Operation and Maintenance (O&M) Manual
Adelaide Avenue High School
375 Adelaide Avenue, Providence, RI

Prepared for

City of Providence – Department of Public Property
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ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
EA	EA Engineering, Science, and Technology, Inc.
EPA	Environmental Protection Agency
ELUR	Environmental Land Usage Restriction
HVAC	Heating, ventilation, and air conditioning
IMP	Interior monitoring point
LEL	Lower explosive limit
LFG	Landfill gas
LGM	Landfill gas meter
MP	Monitoring point
O&M	Operation and Maintenance
OA	Order of Approval
PID	Photo-ionization detector
PPE	Personal protective equipment
PPM	Parts per million
PVC	Polyvinyl chloride
RAWP	Remedial Action Work Plan
RCR	Remedial Action Closure Report
RIDEM	Rhode Island Department of Environmental Management
SHERP	Safety, Health, and Emergency Response Plan
SSD	Sub-slab depressurization
TLV	Threshold limit value
VOC	Volatile organic compound

1. INTRODUCTION

1.1 PROJECT DESCRIPTION

This Operation and Maintenance (O&M) Manual describes O&M procedures for the Adelaide Avenue High School Indoor Methane Alarm System, the sub-slab depressurization (SSD) system, the engineered cap, and the restrictive fencing installed at the Adelaide Avenue High School site (the Site) located at 375 Adelaide Avenue in Providence, Rhode Island.

1.1.1 Background

The Site, owned by the City of Providence (the City), encompasses approximately 4 acres and is part of the former Gorham Manufacturing Facility. Figure 1 provides a site location map.

Historical Site investigations, deemed complete by the Rhode Island Department of Environmental Management (RIDEM) in 2006, concluded that polycyclic aromatic hydrocarbons (PAHs) in surficial soil and volatile organic compounds (VOCs) in soil vapor are compounds of concern at the Site. A RIDEM-approved Remedial Action Work Plan (RAWP) to remedy the Site and eliminate potential exposure to these compounds of concern was implemented at the Site between June 2006 and August 2007. The RAWP included the following elements: (1) construction of an engineered cap and institution of an Environmental Land Usage Restriction (ELUR) to eliminate the potential for direct exposure to contaminated soil by Site users; (2) installation of an active, SSD system to remove potentially harmful soil vapors from beneath the school building slab, thereby eliminating the potential for such vapors to enter into the future school building via subsurface vapor intrusion; (3) installation of a continuous interior methane monitoring and alarm system to monitor methane concentrations in the school and notify school administrators and other responsible representatives in the event that elevated methane levels are detected or if there is a failure of the SSD system extraction fans; and (4) installation, monitoring, and maintenance of a fence designed to prohibit access to areas abutting the Site that are yet to be fully characterized and/or remediated at the time this O&M Manual was finalized.

RIDEM approval of the remedy is documented in an Order of Approval (OA) issued to the City in June 2006, and in two separate Amended Orders of Approval issued in February and July 2007, respectively. For the purposes of this document, the collective Orders of Approval and Amendments (copies provided in Appendix A), will be referred to as the Amended OA. Completion of the RAWP was documented in a Remedial Action Closure Report (RACR) dated and submitted to RIDEM in August 2007. A copy of the RACR (text and As-Built drawings only) is provided in Appendix B.

1.1.2 Objective

The objective of this O&M Manual is to provide guidance relative to routine O&M procedures to ensure efficient, effective, and safe system operation, as well as compliance with system monitoring requirements specified in the RIDEM Amended OA.

1.2 PERSONNEL REQUIREMENTS AND TECHNICAL ASSISTANCE CONTACTS

This O&M Manual is intended to serve as a general guide for operating and maintaining the SSD System, the indoor methane alarm monitoring system, and for complying with the various site inspection, monitoring, and sampling requirements specified in the RIDEM Amended OA. The information contained within this O&M Manual should be used in conjunction with the manufacturer's information and recommendations included in the appendices provided herein. This O&M Manual does not describe all possible O&M functions in detail, but rather identifies normal operating procedures. As such, O&M functions should only be performed by authorized and trained personnel designated by the City.

It is anticipated that a trained technician will be onsite periodically to collect monitoring data and perform maintenance as needed. Prior to performing work onsite, said personnel should thoroughly review and familiarize themselves with the contents of this O&M Manual and appendices. Appendix E contains the names and phone numbers for various technical assistance contacts familiar with the SSD and methane monitoring systems.

1.3 MANUAL ORGANIZATION

This O&M Manual describes the recommended O&M of each major component of the SSD system and methane monitoring system, and is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Remedial Design
- Section 3 – Equipment Cut-Sheets and Manufacturer Supplied User's Manuals
- Section 4 – General Operational Guidelines and RIDEM Requirements
- Section 5 – Detailed O&M Procedures and Forms
- Section 6 – Disclaimer.

2. REMEDIAL DESIGN

2.1 OBJECTIVES

The remedial objective of the RIDEM-approved SSD system is to mitigate the potential accumulation of VOCs and methane gas from beneath the concrete slab of the existing school structure in order to eliminate the potential for soil vapor intrusion into the school. The objective of the interior methane monitoring system is to continuously monitor methane concentrations in various representative areas of the school building, and to provide notification to school administrators and other responsible officials in the event that elevated methane concentrations are detected or if there is a failure of the SSD system. The objective of the engineered cap is to prevent exposure to compounds of concern identified in site soils. Restricting access to areas that abut the Site which are still undergoing site investigation and/or remediation activities is the objective of the fencing installed on the school property.

As-Built Drawings and manufacturer-supplied cut sheets for the engineered cap and the SSD and interior methane alarm system components are included in Appendix B.

2.2 SSD SYSTEM

The design of the active SSD system proposed for the Site was based upon the U.S. Environmental Protection Agency's (EPA's) guidance for radon gas evacuation systems as outlined in Radon Prevention in the Design and Construction of Schools and Other Large Buildings, EPA/625/R-92/016 (January 1993). The SSD system is designed to create a low-pressure zone (i.e., vacuum) beneath the school structure which will prevent VOCs and methane (if any) from entering the building through a series of suction fans, subsurface piping, sub-slab aggregate material, and other design features. Air exhausted from under the slab is released to the atmosphere above the roof.

Air emission design calculations, based upon soil gas data for the Site collected prior to RAWP implementation, predicted that no permits and no treatment of the system effluent will be required. Air emission samples from the three rooftop suction fans, collected in March 2007 after the SSD system was initially turned on-line and again in June 2007, confirmed that no RIDEM air permit applicability thresholds were exceeded. Annual sampling of the air emissions is required to ensure that no air permit applicability thresholds are exceeded.

Each of the major design components of the SSD system is presented in the following subsections. Please refer to the As-Built SSD System Drawings in Appendix B for more details if needed.

2.2.1 Sub-Slab Aggregate Material

An approximate 6-in. layer of aggregate material meeting American Society for Testing and Materials Size No. 5 specifications or equivalent (approximately 0.5- to 1-in. diameter) was evenly placed beneath the entire building slab. A 6-mil polyethylene vapor barrier was placed on top of the aggregate material prior to pouring of the concrete slab to prevent wet concrete from entering the void spaces in the aggregate layer.

2.2.2 Vapor Suction Pits

A total of eight vapor suction pits were installed beneath the building slab to facilitate communication throughout the sub-slab aggregate layer. Each suction pit was constructed as a 4-ft × 4-ft × 8-in. deep void area within the aggregate layer in various locations beneath the school building slab.

2.2.3 Vent Piping

Each suction pit installed beneath the slab is connected via horizontal 4-in. diameter polyvinyl chloride (PVC) vent pipe to one of three vertical risers extending through the floor slab and continuing up through the building roof. All piping joints are solvent welded, and all exposed riser piping within the school either passes through rooms that students do not have access to (e.g., mechanical or electrical rooms) or is located at elevations that render the piping inaccessible. The three vent piping risers penetrate through the school building roofline and terminate a minimum of 25-ft. from any outdoor air intake to reduce the potential for SSD system entry into the building.

2.2.4 Suction Fans

Three in-line suction fans, each capable of providing approximately 500 ft^3 per minute (cfm) of air flow at 0 in. of water column static pressure were installed to create negative pressure beneath the building and exhaust potential sub-slab vapors to the atmosphere. The fans were installed in line with the roof top vent piping via rubber sewage pipe connectors to facilitate proper sealing, quiet operation, and fan maintenance/replacement activities (if needed). The fans were installed on the roof to eliminate the potential adverse effects caused by piping leaks, if any, on the exhaust side of the fans. The SSD system includes electronic controls on each suction fan which are tied into a warning notification light, audible alarm, and an auto dialer to notify responsible personnel if a significant reduction in airflow has occurred at any of the fans (i.e., system operational problem). The system warning light, audible alarm, and auto dialer are located in the school administration office area.

2.2.5 System Monitoring and Sampling Locations

Multiple representative monitoring and sampling locations have been installed at the Site within the sub-slab region, the building interior, and on the rooftop of the school building. These monitoring and sampling locations are discussed in the following subsections.

2.2.5.1 Sub-Slab Monitoring/Sampling Locations

A total of eleven representative monitoring/sampling points were installed beneath the school building. Eight of the monitoring points, labeled MP-1 though MP-8 on the As-Built SSD System Drawings in Appendix B, consist of 10-20 ft. of 1-in. diameter PVC piping extending from grade just outside of the school building into the aggregate layer beneath the building, and are terminated with a 2-ft length of PVC screen wrapped in fabric filter to facilitate vapor monitoring and/or sampling. A bolt-down, gasketed, protective road-box was installed over each of these eight monitoring points flush within the concrete or landscaped areas surrounding the school building. Three of the monitoring points, labeled IMP-1 through IMP-3 on the As-Built SSD System Drawings in Appendix B, were installed through the concrete slab at various interior locations within the school structure. Each of the interior monitoring points consists of an 8-inch stainless steel, recessed, sealed probe finished with a bolt-down, gasketed, protective enclosure.

2.3 INDOOR METHANE MONITORING SYSTEM

The indoor methane monitoring system includes eight continuous methane monitoring locations located throughout the first floor of the school building. Each sensor is electronically connected to a controller equipped with a battery backup feature, visual warning notification light, an audible alarm, and an auto dialer in the school administration area. The continuous methane sensors are equipped to trigger an alarm notification at the controller when the concentration of methane gas at any of the sensors is equal to or greater than 500 ppm or 1 percent of the methane LEL for a period of approximately 1.5 consecutive minutes. In the absence of OSHA standards regarding permissible methane exposure limits, this sensor setting was selected based upon the threshold limit value (TLV) guidance established by the American Conference of Governmental Industrial Hygienists (ACGIH). The ACGIH TLV for methane (2 percent LEL or 1,000 ppm) is a guideline regarding the safe levels of exposure to methane from various hazards found in the workplace. A TLV reflects the level of exposure that a typical worker can experience without an unreasonable risk of disease or injury. A sensor setting of one-half the ACGIH TLV (1 percent LEL or 500 ppm) was selected to afford a significant measure of additional Site safety.

2.4 ENGINEERED CAP

The engineered cap consists of the following layers: 1) closure cap subgrade; 2) geosynthetic fabric filter layer (for some landscaped areas); 3) protective cover soil; 4) vegetative cover; and 5) Site improvements. These cap components are more fully described below, in order of ascendance above the native site soils. Cross-section details of the engineered cap are included on the As-Built Drawings provided in Appendix B.

2.4.1 Closure Cap Subgrade

A closure cap subgrade was prepared from the existing site grade to create adequate storm water drainage for the Site and serve as a suitable base for other components of the closure cap system.

2.4.2 Geosynthetic Fabric Filter Layer

A geosynthetic fabric filter layer (ProPex 4510) was placed above the closure cap subgrade and below a protective soil cover for virtually all landscaped areas of the site to prevent human exposure to impacted soil. The only landscaped areas where fabric was not installed beneath the protective soil cover were areas where a minimum of 2-feet of clean fill was installed. These areas include the landscaped island within the pavement in front of the school building, a landscaped area near the school's southwest corner, and the landscaped areas in the northern portion of the Site where RIDEM required 2-feet of clean fill.

2.4.3 Protective Cover Soil Layer/Vegetative Cover

The protective cover soil layer of the closure cap system, also commonly termed the vegetative support soil layer, consists of a minimum of 2-ft. of certified clean fill material or equivalent in all areas of the site, and a minimum of 2-ft. of clean soil in all areas known or suspected to be subject to the RIDEM Rules and Regulations for Composting Facilities and Solid Waste Management Facilities (Solid Waste Regulations), and under the jurisdiction of RIDEM's Solid Waste Program. One foot of clean fill material over the approved geosynthetic fabric filter layer, 4-in. of concrete or asphalt over 6 in. of appropriate clean fill/gravel base, or the concrete building slab over 6-in. of gravel aggregate are all considered to be the "equivalent" of 2-ft. of clean fill for this project. The upper 4 – 8 in. of the soil layer consisted of organic topsoil (i.e., loam) to support vegetation.

2.4.4 Site Improvements

The Adelaide Avenue School development includes extensive non-landscaped areas containing the school structure, paved roadways, paved walkways, and paved parking areas. Asphalt areas include a minimum of 6 in. of appropriate base coarse fill material covered with a minimum of 4 in. of bituminous asphalt (combined binder and wearing course). Concrete pavement areas include a minimum of 4 in. of poured concrete over a minimum of 6 in. of appropriate base coarse material. An active sub-slab venting system, consisting of a network of suction fans, piping, and suction pits designed to create a negative pressure beneath the school, was installed beneath the building structure. The school's concrete slab foundation serves as the cap beneath the school.

2.5 RESTRICTIVE FENCING

At the time that the Site remedy was being implemented, abutting areas to the north and west of the Site were still undergoing site investigation and/or remediation under the jurisdiction of RIDEM. Therefore, an 8-ft. high chain link fence was erected along the entire western property boundary and upgradient of/parallel to the Site's northern boundary to restrict access to these abutting areas. The fencing running east-west upgradient of and parallel to the Site's northern boundary ties into previously installed off-site restrictive fencing just beyond the Site's northeast property corner.

3. EQUIPMENT CUT-SHEETS AND USER'S MANUALS

The following equipment cut-sheets and/or user's manuals associated with the installed site remedy or with routine O&M currently performed at the Site are provided in Appendix C.

- Geosynthetic fabric filter layer (ProPex 4510).
- In-line suction fans (Fantech FR250).
- Methane sensors/detectors (DOD Technologies PS-7).
- Methane monitoring system controller (DOD Technologies PS-7000).
- Monitoring system auto dialer (United Security Products, Inc. Model AVD-45 B).
- Landfill gas detector (Landfill Control Technologies Model GEM-500).
- Photoionization detector (RAE Systems Model ppbRAE).

All personnel required to perform O&M or site compliance monitoring and sampling should read the manufacturer's specifications and User's Manuals carefully and familiarize themselves with all applicable system component O&M requirements specified therein.

4. GENERAL OPERATIONAL GUIDELINES AND RIDEM REQUIREMENTS

4.1 SSD AND INTERIOR METHANE SYSTEMS

Although the SSD and interior methane monitoring systems are primarily independent of each other, both systems are tied into the auto dialer feature of the remedial design, and the majority of routine O&M for both systems is performed concurrently. Therefore, both systems are discussed together in this section.

The SSD system and the interior methane monitoring system are based upon designs with little or no maintenance requirements. In addition, safety mechanisms (auto dialer, audible alarm, etc.) are in place to notify school administrators and other responsible officials in the event that either of the three roof-top fans experiences a mechanical failure or in the event that elevated methane concentrations are detected within the school.

A spare fan was been procured at the start of SSD system operation to minimize down time if a roof-top fan replacement is necessary. Should one of the roof-top fans fail, the replacement fan will be installed as soon as possible to maintain the integrity of the system, and sub-slab vacuum measurements at each of the eleven sub-slab monitoring points will be performed to identify potential areas where negative pressures may have become compromised and indoor areas where supplemental precautionary air sampling may be prudent. In the event that the spare fan is put into operation, a new spare should be procured as soon as possible to minimize future down time in the event that another fan replacement is required. The spare fan is to be clearly labeled and stored in first floor maintenance office of the school.

A series of eight methane sensors continuously monitor the air quality at various locations throughout the first floor of the school building for methane. Each sensor is equipped with an air filter element that should be replaced a minimum of once every six months. In accordance with a recommendation made by the methane sensor vendor who installed the system, these filter elements are currently scheduled to be replaced by EA (City's environmental contractor) on a quarterly schedule. A spare sensor was been procured at the start of interior methane monitoring system operation to minimize down time if a sensor replacement is necessary. Should one of the sensors require replacement, the replacement sensor should be installed as soon as possible to maintain the integrity of the system, and interior methane measurements via hand-held monitoring equipment within the area affected by the failed sensor(s) should also be performed to ensure that elevated methane is not present in the area. In the event that the spare sensor is put into operation, a new spare should be procured as soon as possible to minimize future down time in the event that another sensor replacement is required. The spare sensor is to be clearly labeled and stored in the first floor maintenance office of the school.

There are no periodic maintenance requirements specified for the methane system controller, and all remaining components of the SSD and methane monitoring systems consist of valves, piping, and tubing with no specific service requirements, although periodic inspections will be performed along with any necessary repairs/replacements by appropriate personnel.

Any unintentional shut-downs to either of the systems are to be reported to RIDEM and documented in accordance with the protocol detailed in Section 5.1.4 of this O&M Manual.

4.2 RIDEM ORDER OF APPROVAL O&M REQUIREMENTS

The RIDEM Amended OA (refer to Appendix A) includes the following monitoring and sampling requirements. Please note that the following list is not intended to be a comprehensive list of all requirements outlined in the Amended OA. The responsible City officials or designated party should read the RIDEM Amended OA carefully and familiarize themselves with all requirements specified therein.

- Continuous methane monitoring at various locations within the first floor of the school building.

- Periodic methane and VOC monitoring with hand-held instrumentation at all 11 sub-slab vapor points, 8 indoor sampling locations, and 3 roof-top fan effluent sampling locations. In addition, periodic sub-slab vacuum measurements (via magnehelic gauge), and air velocity measurements at each roof-top fan location (via anemometer) will be performed. The monitoring frequency for these parameters at the time this O&M Manual was finalized is once per month.

- With respect to air sampling, the Amended OA requires that monthly VOC sampling be completed at 4 of the 11 sub-slab monitoring points (2 interior and 2 perimeter locations, selected on a rotational basis such that each location is sampled at an equal frequency) and all eight of the indoor air sampling locations. One ambient air sample will also be collected from outside the school building during each sampling event. In addition, on an annual basis, air samples from each of the three roof-top fans will be collected to calculate cumulative emissions from the SSD system and determine if treatment, permitting, or registration of the system is required.

- Specific procedures (refer to Section 6[e][vi through viii] of the RIDEM Order of Approval provided in Appendix A) for responding to Action Level exceedances and equipment shutdowns (intentional and unintentional), and for providing verbal notification to RIDEM, follow-up written documentation, and appropriate responses to re-establish compliance and protect human health and the environment.

- Preparation and submission of quarterly air monitoring reports.

- Any deficiencies in the engineered cap shall be immediately reported to RIDEM and shall be repaired within 14 days, and documentation summarizing the repairs shall be submitted to RIDEM within 5 days of completion of the repairs.

The RIDEM Action Level exceedences that require specific responses by the City of Providence are summarized below:

- Within the school building, the methane Action Level is 1% of the methane LEL.

- Under the school building, the methane Action Level is 10% of the methane LEL.

- Within the school building, the VOC Action Levels are the State of Connecticut Draft Proposed Residential Target Air Concentrations with the exception of those compounds for which alternative Action Levels have been established – please refer to the Amended OA for a listing of the VOCs for which alternative Action Levels have been established.

5. DETAILED O&M PROCEDURES AND FORMS

5.1 SSD AND INTERIOR METHANE MONITORING SYSTEM O&M

System O&M should only be performed by qualified and authorized employees or representatives of the City of Providence. Prior to performing system O&M, the individual(s) should read this O&M Manual, including all appendices.

5.1.1 SSD System

During SSD system O&M, the following data should be routinely collected. The data should be recorded on the System O&M Form included in Appendix D. These forms should be included in quarterly status reports furnished to RIDEM.

- General status of the SSD System (e.g., roof-top fans on-line, off-line, etc.).
- The roof-top fan vacuum gauge readings, air velocity measurement, effluent VOC concentration, and effluent %LEL reading.

5.1.2 Interior Methane Monitoring System

During O&M of the interior methane monitoring system, the following data should be routinely collected. The data should be recorded on the System O&M Form included in Appendix D. These forms should be included in quarterly status reports furnished to RIDEM.

- General status of the methane system controller and each of the methane sensors (e.g., on-line, off-line, etc.).
- Integrity of each of the sensor fittings located within the various rooms where the indoor methane is continuously monitored.

- Methane sensor reading from each of the eight sensors.
- Date of last filter element replacement and whether a replacement is being made during the current O&M visit.

5.1.3 Air Monitoring and Sampling

During air monitoring and sampling activities at the site, the following data should be recorded on the System O&M Form included in Appendix D. These forms should be included in quarterly status reports furnished to RIDEM.

