter. The initial and final pressure readings must be recorded in the can dilution logbook. The dilution factor is calculate according to the equation:

$$DF = \frac{PSIA_f}{PSIAi}$$

Where $PSIA_f$ = final pressure reading
$PSIA_I$ = initial pressure reading

Detection limits will be raised proportionately.

9.3 Analytical Procedure

9.3.1 Instrument Maintenance

9.3.1.1 Appropriate instrument maintenance must be performed as necessary prior to initial calibration. Indications of the need for maintenance include poor peak shape, inadequate sensitivity, and inability to pass BFB tune. Steps that may be required to address these problems include replacing one or both traps in the Entech 7100, baking the transfer line and GC column, trimming or replacing the column, and/or cleaning the ion source.

9.3.2 Instrument conditions for TO-15 regular list and Hydrocarbon analysis:

The following GC/MS instrument conditions are used:

Mass range:	35-300 amu
Scan time:	2.82 scan/sec
Initial temperature:	34 ^{0}C, hold for 5.5 minutes
Temperature program	increase at 5 ^{0}C /minute to 70^{0}C, then increase at 15^{0}C /minute to 170^{0}C, then increase at 25^{0}C/ minute to 240^{0}C, holding there for 1-10 minutes.
Final temperature:	240 ^{0}C, hold 1-10 minutes after Hexachloro-1,3-Butadiene elutes.
Injector temperature:	150 ^{0}C
Injection volume:	100cc
Carrier gas:	Helium at 20 cm/sec

9.3.3 Instrument conditions for Ethylene Oxide analysis:

Mass range:	28-250 for Ethylene oxide then at 6.9 min. 29-250 amu
Initial temperature:	34 ^{0}C, hold for 5.5 minutes,
Temperature program	increase at 15 ^{0}C /minute to
Final temperature:	240 ^{0}C, hold 1-10 minutes
Injector temperature:	150 ^{0}C
Injection volume:	100cc

Carrier gas:	Helium at 20 cm/sec

9.3.4 Instrument conditions for 4-Phenylcyclohexene analysis:

Mass range:	SIM Mode (4PCH 74, 108, 158 amu)
Initial temperature:	50 ^{0}C
Temperature program	increase at 10 ^{0}C /minute to 200^{0}C, then increase at 25 ^{0}C /minute.
Final temperature:	250 ^{0}C, hold 1-10 minutes.
Injector temperature:	150 ^{0}C
Injection volume:	100cc
Carrier gas:	Helium at 20 cm/sec

9.4 Instrument Calibration

9.4.1 Instrument Performance Check: At the beginning of a 24-hour analysis sequence it is necessary to show that the GC/MS system meets the instrument performance criteria. This is accomplished by the analysis of a 50-ppbv injection of BFB to demonstrate correct mass calibration, mass resolution, and mass transmission. Any injection containing 50-ppbv of BFB can be used for this purpose.

9.4.1.1 BFB must meet the criteria listed in 9.4.1.2 before standards and samples are analyzed. An acceptable BFB tune is demonstrated once at the beginning of each 24-hour period during which samples or standards are analyzed. The 24-hour period begins with the injection time of the BFB and ends after 24 hours according to the system clock. The following abundance criteria are required to establish instrument tune compliance:

9.4.1.2 Tune acceptance criteria:

Mass	Ion Abundance Criteria
50	8.0-40.0 percent of mass 95
75	30.0-66.0 percent of mass 95
95	base peak, 100 percent relative abundance
96	5.0-9.0 percent of mass 95
173	Less than 2.0 percent of mass 174
174	50.0 - 120 percent of mass 95
175	4.0-9.0 percent of mass 174
176	Greater than 93.0 percent but less than 101.0 percent of mass 174
177	5.0-9.0 percent of mass 176

9.4.1.3 For demonstrating an acceptable tune, the mass spectrum of BFB must be obtained. This is can be performed by the HP/Agilent Chemstation Software using the Auto-find BFB function. This function works as follows: three scans are taken (the peak apex scan, and the scans immediately preceding and following the apex) and then averaged. Background subtraction is required, and must be accomplished using a single scan acquired no more than 20 scans prior to the elution of BFB. The background subtraction is designed to eliminate column bleed and instrument background ions. Alternately, the BFB spectrum can be obtained/performed manually.

9.4.2 Calibration standards are analyzed concurrently or once BFB meets acceptance criteria.

9.4.3 Initial Calibration

9.4.3.1 For use with 100cc-sample injection volume TO15 analysis (i.e. 400-1000cc canisters): A minimum 5-point calibration curve must be analyzed prior to sample analysis. The internal standards must be added at 50-ppbv to each curve concentration level. Analyze to determine the instrument sensitivity and linearity of the GC/MS response for the target compounds. Analyze the following volumes from the 25 and/or 50-ppbv working standard canister to obtain the desired concentration. Other standard levels can be used as needed to meet calibration range criteria. A 5-ppbv standard is utilized (100-cc injection volume) for the 5-ppbv level on some instruments. A blank should be run in-between the three highest standards (for example, between the 100 and 150-ppbv standards).