- For indoor air monitoring and sampling:
    - The location of the monitoring/sampling (i.e., gymnasium, Room 118, etc.).
    - Status of HVAC system operation and any observations within the monitoring/sampling locations that may impact the monitoring/sampling results.
    - Calibration information for field instrumentation being used, as applicable.
    - VOC and methane monitoring readings. In the event that the RIDEM Action Level for methane inside the Site building (1% LEL) is exceeded, the individual performing the O&M should recheck the %LEL with the field instrument. If the data still exceeds the action level, the %LEL should be rechecked again after the instrument's calibration is verified or the instrument is re-calibrated. If the instrument is functioning properly, is properly calibrated, and the %LEL still exceeds 1%, then the data should be recorded on the System O&M Form and the necessary requirements outlined in the RIDEM Amended OA (notify RIDEM orally and in writing, take steps to address the non-compliance, etc.) should be followed.
    - During air sampling events, record the appropriate data in accordance with the analytical laboratory procedures applicable to the type of sampling being

completed. For example, for summa canister sampling for VOC analysis, record the summa canister and flow controller identification numbers, the sampling start time and initial canister vacuum, and the sample collection end time and canister vacuum. Secure the sampling locations such that no interferences or interruptions to the sampling procedure occur. In the event that any sampling interferences or interruptions do occur, document the event on the O&M Form. Summa canisters are to be placed within the various sampling areas inside the school such that the sample air intake is located approximately 2-ft above the floor level. Complete the sampling in accordance with the laboratory protocol that is specific to the type of sampling being performed. Complete the laboratory chain-of-custody and submit the samples to the analytical laboratory in accordance with laboratory protocols.

- For sub-slab air monitoring and sampling:

    - The location of the monitoring/sampling (i.e., MP-1, IMP-2, etc.).
    - Status of the SSD System.
    - Any observations within the monitoring/sampling locations that may impact the monitoring/sampling results.
    - Calibration information for field instrumentation being used, as applicable.
    - Sub-slab vacuum measurement within the monitoring/sampling location.
    - Immediately prior to sample collection, record VOC and methane concentrations utilizing field instrumentation. For perimeter sub-slab monitoring/sampling locations only, ensure that the PID and landfill gas analyzers are applied to each monitoring/sampling point for approximately 7-10 minutes to obtain representative sub-slab data. Because the interior monitoring points are only 8-inches long and penetrate directly through the slab, representative sub-slab data is immediately obtainable and therefore there is no need to extract air for the same length of time. In the event that the RIDEM Action Level for methane beneath the Site building (10% LEL) is exceeded, the individual performing the O&M

should recheck the %LEL with the field instrument. If the data still exceeds the action level, the %LEL should be rechecked again after the instrument's calibration is verified or the instrument is re-calibrated. If the instrument is functioning properly, is properly calibrated, and the %LEL still exceeds 10%, then the data should be recorded on the System O&M Form and the necessary requirements outlined in the RIDEM Order of Approval (notify RIDEM orally and in writing, take steps to address the non-compliance, etc.) should be followed.

- Immediately after VOC and methane monitoring, connect the air sampling canister to the sampling port via Teflon tubing and commence with sample collection.
- During air sampling events, record the appropriate data in accordance with the analytical laboratory procedures applicable to the type of sampling being completed. For example, for summa canister sampling for VOC analysis, record the summa canister and flow controller identification numbers, the sampling start time and initial canister vacuum, and the sample collection end time and canister vacuum. Secure the sampling locations such that no interferences or interruptions to the sampling procedure occurs. In the event that any sampling interferences or interruptions do occur, document the event on the O&M Form. Complete the sampling in accordance with the laboratory protocol that is specific to the type of sampling being performed. Complete the laboratory chain-of-custody and submit the samples to the analytical laboratory in accordance with laboratory protocols.

- For ambient outdoor air monitoring and sampling:

  - The location of the ambient monitoring/sampling.
  - Weather conditions, including wind direction and approximate speed, temperature, and precipitation.
  - Calibration information for field instrumentation being used, as applicable.
  - Ambient VOC and methane monitoring readings.

- During air sampling events, record the appropriate data in accordance with the analytical laboratory procedures applicable to the type of sampling being completed. For example, for summa canister sampling for VOC analysis, record the summa canister and flow controller identification numbers, the sampling start time and initial canister vacuum, and the sample collection end time and canister vacuum. To the extent possible, secure the sampling location to prohibit potential interferences to the sampling procedure such as nearby cigarette smoking, vehicle idling, etc. In the event that any sampling interferences or interruptions do occur, document the circumstances on the O&M Form. Complete the sampling in accordance with the laboratory protocol that is specific to the type of sampling being performed. Complete the laboratory chain-of-custody and submit the samples to the analytical laboratory in accordance with laboratory protocols.

- For roof-top fan air monitoring and sampling:

  - The identification number of the roof-top fan being monitored/sampled.
  - Calibration information for field instrumentation being used, as applicable.
  - Operational status, vacuum gauge reading, air velocity measurement, and VOC/methane monitoring readings.
  - During air sampling events, record the appropriate data in accordance with the analytical laboratory procedures applicable to the type of sampling being completed. For example, for summa canister sampling for VOC analysis, record the summa canister and flow controller identification numbers, the sampling start time and initial canister vacuum, and the sample collection end time and canister vacuum. Secure the sampling locations such that no interferences or interruptions to the sampling procedure occurs. In the event that any sampling interferences or interruptions do occur, document the event on the O&M Form. Complete the sampling in accordance with the laboratory protocol that is specific to the type of sampling being performed. Complete the laboratory chain-of-custody and submit the samples to the analytical laboratory in accordance with laboratory protocols.

5.1.4 Requirements For Responses to and Recording of Unintentional System Shut-Downs

In the event that either the SSD or interior methane monitoring system shuts down unintentionally, the audible alarm will notify school administrators and the auto dialer installed within the methane monitoring system control panel will notify the City's environmental contractor and maintenance company. In the event of an unintentional system shut-down, a response as soon as possible should be made by authorized personnel familiar with system O&M (e.g., environmental consultant). An initial determination regarding potential safety concerns must be made, and the authorized responder should troubleshoot the system by following the procedures outlined below:

- Record the date, time, and description of the problem that caused the system to shut down.

- Inspect the system components for any signs of damage, vandalism, or operational problem.

- If required, refer to the troubleshooting and/or system maintenance sections within the appropriate User's Manuals for the respective systems.

- If required, initiate replacement of system components.

- Document any system repairs and/or adjustments as required and clear any system alarm conditions from the control panel.

- If repairs/adjustments can not be made, or if the problem(s) can not be identified, do not attempt to restart the system. Contact the appropriate entity (environmental consultant, equipment supplier, equipment manufacturer, electrician, etc.) for technical assistance. A table of technical assistance contacts is provided in Appendix E.

- Record a description of the failure including the cause (if known) and steps taken to correct the failure and reduce or eliminate the likelihood of the failure repeating itself on the Methane Alarm Report/Unintentional System Shut-Down Form provided in Appendix D.

- Fulfill the oral and written notification requirements to RIDEM, and follow–up repairs, if necessary, as stipulated in the Amended OA (refer to Appendix A).

5.1.4.1 Specific Requirements For Responses to Interior Methane Alarm

Methane is an odorless gas and is lighter than air. Methane can displace oxygen in confined areas, resulting in an oxygen-deficient atmosphere. Methane is considered an asphyxiant at extremely high concentrations and can displace oxygen in the blood. Methane can explode at concentrations of 50,000 ppm or more. The Occupational Safety and Health Administration (OSHA) has no permissible exposure limit for methane, but the National Institute for Occupational Safety and Health's (NIOSH) maximum recommended safe methane concentration for workers during an 8-hour period is 1,000 ppm (2% LEL). OSHA does however state that a level of 10% LEL requires building evacuation. Conservatively, the indoor methane sensors are calibrated to trigger an audible alarm if they detect methane at a concentration that exceeds 50% of the NIOSH recommended safe methane concentration or 500 ppm (1% LEL). Therefore, in the event that elevated methane concentrations are detected within the school building as indicated by the audible (horn) and visible (blinking light) alarm or via routine monitoring activities, the following procedure should be implemented by the environmental consultant on behalf of the City:

First and foremost, it is imperative that health and safety of building occupants be considered the most important factor when evaluating the possible responses to an indoor methane alarm provided below. If, for any reason, a serious threat to human life is known or suspected within the building, building evacuation procedures and notification of the local fire department by dialing "911" should be initiated. The fire department will make a determination relative to the building conditions and whether or not occupancy can resume.

- Notify RIDEM immediately of all alarm incidents, unless such alarm was caused as a result of routine and intentional O&M (e.g., system calibration or testing). Provide RIDEM with a summary of alarm conditions if known, the steps taken to protect human health (i.e., additional monitoring, etc.), and the steps taken or scheduled to be taken to investigate and correct the condition(s) that caused the alarm. Submit a written notification that includes the above information to RIDEM within seven (7) days of the alarm incident at the following address:

  Mr. Joseph T. Martella II, Senior Engineer
  RIDEM - Office of Waste Management
  235 Promenade Street, 3rd Floor
  Providence, RI 02908-5767

- Based upon the information available, evaluate site safety conditions and determine if notification to the local fire department is warranted. The following decision matrix is designed to assist the City and/or their environmental consultant in determining the appropriate response. As it is not feasible to present all potential scenarios that could result at the Site with respect to the methane alarm system, this matrix should only be used as a tool to assist the City and/or their environmental consultant in responding to an indoor air methane alarm.

If Indoor Methane Sensor Concentration is ...	**Then ...**
Less than 1% LEL	No response required.
Greater than 1% LEL but less than 2% LEL	Continue to monitor sensors, contact environmental consultant to confirm that auto dialer notification was received, develop and implement steps to correct the problem, notify RIDEM per Amended OA.

Greater than 2% LEL but less than 10% LEL	Continue to monitor sensors, contact environmental consultant to confirm that auto dialer notification was received, continuously evaluate site safety, develop and implement steps to correct the problem, notify RIDEM, evacuate building occupants if greater than 2% persists for 8 or more continuous hours.
Greater than or equal to 10% LEL	Immediately evacuate building and notify local fire department via "911". Once building occupancy is allowed to resume, continue to monitor sensor concentrations, contact environmental consultant for guidance, continuously evaluate site safety, develop and implement steps to correct the problem, notify RIDEM.

- Fully document the incident on the Methane Alarm Report/Unintentional System Shut-Down Form (copy provided in Appendix D).

5.2 Engineered Cap and Restrictive Fencing Inspections

As previously discussed in Section 2.4, the remedy for the Site includes an engineered cap and restrictive fencing along the northern and western Site boundaries to prohibit access to contamination below the Site or at adjacent locations yet to be fully investigated or remediated. Routine inspections of the cap and fencing to document their integrity and to repair any noted deficiencies are required. Therefore, during each routine site visit made to perform system O&M, the following inspections should occur with the findings documented on the System O&M Form (copy provided in Appendix D). Furthermore, in accordance with Item 19(h) of the Amended OA, RIDEM should be notified immediately upon discovery of any deficiencies in the cap or fencing, repairs should be completed within fourteen (14) days, and documentation summarizing the repairs should be submitted to RIDEM within five (5) days of completion of the repairs.

- Inspect the condition of all asphalt and concrete paved surfaces, taking note and photographs of areas with cracks, sinking, or other visible signs of compromised cap integrity (if any).

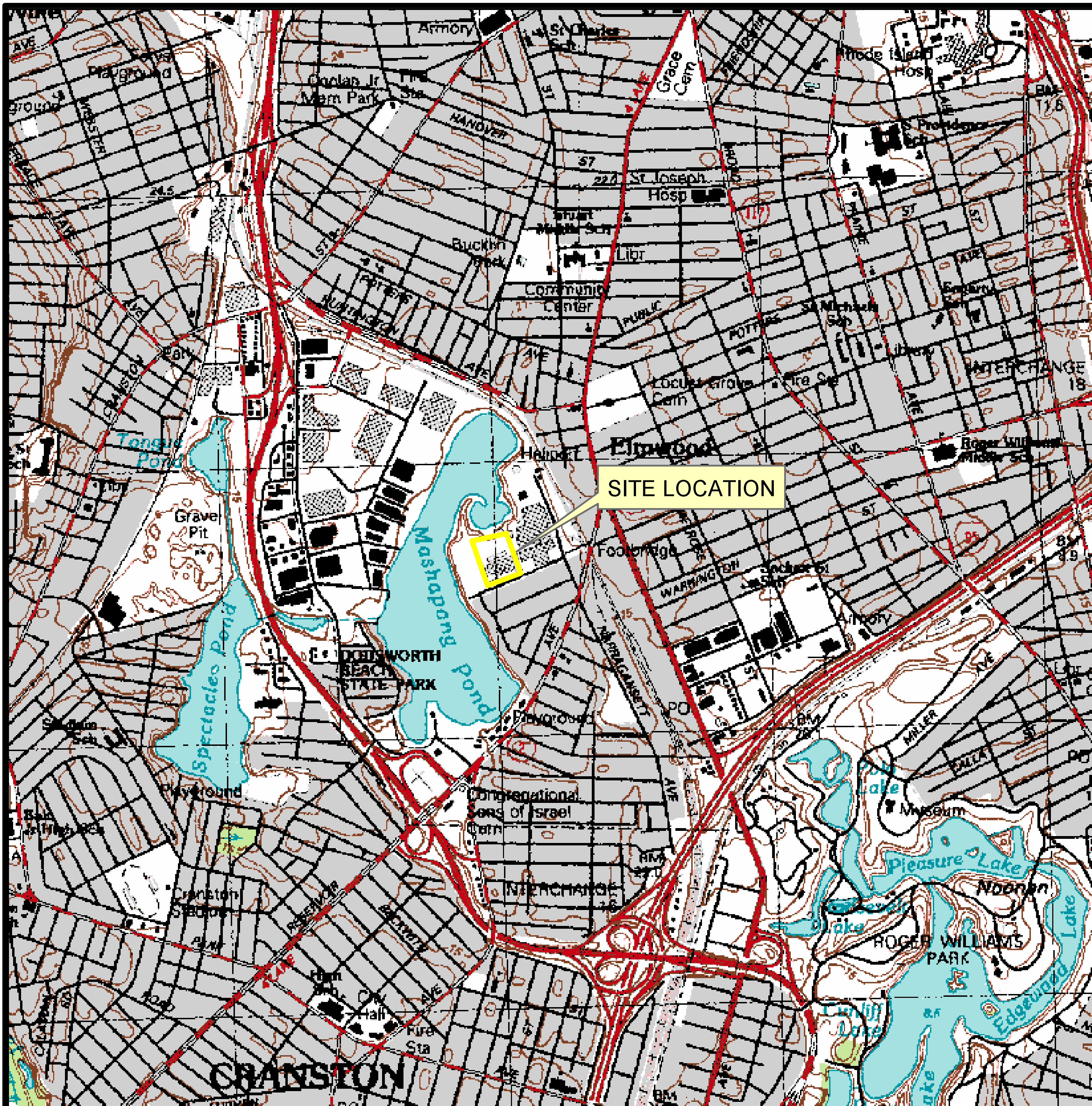
- Inspect all landscaped areas, taking note and photographs of areas of compromised cap integrity (if any).

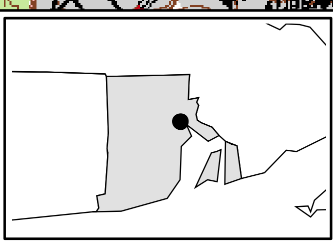
- Inspect the northern and western fence lines, taking note of any areas of damaged or vandalized fencing which compromise the fencing integrity (if any).

Please note that the soil management plan (SMP) included in the ELUR for the Site must be adhered to if any engineered cap/fencing repair work involving the disturbance of native site soils beneath the cap is required.

6. DISCLAIMER

The intent of this O&M Manual is to provide an overview of the remedial design implemented at the Site, equipment specifications, manufacturer's recommended maintenance requirements, RIDEM requirements, and recommended system operation, monitoring, inspection, and maintenance procedures. This O&M Manual is not designed or intended to be a comprehensive, all-inclusive manual detailing all applicable Site related topics. In addition, this O&M Manual does not provide, nor is it intended to provide personnel with all specific protection standards or mandatory safety practices to be followed while O&M activities are being performed. Therefore, EA assumes no liability resulting from the intentional or unintentional use or misuse of this manual or any of the attached appendices by any other individual or entity.





EA	FORMER GORHAM MANUFACTURING SITE, PARCEL B 333 ADELAIDE AVENUE PROVIDENCE, RHODE ISLAND	FIGURE 1 SITE LOCATION MAP

PROJECT MGR:	DESIGNED BY:	CREATED BY:	CHECKED BY:	SCALE:	DATE:	PROJECT NO:	FILE NO:
TR	DC	DC	JP	AS SHOWN	FEBRUARY 2005	6196501	I:\RI\FIG1 333 ADELAIDE_PROV.MXD

Appendix A

RIDEM Order of Approval and Amended Orders of Approval

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
235 Promenade Street, Providence, RI 02908-5767 TDD 401-222-4462

June 9, 2006

CERTIFIED MAIL

Alan Sepe, Acting Director
Department of Public Properties
City of Providence
25 Dorrance Street
Providence, RI 02903

RE: Order of Approval, Proposed Providence Public School Site – Parcel B
Formerly a portion of the Gorham/Textron Dump site, 333 Adelaide Avenue, Providence
City of Providence Tax Assessor's Office Plat 51, Lot 323, Parcel B
Case No. 2005-029 (Formerly part of Case No. 97-030)

Dear Mr. Sepe:

Enclosed please find the Order of Approval (Order) for the proposed remediation plan for the above referenced facility. Please review the stipulations of this Order thoroughly to ensure your compliance with the requirements. This Order places primary responsibility for the construction, operation, maintenance and monitoring of the approved Remedial Action Work Plan (RAWP) on the City of Providence (City). In order to enable the Department to monitor the City's compliance with the RAWP, the Order requires the City to notify the Department of any condition that is non-compliant with the Order or that constitutes an interruption of the RAWP. In order to maintain compliance with the Order and the RAWP, the City's responsibilities under the Order necessarily include the responsibility to respond to and correct non-compliant conditions in a timely, proactive and professional manner that minimizes non-compliance with the Order and RAWP, and protects human health and the environment.

Please notify this office 48 hours prior to the beginning of any work related to the remediation of the property. If you have any questions regarding this matter, please contact me at (401) 222-2797 x7109.

This Order shall be recorded in the land evidence records of the City of Providence as required by law, and a recorded copy must be returned to the Department within 7 days of recording.

Sincerely,

Joseph T. Martella II
Senior Engineer, Office of Waste Management

30% post-consumer fiber

cc: Terrence D. Gray, P.E., Assistant Director, RIDEM/AW&C
Leo Hellested, P.E., Chief, RIDEM/OWM
Kelly J. Owens, RIDEM/OWM
Brian Wagner, Esq., RIDEM/OLS
Christopher Walusiak, RIDEM/OWM
Douglas McVay, RIDEM/OAR
Barbara Morin, RIDEM/OAR
Dr. Robert Vanderslice, PHD, RIDOH
Hon. David N. Cicilline, Mayor, City of Providence
Senator Juan M. Pichardo, District 2
Representative Thomas Slater
Providence City Councilman Ronald Allen
John J. Lombardi, City of Providence
Thomas Deller, City of Providence
Mary McClure, President – Providence School Bd.
Sara Rapport, Esq., City of Providence
James Ryan, Esq, PS&H
Peter M. Grivers, EA
Gregory L. Simpson, Textron
Gerald Petros, Esq., Hinkley Allen
Steven Fischbach, Esq., RILS
Knight Memorial Library – Project Repository

RHODE ISLAND DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

In the matter of Remedial Action Approval at: **Case No. 2005-029**
Proposed Providence Public School Site – Parcel B
(Formerly a portion of the Gorham/Textron Dump site)
333 Adelaide Avenue, Providence, RI, Plat 51, Lot 323 (the Site)

ORDER OF APPROVAL

In the above entitled matter wherein the following documents have been filed by or on behalf of the **City of Providence (City), in its capacity as owner and Responsible Party for the remediation of property located at 333 Adelaide Avenue, Providence**, or are otherwise on record with the Rhode Island Department of Environmental Management (the Department):

1. Remedial Action Work Plan, Former Gorham Manufacturing Facility, Parcel B, Adelaide Avenue, Providence, Rhode Island (RAWP), prepared by EA Engineering, Science, and Technology, Inc. (EA), dated April 2006, received April 26, 2006;

2. Electronic mail from EA to the Department, Re: Gorham ... Proposed Indoor Air Sampling, dated April 28, 2006;

3. Department Comment Letter, Re: Remedial Action Work Plan Comments - Proposed Providence Public School Site, (Former) Gorham Textron Dump Property, 333 Adelaide Avenue, Parcel B, Providence, City of Providence Tax Assessor's Office Plat 51, Lot 323, Parcel B, Case No. 2005-029 (Formerly part of Case No. 97-030), dated May 23, 2006;

4. Response to RAWP Comments, Former Gorham Manufacturing Facility, Parcel B, 333 Adelaide Avenue, Providence, Rhode Island, Case No. 2005-029, prepared by EA, dated May 25, 2006;

5. Letter from EA to the Department, Re: Draft ELUR for Parcel B Former Gorham Manufacturing Facility, Parcel B, 333 Adelaide Avenue, Providence, Rhode Island, Case No. 97-030 (Including Case No. 2005-029 and Case No. 2005-059), including a draft copy of the proposed Environmental Land Usage Restriction, delivered in PDF format via e-mail, dated June 7, 2006; and

6. Letter from Mark V. Dunham, Chief Financial Officer, Providence School Department, Re: Response to RAWP Comment No. 6, Former Gorham Manufacturing Facility, Parcel B, 333 Adelaide Avenue, Providence, Rhode Island, Case No. 2005-029, dated June 6, 2006, received via facsimile machine on June 8, 2006.