Standard Level	25-ppbv working standard	50-ppbv working standard
5-ppbv standard	Use 20cc	Use 10cc
20-ppbv standard	Use 80cc	Use 40cc
50-ppbv standard	Use 200cc	Use 100cc
100-ppbv standard	Use 400cc	Use 200cc
150-ppbv standard	Use 600cc	Use 300cc
200-ppbv standard	N/A	Use 400cc

9.4.3.2 For use with 500cc-sample injection volume analysis (i.e. 6-liter canisters): A minimum 5-point calibration curve must be analyzed prior to sample analysis. The internal standards must be added at 10-ppbv for each curve concentration level. Analyze to determine the instrument sensitivity and linearity of the GC/MS response for the target compounds. Analyze the following volumes from the 25-ppbv working standard canister to obtain the desired concentration. Other standard levels can be used as needed to meet calibration range criteria. Blanks should be run in-between the three highest standards (for example, between the 20 & 30-ppbv standards).

Standard Level	1-ppbv working standard	5-ppbv working standard	25-ppbv working standard
0.2-ppbv standard	Use 100cc	Use 500cc	N/A
1-ppbv standard	N/A	Use 100cc	Use 20cc
5-ppbv standard	N/A	N/A	Use 100cc
10-ppbv standard	N/A	N/A	Use 200cc
20-ppbv standard	N/A	N/A	Use 400cc
30-ppbv standard	N/A	N/A	Use 600cc

9.4.3.3 For use with 1000cc-sample injection volume analysis (6 liter SIM): A minimum 5-point calibration curve must be analyzed prior to sample

analysis. The internal standards must be added at midpoint for each curve concentration level. Analyze to determine the instrument sensitivity and linearity of the GC/MS response for the target compounds. Analyze the following volumes from either 0.05-ppbv working standard canister or 1-ppbv working standard canister to obtain the desired concentration. Other standard levels can be used as needed to meet calibration range criteria. Blanks should be run in-between the highest standards (for example, between the 0.4 & 0.6-ppbv standards) and blanks should be run after the calibration to clean out the system.

Standard Level	0.05-ppbv working standard	1-ppbv working standard
0.005-ppbv standard	Use 100cc	N/A
0.025-ppbv standard	Use 500cc	N/A
0.1-ppbv standard	N/A	Use 100cc
0.2-ppbv standard	N/A	Use 200cc
0.4-ppbv standard	N/A	Use 400cc
0.6-ppbv standard	N/A	Use 600cc

9.4.3.4 Calculate the relative response factor for each compound using the following equation:

$$RRF = \frac{A_x}{A_{is}} * \frac{C_{is}}{C_x}$$

Where:

A_x = Area of the characteristic quant ion for the compound to be measured (see *Table 1 and 2*).

A_{is} = Area of the characteristic quant ion for the designated internal standard (see *Table 1*).

C_{is} = Concentration of the internal standard (ppbv).
C_x = Concentration of the compound to be measured (ppbv).

9.4.3.5 Calculate the average RRF for each analyte in the curve.

9.4.3.6 Calculate the % Relative Standard Deviation (%RSD) of RRF values for the initial calibration curve using the following equation:

$$\%RSD = \frac{\text{Standard Deviation (n-1)}}{\text{Average RRF}} * 100$$

9.4.3.7 Calculate the average RT for each internal standard over the initial calibration range.

9.4.4 Calibration acceptance criteria

9.4.4.1 The <u>BFB</u> must meet the specified criteria

9.4.4.2 The <u>%RSD</u> is calculated and must be less than or equal to 30% for all compounds. This criterion must be met for the initial calibration to be valid. However, an exception can be made for up to 2 compounds that may exceed 30% RSD, but the RSD for these compounds must be <40.0%. Refer to QC-SOP-12 (current revision) for calibration level rejection criteria.

9.4.4.3 Evaluation of IS retention time: The retention time shift for each of the internal standards at each calibration level must be within 20s of the mean retention time over the initial calibration range.

9.4.4.4 Evaluation of target compound retention time: The relative retention time (RRT) of each target analyte in each calibration level must be within 0.06 RRT units of the mean RRT for that compound

9.5 Calibration verification

9.5.1 Instrument Performance Check: Prior to sample analysis, a 10/50-ppbv injection of BFB must meet the criteria listed in 9.4.1.2.

9.5.2 Calibration verification standard: The initial calibration must be verified on a daily basis prior to the analysis of any samples. Analyze a mid-level (10/50-ppbv)-calibration standard at the beginning and end of each 24-hour working period after meeting BFB tune criteria.

9.5.2.1 Calculate the % Difference between the average response factor from the calibration curve and the response factor from the daily standard using the equation below:

$$\%\ \text{Difference} = \frac{|RRF_i - RRF_c|}{RRF_i} * 100$$

Where:

RRF_i = Average relative response factor from initial calibration.

RRF_c = Relative response factor from the current calibration check standard.

The %D in the daily standard must be +/-30% for all compounds.

The %D report is monitored daily to evaluate instrument performance and watch for trends that might indicate the need for corrective action.

9.6 Method Blank

9.6.1 A Method blank is a volume of a clean reference matrix (Nitrogen @ 99.9999% purity) carried through the entire analytical procedure. The volume of the method blank must be approximately equal to the volume of the associated samples.

9.7 Laboratory Control Sample and Duplicate (LCS/LCSD)

9.7.1 A laboratory control sample and duplicate (consisting of a representative list of target analytes prepared near the mid-level of the calibration curve) are analyzed daily. The LCS/LCSD are spiked into Mini Cans or 6 liter canisters and are analyzed in the same manner as client samples. The LCS/LCSD standard must be from a separate source than that of the calibration standards. Sub-sampling for an LCS or LCSD from a 6 liter standard stock canister requires the 6 liter canister to be > or = 10 psig to minimize any sub-sampling biases for the wide variety of volatile compounds analyzed by this method.

9.8 Detection Limit Standard (DLS)

9.8.1 The lower limit of quantitation is verified daily by the analysis of a standard at the detection limit (5-ppbv for most compounds in Minican, 0.2-ppbv or 1-ppbv for 6 liter) in the TO15 list analysis. ***The lower limit of quantitation for SIM analysis will depend on client specifications and targets.*** Recovery of all compounds with the DLS should be within the range of 60-140%. The Ethylene Oxide DLS is analyzed at 20-ppbv and the 4-Phenylcyclohexene DLS is at 1-ppbv (limits are also 60-140%).

9.9 Sample analysis

9.9.1 Once the instrument check and calibration verification standards have passed the acceptance criteria, samples may be analyzed.

9.9.2 Add 50cc of the 100-ppbv internal standard/surrogate mixture (for a level of 50-ppbv for a 100cc-sample injection and 10-ppbv for a 500cc-sample injection) to the sample extract obtained from the sample mini-canister.

9.9.3 Analyze the sample on the GC/MS system using the same operating conditions that were used for the calibration.

9.9.4 If the concentration of any target analyte in the sample exceeds the initial calibration range of the GC/MS system, the sample must be diluted and reanalyzed.

9.9.4.1 Dilutions can be automated by using the Entech 7100 system. However, the smallest sample size that can be analyzed reliably is 10cc. If greater than a 10X dilution is needed on the can, the analyst must pressurize the canister with nitrogen to further dilute the sample. The pressurization factor is multiplied by the instrument dilution to obtain the total dilution factor:

$$\text{Total Df} = \frac{P_{sia}\ \text{final}}{P_{sia}\ \text{initial}} \times \frac{100\text{cc}}{\text{inj vol}} \times \text{(split factor for loop injector, if used)}$$

Once the canister is pressurized above atmospheric pressure, or 14.7 P_{sia}, the Entech 7032 loop injector may be used to withdraw a 1-cc injection volume. Automated splitting of the sample stream can further dilute this volume up to a factor of 10x. If the sample is to be reanalyzed via normal injection, it must be vented to ambient pressure by depressing the quick-connect pin on the Mini Can.

9.10 Qualitative analysis

9.10.1 Identification of Target Compounds

The qualitative identification of compounds is based on retention time and comparison of the sample spectrum with characteristic ions in a reference mass spectrum. The characteristic ions from the reference mass spectrum are defined as the three ions of greatest relative intensity, or any ions over 30% relative intensity, if less than three such ions occur in the reference spectrum. The list of characteristic ions for each analyte is presented in *Table 1*. Target compounds are positively identified when the following criteria are met:

9.10.1.1 The EICPs of the characteristic ions of an analyte must maximize within one scan of each other.

9.10.1.2 The RRT of the sample component is within +/- 0.06 RRT units of the RRT of the standard component.

9.10.1.3 The relative intensities of the characteristic ions in the sample analyte must agree within 30 percent of the relative intensities of these ions in the reference spectrum from the most recent calibration verification standard. The analyst must account for deviations from this criterion such as in the case of interference/co-elution.

9.10.1.4 Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is less than 25 percent of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs (for example, m- & p-xylene).

9.10.1.5 Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When gas chromatographic peaks obviously represent more than one sample component, appropriate selection of analyte spectra and background spectra is important. When analytes coelute the identification criteria can be met, but each analyte spectrum will contain extraneous ions contributed by the coeluting compound.

9.10.2 Identification of Non-Target Compounds

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. Up to 20 organic compounds with greatest concentration excluding surrogate and internal standards will be identified and reported. ***Non-Target compounds identification is not possible in SIM analysis.***

9.10.2.1 Major ions in the reference spectrum (ions greater than 10 percent of the most abundant ion) should be present in the sample spectrum.