Subject to the conditions herein, these documents fulfill the requirements of Section 9.00 (Remedial Action Work Plan) of the Department's Rules and Regulations for the Investigation and Remediation of Hazardous Materials Releases (Remediation Regulations), as amended February 24, 2004, and describe a plan to remediate existing contamination pursuant to 23-19.14-1 et seq. and Department's Remediation Regulations, amended February 24, 2004 in accordance therewith.

This Order of Approval (Order) places primary responsibility for the construction, operation, maintenance and monitoring of the approved Remedial Action Work Plan (RAWP) on the City. In order to enable the Department to monitor the City's compliance with the RAWP, the Order requires the City to notify the Department of any condition that is non-compliant with the Order or that constitutes an interruption of the RAWP and to take immediate action to correct the non-compliant condition. In order to maintain compliance with the Order and the RAWP, the City's responsibilities under the Order necessarily include the responsibility to independently and proactively respond to and correct non-compliant conditions in a timely manner.

As the responsible party and performing party, the City is expected to implement the RAWP semi-autonomously; i.e. with Department oversight but without the need for constant Department direction or approval of the City's activities. The City is also responsible for promptly addressing non-compliant site conditions (e.g. equipment malfunctions or exceedances of established contaminant limits). Upon identifying any non-compliant condition, the City is expected to act accordingly to develop and implement an appropriate response to re-establish compliance. The City's response(s) to non-compliant conditions must be implemented in an expeditious and professional manner that minimizes non-compliance with the Order and RAWP, and protects human health and the environment.

It is the Department's intent that this Order implement clear and specific timelines for deliverables that must be met by the City with respect to the on-site monitoring, reporting and operation & maintenance requirements necessary to maintain the Remedy in a state of compliance. Upon consideration thereof, and in accordance with Rule 10.1 (Remedial Action Approvals) of the Remediation Regulations, the Department conditionally approves said RAWP through this Order, provided that:

1) All work, operations, activities and schedules shall be performed in accordance with the terms and conditions of this Order, the Department approved RAWP, and all other applicable federal, state and local laws and regulations.

2) The City shall prepare and distribute a community notice to the residents in the reservoir triangle neighborhood and to other interested parties (e.g. community groups and local elected officials). The notice shall be printed in English and Spanish and shall include an estimated schedule for remedial activities and construction, a brief description of the work to be performed and the precautions to be taken to protect the community, and relevant contact information for the City and its on-site contractors (name, phone, e-mail … etc.) for questions and complaints.

3) Work shall be initiated at the Site within thirty (30) days of receipt of this Order.

4) No hazardous waste shall be accepted from any off-site sources for treatment or disposal at the Site.

5) Sampling and analysis of all media involved in the Remedial Action shall be conducted in accordance with the requirements of the RAWP and this Order.

6) The Site remedy as described in the RAWP shall incorporate the following:

   a) All work, operations, and activities shall be performed to ensure the applicable remedial objectives for the site are achieved for all hazardous substances at the site, so as to manage actual or potential risks to human health and the environment.

   b) Encapsulation of all regulated site soils through the installation of Department approved engineered controls (including the building foot print, side walks, asphalt parking areas, landscaped areas, or other engineered caps). A Department approved engineered control shall cover every portion of Parcel B up to the "barrier to prevent access to the Park Parcel" described in the March 29, 2006 Superior Court Consent Order (Parcels B & C). All engineered controls shall provide a level of protection equivalent to a minimum of two feet of clean soil. Any additional proposed engineered control design, not previously described in the RAWP and approved through this Order, must be submitted to the Department for approval prior to installation. Engineered control caps consisting of concrete pavement or walkways shall be completed with a minimum six (6) inch base of appropriate clean material covered with a minimum of four (4) inches of concrete. All engineered controls over areas known or suspected to be subject to the Solid Waste Regulations, and under the jurisdiction of the Solid Waste Program, shall consist of a minimum of two feet of clean soil. All regulated site soils and engineered controls shall be subject to an Environmental Land Usage Restriction (ELUR).

   c) Construction, installation, maintenance and continuous operation of an active sub-slab ventilation (SSV) system designed to extract soil vapor from under the building, and to prevent the accumulation and/or buildup of methane gas or volatile organic compounds (VOCs), and to ensure levels of methane and or VOCs are maintained below applicable "Action Levels." The SSV system shall also be equipped with an alarm system, and system operation and maintenance will include periodic monitoring of methane and VOC levels below the building, within the building, and in the extracted soil vapor.

   d) Following the installation of the sub-slab ventilation system, its proper operation shall be tested to demonstrate compliance with the Department approved performance criteria in the final RAWP, and to verify actual emission values, in order to determine if treatment, a permit, or registration for the SSV system is required under the Department's Office of Air Resources (OAR) Air Pollution Control (APC) Regulation No. 9.

e) Implementation of a long term vapor and air-monitoring program sufficient to ensure site conditions are maintained in compliance with the applicable remedial objectives. Said monitoring program shall include at a minimum:

i) Incorporation of remedial "Action Levels" as follows:
   (1) Within buildings, the remedial Action Level shall be 1 percent of the methane lower explosive limit (LEL).
   (2) Under buildings, the remedial Action Level shall be 10 percent of the methane LEL.
   (3) The remedial Action Level for VOCs shall be the Connecticut Residential Proposed Target Indoor Air Concentrations (TACs). An appropriate analytical method shall be selected with a detection limit sufficiently sensitive to allow proper comparison of detected VOC concentrations to each applicable TAC (e.g. speciated VOCs using EPA method TO-15).

ii) The proposed location of each interior methane monitor/alarm (i.e. continuous within the buildings), as well each proposed interior and sub slab sample collection location shall be provided to the Department prior to installation.

iii) Performance of baseline ambient air monitoring within the subsurface slab area and the building interior shall be conducted, prior to system start up and any occupancy, to evaluate concentrations of methane and VOCs at the site.

iv) The schedule for periodic compliance monitoring shall be weekly from system start-up through the first quarter of system operation, followed by monthly provided that there are no exceedances of the applicable remedial Action Levels. After successfully demonstrating one year of continuously compliant system operation, the City may petition the Department to decrease the required monitoring frequency.

v) A minimum of three (3) representative sub slab monitoring locations shall be sampled and analyzed for both methane and VOCs. In the event that concentrations of VOCs in the sub slab air are detected at a level which exceeds an Action Level, VOC samples shall immediately be collected and analyzed from correspondingly representative interior monitoring locations.

vi) In the event that a remedial Action Level is exceeded in a location that is already being addressed by the active sub-slab ventilation system (i.e. indoor air or under a building), the City shall immediately notify the Department by telephone and respond to and correct non-compliant conditions in a timely manner. Written notification to the Department shall follow within seven (7) days with any plans to upgrade or adjust the system to remedy the problem, including steps taken to address the non-compliance. It shall be the City's responsibility to assess immediate threat or emergency situations and to address non-compliant conditions in an expeditious and professional manner that minimizes non-compliance with the Order and RAWP, and protects human health and the environment.

vii) Each of the interior methane monitors shall be operated continuously and be connected to the remote alarm system in such a manner as to trigger the alarm should the concentration of methane in any building exceed the remedial Action Level of 1 percent of the methane LEL. Each interior methane monitor shall be powered in a manner such that operation will not be interrupted during a power failure. In the event that the concentration of methane in any building exceeds the remedial Action Level of 1 percent of the methane LEL, the City shall act accordingly to develop and implement an appropriate response to re-establish compliance, and protect human health and the environment. Response protocols may include, but not necessarily be limited too, building evacuation, notification of the Providence Fire Department via "911", notification of the Department, and other steps, as appropriate, designed to identify and correct any alarm system or SSV system-related problems that may have contributed to site conditions, which caused the methane sensor alarm.

viii) All equipment shutdowns (intentional and unintentional) or operational problems shall be reported to the Department immediately. Intentional equipment shutdowns for regular maintenance shall not require immediate notification to the Department provided that the shutdown is for less than twenty-four (24) hours and the maintenance activity is discussed in the next quarterly report.

ix) Monitoring of methane and VOCs shall continue at the specified rate as long as a source of contamination exists.

f) Preparation and submission of quarterly air monitoring reports in accordance with this Order, and including the recording of the following parameters:

i) The concentrations of methane and VOCs detected in each sample collected and analyzed during monitoring activities for the current reporting period.

ii) A summary table of the concentrations of methane and VOCs detected in each sample collected and analyzed during prior reporting periods.

iii) The occurrences of any alarm activations during the quarter and the resulting activities performed in response to the alarm activation.

iv) The occurrences of any remedial Action Level exceedances during the quarter and resulting activities performed in response to the exceedance.

v) The system operational status during the quarter, particularly noting the length of any system shutdown due to power failure, system malfunction, repairs, scheduled maintenance, etc.

vi) The anticipated delivery date of the next scheduled monitoring report submittal.

g) Management of all Site soil in accordance with the requirements of the RAWP and this Order.

h) Implementation of appropriate procedures to manage, control and monitor regulated soil, asbestos containing material (ACM) and dust in a manner consistent with the asbestos and fugitive dust management precautions employed during the Department-approved Limited Remedial Action Work Plan (LRAWP) for Parcel B, except as amended by the RAWP, including but not limited too:

i) Real-time dust monitoring shall be conducted at the perimeter of the site to ensure that site activities do not create unacceptable impacts to off-site air quality and risks to nearby populations. Dust monitoring results must be submitted to the Department on a weekly basis, at a minimum, and be made part of the Operating Log for the RAWP. The Department must be immediately notified of any exceedances of any approved action levels (see above referenced LRAWP), any corrective action that was performed, and the results and effectiveness of corrective action measures.

ii) Regular application of water to the work area or any area of soil disturbance to control dust through the use of either a water truck equipped with multiple spray nozzles and a manual hose attachment, or multiple oscillating water sprinklers.

i) Preparation and submission of a Remedial Action Closure Report documenting the work performed and including at a minimum the following items:

   i) A post remediation survey of the entire site with as-built plans demarcating the exact location (e.g. vertical and horizontal extent and type) of the installed engineered controls, including: geotextile fabric, clean fill, utilities, structures, basins, swales, the storm water detention pond, the SSV system, and all monitoring locations.

   ii) Analytical results and summary of all post remediation/post construction methane, VOC and air monitoring performed to date, demonstrating compliance with the requirements of this Order.

   iii) All original laboratory analytical data results from the remedial activities, compliance and confirmation sampling, and clean fill sampling as applicable.

   iv) A statement from the facility or environmental consultant attesting to the origin of the clean fill and/or loam, and suitability consistent with the RAWP and this Order. Any organic topsoil utilized shall conform to the general vegetated top cover criteria outlined in Rule 2.2.12 of the Solid Waste Regulations.

j) The final Department approved ELUR, referenced as document 5 above, shall be recorded in the City of Providence land evidence records of the subject property.

k) Long-term maintenance of the engineered controls and portions of the property subject to the ELUR, including annual inspection and certification by an environmental professional.

7) The SSV system (including the alarm system) shall be operated and maintained to prevent methane and/or VOC concentrations from reaching or exceeding the remedial Action Levels within any and all occupied structures at the site.

8) Any temporarily stockpiled regulated soils shall be placed upon and covered with polyethylene of thickness at least 6mm or greater to prevent tearing, and segregated from clean fill material to prevent cross contamination.

9) All excess fill material generated on site, shall have all solid waste and debris removed prior to reuse as closure cap subgrade beneath the filter fabric layer.

10) Any material discovered during excavation activities that qualifies as "Solid Waste," as defined by the Department's Solid Waste Regulations, must be disposed of at a licensed Solid Waste Facility. This includes, but is not limited to, any solid waste material removed under the proposed building footprint.

11) All RAWP activities shall be performed in compliance with all appropriate Office of Air Resources (OAR) Rules and Regulations, including but not limited to the monitoring and control of any air emissions and the timely acquisition of any required Air Pollution Control Permits (Air Permits).

12) Any portion of the RAWP or development project conducted on the Site which falls under the jurisdiction of the Department's Freshwater Wetlands Program must be done in accordance with the Rules and Regulations Governing the Administration and Enforcement of the Freshwater Wetlands Act (the Wetlands Regulations), including but not limited to the timely acquisition of a Wetlands Permit.

13) Any portion of the RAWP or development project conducted on the Site which falls under the jurisdiction of the Department's Office of Water Resources (OWR), Rhode Island Pollution Discharge Elimination System (RIPDES) Program, must be performed in compliance with all appropriate OWR/RIPDES Rules and Regulations, including but not limited to the timely acquisition of a RIPDES Permit or a General Permit for Storm Water Discharge Associated with Construction Activity as appropriate and/or applicable.

14) All waste derived from implementation of the RAWP, the repair and maintenance of the Remedy, or the engineered systems shall be managed in accordance with the Department's Remediation Regulations, Rules and Regulations for Hazardous Waste Management, and Solid Waste Regulations, as appropriate. In accordance with Rule 11.07 (Initiator) of the Remediation Regulations, the City must comply with the requirements of the Solid Waste Regulations, as amended, for all solid waste shipments that they initiate, and documentation of disposal shall be provided to the Office of Waste Management (OWM).

15) All fill material brought onto the Site and all soil utilized for the engineered control cap must be compliant with the Department's Method 1 Residential Direct Exposure Criteria pursuant to the Remediation Regulations. All clean fill, including sub-grade material and loam, imported to the site must be sampled in accordance with the RAWP and this Order, prior to delivery and placement. Laboratory analytical results must be submitted to the OWM via fax (401) 222-3812. Written approval (via e-mail, fax or letter) to use the fill must be received from the Department prior to use.

16) Within sixty (60) days of completion of the Remedial Action described in the RAWP, a Remedial Action Closure Report, detailing the Remedial Action and current site status, shall be submitted to the OWM for review and approval. The Remedial Action Closure Report shall include a draft Site specific post remediation Soil Management Plan (SMP) and a post

remediation survey and as-built plan, to be recorded with the Department approved ELUR referenced as document 5 above.

17) Within thirty (30) days of receiving Department approval of the Remedial Action Closure Report, the City will have the Department approved ELUR recorded in the Providence land evidence records, and submit a recorded (stamped) copy to the OWM within fifteen (15) days of the date that it is recorded.

18) Within ten (10) days of submittal of the recorded (stamped) copy of the Department approved ELUR to the OWM, the City shall notify all abutting property owners, tenants, and interested parties that the ELUR has been recorded.

19) The City, its representatives, employees, agents and contractors shall adhere to the following timelines in its management, operation and maintenance of the Site.

   a) The City shall immediately notify the OWM of any Site or operating condition that results in non-compliance with this Order, or that indicates that the Remedy is not meeting its intended goal of preventing human exposure to hazardous materials contained in the former manufacturing facility site.

   b) The OWM shall be notified in writing immediately if the City suspects or has reason to believe that any of the remedial objectives will not be met.

   c) The OWM will be notified a minimum of five (5) working days in advance of any changes in contractors and/or consultants for the remedial activities in this RAWP, and will be promptly supplied with complete contact information for each new contractor or consultant (including but not limited to company name and address, contact name and address, contact telephone number and e-mail address).

   d) Any RAWP interruptions shall be reported to the OWM by telephone within one (1) working day and in writing within seven (7) days.

   e) All exceedances of the "Action Levels" established in the Order that are detected during any site monitoring activity (including but not limited to monitoring of sub-slab ventilation systems, or interior methane monitors/alarms) shall be reported to the OWM immediately and responded to immediately by the City.

   f) All equipment shutdowns (intentional and unintentional) or operational problems shall be reported to the OWM immediately. Intentional equipment shutdowns for regular maintenance shall not require immediate notification to the OWM provided that the shutdown is for less than twenty-four (24) hours and the maintenance activity is discussed in the next quarterly report.

g) All repairs or replacements of equipment or other actions taken in response to any non-compliance with the RAWP shall be completed within fourteen (14) days of discovery of the non-compliant condition. Additional time may be requested from the OWM in writing, provided that the request is supported with a justifiable explanation as to why the work cannot be completed within 14 days and includes a binding timetable for the completion of all work. All requests for additional time shall be submitted to the OWM as soon as the City becomes aware that additional time is necessary, but not later than 14 days from the discovery of the non-compliant condition. Documentation describing the repairs and certifying that the malfunction was corrected and that the equipment is operational must be received by the OWM within 5 (five) days of completion of the repairs.

h) All deficiencies in the approved engineered cap (including but not limited to sinking, cracking or excavation of soil, asphalt, cement or foundations) shall be reported to the OWM immediately upon discovery and shall be repaired within fourteen (14) days. Until repairs are made, the City shall prevent access to the deficient areas by staff, students, visitors or the general public. Documentation describing the deficiency, the repairs and certifying that the repairs meet the requirements of the Remedy must be received by the OWM within 5 days of completion of the repairs.

i) Any report or notice required to be submitted to the OWM "immediately," shall require verbal notification to the OWM within twenty-four (24) hours and written notification to the OWM within seventy-two (72) hours. The report or notice shall include a description of: the point of non-compliance (e.g. Action Level exceedance, equipment problems); the known or suspected cause for the non-compliance; any response actions taken as of the time of the report or notice; preliminary concepts for response actions to address, correct and/or prevent recurrence of the non-compliance; and a preliminary timetable for the completion of any further response actions. Final plans and timetables for response actions shall be reported to the OWM as soon as they are developed.

20) All notifications or reports required to be made or submitted to the Department under this Order, any other information pertinent to the RAWP, and/or any other notification regarding the subject site shall be reported to:

Joseph T. Martella II, Senior Engineer
RIDEM – Office of Waste Management
235 Promenade St., 3rd Floor
Providence, RI 02908-5767

Tel: (401) 222-2797 x7109
Fax: (401) 222-3812
E-mail: joseph.martella@dem.ri.gov

21) This Order does not remove the obligation of the City to obtain any other permits, licenses or approvals from any state, local, or federal agencies (including the Department) that may be necessary to comply with this Order.

22) It is the City's sole obligation to obtain all necessary approvals and permits required to implement the RAWP in a timely manner consistent with the RAWP schedule and deadlines in this Order.

23) The City shall have this Order recorded in the City of Providence, land evidence records of the subject property within thirty (30) days of execution of this Order.

24) There shall be no occupation or use of any building, facility or grounds on the Site until all the requirements described in the RAWP and this Order have been met to ensure that the applicable remedial objectives for the site are achieved for all hazardous substances, so as to manage actual or potential risks to human health and the environment for workers, clients, visitors and trespassers at the Site.

Subject to future revisions or amendments by the Department, this Order shall remain in full force and effect for as long as said RAWP shall be operated and maintained in a condition satisfactory to the Department. Failure to comply with all points outlined in the Department approved RAWP and stipulated in this Order shall result in the issuance of a Notice of Violation and Order against the City.

This Order shall be subject to modification or revocation in accordance with law.

Entered as an approval by the Department this 9TH day of June, 2006.

By: Leo Hellested

Leo Hellested, P.E.
Chief, Office of Waste Management
Department of Environmental Management

RECEIVED:

Providence
Received for Record
Aug 15,2007 at 12:01:01P
Document Num: 00191904
Barbara Troncy
Recorder of Deeds

RHODE ISLAND DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

In the matter of Remedial Action Approval at: **Case No. 2005-029**
Proposed Providence Public School Site – Parcel B
(Formerly a portion of the Gorham/Textron Dump site)
333 Adelaide Avenue, Providence, RI, Plat 51, Lot 323 (the Site)

ORDER OF APPROVAL ADDENDUM

In the above entitled matter wherein the following documents have been filed by or on behalf of the **City of Providence (City), in its capacity as owner and Responsible Party for the remediation of property located at 333 Adelaide Avenue, Providence**, or are otherwise on record with the Rhode Island Department of Environmental Management (the Department):

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4. Response to RAWP Comments, Former Gorham Manufacturing Facility, Parcel B, 333 Adelaide Avenue, Providence, Rhode Island, Case No. 2005-029, prepared by EA, dated May 25, 2006;

5. Letter from EA to the Department, Re: Draft ELUR for Parcel B Former Gorham Manufacturing Facility, Parcel B, 333 Adelaide Avenue, Providence, Rhode Island, Case No. 97-030 (Including Case No. 2005-029 and Case No. 2005-059), including a draft copy of the proposed Environmental Land Usage Restriction, delivered in PDF format via e-mail, dated June 7, 2006; and

6. Letter from Mark V. Dunham, Chief Financial Officer, Providence School Department, Re: Response to RAWP Comment No. 6, Former Gorham Manufacturing Facility, Parcel B, 333 Adelaide Avenue, Providence, Rhode Island, Case No. 2005-029, dated June 6, 2006, received via facsimile machine on June 8, 2006.