9.10.2.2 The relative intensities of the major ions should agree within +/-20 percent. For example: an ion with an absolute abundance of 50 percent in the standard spectrum must be between 30 and 70 percent in the corresponding sample spectrum.

9.10.2.3 Molecular ions present in the reference spectrum should be present in the sample spectrum.

9.11 Quantitative identification

9.11.1 Once a target compound has been identified, the quantitation of that compound is based on the total abundance, or EICP integration area, of the primary characteristic ion.

9.11.2 The concentration of a compound in the sample is determined using the mean relative response factor determined from the initial calibration.

9.11.3 Concentration is calculated from the equation:

$$\text{ppbv} = \frac{(Ax)(Is)(Df)}{(Ais)(RRF_i)}$$

Where:
Ax = Area of the compound characteristic ion in the sample.
Ais = Area of the characteristic ion for the corresponding internal standard.
Is = Concentration of internal standard in ppbv
RRF_i = Mean relative response factor (from initial calibration) for the compound being measured.
Df = Dilution factor

9.11.4. In all instances where the quantitation report has been edited, or where manual integration or quantitation has been performed, the GC/MS operator must identify edits or manual procedures by initialing and dating the changes made to the report. The data system flags a manual integration on the quantitation report by placing the symbol "m" next to the area. The analyst who performed the integration should initial and date this flag.

9.11.5 Samples that contain target analytes above the linear range of the curve must be diluted to bring the analytes within the curve range. If a dilution was initially performed and no target analytes are detected above the LOQ, the sample must be reanalyzed at a more concentrated level.

9.12 Technical Acceptance Criteria for Sample analysis

9.12.1 The samples must be analyzed on a system meeting BFB, initial calibration and calibration verification criteria.

9.12.2 The sample must have an associated method blank meeting acceptance criteria (see section 11.2).

9.12.3 Surrogate recovery must fall within default limits of 80-120% for all samples and blanks.

9.12.4 The retention time of each internal standard must be within ±20s of the retention time in the most recent calibration verification standard.

9.12.5 The instrumental response (EICP area) for each of the internal standards must be within ± 40% of the area response in the most recent calibration verification standard. If analyzed within the same sequence a calibration curve, then the average of the area responses for all calibration standards can be used for this criteria comparison.

9.12.6 Concentration of all analytes must be within the calibration range determined from the initial calibration.

9.12.7 Control Sample/Duplicate must be evaluated to determine if recoveries (and RPDs) are within control limits.

9.13 Hydrocarbon Analysis

9.13.1 Initial Calibration

9.13.1.1 A copy of the day's data folder is made and renamed "InstID+date+HC." For example, if the date is 02/25/2011 on instrument J, the new folder will be named J022511HC. Load the previous hydrocarbon calibration curve, rename with the current date and save the method.

9.13.1.2 With the global detection limit set to zero, re-quantitate the same data files used for the TO-15 calibration curve. Q-Edit the files to ensure that all of the hydrocarbon peaks are correct, using the following table.

Name	Major Peak
Bromochloromethane	130
1,4-Difluorobenzene	114
Chlorobenzene-d5	117
Bromofluorobenzene	174
Total VOC's as n-Heptane	43,57,71,100
Trimethyl Siloxanol	75
Hexmethyl Cyclotrisiloxane	207
Octomethyl Cyclotetrasiloxane	281
Siloxane	267

Note: In standards and blanks, the Trimethyl Siloxanol and Siloxane may not be present. Highlight the peak around the retention time of where it should be, with the lowest level present. This is usually the beginning of the peak found.

9.13.1.3 Once the peaks have been selected correctly, clear the calibration responses in the curve. Update all the levels of the calibration using the same data files that were used for the TO-15 curve. Ensure that you select "Quantitate Using Initial Cal RF's" under the "Quant" menu before saving the method.

9.13.1.4 Repeat steps 9.4.3.2 – 9.4.3.5 for n-Heptane only. An additional conversion may be necessary, depending on client, to convert n-Heptane to Gasoline (M.W. Gasoline divided by M.W. of n-Heptane). Siloxanes are not calibrated compounds. RSD for siloxanes should be crossed out and marked “Not calibrated for these compounds.” Update the Custom Report Response factor using the Average of the Total VOC’s as n-Heptane.

9.14 SIM Analysis

9.14.1 SIM analysis is a technique used to increase sensitivity with GCMS for for target compounds using only specific ions. The only ions scanned for are those that are characteristic of target compounds only. As a result non target compounds are not able to be detected using SIM analysis.

9.14.2 SIM analysis can be done upon client request for compounds that require lower detection limits than the low level 0.2-ppbv standard.

9.14.3 Target compounds will depend on client target list and will be ordered at a lower level primary standard if needed (example: Order a 10-ppbv standard if client requests detection limit of 0.005-ppbv)

9.14.4 If the detection limits can be meet with a standard SCAN TO-15 method but client requests SIM analysis, the same stock and working standards used for SCAN analysis can be used.

9.14.5 Target compounds will be quantitated from the primary ion for each respective compound with at least 1 secondary ion for qualitative identification. Retention time will be the primary method of identification per 9.10.1.

9.14.6 SIM analysis will be set up using a separate chemstation method using only the ions for compounds that require SIM analysis. This will keep from scanning non target compound ions which will increase sensitivity. Target ions will depend on client request and the ions used should be seen in regular TO-15 SCAN ECIP.

9.14.7 SIM methods will be made per client project to maximize sensitivity by minimizing dwell time by the mass spectrometer. See section supervisor or alternate for any questions.

9.14.8 Blank should be run after any QC until system is fully cleaned out before running any client samples. This will ensure that client samples are free from any possible carry over effects from working standards used for QC. Blanks should be run at the end of client sample batch to ensure that there is no carry over. Blanks should be run in between any client samples with a hit at or greater than the mid point calibration level, to ensure that subsequent client samples are not contaminated with carry over.

9.15 Corrective Action

9.15.1 Corrective Action for sample analysis: the sample technical acceptance criteria must be met. If any samples do not meet acceptance criteria, consult with the section supervisor to determine whether reanalysis is required.

9.15.2 Corrective Action for surrogate recovery failure: check calculations and examine the chromatogram for interference. If no interference is noted, reanalyze any sample that exceeds criteria. If the sample meets criteria upon reanalysis, report the reanalysis only. If the sample produced similar results upon reanalysis, the problem may be matrix-related. Contact the project manager so the client may be notified.

9.15.3 Corrective Action for Internal Standard Response failures: if any internal standard exceeds acceptance criteria, check calculations. Verify that the standard concentration is accurate, and that the instrument did not malfunction. Reanalyze the sample to see if the problem was matrix related. If the reanalysis meets criteria, report the reanalysis only. If the reanalysis produced similar results, consult with the section supervisor and project manager to determine the best course of action.

9.15.4 Corrective Action for Internal Standard Retention Time: if any internal standard exceeded retention time criteria, follow the same guidelines used in Section 9.14.3.

9.15.5 Corrective Action for Instrument Contamination: if an instrument has come into contact with a PPM level of analytes, the instrument might need extra cleaning to ensure that there is no carry-over to other client samples. Block access to the ports affected on the Entech autosampler until they go through at least 5 flush and bake cycles. Test the ports, as room air blanks, to see if there is carry-over. If there no carry-over, go ahead and use the ports during the next run. If there is carry-over, see section supervisor for other possible actions, which may include cleaning the source.

10.0 DOCUMENTATION

10.1 The raw data is archived to CD-ROM and is stored in a secured area. Hard copies of raw data are kept for a period of ~1 year in the laboratory and then stored for a total time of 5 years before disposal.

10.2 Chain of custody forms, instrument maintenance logs, standards preparation logs, analytical run logs, and corrective action logs must be filled out in a timely manner. These records are maintained in the laboratory for five years.

11.0 CALCULATIONS

All calculations are covered in Section 9.

12.0 QUALITY CONTROL CHECKS & CRITERIA

12.1 Instrument performance must be monitored to ensure that all of the tuning, initial calibration and calibration verification criteria requirements are met.

12.2 Method blanks

12.2.1 A method blank is a volume of a clean reference matrix (nitrogen @ 99.9999% purity) carried through the entire analytical procedure. The volume of the method blank must be approximately equal to the volume of the associated samples. The purpose of the method blank is to determine the level of contamination associated with the preparation and analysis of samples.

12.2.2 Method blanks must be analyzed with each batch of samples, or at a minimum frequency of 1 for every 20 samples.

12.2.3 A method blank is analyzed following the calibration verification standard under the same conditions as the standards and samples before any samples may be analyzed.

12.2.4 The method blank must contain no targets above the LOQ of 5-ppbv (100cc injection for Minican) and 0.2-ppbv (500cc injection for 6-L Summa canisters) for the TO15 list. ***They should contain no targets above client specific detection limits for SIM analysis.*** The LOQ for Ethylene Oxide is 20-ppbv and the 4-Phenylcyclohexene LOQ is 1-ppbv.

12.2.5 If the method blank does not meet this criterion, repeat the analysis until an acceptable blank is obtained. Sample analysis may not begin until a method blank meeting criteria has been successfully analyzed.

12.2.6 If the surrogate recovery in the method blank does not meet control limits, reanalyze the method blank. If the surrogate recovery is still outside control limits, it may be necessary to re-prepare the internal standard/surrogate mixture or recalibrate the instrument.

12.3 Laboratory Control Sample/ Laboratory Control Sample Duplicate

12.3.1 A laboratory control sample & duplicate (LCS/LCSD) consist of an aliquot of a clean reference matrix (UHP nitrogen), spiked with a representative list of the target analytes at the mid-level of the calibration curve. The spiking standard must be from a source different from that of the calibration standards.