Subsequent to the Department issuing the original Order of Approval dated June 9, 2006, the following documents were also filed by or on behalf of the City:

7. RAWP Implementation Status Letter No. 1, Former Gorham Manufacturing Facility, Parcel B, 333 Adelaide Avenue, Providence, Rhode Island, Case No. 2005-029, (RAWP Status Letter 1), prepared by EA, dated September 28, 2006; and

8. RAWP Implementation Status Letter No. 2, Former Gorham Manufacturing Facility, Parcel B, 333 Adelaide Avenue, Providence, Rhode Island, Case No. 2005-029, (RAWP Status Letter 2), prepared by EA, dated December 13, 2006.

In addition, the Agency for Toxic Substances and Disease Registry (ATSDR), has submitted the following document regarding the site:

9. Health Consultation – Providence High School Parcel B, (a/k/a Former Gorham Site), Providence, Rhode Island, EPA Facility ID: RID001195015, prepared by ATSDR, dated December 4, 2006.

Subject to the conditions herein, these documents fulfill the requirements of Section 9.00 (Remedial Action Work Plan) of the Department's Rules and Regulations for the Investigation and Remediation of Hazardous Materials Releases (Remediation Regulations), as amended February 24, 2004, and describe a plan to remediate existing contamination pursuant to 23-19.14-1 et seq. and the Department's Remediation Regulations, amended February 24, 2004 in accordance therewith.

It is the Department's intent that all conditions set forth in the Order of Approval (Order) dated June 9, 2006, shall remain in full force and effect unless specifically altered by this Order of Approval Addendum (OA Addendum). This OA Addendum continues to place primary responsibility for the construction, operation, maintenance and monitoring of the approved Remedial Action Work Plan (RAWP) on the City. As the responsible party and performing party, the City is expected to implement the RAWP in an expeditious and professional manner that prevents non-compliance with the Order, OA Addendum and RAWP, and protects human health and the environment. For the convenience of the City and its contractors and consultants the changes made to the Order by this OA Addendum have been highlighted below using boldfaced type and include a reference to the original paragraph of the Order as applicable.

Upon consideration thereof, and in accordance with Rule 10.1 (Remedial Action Approvals) of the Remediation Regulations, the Department approves said RAWP through this OA Addendum, subject to the following amended conditions:

1) **All conditions set forth in the Order of Approval dated June 9, 2006, shall remain in full force and effect unless specifically altered by this OA Addendum.**

2) Sampling and laboratory analysis of all media involved in the Remedial Action shall be conducted in accordance with the requirements of the RAWP, **the Order and this OA Addendum** [Ref. Order ¶ 5].

3) The Site remedy as described in the RAWP **and Order** shall **also** incorporate the following [Ref. Order ¶ 6]:

   a) All work, operations, activities, **monitoring and sampling** shall be performed to ensure that the applicable remedial objectives for the site are achieved for all hazardous substances at the site, so as to manage actual or potential risks to human health and the environment [Ref. Order ¶ 6.a].

   b) Construction, installation, maintenance and continuous operation of an active sub-slab ventilation (SSV) system designed to extract soil vapor from under the building, and to prevent the accumulation and/or buildup of methane gas or volatile organic compounds (VOCs), and to ensure levels of methane and or VOCs are maintained below applicable "Action Levels." The SSV system shall also be equipped with an alarm system, and system operation and maintenance will include periodic monitoring **and compliance sampling** of methane and VOC levels below the building, within the building, and in the extracted soil vapor **measured at each of the stack pipes venting through the building roof** [Ref. Order ¶ 6.c].

   c) Following the installation of the sub-slab ventilation system, its proper operation shall be **evaluated by periodic compliance sampling with analytical laboratory testing** to demonstrate compliance with the Department approved performance criteria in the final RAWP, **the Order, and this OA Addendum,** and **also** to verify actual emission values in order to determine if treatment, a permit, or registration of the SSV system is required under the Department's Office of Air Resources (OAR) Air Pollution Control (APC) Regulation No. 9 [Ref. Order ¶ 6.d].

   d) Implementation of a long-term vapor and air monitoring **and compliance sampling** program sufficient to ensure site conditions are maintained in compliance with the applicable remedial objectives. Said monitoring **and compliance sampling** program shall include at a minimum [Ref. Order ¶ 6.e]:

      i) Incorporation of remedial "Action Levels" as follows:
         (1) Within buildings, the remedial Action Level shall be 1 percent of the methane lower explosive limit (LEL).
         (2) Under buildings, the remedial Action Level shall be 10 percent of the methane LEL.
         (3) The remedial Action Level for VOCs shall be the Connecticut Residential Proposed Target Indoor Air Concentrations (TACs). An appropriate analytical method shall be selected with a **detection limit (DL) or reporting limit (RL)** sufficiently sensitive to allow proper comparison of detected VOC concentrations to each applicable TAC (e.g. speciated VOCs using EPA method TO-15 **with the Selective Ion Monitoring [SIM] procedure RLs, or equivalent). Since no analytical laboratory to date has been identified which can reliably achieve the TAC RLs for five (5) of the VOCs (1,2-Dichloroethane, Ethylene dibromide, 1,1,1,2-Tetrachloroethane, 1,1,2,2-Tetrachloroethane, and Bromodichloromethane),**

their provisional remedial Action Levels shall be their respective SIM procedure RLs, until such time as laboratory technology allows detection of the TACs, or an alternative laboratory capable of lower detection levels is identified. Prior to each analytical sampling round, the City's environmental contractor shall contact the laboratory to determine their ability to achieve detection limits consistent with the TACs. The results of each inquiry shall be documented in the quarterly monitoring and compliance sampling reports. Once reporting limits consistent with the TACs are achievable for the five listed VOCs, they shall become the required reporting limit, remedial objective and remedial Action Level for those VOCs in air [Ref. Order ¶ 6.e.i.(3)].

ii) **The location of the eight (8) interior continuous methane monitors/alarms (i.e. continuous within the buildings), as well the eight (8) sub slab sample collection locations (MP-1 through MP-8) shall be as described in RAWP Status Letter 2, Appendix B (Figure Illustrating Monitoring System Component Locations) and Appendix C (Figure Illustrating Proposed Sub-Slab Sampling Locations)** [Ref. Order ¶ 6.e.ii].

iii) **The location of the eight (8) interior VOC sampling locations, shall be proximate to the eight (8) interior methane monitoring locations described in RAWP Status Letter 2. The Summa canister samples shall be collected in a manner such that the canister intake is at an elevation approximately two (2) feet above floor level, and the samples shall be analyzed for VOCs by EPA TO-15 SIM. The locations are identified in RAWP Status Letter 2, Appendix B (Figure Illustrating Monitoring System Component Locations).**

iv) **The location of the four (4) sub-slab VOC sampling locations shall be MP-1, MP-2, MP 5 and MP-7 as identified in RAWP Status Letter 2, Appendix C (Figure Illustrating Proposed Sub-Slab Sampling Locations). Samples shall be analyzed for VOCs by EPA TO-15 SIM.**

v) Performance of baseline ambient air monitoring **and compliance sampling** within the subsurface slab area and the building interior shall be conducted, prior to system start up and any occupancy, to evaluate concentrations of methane and VOCs at the site [Ref. Order ¶ 6.e.iii].

vi) **A "complete round" of compliance monitoring for methane and compliance sampling and analysis for VOCs shall indicate performance of methane monitoring and VOC sampling and analysis at all previously specified monitoring and sampling locations in the sub-slab and interior air.**

vii) **The schedule for periodic compliance monitoring and compliance sampling shall be as follows** [Ref. Order ¶ 6.e.iv]:

(1) **Prior to sub-slab venting system start-up, performance of a complete round of compliance monitoring for methane and compliance sampling and analysis for VOCs in the sub-slab and interior air;**

(2) **One (1) week after sub-slab venting system start-up, performance of a complete round of compliance monitoring for methane and compliance sampling and analysis for VOCs in the sub-slab, interior air and at each of the stack pipes venting through the building roof;**

(3) **Following the first sampling round collected after sub-slab venting system start-up, the required monitoring/sampling frequency shall be revised to every thirty (30) days and each periodic event shall include performance of a complete round of compliance monitoring for methane and compliance sampling and analysis for VOCs in the sub-slab and interior air;**

(4) **Four (4) weeks prior to the proposed opening of the school to students, the required monitoring/sampling frequency shall be revised to weekly and each periodic event shall include performance of a complete round of compliance monitoring for methane and compliance sampling and analysis for VOCs in the sub-slab and interior air;**

(5) **Four (4) weeks following occupation of the school by students, the required monitoring/sampling frequency may be adjusted to every thirty (30) days, provided that there are no exceedances of the applicable remedial Action Levels for VOCs or methane. Each periodic monitoring/sampling event shall continue to include performance of a complete round of compliance monitoring for methane and compliance sampling and analysis for VOCs in the sub-slab and interior air;**

(6) **After successfully demonstrating one year of continuously compliant system operation (i.e. there are no exceedances of the applicable remedial Action Levels for VOCs or methane), the City may petition the Department to decrease the required compliance monitoring and compliance sampling frequency.**

(7) **Following the first sampling round collected after sub-slab venting system start-up, the required monitoring/sampling frequency at each of the stack pipes venting through the building roof shall be revised to quarterly for the first year of system operation, and each periodic event shall include performance of compliance monitoring for methane and compliance sampling and analysis for VOCs. Following each monitoring/sampling round, the actual measured emission values shall be used to calculate the cumulative emissions from all three venting pipes in order to determine if treatment, a permit, or registration for the SSV system is required by the OAR. Depending upon the results of actual measured emissions and OAR requirements, the City may petition the Department to decrease the required compliance monitoring and compliance sampling frequency at each of the stack pipes venting through the building roof, if appropriately supported by the data.**

viii) **Periodic** monitoring of **methane and compliance sampling and analysis of VOCs** shall continue at the specified rate as long as a source of contamination exists [Ref. Order ¶ 6.e.ix].

e) Preparation and submission of quarterly air monitoring **and compliance sampling** reports in accordance with the Order **and this OA Addendum**, and including the recording of the following parameters [Ref. Order ¶ 6.f]:

i) The concentrations of methane and VOCs detected in each sample collected and analyzed during **periodic** monitoring and sampling activities for the current reporting period [Ref. Order ¶ 6.f.i].
ii) A summary table of the concentrations of methane and VOCs detected in each sample collected and analyzed during prior reporting periods.
iii) The occurrences of any alarm activations during the quarter and the resulting activities performed in response to the alarm activation.
iv) The occurrences of any remedial Action Level exceedances during the quarter and resulting activities performed in response to the exceedance.
v) The system operational status during the quarter, particularly noting the length of any system shutdown due to power failure, system malfunction, repairs, scheduled maintenance, etc.
vi) **A schedule that includes** the anticipated delivery date of the next monitoring **and compliance sampling** report submittal [Ref. Order ¶ 6.f.vi].
vii) **An evaluation of the status of VOC soil gas rebound in sub-slab soil vapor.**
viii) **An evaluation of the cumulative emissions from all three venting pipes in order to determine if treatment, a permit, or registration for the SSV system is required by the OAR.**

f) Preparation and submission of a Remedial Action Closure Report documenting the work performed and including at a minimum the following items [Ref. Order ¶ 6.i]:

i) A post remediation survey of the entire site with as-built plans demarcating the exact location (e.g. vertical and horizontal extent and type) of the installed engineered controls, including: geotextile fabric, clean fill, utilities, structures, basins, swales, the storm water detention pond, the SSV system, and all monitoring **and sampling** locations [Ref. Order ¶ 6.i.i].
ii) Analytical results and summary of all post remediation/post construction methane, VOC and air monitoring **and sampling** performed to date, demonstrating compliance with the requirements of **the Order and this OA Addendum** [Ref. Order ¶ 6.ii].
iii) All original laboratory analytical data results from the remedial activities, compliance and confirmation sampling, and clean fill sampling as applicable.
iv) A statement from the facility or environmental consultant attesting to the origin of the clean fill and/or loam, and suitability consistent with the RAWP, **the Order and this OA Addendum.** Any organic topsoil utilized shall conform to the general vegetated top cover criteria outlined in Rule 2.2.12 of the <u>Solid Waste Regulations</u> [Ref. Order ¶ 6.iv].

4) All RAWP activities shall be performed in compliance with all appropriate OAR Rules and Regulations, including but not limited to the monitoring, **sampling, evaluation** and control of any air emissions and the timely acquisition of any required Air Pollution Control Permits (Air Permits) [Ref. Order ¶ 11].

5) The City, its representatives, employees, agents and contractors shall adhere to the **timelines established in the Order as well as the** following **revised** timeline in its management, operation and maintenance of the Site [Ref. Order ¶ 19].

   a) All exceedances of the "Action Levels" established in the Order **and this OA Addendum** that are detected during any site monitoring **or sampling** activity (including but not limited to monitoring **or sampling** of sub-slab ventilation systems, **interior air,** or interior methane monitors/alarms) shall be reported to the OWM immediately and responded to immediately by the City [Ref. Order ¶ 19.e].

6) **The City shall have this OA Addendum recorded in the City of Providence, land evidence records of the subject property within thirty (30) days of execution of this OA Addendum** [Ref. Order ¶ 23].

7) There shall be <u>no occupation or use</u> of any building, facility or grounds on the Site until all the requirements described in the RAWP, **the Order and this OA Addendum** have been met to ensure that the applicable remedial objectives for the site are achieved for all hazardous substances, so as to manage actual or potential risks to human health and the environment for students, workers, clients, visitors and trespassers at the Site [Ref. Order ¶ 24].

Subject to future revisions or amendments by the Department, the Order **and this OA Addendum** shall remain in full force and effect for as long as said RAWP shall be operated and maintained in a condition satisfactory to the Department. Failure to comply with all points outlined in the Department approved RAWP and stipulated in the Order **and this OA Addendum** shall result in the issuance of a Notice of Violation and Order against the City.

The Order **and this OA Addendum** shall be subject to modification or revocation in accordance with law.

Entered as an approval by the Department this 27TH day of February, 2007.

By: Leo Hellested

Leo Hellested, P.E.
Chief, Office of Waste Management
Department of Environmental Management

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Barbara Troncy
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Doc No: 00191905
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RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
235 Promenade Street, Providence, RI 02908-5767 TDD 401-222-4462

CERTIFIED MAIL

July 26, 2007

Alan Sepe, Acting Director
Department of Public Properties
City of Providence
25 Dorrance Street
Providence, RI 02903

RE: Order of Approval Addendum 2, Proposed Providence Public School Site – Parcel B
Formerly a portion of the Gorham/Textron Dump site, 333 Adelaide Avenue, Providence
City of Providence Tax Assessor's Office Plat 51, Lot 323, Parcel B
Case No. 2005-029 (Formerly part of Case No. 97-030)

Dear Mr. Sepe:

Enclosed please find the Order of Approval Addendum 2 (OA Addendum 2) for the remediation plan for the above referenced facility. Please review the stipulations of the attached OA Addendum 2 thoroughly to ensure your compliance with the requirements. The original Order of Approval (Order) dated June 9, 2006, the Order of Approval Addendum 1 (OA Addendum 1) dated February 27, 2007, and this OA Addendum 2 (collectively the Amended Orders) place primary responsibility for the construction, operation, maintenance and monitoring of the approved Remedial Action Work Plan (RAWP) and its associated remedy on the City of Providence (the City). In order to enable the Department to monitor the City's compliance with the RAWP, the Amended Orders require the City to notify the Department of any condition that is non-compliant with the Amended Orders, or that constitutes an interruption of the RAWP. In order to maintain compliance with the Amended Orders and the RAWP, the City's responsibilities under the Amended Orders necessarily include the responsibility to respond to and correct non-compliant conditions in a timely, proactive and professional manner that minimizes non-compliance with the Amended Orders and RAWP, and protects human health and the environment.

This OA Addendum 2 shall be recorded in the land evidence records of the City of Providence within 30 days of execution as required by law, and a recorded copy must be returned to the Department within 7 days of recording. If you have any questions regarding this matter, please contact me at (401) 222-2797 x7109.

Sincerely,

Joseph T. Martella II
Senior Engineer, Office of Waste Management

30% post-consumer fiber

cc: Terrence D. Gray, P.E., Assistant Director, RIDEM/AW&C
Leo Hellested, P.E., Chief, RIDEM/OWM
Kelly J. Owens, RIDEM/OWM
John Langlois, Esq., RIDEM/OLS
Richard Enander, PhD, RIDEM/OTCA/Risk Assessment
Christopher Walusiak, RIDEM/OWM
Douglas McVay, RIDEM/OAR
Barbara Morin, RIDEM/OAR
Robert Vanderslice, PhD, RIDOH
Frank Battaglia, EPA – Region 1
Tammie A. McRae, ATSDR
Richard A. Sullivan, ATSDR
Hon. David N. Cicilline, Mayor, City of Providence
Senator Juan M. Pichardo, District 2
Representative Thomas Slater
Councilman John J. Lombardi
Councilman Leon F. Tejada
Thomas Deller, City of Providence
Dr. Donald Evans, Superintendent, Providence Schools
Mary McClure, President – Providence School Bd.
Sara Rapport, Esq., City of Providence
John Boehnert, Esq, PS&H
Peter M. Grivers, EA
Gregory L. Simpson, Textron
Gerald Petros, Esq., Hinkley Allen
Steven Fischbach, Esq., RILS
Knight Memorial Library – Project Repository

RHODE ISLAND DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

In the matter of the application for a Remedial Action Approval at: **Case No. 2005-029**
Proposed Providence Public School Site – Parcel B
(Formerly a portion of the Gorham/Textron Dump site)
333 Adelaide Avenue, Providence, RI, Plat 51, Lot 323 (the Site)

ORDER OF APPROVAL ADDENDUM 2

In the above entitled matter the Rhode Island Department of Environmental Management (the Department), issued to the **City of Providence (the City), in its capacity as owner and Responsible Party for the remediation of property located at 333 Adelaide Avenue, Providence**, an Order of Approval (Order) dated June 9, 2006, and an Order of Approval Addendum (OA Addendum 1) dated February 27, 2007.

On June 26, 2007, and June 29, 2007 respectively, the Department received written requests from EA Engineering, Science, and Technology, Inc. (EA) and Partridge Snow & Hahn. LLC (PS&H), to amend the City's indoor air and sub slab vapor sampling frequency as required by OA Addendum 1. In response to the formal requests, the Department met on July 18, 2007 with representatives of EA to discuss the ongoing operation of the system and the air and soil vapor data results collected to date. Based on that review, the Department concluded that additional modification to the prior Order is warranted. Following the meeting, the following additional document was filed on behalf of the City:

- Electronic mail from EA to the Department, Re: Proposed Interior Vapor Probe Locations, dated July 19, 2007, including a Letter Attachment Figure showing three new proposed sub slab vapor probe locations, located centrally within the building footprint.

Subject to the conditions herein, the listed document, as well as the documents listed in the Order dated June 9, 2006, and the OA Addendum 1 dated February 27, 2007, fulfill the requirements of Section 9.00 (Remedial Action Work Plan) of the Department's Rules and Regulations for the Investigation and Remediation of Hazardous Materials Releases (Remediation Regulations), as amended February 24, 2004, and describe a plan to remediate existing contamination pursuant to 23-19.14-1 et seq. and the Department's Remediation Regulations, as amended February 24, 2004, in accordance therewith.

It is the Department's intent that all conditions set forth in the Order dated June 9, 2006, and OA Addendum 1 dated February 27, 2007, shall remain in full force and effect unless specifically altered by this second Order of Approval Addendum (OA Addendum 2). This OA Addendum 2 continues to place primary responsibility for the construction, operation, maintenance and monitoring of the approved Remedial Action Work Plan (RAWP) and its associated remedy on the City. As the responsible party and performing party, the City is expected to implement the RAWP in an expeditious and professional manner that prevents non-compliance with the original Order, OA Addendum 1, OA Addendum 2 and RAWP, and protects human health and the environment. For the convenience of the City and its contractors and consultants, the changes made to the original Order by this OA Addendum 2 have been highlighted below using boldfaced type and include a reference to the original paragraph of the Order as applicable.

Upon consideration thereof, and in accordance with Rule 10.1 (Remedial Action Approvals) of the Remediation Regulations, the Department approves said RAWP to remediate contamination through this OA Addendum 2, subject to the following amended conditions:

1) **All conditions set forth in the Order of Approval dated June 9, 2006, and OA Addendum 1 dated February 27, 2007, shall remain in full force and effect unless specifically altered by this OA Addendum 2.**

2) Sampling and laboratory analysis of all media involved in the Remedial Action shall be conducted in accordance with the requirements of the RAWP, **the original Order, OA Addendum 1 and this OA Addendum 2** [Ref. original Order ¶ 5].