12.3.2 The LCS & LCSD must be analyzed with each analytical run. The recoveries should fall within the range of 70-130%. For compounds 1,2,4-Trichlorobenzene and Hexachloro-1, 3-Butadiene, separate limits have been established based on historical laboratory data (these compounds are no longer in the TO-15 regular list). RPD method default limits of 25% are used to assess analytical precision. If recovery and/or RPD are not within this range, the possible effect(s) on the sample data must be determined. The data may be qualified or the LCS/LCSD sample may be reanalyzed.

12.4 Surrogate Recoveries

12.4.1 All samples, including quality control samples, are spiked with 50ppbv Bromofluorobenzene as a surrogate.

12.4.2 The surrogate (BFB) recovery control limits are 80-120%. All samples should meet the surrogate recovery criterion. If BFB recovery falls outside control limits for any sample, the sample must be reanalyzed. If the reanalysis produces similar results, contact the project manager.

12.5 Duplicate analysis.

12.5.1 A sample is analyzed in duplicate to assess precision. Duplicates must be analyzed with each batch of samples, or at a minimum frequency of 1 for every 24-hour analytical sequence. The relative percent difference (RPD) between measurements should be 25% or less.

12.6 Initial Demonstration of Proficiency (IDP)

12.6.1 Demonstration of proficiency is established by generating data of acceptable accuracy and precision for target analytes for each preparative method and matrix by analyzing reference samples. On-going demonstration is performed on a semiannual basis.

12.6.2 Four reference samples are prepared so that each analyst tests 4 samples of unknown concentration containing all analytes of interest. Analyst One prepares two different stock standards independently and fills two sample canisters from each. The preparing analyst labels the canisters with the injection volume to use and gives them a sample ID. This results in 4 different concentrations for each analyst. A second analyst repeats the process for any other analysts. The standards must be made from stock standards prepared independently from those used for calibration. The concentration of targets in the four reference samples may be anywhere within the current calibration range of the instrument.

12.6.3 Analyze the four reference samples by the same procedure used for analyzing actual samples. Calculate both the average recoveries in ppbv and the relative standard deviations of the recovery for each analyte of interest. The average recovery should fall within the in-house generated control limits for each analyte.

12.6.4 IDP procedures must be repeated whenever new staff is trained or significant changes in preparative or analytical methods are made.

12.7 Verification of Method Detection Limit

12.7.1 Instrument reporting limits are verified (at least) annually by analyzing 7 replicates at the reporting limit. All compounds must be within 60-140% recovery for the detection limit standard (DLS) when using a nominal sample injection volume of 100-cc for MiniCan, 500-cc for Summa Canisters ***or 1000-***

cc for SIM analysis.

12.7.2 Alternatively, an MDL study can be performed if needed. MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The MDL is determined by the analysis of seven replicate injections of each compound of interest at a level near the expected detection limit. The standard deviation of the seven measurements multiplied by 3.14 (Student's *t* value for 99% confidence for seven values) defines the MDL for each analyte.

12.7.3 MDLs are determined only if needed for each instrument, as the detection limit studies (described in 12.7.1) are used to verify instrument-reporting limits.

12.7.4 ***For SIM analysis, detection limits should meet or exceed client specifications.***

12.8 Additional Control Procedures

12.8.1 Logbook Review Procedure:
The supervisor or designee will review GCMS run logs and maintenance logs weekly. The logbooks will be reviewed for content and for the absence of cross outs. All forms will be verified to be the most recent approved version. Logbooks will be initialed and dated as to the date of review. MS-Form-6 will be used to document that all logbooks are reviewed as per their set schedule. The preventative maintenance log will be reviewed as the maintenance is done (some is weekly, some monthly and also some at 6-12 month intervals). The standards logbooks are reviewed each time a standard is made. Can cleaning logbooks and canister dilution logbooks will be reviewed weekly.

12.8.2 Forms Control Procedure:
In addition to forms being reviewed on a weekly basis new forms once approved (notification through email) will be printed and a new logbook made by the end of the next business day. Previous logbooks will be closed out and archived.

12.8.3 Preventative Action Plan Initiation/Review Policy:
A PAP should be initiated whenever an action can be initiated to prevent a future problem. Consultation with the QC group will be used to determine if a PAP is required. PAPs will be reviewed at least weekly until completed.

12.8.4 Entech auto-sampler ports are flushed before use and this is indicated on system injection log.

12.8.5 All working standard numbers (IH numbers) will be verified on hard copy reports and in LIMS to ensure accuracy and traceability for standard documentation.

12.8.6 Sample Canister Cleaning Approval Procedure.
This procedure is used to ensure sample analysis is complete before sample canisters are cleaned. After a sample analysis sequence is complete, canisters are placed in project holding bin (red or purple) waiting for approval of all Quality control and sample results. If any re-analysis is required, those samples are kept

in this bin until re-analysis is performed. When approval is given by supervisor and/or designee to clean sample canisters, canisters are then transferred to the "approved for cleaning bin" (black or blue) by verifying sample identification using Galson Login number and individual sample number. This bin is then taken to the sample cleaning area.

13.0 CORRECTIVE ACTION

13.1 See section 9.14 for corrective actions.

14.0 WASTE DISPOSAL

14.1 Refer to Galson Laboratories SOP LF-DISPO (current revision).

15.0 REFERENCES

15.1 Compendium Method TO-15: Determination of Volatile Organic Compounds (VOCs) In Air Collected I Specially-Prepared Canisters And Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS), Second Edition, U. S. Environmental Protection Agency, Research Triangle Park, NC 27711, EPA/626/R-96/010b, January 1999.

15.2 PV2120: Volatile Organic Compounds in Air, U. S. Department of Labor – Occupational Safety & Health Administration, Control Number T-PV2120-01-0305-ACT, May 2003

16.0 METHOD MODIFICATIONS

Method PV2120:

The samples arrive in the lab at ~ 15 psia (atmospheric pressure, 0 psig) and this is adequate to sample without pressurizing (diluting) the sample up to 30 psig (45 psia).

Method TO-15: (parentheses denote method-referenced sections)

(10.7.5)
Daily blank limit is set at 5-ppbv for TO15 list (the normal reporting limit for most compounds), not 3x the MDL.

(8.4.1.2)
Can leak-checks are done by evacuating cans to ~ 30" of Mercury (vacuum reading), and then checking them before sample shipment. If vacuum falls to <28" of Mercury within 24 hours, a can is considered to be leaking (TO-15 leak-checks by pressurizing cans to 30 psig and has pass/fail criteria of <+/- 2 psig) in 24 hours.

(8.4.1.6)
Cans containing less than 2-ppm of individual contaminants are cleaned in batches where a representative can is tested to demonstrate cleanliness of the batch. For cans containing analytes greater than 2-ppm, these cans are tested individually to verify cleanliness. Can cleaning limits are higher (refer to section 9.2.2.2). For MiniCans: the

representative can cleaning blank limit (or individual can) for TO-15 list is set at 5-ppbv, the normal reporting limit. The warning limit is 2.5-ppbv. Quantitation in general is not reliable below 5-ppbv. Cans are generally re-cleaned if above 2.5-ppbv for any analyte. For 6-L Summa Canisters: the cleaning blank limit is 0.2-ppbv (IDL for most compounds), anything less than 0.2-ppbv is considered clean. Correspondingly, for Ethylene Oxide the limit is 20-ppbv and for 4-Phenylcyclohexene the limit is 1 ppbv.

(10.8.1)
For Minican analysis: 100mL-sample injection volume is used when sampling is done with 400mL and 1-liter canisters rather than 6-liter summa canisters. Therefore, MDL limits, etc. are ~ 5x higher because the sample injection volume is 5x less.

(9.2.2.3)
For Minican analysis: Internal standard/surrogate levels are spiked at 50-ppbv rather than 10-ppbv to be consistent with calibration levels for TO15 list analyses.

(10.7.2)
A blank is not always analyzed after a high level sample. If the compound that was high is detected in samples injected after the high level sample, those samples would be reanalyzed after the system was shown to be clean.

(10.7.5)
Internal standard area limit of +/- 40% is calculated versus the daily standard for all injections that day (24 hour window) not versus the most recent calibration curve average areas.

Table 1
Characteristic Ions, PQLs

COMPOUND	**EI PRIMARY**	**EI SECONDARY**	**EI TERTIARY**	**PQL ppb**	
				Summa	**Minican**
Propylene	41	39		0.2	5
Freon-12	85	87		0.2	5
Chloromethane	50	52		0.2	5
Freon-114	85	135	87	0.2	5
Vinyl Chloride	62	64		0.2	5
1,3-Butadiene	39	54		0.2	5
Bromomethane	94	96		0.2	5
Chloroethane	64	66		0.2	5
Vinyl Bromide	106	108		0.2	5
Freon-11	101	103	105	0.2	5
Isopropyl Alcohol	45	43		0.2	5
Acetone	43	58		0.2	5
1,1-Dichloroethene	96	61	98	0.2	5
Methylene Chloride	84	86	49	0.2	5
Freon-113	101	101	151	0.2	5
Allyl chloride	76	41	39	0.2	5
Carbon Disulfide	76	78		0.2	5
Trans-1,2-Dichloroethene	61	96	98	0.2	5
Methyl Tert-Butyl Ether	73	41	57	0.2	5
1,1-Dichloroethane	63	65		0.2	5
Vinyl Acetate	43	86		0.2	5
Methyl Ethyl Ketone	43	57	72	0.2	5
cis-1,2-Dichloroethylene	61	96	98	0.2	5
Hexane	57	41	43	0.2	5
Ethyl Acetate	43	45	61	0.2	5
Chloroform	83	85	47	0.2	5
Tetrahydrofuran	42	71	72	0.2	5
COMPOUND	**EI PRIMARY**	**EI SECONDARY**	**EI TERTIARY**	**PQL ppb**	
				Summa	**Minican**