3) The Site remedy as described in the RAWP, original **Order, and OA Addendum 1,** shall **also** incorporate the following [Ref. original Order ¶ 6]:

   a) **Three (3) new sampling locations, centrally located within the sub-slab as identified in the previously referenced e-mail from EA to the Department, Re: Proposed Interior Vapor Probe Locations, dated July 19, 2007, specifically in the Letter Attachment Figure.**
   b) **A "complete round" of compliance sampling shall include 12 sample locations per sampling event, selected from the network as follows:**
      i) **All eight (8) interior sampling locations;**
      ii) **Two (2) of the eight (8) perimeter sub slab sample collection locations (MP-1 through MP-8), selected on a rotational basis such that each location is sampled at an equal frequency;**
      iii) **Two (2) of the three (3) new centrally located sub slab sample locations (IMP-1 through IMP-3), selected on a rotational basis such that each location is sampled at an equal frequency;**
      iv) **All samples shall be analyzed for volatile organic compounds (VOCs) by EPA TO-15 SIM.**
   c) **The schedule for periodic compliance sampling and compliance monitoring shall be as follows** [Ref. Order ¶ 6.e.iv]:
      i) **Starting August 2007, and monthly thereafter, a "complete round" of VOC compliance sampling and analysis shall be performed at the locations identified in item b) above.**
      ii) **Starting August 2007, and monthly thereafter, methane monitoring shall be performed at all interior and sub slab locations.**
      iii) **Annually compliance monitoring/sampling shall occur at each of the three (3) stack pipes venting through the building roof. Each periodic event shall include performance of compliance monitoring for methane and compliance sampling and analysis for VOCs by EPA TO-15. Following each annual venting stack**

monitoring/sampling round, the actual measured emission values shall be used to calculate the cumulative emissions from all three venting pipes in order to determine if treatment, a permit, or registration for the Sub Slab Venting (SSV) system is required by the Department's Office of Air Resources.

iv) **Following completion of the February 2008 monthly sampling round and submission of the complete sampling results, the City may petition the Department to modify the required compliance monitoring and compliance sampling plan.**

d) **Periodic** monitoring of **methane and compliance sampling and analysis of VOCs** shall continue at the specified rate as long as a source of contamination exists, **unless otherwise authorized by the Department in written correspondence to the City** [Ref. Order ¶ 6.e.ix].

4) **The City shall have this OA Addendum 2 recorded in the City of Providence, land evidence records of the subject property within thirty (30) days of execution of this OA Addendum 2** [Ref. Order ¶ 23].

Subject to future revisions or amendments by the Department, the original Order, **OA Addendum 1 and this OA Addendum 2** shall remain in full force and effect for as long as said RAWP shall be operated and maintained in a condition satisfactory to the Department. Failure to comply with all points outlined in the Department approved RAWP and stipulated in the original Order, **OA Addendum 1 and this OA Addendum** 2 shall result in the issuance of a Notice of Violation and Order against the City.

The original Order, **OA Addendum 1 and this OA Addendum 2** shall be subject to modification or revocation in accordance with law.

Entered as an approval by the Department this 26TH day of July, 2007.

By: [signature]
Leo Hellested, P.E.
Chief, Office of Waste Management
Department of Environmental Management

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Appendix B

Remedial Action Closure Report (Text and As-Built Drawings only)

Remedial Action Closure Report
Adelaide Avenue High School
375 Adelaide Avenue
Providence, Rhode Island

Prepared for

City of Providence
Department of Public Property
25 Dorrance Street
Providence, Rhode Island 02903

Prepared by

EA Engineering, Science, and Technology, Inc.
2350 Post Road
Warwick, Rhode Island 02886
(401) 736-3440

August 2007
EA Project No. 61965.01

CONTENTS

Page

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
CFM	Cubic feet per minute
CTRTAC	State of Connecticut Draft Proposed Residential Targeted Air Concentrations
EA	EA Engineering, Science, and Technology, Inc.
EPA	Environmental Protection Agency
ELUR	Environmental Land Usage Restriction
HVAC	Heating, ventilation, and air conditioning
IMP	Interior monitoring point
LEL	Lower explosive limit
LFG	Landfill gas
LGM	Landfill gas meter
LRAWP	Limited Remedial Action Work Plan
MP	Monitoring point
O&M	Operation and Maintenance
OA	Order of Approval
PID	Photo-ionization detector
PPE	Personal protective equipment
PPM	Parts per million
PVC	Polyvinyl chloride
RAWP	Remedial Action Work Plan
RACR	Remedial Action Closure Report
RIDEM	Rhode Island Department of Environmental Management
RIRRC	Rhode Island Resource Recovery Corporation
SHERP	Safety, Health, and Emergency Response Plan
SSD	Sub-slab depressurization
TLV	Threshold limit value
VOC	Volatile organic compound

1. INTRODUCTION

On behalf of the City of Providence (the City), EA Engineering, Science, and Technology, Inc. has prepared this Remedial Action Closure Report (RACR) for the Parcel B area of the former Gorham Manufacturing site in Providence, Rhode Island now referred to as the Adelaide Avenue School site (the Site). A Site Location Map is provided as Figure 1. This RACR has been prepared to satisfy the remedial action closure requirements specified in Section 11.09 of the Rhode Island Department of Environmental Management (RIDEM) Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (the Remediation Regulations dated August 1996, as amended February 2004) and Item 6(i) of the RIDEM Order of Approval issued in June 2006, as amended in February and July 2007. For the purposes of this RACR, the original and the amended Orders of Approval will collectively be referred to as the Amended OA. A copy of the Amended OA, recorded in the City of Providence Land Evidence Records, is provided in Appendix A.

2. REMEDIAL OBJECTIVES

2.1 SOIL

The long-term remedial objective for soil is to prevent direct exposure to Site soils containing contaminant levels above the RIDEM Residential Direct Exposure Criteria. An engineered cap was constructed at the Site to isolate the soil and protect the health of future Site visitors.

The short-term remedial objective for soil during remedial and construction activities was to minimize direct contact with Site soils.

2.2 GROUNDWATER

Groundwater beneath the Site, located at approximately 25-ft. below ground surface, is classified as GB by RIDEM. The 2005 site investigation indicated that groundwater beneath the Site is in compliance with the RIDEM GB Groundwater Objectives. No contact with site groundwater occurred during construction activities, and groundwater would not be used for any purpose during or following construction activities. Therefore, no groundwater objectives were proposed in the Remedial Action Work Plan (RAWP) or imposed by RIDEM for the Site.

2.3 SURFACE WATER AND SEDIMENT OBJECTIVES

There is no surface water or sediment located at the Site. No contact with nearby Mashapaug Pond or sediments occurred during construction and remediation activities, and restrictive fencing with deterrent vegetation was installed along the northern Parcel B property boundary prior to implementation of the RAWP to further restrict access to nearby surface water and sediment. Therefore, no surface water or sediment objectives were proposed in the RAWP or imposed by RIDEM for the Site.

2.4 AIR OBJECTIVES

The site investigation and Limited Remedial Action Work Plan (LRAWP) activities completed in 2005 indicated that there was a potential for VOCs and, to a lesser extent, methane gas to build up beneath the future building slab and migrate into the proposed structure. Therefore, the first long-term air objective for the Site is to prevent the users of the proposed structure from direct exposure to indoor air containing methane in excess of 1 percent of the lower explosive limit (LEL) or VOCs in excess of Draft Proposed State of Connecticut Residential Target Air Concentrations (CT RTAC). Installation, operation, and maintenance of an active sub-slab depressurization (SSD) system and implementation of an air monitoring and sampling program that includes periodic sub-slab air sampling and laboratory analysis for VOCs and continuous indoor air methane monitoring will achieve this objective.

The second long-term air objective for the Site is to prevent the discharge of contaminants from the sub-slab venting system to the atmosphere in concentrations that exceed criteria contained in the RIDEM Air Pollution Control Regulations (Regulation No. 9). Preliminary air emission estimates, based upon soil gas survey data collected during the 2005 site investigation, indicated that emissions from the proposed SSD system would not likely require treatment or a permit from RIDEM's Office of Air Resources. Actual emission values calculated after the system was installed and operational, based upon laboratory analysis performed on the SSD system effluent, has verified that no treatment/ permitting requirements currently apply.

The short-term air objective for the Site was to prevent airborne nuisance dust migration from impacting nearby residents during intrusive construction or remediation activities. This objective was accomplished by implementing a comprehensive, RIDEM-approved dust monitoring and dust suppression program during intrusive phases of the project.

3. REMEDIAL COMPLETION

The long-term remedy proposed for the Site involves the following elements:

- Engineered cap construction.
- Instituting an Environmental Land Usage Restriction (ELUR) for the property.
- Installation, operation, monitoring, and maintenance of an active SSD system.
- Installation, operation, monitoring, and maintenance of a continuous indoor methane monitoring and alarm system.
- Installation, monitoring, and maintenance of a fence designed to prohibit access to areas abutting the school parcel that are yet to be fully characterized and/or remediated.

This long-term remedy for impacted soils and soil vapor is consistent with the Remediation Regulations and is appropriate and safe for the specific use (high school) proposed within the boundaries of the portion of the contaminated site for which it is designed (Parcel B). Furthermore, as an additional measure of safety and protection, the proposed remedy is also designed to provide an effective physical barrier (fencing) to prevent access to abutting areas scheduled for remediation, or potentially in need of remediation as applicable site investigations and RAWPs are being developed and/or implemented. The completion of these remedial elements is documented in the following subsections.

3.1 ENGINEERED CAP CONSTRUCTION

The objective for this project was to integrate access roadways, parking areas, building footprints, and the landscaped areas into the final cap design. The engineered cap components consisted of the following layers:

- Closure cap subgrade
- Geosynthetic fabric filter layer (for landscaped areas)
- Protective cover soil
- Vegetative cover
- Site improvements.

These layers are more fully described below, in order of ascendance above the native site soils. Unless otherwise specifically noted in this RACR, the design criteria and specifications presented in the original RAWP, or the modified design criteria and specifications approved by RIDEM during implementation of the RAWP, have been adhered to. An As-Built Site Plan illustrating the various engineered cap elements and thicknesses is provided in Appendix B. Progress and finish photographs of various elements of the engineered cap are presented in Appendix C.

3.1.1 Closure Cap Subgrade

A closure cap subgrade was prepared from the existing site grade to create adequate storm water drainage for the Site and serve as a suitable base for other components of the closure cap system.

3.1.2 Geosynthetic Fabric Filter Layer

A geosynthetic fabric filter layer (ProPex 4510) was placed above the closure cap subgrade and below a protective soil cover for virtually all landscaped areas of the site to prevent human exposure to impacted soil. The only landscaped areas where fabric was not installed beneath the protective soil cover were areas where a minimum of 2-ft. of clean fill was installed. These areas include the landscaped island within the pavement in front of the school building, a landscaped area near the school's southwest corner, and the landscaped areas in the northern portion of the Site where RIDEM required 2-ft. of clean fill.

3.1.3 Protective Cover Soil Layer/Vegetative Cover

The protective cover soil layer of the closure cap system, also commonly termed the vegetative support soil layer, consisted of a minimum of 2-ft. of certified clean fill material or equivalent in all areas of the site, and a minimum of 2-ft. of clean soil in all areas known or suspected to be subject to the RIDEM Rules and Regulations for Composting Facilities and Solid Waste Management Facilities (Solid Waste Regulations), and under the jurisdiction of RIDEM's Solid Waste Program. One foot of clean fill material over the approved geosynthetic fabric filter layer, 4-in. of concrete or asphalt over 6-in. of appropriate clean fill/gravel base, or the concrete building slab over 6-in. of gravel aggregate are all considered to be the "equivalent" of 2-ft. of clean fill for this project. The upper 4–8 in. of the soil layer consisted of organic topsoil (i.e., loam) to promote vegetation.

All clean fill material imported to the Site, including sub-grade material and loam, was sampled and analyzed for compliance with the RIDEM Method 1 Residential Direct Exposure Criteria in accordance with the following frequency: one sample for every 500 cubic yards was analyzed for arsenic, and one quarter of the total number of compliance samples was also analyzed for VOCs, Total Priority Pollutant metals, polycyclic aromatic hydrocarbons, and total petroleum hydrocarbons. Laboratory analytical results were forwarded to RIDEM via electronic mail, and written approval was received from RIDEM prior to use at the Site. A total of approximately 5,966 cubic yards of sub-grade material from P.J. Keating, Inc. (Cranston, RI) and 933 cubic yards of loam from Richmond Sand & Gravel (Richmond, RI) were brought to the site for use in constructing the engineered cap during the project. Laboratory results for all approved sub-grade fill and loam used at the Site, RIDEM correspondence approving its use, and weight slips for the material and correspondence provided by the supplier of the fill attesting to its origin and suitability are provided in Appendices D and E, respectively.

Referring to the As-Built Site Plan in Appendix B, multiple hand-dug test pits were conducted in the engineered cap which verified that the minimum-required thicknesses and geosynthetic fabric (where applicable, refer to Section 3.1.2) were installed at the Site.

3.1.4 Site Improvements

The Adelaide Avenue School development includes extensive non-landscaped areas containing the school structure, paved roadways, paved walkways, and paved parking areas. Asphalt areas include a minimum of 6-in. of appropriate base coarse fill material covered with a minimum of 4-in. of bituminous asphalt (combined binder and wearing course). Concrete pavement areas include a minimum of 4-in. of poured concrete over a minimum of 6-in. of appropriate base coarse material. An active sub-slab venting system, consisting of a network of suction fans, piping, and suction pits designed to create a negative pressure beneath the school, was installed beneath the building structure. The school's concrete slab foundation serves as the cap beneath the school.

3.2 ENVIRONMENTAL LAND USAGE RESTRICTION

In accordance with Item 17 of the Amended OA, an ELUR, approved by RIDEM for use at the Site and documenting the required maintenance and annual inspection of the remedy, will be recorded in the City's land evidence records for the property following RIDEM approval of this RACR and the As-Built Site Plan (Appendix B). A copy of the ELUR to be recorded is provided in Appendix F.

3.3 SUB-SLAB DEPRESSURIZATION SYSTEM

The design of the active SSD system proposed for the Site was based upon the U.S. Environmental Protection Agency's (EPA's) guidance for radon gas evacuation systems as outlined in Radon Prevention in the Design and Construction of Schools and Other Large Buildings, EPA/625/R-92/016 (January 1993). The SSD system is designed to create a low-pressure zone beneath the school structure which will prevent VOCs and methane (if any) from entering the building through a series of suction fans, subsurface piping, sub-slab aggregate material, and other design features. Air exhausted from under the slab is released to the atmosphere above the roof of the school building.

Air emission design calculations, based upon soil gas data for the Site collected prior to RAWP implementation, predicted that no permits and no treatment of the system effluent will be required. Air emission samples from the three rooftop suction fans, collected in March 2007 after the SSD system was initially turned on-line and again in June 2007, confirmed that no RIDEM air permit applicability thresholds were exceeded. The air emission sampling data was summarized along with indoor, ambient, and sub-slab air sampling data in monthly correspondence to RIDEM between April and August 2007. Please refer to these previous submittals for more information if needed. In accordance with Item 6(f) of the Amended OA, future air sampling data will be presented in Quarterly Status Reports.

Each of the major design components of the active sub-slab venting system is presented in the following subsections. The suction pit locations, vertical piping locations, and other design specifications are presented on the As-Built SSD System Drawings in Appendix B. Various progress and finish photographs of elements of the SSD system are presented in Appendix C.

3.3.1 Sub-Slab Aggregate Material

An approximate 6-in. layer of aggregate material meeting American Society for Testing and Materials Size No. 5 specifications or equivalent (approximately 0.5- to 1-in. diameter) was evenly placed beneath the entire building slab. A 6-mil polyethylene vapor barrier was placed on top of the aggregate material prior to pouring of the concrete slab to prevent wet concrete from entering the void spaces in the aggregate layer.

3.3.2 Vapor Suction Pits

A total of eight vapor suction pits were installed beneath the building slab to facilitate communication throughout the sub-slab aggregate layer. Each suction pit was constructed as a 4-ft × 4-ft × 8-in. deep void area within the aggregate layer in various locations beneath the school building slab.

3.3.3 Vent Piping

Each suction pit installed beneath the slab is connected via horizontal 4-in. diameter polyvinyl chloride (PVC) vent pipe to one of three vertical risers extending through the floor slab and continuing up through the building roof. All piping joints were solvent welded, and all exposed riser piping within the school either passes through rooms that students do not have access to (e.g., mechanical or electrical rooms) or is located at elevations that render the piping inaccessible. The three vent piping risers penetrate through the school building roofline and terminate a minimum of 25-ft. from any outdoor air intake to reduce the potential for SSD system effluent entry into the building.

3.3.4 Suction Fans

Three in-line suction fans, each capable of providing approximately 500 ft^3 per minute (cfm) of air flow at 0-in. of water column static pressure were installed to create negative pressure beneath the building and exhaust potential sub-slab vapors to the atmosphere. The fans were installed in line with the roof top vent piping via rubber sewage pipe connectors to facilitate proper sealing, quiet operation, and fan maintenance/replacement activities (if needed). The fans were installed on the roof to eliminate the potential adverse effects caused by piping leaks, if any, on the exhaust side of the fans. The SSD system includes electronic controls on each suction fan which are tied into a warning notification light, audible alarm, and an auto dialer to notify responsible personnel if a significant reduction in airflow has occurred at any of the fans (i.e., system operational problem).. The system warning light, audible alarm, and auto dialer are located in the school administration office area.

3.3.5 System Monitoring and Sampling Locations

Multiple representative monitoring and sampling locations have been installed at the Site within the sub-slab region, the building interior, and on the rooftop of the school building. These monitoring and sampling locations are presented in the following subsections.

3.3.5.1 Sub-Slab Monitoring/Sampling Locations

A total of eleven representative monitoring/sampling points were installed beneath the school building. Eight of the monitoring points, labeled MP-1 though MP-8 on the As-Built SSD System Drawings in Appendix B, consist of 10-20 ft. of 1-in. diameter PVC piping extending from grade just outside of the school building to the aggregate layer beneath the building, and are terminated with a 2-ft length of PVC screen wrapped in fabric filter to facilitate vapor monitoring and/or sampling. A bolt-down, gasketed, protective road-box was installed over each of these eight monitoring points flush within the concrete or landscaped areas surrounding the school building. Three of the monitoring points, labeled IMP-1 through IMP-3 on the As-Built SSD System Drawings in Appendix B, were installed through the concrete slab at various interior locations within the school structure. The interior monitoring points consist of an 8-inch stainless steel, recessed, sealed implant finished with a bolt-down, gasketed, protective enclosure.

3.3.5.2 Indoor Air Methane Monitoring

An indoor air monitoring system designed to continuously monitor the percentage of the methane LEL inside the proposed school building was installed. The indoor monitoring system includes eight continuous methane monitoring locations located throughout the first floor of the school building. Each sensor is electronically connected to a controller equipped with a battery backup feature, a visual warning notification light, an audible alarm, and an auto dialer in the school administration area. The continuous methane sensors are equipped to trigger an alarm notification at the controller when the concentration of methane gas at any of the sensors is equal to or greater than 500 ppm or 1 percent of the methane LEL for a period of 1.5 consecutive minutes. In the absence of OSHA standards regarding permissible methane exposure limits, this sensor setting was selected based upon the threshold limit value (TLV) guidance established by the American Conference of Governmental Industrial Hygienists (ACGIH). The ACGIH TLV for methane (2 percent LEL or 1,000 ppm) is a guideline regarding the safe levels of exposure to methane from various hazards found in the workplace. A TLV reflects the level of exposure that a typical worker can experience without an unreasonable risk of disease or injury. A sensor setting of one-half the ACGIH TLV (1 percent LEL or 500 ppm) was selected to afford a significant measure of additional Site safety.

3.3.5.3 Rooftop Monitoring/Sampling Locations

Vacuum gauges, air velocity monitoring locations, and air sampling ports have been installed in the vicinity of the inline suction fans on the building rooftop to facilitate system monitoring and sampling procedures.

3.4 FENCE INSTALLATION, MONITORING, AND MAINTENANCE

3.4.1 Fence Installation

Prior to initiating Site development and RAWP implementation activities, a new 8-ft high chain link fence with deterrent vegetation planted along the proposed development side of the fencing was installed along the northern property boundary of the school property (Parcel B) in accordance with a Superior Court Order, dated 29 March 2006. In accordance with the Court Order, the fencing along the northern property boundary of Parcel B (i.e., the school parcel) includes signage in English and Spanish that states, "Warning – Keep Out – Environmental Cleanup in Progress." Please refer to correspondence submitted to RIDEM dated 15 July 2006 for more information regarding the location, construction details, and photographs illustrating the completion of the court ordered fencing.

Based upon the fact that site assessment and/or site remediation activities at neighboring properties to the north and west of the school were yet to be initiated or still ongoing, a second 8-ft. high chain link fence was installed in accordance with RIDEM approval along the northern and western property lines of the Site to minimize potential access to these abutting properties from the school Site.

Temporary fencing with fabric windscreen was in place around the school property's eastern, western, and southern property boundaries throughout the majority of school construction until such time that the cap was completed.

3.4.2 Fence Monitoring During Remedy Implementation

The permanent and temporary fences described above were periodically monitored throughout the remedy implementation period. Several issues of fence vandalism by trespassers or fence maintenance requirements were addressed by the City's subcontractors during implementation of the Site remedy.

3.5 LONG-TERM MONITORING, REPORTING, AND OPERATION AND MAINTENANCE

Now that the school is constructed and the remedy has been installed, the City is responsible for long-term operation and maintenance of the remedy and identification and correction of non-compliant Site conditions including, but not limited to, equipment failures or exceedances of established action levels. An Operation and Maintenance (O&M) Manual has been prepared for the site and is included in Appendix G.

4. DEMONSTRATED POINTS OF COMPLIANCE

Compliance with the RAWP objectives has been demonstrated through completion of the following activities:

- Construction of the engineered cap.
- Construction the sub-slab venting system.
- Completion of venting system start-up sampling activities.
- Installation of indoor methane alarm system and start-up of methane system monitoring.

Documentation illustrating compliance with the RAWP objectives is provided in the following subsections and within the various attachments to this RACR. Long-term compliance of the remedy will be determined by successful and timely completion of the maintenance and monitoring procedures and through preparation and submittal of Annual ELUR Inspection Reports. As required by RIDEM, the Annual ELUR Inspection Report for the Site will include a discussion relative to the regulatory compliance status of abutting parcels that comprise the entire former Gorham property. The first ELUR Inspection Report will be prepared and submitted approximately one year from the date that RIDEM approves this RACR and the ELUR is recorded in the City's land evidence records.

4.1 SOIL

The impacted soil at the site was considered to be in compliance once it was capped as proposed in the RAWP or as approved by subsequent RIDEM approvals. An ELUR, previously discussed in this RACR, will be placed on the Site once the RACR is approved by RIDEM.

The engineered cap installed at the Site consists of a minimum of 2-ft. of clean fill or the equivalent (where allowable). Department-approved equivalents to 2-ft. of clean fill include the school building footprint, asphalt and concrete paved areas, and 1-ft. of clean fill over a geosynthetic fabric as described in Section 3.1.

Soil compliance at this Site was also demonstrated through laboratory analysis of the clean fill material used for construction of the engineered cap by obtaining written approval from RIDEM for said clean fill material, through visual inspection of paving and concrete pouring activities, visual inspection of geosynthetic fabric installation, and field measurements of cap depths within hand-dug test pits in multiple areas across the Site. Copies of laboratory analytical reports and RIDEM correspondence approving use of fill material, and weight receipts obtained from the subcontractor responsible for delivering the fill material to the site are provided in Appendices D and E, respectively.

A copy of an As-Built Site Plan that includes the hand-dug test pit locations and associated cap thicknesses is provided in Appendix B and photos illustrating various elements of cap installation activities are included in Appendix C.

4.2 SSD SYSTEM EFFLUENT

Preliminary air emission estimates based upon the maximum soil gas concentrations collected during the soil vapor survey completed on 5 October 2005, and the proposed total effluent air flow rate of 1,500 cfm (500 cfm each for 3 suction fans) were summarized in the RAWP. The emission estimates were far below the hourly, daily, and annual permit applicability thresholds of 10 lb/hour and 100 lb/day for an air contaminant, 10 tons/year (individual Hazardous Air Pollutants [HAPs], and 25 tons/year (combined HAPs) specified in Section 9.3.1 of RIDEM's Air Pollution Control Regulation No. 9, and were also in compliance with the HAP minimum quantities specified in Appendix A of RIDEM's Air Pollution Control Regulation No. 9.

Following startup of the SSD system in March 2007, and again in June 2007, three venting system effluent air samples (one from the discharge of each suction fan) were collected and submitted for laboratory analysis of VOCs (via Method TO-15). The effluent data was used to calculate actual emission values and to re-evaluate if treatment or permitting requirements apply. The actual air emission values confirmed that RIDEM permit applicability thresholds are not being exceeded by the SSD system effluent.

4.3 SUB-SLAB SOIL GAS AND PRESSURE

Between 12 March and 30 July 2007, a total of six rounds of sub-slab air sampling have been completed at the Site. In addition to these six rounds of sub-slab air sample collection, field monitoring for VOCs, methane, and sub-slab vacuum was also performed weekly through the first 3 months of system operation and monthly thereafter (total number of monitoring events = 16) during this time period. Remedial compliance has been demonstrated at the site based upon the following:

- Throughout the time period of O&M from SSD System start-up until the writing of this RACR, sub-slab vacuum ranging from -0.04 to -0.20 inches of water column was maintained at all monitoring points located across the sub-slab region.

- The sub-slab Action Level for methane (10% LEL) established for this project has not been exceeded at any time in any of the sub-slab monitoring ports located across the sub-slab region.

- Sub-slab VOC monitoring and sampling has been completed in accordance with the Amended OA.

Please refer to the data summary reports previously submitted to RIDEM for more details regarding these sub-slab sampling results collected at the Site prior to the date of this RACR.

4.4 INDOOR AIR

The indoor methane monitoring system continuously monitors the methane concentration within the school building at the eight Department-approved monitoring locations, and is equipped to notify school officials and other responsible parties (via visual alarm, audible alarm, and auto dialer) if an exceedence of the 1% LEL Indoor Air Action Level (i.e., 500 ppm) occurs. The indoor methane monitoring system has been continuously operational at the site since 15 May 2007 without interruption, failure of any kind, or exceedence of the indoor air methane Action Level.

With respect to VOCs, between 12 March and 30 July 2007, a total of six rounds of indoor air sampling have been completed at all eight Department-approved sampling locations within the school. In addition to these six rounds of indoor air sample collection, field monitoring for VOCs and methane was also performed weekly through the first 3 months of system operation and monthly thereafter (total number of monitoring events = 16) during this time period. Remedial compliance has been demonstrated at the site based upon the following:

- With the exception of VOCs attributable to construction activities (e.g., painting, application of adhesives, etc.), VOCs contained in new building materials (e.g., carpeting, vinyl products, tiles, etc.), VOCs known to be found in background ambient air throughout the United States and also found in background ambient outdoor air at this Site, or VOCs most likely attributable to inadvertent laboratory contamination, no VOCs were found in indoor air at the Site in concentrations that exceed the Action Levels applicable to indoor air.

- Upon receipt and review of the laboratory data associated with these sampling events, RIDEM was immediately notified of any issues of non-compliance and written sampling summary reports were submitted to RIDEM within one week of said notifications.

Please refer to the previously submitted data summary reports for more details regarding these indoor air sampling results collected at the Site prior to the date of this RACR.

4.5 OUTDOOR AIR

The following Department-approved dust suppression and dust monitoring program was implemented during intrusive construction activities at the Site:

- During intrusive site construction activities, a tow-behind water tank equipped with multiple spray nozzles and a hose attachment regularly traversed the work area and applied water to minimize nuisance dust. In some instances, water sprinklers were used in place of or to supplement water application by the tow-behind water tank.

- Water was also manually applied to specific work areas, debris, soil piles, and any other areas in need of dust control not covered by the tank's spray nozzles.

- Fabric wind screens were installed and maintained along the perimeter fencing at the Site to minimize off-site dust migration.

- During the first week of intrusive construction activities, daily time-weighted air samples were collected and analyzed for nuisance dust via Phase Contrast Microscopy (PCM). Due to compliant sampling results, the Department-approved sampling frequency was reduced to once per week for the remainder of the intrusive activities. No sampling was performed or required during times when no intrusive site activities were ongoing.

- All samples were collected from a stationary sampling station equipped with a low volume sampling pump located along the southern fence line closest to the residential neighborhood abutting the Site. The sampling pump collected a time-weighted sample over the course of the workday during hours of on-site activities.

- All dust sampling results were less than the dust action levels established for this project.

- Dust sampling data was forwarded to RIDEM upon receipt from the laboratory and are also provided in Appendix H.

4.6 OTHER MEDIA

There are no remedial objectives for groundwater, surface water, or any other types of media (e.g., sediment) at the site. Therefore, points of compliance are not applicable with respect to these other types of media.

5. ADDITIONAL AMENDED OA COMPLIANCE

Information and supporting documentation relative to compliance with other Amended OA provisions not already discussed in previous sections of this RACR are presented below.

5.1 COMMUNITY NOTICE

On behalf of the City, EA prepared and distributed a bi-lingual community notice in accordance with Provision 2 of the Amended OA.

5.2 INITIATION OF WORK

In accordance with Provision 3 of the Amended OA, work at the Site was initiated within thirty (30) days of the City's receipt of the June 2006 Order of Approval.

5.3 NO ACCEPTANCE OF WASTE FROM OFF-SITE SOURCES

In accordance with Provision 4 of the Amended OA, no hazardous waste was accepted from any off-site sources for treatment or disposal at the Site

5.4 OFF-SITE DISPOSAL OF EXCESS SITE SOIL

In November 2006, during the implementation of the remedy, approximately 1,130 cubic yards of excess site soil was removed from the Site and was disposed of at the Rhode Island Resource Recovery Corporation (RIRRC). Removal of the soil was needed to accommodate the Site grading necessary to construct the engineered cap. Prior to disposal, the excess soil was sampled for various chemical parameters and the results were submitted to the RIRRC for review and acceptance. The RIRRC approved disposal of the soil at their Johnston, RI facility (Central Landfill) as alternative cover.

Copies of the RIRRC Acceptance Letter, associated soil sampling laboratory reports, and disposal receipts from the Central Landfill are provided in Appendix I.

6. CERTIFICATIONS

The undersigned certify that this RACR is a complete and accurate representation of the contaminated site and contains all known facts to the best of their knowledge.

8/29/07

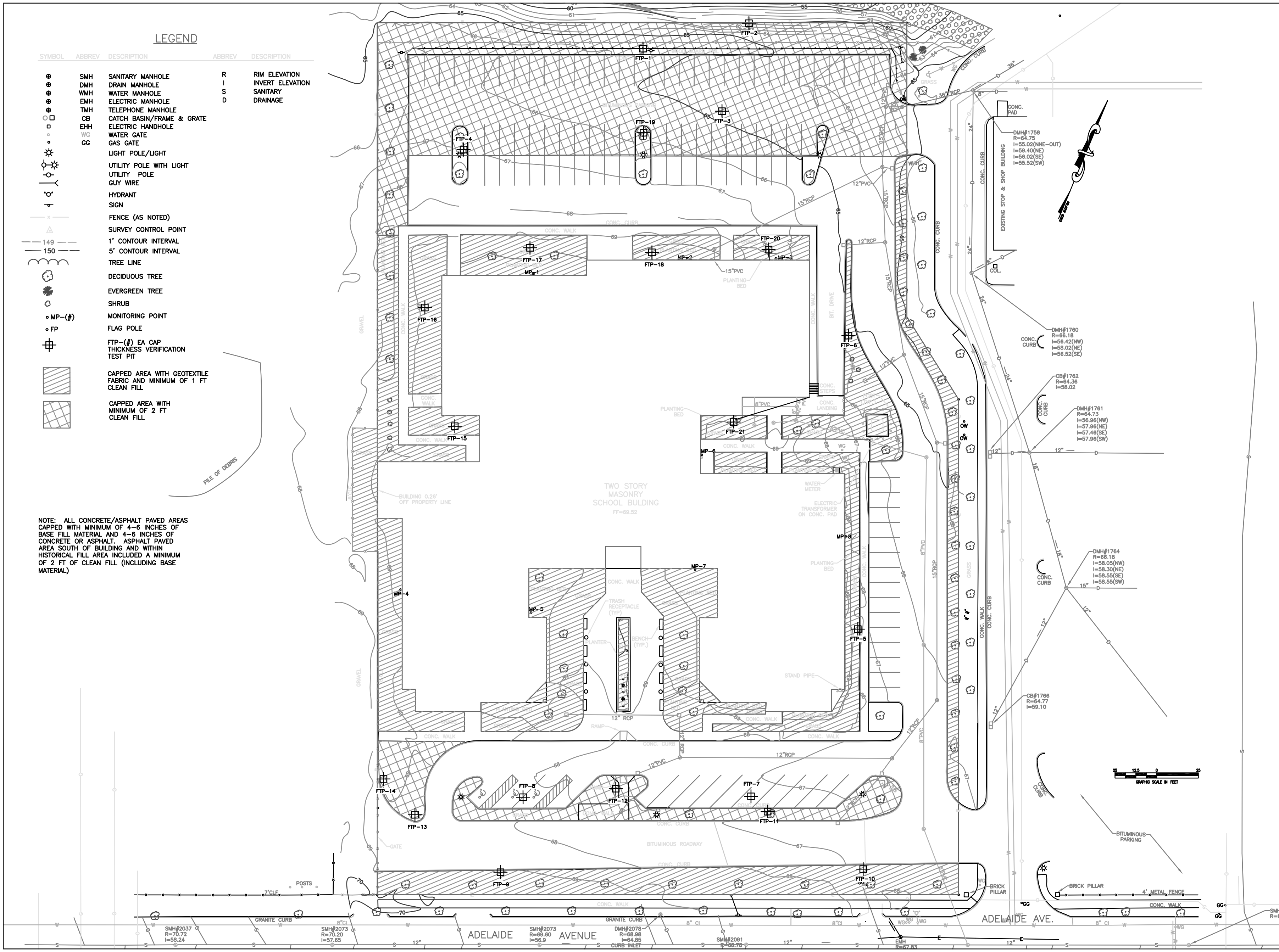
Peter M. Grivers, P.E., Project Manager **Date**
EA Engineering, Science, and Technology, Inc.

8/29/07

Timothy C. Regan, P.E., Senior Engineer **Date**
EA Engineering, Science, and Technology, Inc.

8/29/07

Alan Sepe **Date**
Director, Providence Department of Public Property



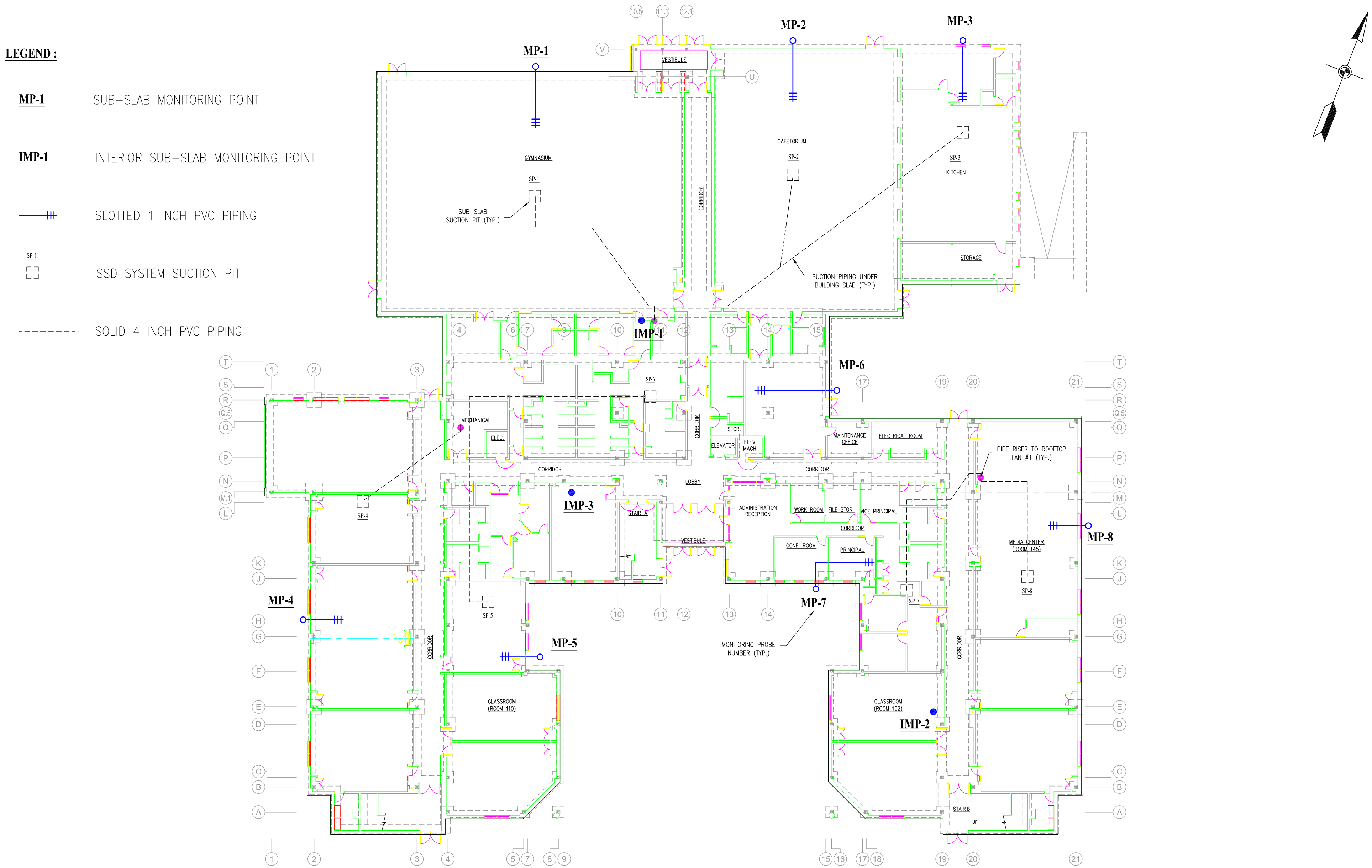
ADELAIDE AVE HIGH SCHOOL
REMEDIAL CLOSURE REPORT – AS BUILT SITE PLAN
PROVIDENCE, RI

REVISIONS			
NO.	DATE	BY	DESCRIPTION

SEAL

EA ENGINEERING, SCIENCE, AND TECHNOLOGY
2350 Post Road
Warwick, RI 02886
(401) 736-3440

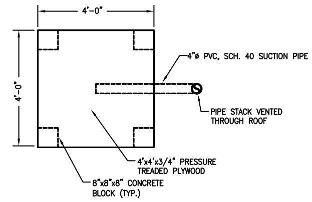
DATE	08-27-07
DESIGNED BY	PMG
DRAWN BY	DMA
CHECKED BY	PMG
PROJECT MANAGER	61965.01
PROJECT NUMBER	61965.01
SCALE	1 INCH = 25 FEET
FILE NAME	6196501 EA FTP
DRAWING NUMBER	N/A
SHEET NUMBER	1 OF 3



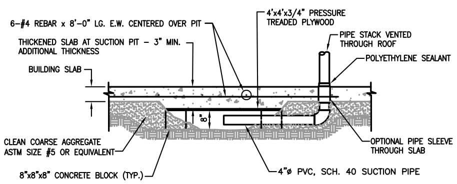
DESIGNED BY	DRAWN BY	DATE	PROJECT NO.	FILE NAME
PMG	DMA	AUG 27 2007	61965.01	AS-BUILT08-07
CHECKED BY	PROJECT MGR.	SCALE	DRAWING NO.	FIGURE
PMG	PMG	NTS	2 OF 3	N/A

AS-BUILT
SUB SLAB MONITORING AND SAMPLING LOCATIONS
ADELAIDE AVE HIGH SCHOOL
PROVIDENCE, RHODE ISLAND

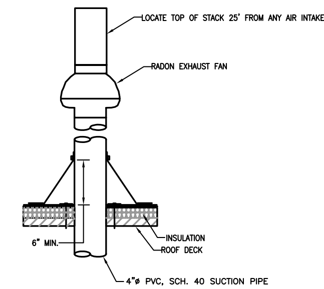
REMEDIAL CLOSURE REPORT
AS-BUILT SUB-SLAB
MONITORING AND SAMPLING PLAN



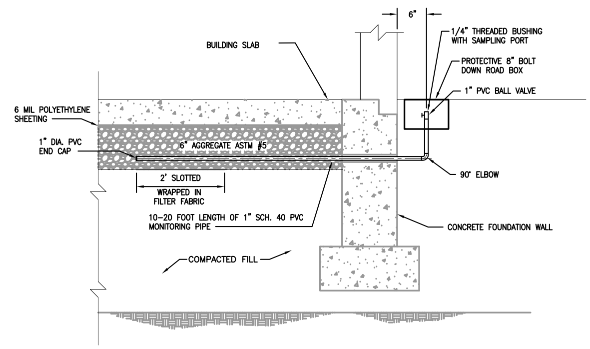
TYPICAL SUCTION PIT PLAN
SCALE: 1/2"=1'-0"



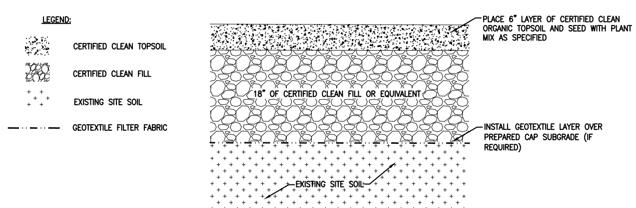
TYPICAL SUCTION PIT SECTION
SCALE: 1/2"=1'-0"



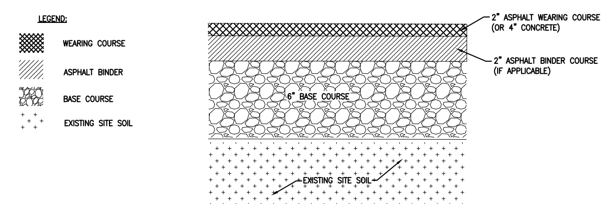
TYPICAL ROOF VENT
SCALE: NOT TO SCALE



MONITORING PROBE OUTLET SECTION
SCALE: 3/4"=1'-0"



TYPICAL ENGINEERED CAP
CROSS SECTION-UNPAVED AREAS
SCALE: NOT TO SCALE



TYPICAL ENGINEERED CAP
CROSS SECTION-PAVED AREAS
SCALE: NOT TO SCALE

REVISIONS			
NO.	DATE	BY	DESCRIPTION

SEAL

ADELAIDE AVENUE HIGH SCHOOL
PROVIDENCE, RHODE ISLAND

AS BUILT DEPICTING SUB SLAB VENTING SYSTEM DETAILS AND ENGINEERED CAP CROSS SECTIONS

EA ENGINEERING, SCIENCE, AND TECHNOLOGY
2350 Post Road
Warwick, RI 02886
(401) 736-3440

DATE	AUGUST 2007
DESIGNED BY	PMG
DRAWN BY	DMA
CHECKED BY	PMG
PROJECT MANAGER	PMG
PROJECT NUMBER	61965.01
SCALE	AS SHOWN
FILE NAME	6196501_SUB SLAB DETAILS.DWG
DRAWING NUMBER	N/A
SHEET NUMBER	3 OF 3

Appendix C

Equipment Cut-Sheets and Users Manuals

ProPex®

geotextiles

4510

ProPex 4510 is a polypropylene nonwoven needlepunched fabric. This engineered geotextile is stabilized to resist degradation due to ultraviolet exposure. It is resistant to commonly encountered soil chemicals, mildew and insects, and is non-biodegradable. Polypropylene is stable within a pH range of 2 to 13, making it one of the most stable polymers available for geotextiles today. We wish to advise that **ProPex 4510** meets the following minimum average roll values:

Property	Test Method	Minimum Average Roll Value (English)	Minimum Average Roll Value (Metric)
Unit Weight	ASTM-D-5261	10 oz/yd^2	339 g/m^2
Grab Tensile	ASTM-D-4632	250 lb	1.11 kN
Grab Elongation	ASTM-D-4632	50 %	50 %
Mullen Burst	ASTM-D-3786	520 psi	3584 kPa
Puncture	ASTM-D-4833	155 lb	0.689 kN
Trapezoidal Tear	ASTM-D-4533	100 lb	0.445 kN
UV Resistance	ASTM-D-4355	70 % at 500 hrs	70 % at 500 hrs
AOS(1)	ASTM-D-4751	100 sieve	.15 mm
Permittivity	ASTM-D-4491	1.2 sec^{-1}	1.2 sec^{-1}
Flow Rate	ASTM-D-4491	85 $gal/min/ft^2$	3460 $L/min/m^2$
Coefficient of Permeability	ASTM-D-4491	0.20 cm/sec	0.20 cm/sec
Thickness	ASTM-D-5199	85 mils	2.15 mm

(1) max. average roll value

Amoco Fabrics and Fibers Company manufacturers the nonwoven fabric indicated above. The values listed are a result of testing conducted in on-site laboratories. A letter certifying the minimum average roll values will be issued from the manufacturing plant by the Quality Control Manager at the time shipment is made.