1,2-Dichloroethane	62	64		0.2	5
1,1,1-Trichloroethane	97	99	61	0.2	5
Cyclohexane	56	41	84	0.2	5
Carbon Tetrachloride	117	119		0.2	5
Benzene	78	77	50	0.2	5
1,4-Dioxane	88	58		0.8	20
2,2,4-Trimethylpentane	57	41	56	0.2	5
Heptane	43	57	71	0.2	5
1,2-Dichloropropane	63	41	62	0.2	5
Trichloroethylene	130	132	95	0.2	5
Bromodichloromethane	83	85		0.2	5
cis-1,3-Dichloropropene	75	39	77	0.2	5
Trans-1,3-Dichloropropene	75	39	77	0.2	5
1,1,2-Trichloroethane	97	83	61	0.2	5
Toluene	92	91	92	0.2	5
Dibromochloromethane	129	127		0.2	5
Methyl Isobutyl Ketone	43	57	58	0.8	20
Methyl Butyl Ketone	43	57	58	0.8	20
1,2-Dibromomethane	107	109		0.2	5
Tetrachloroethylene	164	166	131	0.2	5
Chlorobenzene	112	77	114	0.2	5
Ethylbenzene	91	106		0.2	5
Bromoform	173	175		0.2	5
Styrene	104	78	103	0.2	5
o-xylene	91	106		0.2	5
m- & p-xylene (co-elute)	91	106		0.4	10
1,1,2,2-Tetrachloroethane	83	85		0.2	5
4-Ethyltoluene	105	120		0.2	5
1,3,5-Trimethylbenzene	105	120		0.2	5

COMPOUND	**EI PRIMARY**	**EI SECONDARY**	**EI TERTIARY**	**PQL ppb**	
				Summa	**Minican**
1,2,4-Trimethylbenzene	105	120		0.2	5
1,3-Dichlorobenzene	146	148	111	0.2	5

Benzyl Chloride	91	126		0.2	5
1,4-Dichlorobenzene	146	148	111	0.2	5
1,2-Dichlorobenzene	146	148	111	0.2	5
1,2,4-Trichlorobenzene	180	182	184	0.2	5
Hexachloro-1,3-Butadiene	225	227	223	0.2	5
Ethylene Oxide	44	29	NA		20
4-Phenylcyclohexene	104	158	78		1
Bromofluorobenzene (surrogate)	95			-	
*Bromochloromethane	128			-	
*1,4-Difluorobenzene	114			-	
*Chlorobenzene-d5	117			-	

*Indicates internal standard

Table 2

Volatile Internal Standards with Corresponding Analytes Assigned for Quantitation

*Bromochloromethane	*1,4-Difluorobenzene	*Chlorobenzene-d5
Propylene	1,1,1-Trichloroethane	Toluene
Freon-12	Cyclohexane	Dibromochloromethane
Chloromethane	Carbon Tetrachloride	Methyl Isobutyl ketone
Freon-114	Benzene	Methyl Butyl ketone
Vinyl Chloride	1,4-Dioxane	1,2-Dibromoethane
1,3-Butadiene	2,2,4-Trimethylpentane	Tetrachloroethylene
Bromomethane	Heptane	Chlorobenzene
Chloroethane	1,2-Dichloropropane	Ethylbenzene
Vinyl bromide	Trichloroethylene	m- & p-xylene (co-elute)
Freon-11	Bromodichloromethane	Styrene
Isopropyl alcohol	cis-1,3-Dichloropropene	o-xylene
Acetone	trans-1,3-Dichloropropene	Bromoform
1,1-Dichloroethene	1,1,2-Trichloroethane	1,1,2,2-Tetrachloroethane
Methylene Chloride		4-Ethyltoluene
Freon-113		1,3,5-Trimethylbenzene
Allyl chloride		1,2,4-Trimethylbenzene
Carbon disulfide		Benzyl chloride
Trans-1,2-Dichloroethene		1,3-Dichlorobenzene
Methyl tert-butyl ether		1,4-Dichlorobenzene
1,1-Dichloroethane		1,2-Dichlorobenzene
Vinyl acetate		1,2,4-Trichlorobenzene
Methyl ethyl ketone (2-butanone)		Hexachloro-1,3-Butadiene
Cis-1,2-Dichloroethylene		Bromofluorobenzene (surrogate)
Hexane		4-Phenylcyclohexene
Ethyl acetate		
Chloroform		
Tetrahydrofuran		
1,2-Dichloroethane		
Ethylene Oxide		