DATE ISSUED: 01/02/04

Amoco Fabrics and Fibers Company
260 The Bluffs
Austell, GA 30168
PH: 770-944-4569
FX: 770-944-4584

Exclusion of Liability

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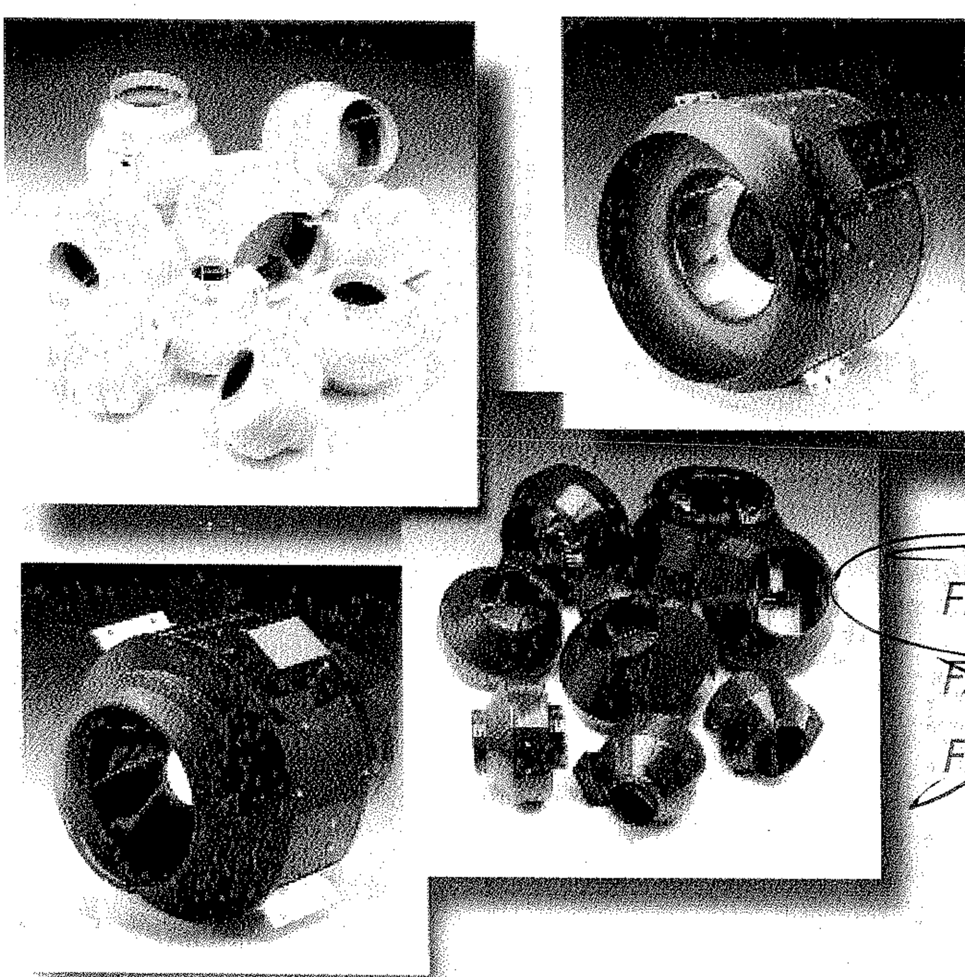
bp

Inline Centrifugal Fans for Round Duct

the ultimate in quality, quiet performance and cost efficiency



FR Series

~~FX Series~~

~~FKD Series~~

Fantech FR Series

Versatility and Value

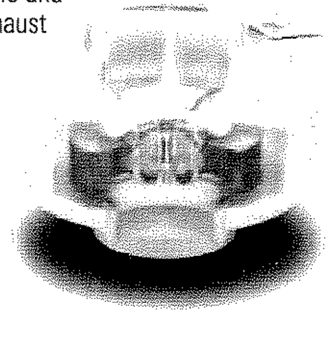
Fantech's versatile FR Series fans feature a plastic housing constructed of UL-recognized, UV-protected thermoplastic resin. This tough protective shell allows the fan to be mounted in outdoor and wet locations.* Ideal for multiple point exhaust, dual bathroom exhaust, or new room additions, Fantech's FR Series fans are caulked at the motor screws, the wiring cables and along the seams of the fan to prevent moisture from entering the housing. Fantech's FR Series fans have long been the choice of residential builders and remodelers but now can be used for commercial projects with our recent UL commercial applications rating.

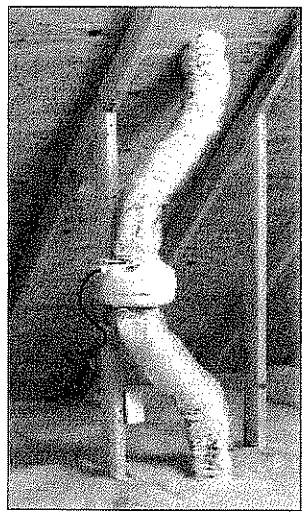
Easy to install
Loaded with features

- Prewired and supplied with a mounting bracket for easy installation
- Available singularly with bracket or in a variety of kits for specific applications. Each kit includes the appropriate fan and accessories
- UL Listed; CSA Certified
- Approved for residential and commercial applications and for wet locations
- Suitable for airstream temperatures up to 140° F
- Easy connection using external wiring box with waterproof gasket
- 122-649 CFM
- 4" to 10" duct diameters
- 100% speed controllable
- Five-year factory warranty

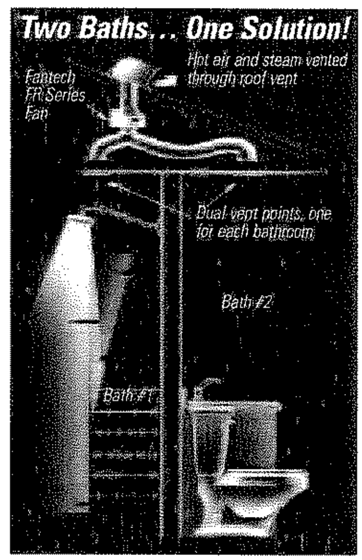
Kits are available for the following applications:

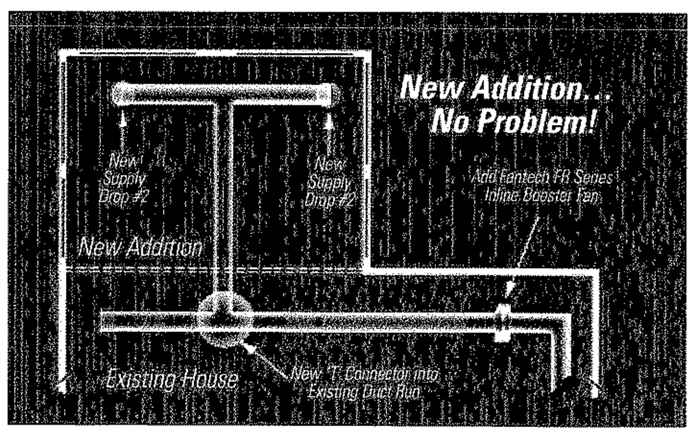
- Regular Kits (REG 100 and REG 140) for single point exhaust applications
- Deluxe Kits (DLX 110, DLX 150, and DLX 200) designed for dual point exhaust applications
- Vent Light Kits (REG 100L, DLX 150L) for single and dual vent light exhaust applications





Typical attic installation





** The FR Series is not manufactured to operate with water running through the motor compartment, or to be used in applications where the fan would be buried underground. A UL-recognized waterproof conduit should be used for all outdoor applications to prevent moisture entry via knockout in wiring box.*

FR Kits

Pictured from left to right: DLX150 – Dual Point Ventilation Kit; REG100L – Single Vent Light Kit. Additional kits (not pictured) are available.

DLX150

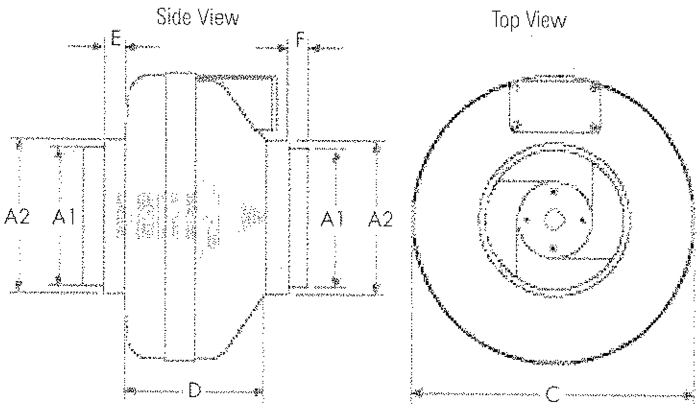
REG100L

Specifications

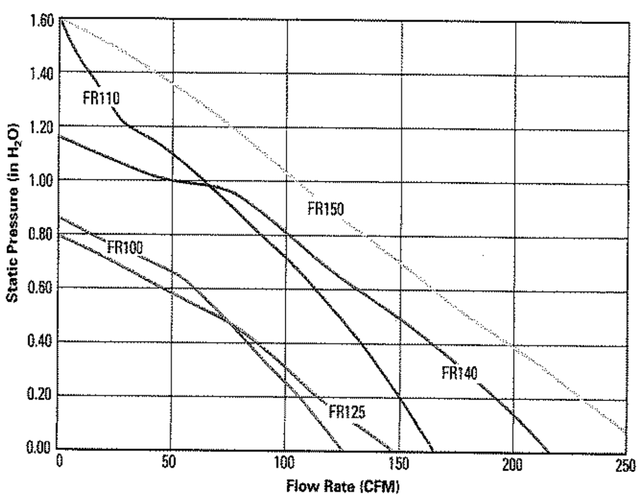
FR Series Dimensional Data

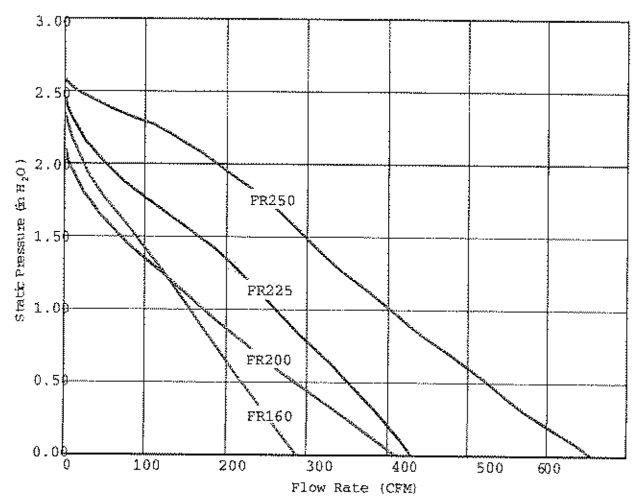
model	†A1	A2	C	D	E	F
FR 100	4	5	9½	6⅛	⅞	⅞
FR 110	4	5	9½	6⅛	⅞	⅞
FR 125	—	5	9½	6⅛	⅞	—
FR 140	6	6¼	11¾	5⅞	1	⅞
FR 150	6	6¼	11¾	5⅞	1	⅞
FR 160	6	6¼	11¾	6⅜	1	⅞
FR 200	8	10	13¼	6¼	1½	1½
FR 225	8	10	13¼	6¼	1½	1½
FR 250	—	10	13¼	6¼	1½	—

All dimensions in inches. † Duct connections are 1/8" smaller than duct size.



FR Series Air Performance Graphs





FR Series Performance Data

Fan Model	Energy Star	RPM	Volts	Rated Watts	Wattage Range	Max. Amps	Static Pressure in Inches W.G 0"	.2"	.4"	.6"	.8"	1.0"	1.5"	Max. Ps	Duct Dia.
FR 100	√	2900	115	19	13 – 19	0.18	122	100	78	55	15	—	—	0.87"	4"
FR 110	—	2900	115	80	62 – 80	0.72	167	150	133	113	88	63	4	1.60"	4"
FR 125	√	2950	115	18	15 – 18	0.18	148	120	88	47	—	—	—	0.79"	5"
FR 140	√	2850	115	61	47 – 62	0.53	214	190	162	132	99	46	—	1.15"	6"
FR 150	√	2750	120	71	54 – 72	0.67	263	230	198	167	136	106	17	1.58"	6"
FR 160	—	2750	115	129	103 – 130	1.14	289	260	233	206	179	154	89	2.32"	6"
FR 200	√	2750	115	122	106 – 128	1.11	408	360	308	259	213	173	72	2.14"	8"
FR 225	√	3100	115	137	111 – 152	1.35	429	400	366	332	297	260	168	2.48"	8"
FR 250	—	2850	115	241	146 – 248	2.40	649	600	553	506	454	403	294	2.58"	10"

FR Series performance is shown with ducted outlet. Per HVI's Certified Ratings Program, charted air flow performance has been derated by a factor based on actual test results and the certified rate at .2 inches WG.

EXTRACTIVE GAS DETECTOR

OPERATION MANUAL

Model PS-7

Contains the PS-7, PS-7 Administrator & Pyrolyzer Manuals

- Store this operation manual in a convenient location, and consult it whenever necessary.
- Operate this unit only after reading and fully understanding the content of this manual.
- This manual uses standard specifications. If your specifications are different, the operation manual that came with your unit takes priority.

NEW COSMOS ELECTRIC CO., LTD.

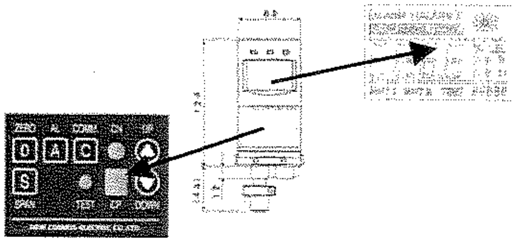
DOD Technologies, Inc.
Innovative Life Safety Systems & Services

740 McArdle Drive, Unit C – Crystal Lake, IL 60014

815-788-5200 Phone   815-788-5300 Fax   www.dodtec.com

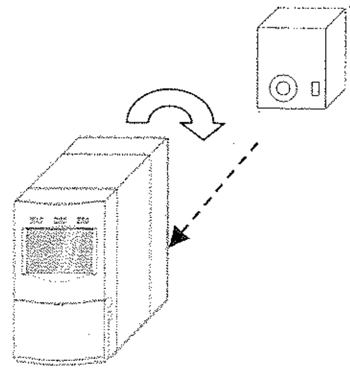
The name and function of each component

→P 5



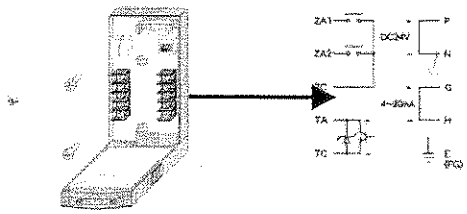
How to install the sensor unit

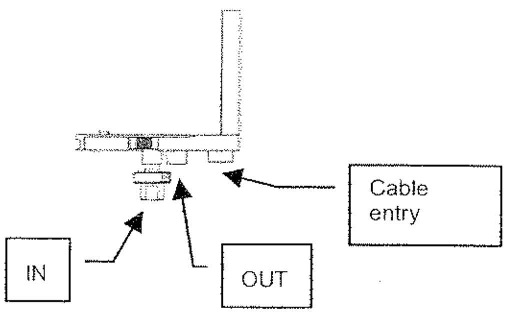
→P 30



Installation and wiring the base unit

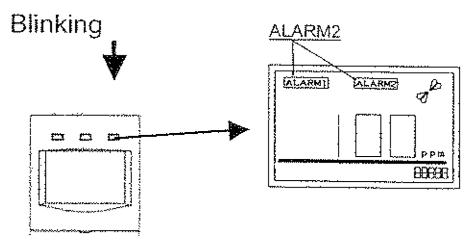
→P 9





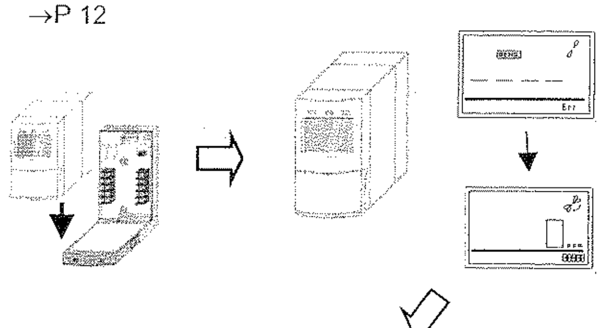
When the gas alarm is activated

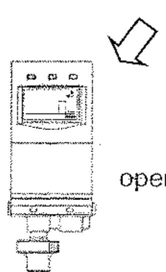
→P 22 and P 21



Basic operating instructions

→P 12



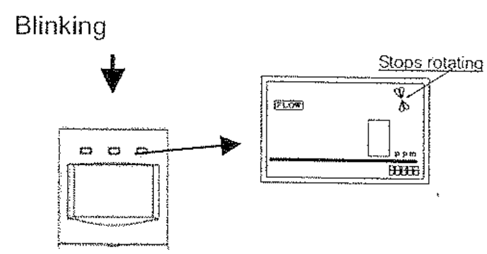


Normal operation

state →P 21

The different types of trouble warnings

→P 24



Troubleshooting

→P 36

TABLE OF CONTENTS

1 Introduction

- Thank you for purchasing the extractive COSMOS Gas Detector Model PS-7.
- This Gas Detector is designed to detect the leakage of toxic and combustible gases. It is designed to display the concentration level of detected gases on the main unit and output that information externally as an analog signal. When a preset warning level of gas is detected, the warning lamp (ALARM lamp) on the main unit starts to blink, the external contact output is activated, and the amount of leaking gas is monitored.
- The sensor unit and sampling unit used in the Gas Detector can be replaced without the use of tools. Regular replacement of these components eliminates the need to perform calibration on-site.
- To ensure correct operation, read this manual carefully before attempting to install or operate the Gas Detector.

Explanation of Symbols

This manual uses the following symbols. Their meanings must be understood and observed to ensure safe operation of the unit.

⚠ **Danger:**	Indicates an impending hazardous situation that, if not avoided, will result in serious injury or death.
⚠ **Warning:**	Indicates a potentially hazardous situation that, if not avoided, could result in serious injury or death.
⚠ **Caution:**	Indicates a potentially hazardous situation that, if not avoided, could result in minor injury or physical damage.
Note	Indicates operational advice and/or instructions.

2 Safety Instructions

- Read and understand the following information to ensure that the Gas Detector is used correctly.
- The Gas Detector must always be used in accordance with relevant laws and regulations, and all wiring, installation, and other work associated with the Gas Detector must be performed by qualified personnel.

⚠ Warning

- When the Gas Detector detects a gas leak, carry out the procedures stipulated by your company in response to gas leaks.
- The Gas Detector must be grounded to prevent electric shock.
- The Gas Detector is not explosion-proof. It must be installed in a safe location.

⚠ Caution

- Do not disassemble or modify the unit, or change its construction or circuitry in any way. Doing so may impair the unit's performance.
- The Gas Detector is not drip-proof and must be installed in a location free from spattering water.
- The unit must be used in accordance with prescribed laws and regulations.
- Please turn the power switch located on the front of the base unit OFF when attaching or removing the main unit. If this is done with the switch left ON, the unit may become damaged, or give false alarms.

3 Contents of This Package

- The following components are included with the standard Gas Detector unit. Ensure that all components are present before attempting to use the unit. Every effort is made to ensure that the unit is packed correctly, but if any components are damaged or missing, contact your local authorized distributor.

Description	Quantity
PS-7 Gas Detector	1
Male connector (R1/4- ø6)	2
Filter elements (FE-1, 12 pcs.) (For MF-50 Filter Unit)	1
Fuse (0.5 A)	1
Mounting screws (M4 × 8)	2
Stick for Test	2*1
Operation Manual	1*2
Operation Manual	1*2

*1 2 sticks are provided with each system.

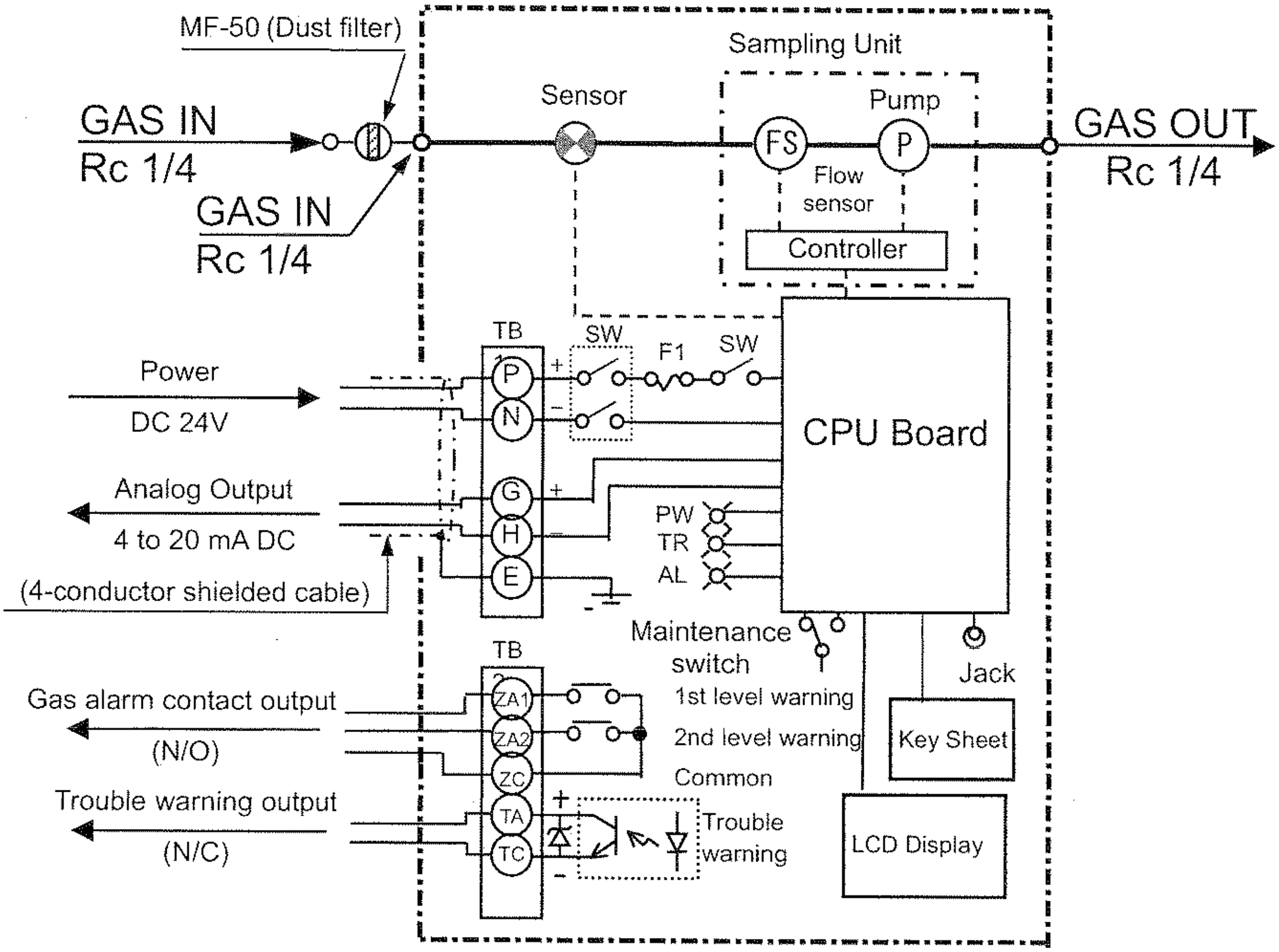
Note: 1)The sensor unit is not bundled with the Gas Detector, and must be purchased separately.
2)When it is with DeviceNet unit, the contents are as described in the DeviceNet Unit Instruction manual

Options

Option	Quantity
Filter (MF-51)*3	Ordered quantity
Gas collector (PF-D1)	Ordered quantity

*3 Recommended for use with highly adsorbent gases (HCl, Cl_2, NH_3, etc.) other than HF and F_2.

4 System Flow Diagram



Warning contact capacity (ZA1orZA2-ZC)
(Rated load: 125 V AC or 30 V DC
0.5-A resistance load)

Trouble output (TA-TC)
(Rated load: 30 V DC 30-mA
resistance load)

Figure 1 System flow diagram

⚠ Warning

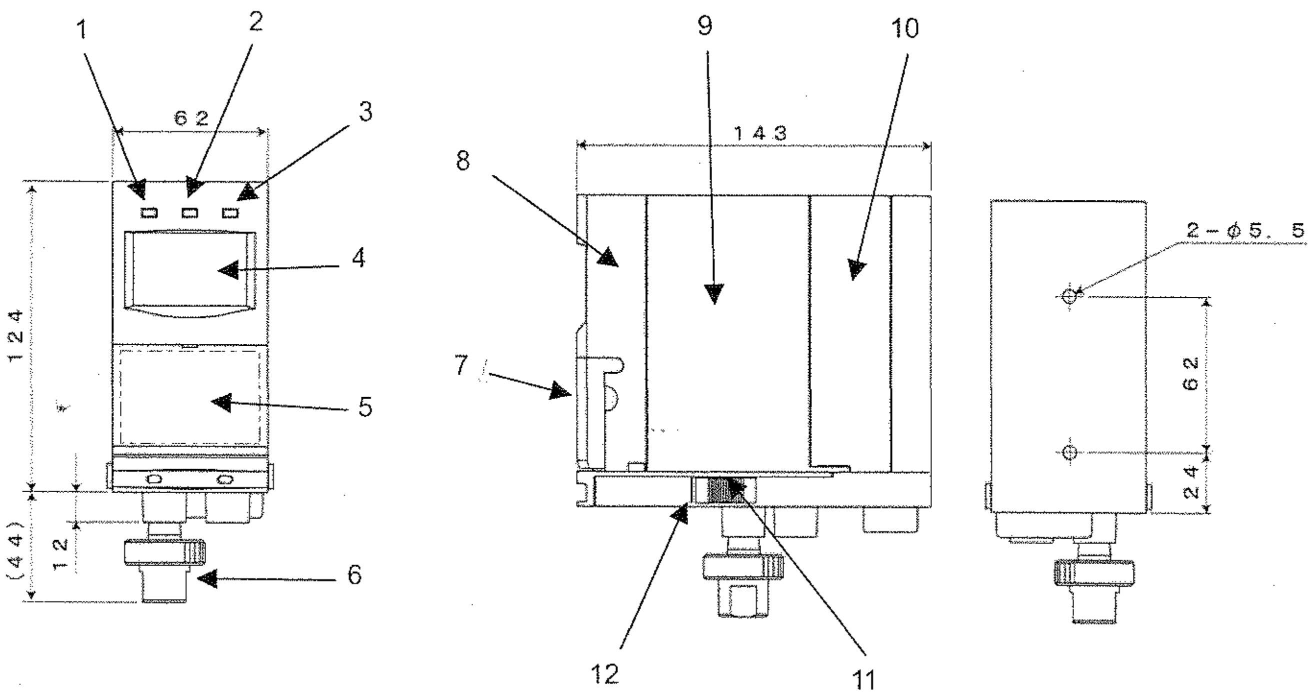
Pay special attention to the polarity of the trouble warning output. As the circuit protection diodes are internalized, if the polarity is reversed, the trouble warning signal will not be output.

⚠ Caution

The analog output source is not insulated from the power source. In case it is used in combination with other types of devices, the analog signal must be isolated from flowing into the power sources of the other devices.

5 Description

5-1 Components on the Main Unit



No.	Description	Function
1	POWER lamp	(Green) Power lamp. Illuminates during regular monitoring operations.
2	TROUBLE lamp	(Yellow) The lamp blinks when trouble occurs.
3	ALARM lamp	(Red) The lamp blinks when the concentration level of detected gas exceeds that of the preset alarm level.
4	LCD display	Warning displays, detected gas levels, bar graphs of gas levels, trouble states, maintenance modes, test mode, flow sign are all shown on the LCD display.
5	Key switches (inside)	Switches to carry out the various settings.
6	Filter unit (MF-50)	Incorporates a filter element (FE-1) that prevents dust from entering the gas inlet and tubes leading to the sensor.
7	Operation section cover	Lift up gently to use key switches.
8	Front panel	Contains the main board.
9	Sampling unit	The pump is contained inside the sampling unit.
10	Main body cover	The cover protecting the sensor unit.
11	Latches	Latches to attach the main unit onto the base unit.
12	Locked/unlocked line	A line (mark) to show the return position of the latch.

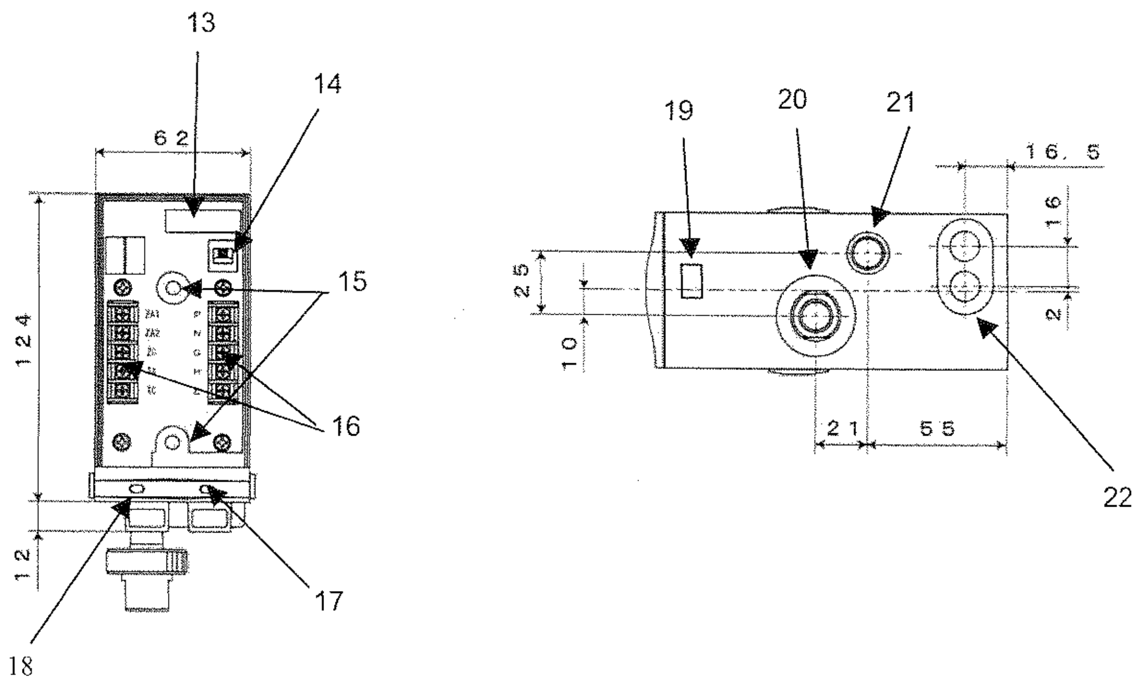


Figure 3 Dimension & description (Units: mm)

No.	Description	Function
13	Fuse	125 V, 0.5 A
14	Base unit power switch	The power switch for the base unit.
15	Mounting holes	Screw holes (∅5.5) for wall mounting.
16	Terminal strip	Used to connect external wiring.
17	Main unit power switch	The power switch for the main unit.
18	Maintenance switch	A switch that is set to regular, maintenance mode 1 (MNT1) or maintenance mode 2 (MNT2).
19	Connector for the pyrolyzer	A connector to provide power to the pyrolyzer when one is being used. (CDP-7 type).
20	Gas inlet	Aspiration inlet for sampled gas. A filter unit (MF-50) is attached.
21	Gas outlet	Exhaust outlet for sampled gas.
22	Cable entry	A hole for incoming cables.

5-2 Details of the Key Switch Section

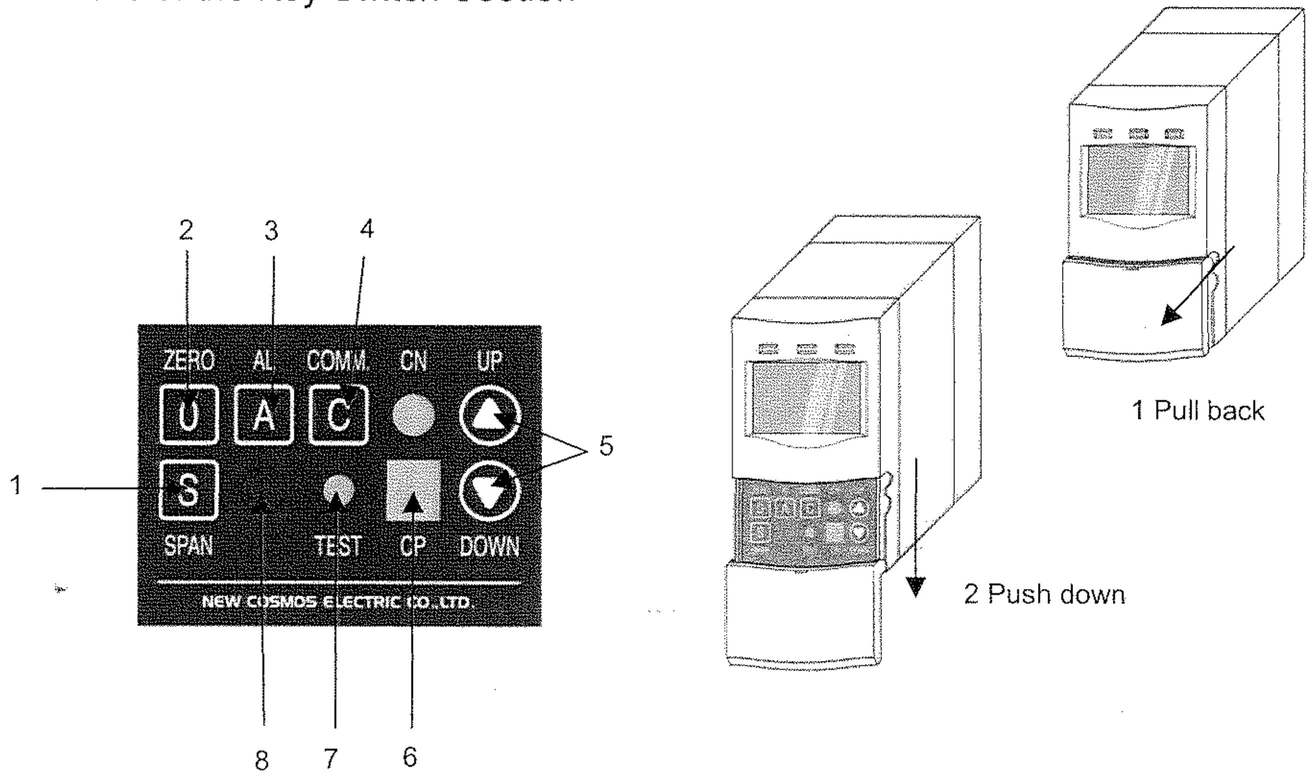
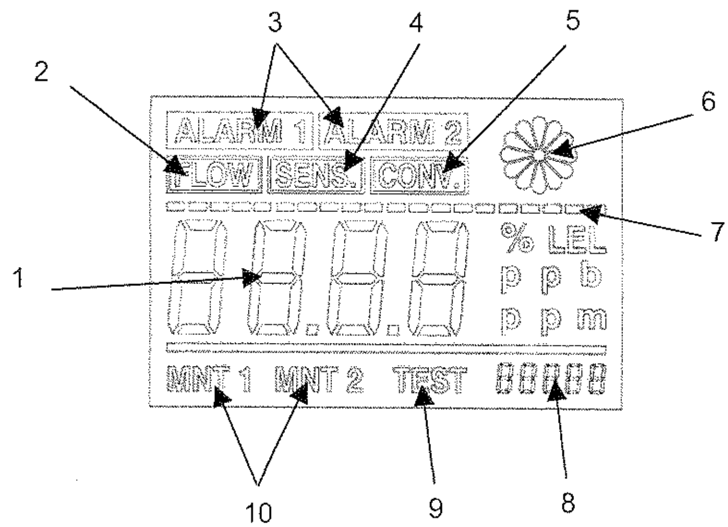


Figure 4 Names and functions of key switches

No.	Description	Display	Function
1	Span adjustment switch	SPAN	To carry out 21vol% adjustments. (For the COS-7 oxygen sensor unit.)
2	Zeroing switch	ZERO	To carry out zeroing. (For the CHS-7 flammable gas sensor unit or CDS-7 toxic gas sensor unit.)
3	Alarm point set switch	AL	Used to check the values of various alarm settings.
4	Communications switch	COMM.	Sends sensor unit information to the main unit after initial start-up, etc.
5	Up/down switch	UP DOWN	Used to change the values of the test output, etc.
6	Connector to check analog output	CP	A connector employed especially to check the analog output from the main unit (4- 20 mA).
7	Test switch	TEST	Used to set to test mode.
8	Special command switch	(None)	Used to change the values of various settings. (For administrative use.)

5-3 Details of the LCD Screen Display



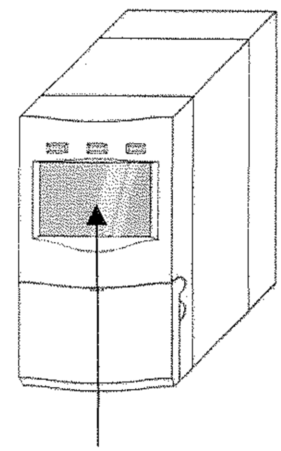


Figure 5 Parts of the LCD screen display

No.	Meaning
1	Shows the detected gas concentration (with units).
2	Lights when the flow rate is decreasing. (Also see no. 6 below.)
3	These light when the detected gas concentration exceeds that of the preset alarm level.
4	Lights on when there is sensor trouble, or when a sensor is inserted incorrectly.
5	Lights on when the pyrolyzer is disconnected.
6	Shows the flow rate of the sampling gas. Fast rotating display: When flowing at normal rate (0.5 L/min). Slowly rotating display: (Showing that it is clogged) When the load on the pipe is high. No rotation: (Warning that the flow rate is decreasing) When the flow rate has decreased.
7	Bar graph of gas concentration. One division is 5% of a full scale value. When the bar extends to the far right, it is at full scale.
8	Shows the values of various settings. (For administrative use.)
9	Lights while in test mode.
10	Lights while in either maintenance mode 1 (MNT1) or mode 2 (MNT2).

6 Installation and Wiring

⚠ Warning

- The Gas Detector is not explosion-proof. It must be installed in a safe location.
- When detecting highly adsorbent gases such as HF and F_2, install the Gas Detector with the filter element (FE-1) removed from the filter unit (MF-50). (Refer to *9-1 Replacing the Filter Element.*)
- For the gas sampling pipe, use a Teflon conduit of ø6/4 having a maximum length of 20 meters. Note, however, that for highly absorbent gases, such as HF, F_2, HCl, Cl_2 and NH_3, the length of the conduit should be no more than five meters.

⚠ Caution

- The Gas Detector should be installed in a location free from shock and vibration, and away from sources of high frequencies or magnetism.
- Do not use the gas collector hood when detecting gas concentrations in narrow spaces such as ducts.
- Do not install the Gas Detector in locations where the temperature may exceed 40°C or dew condensation or sudden temperature fluctuations may occur.
- The Gas Detector is not drip-proof.
- The pressure difference between the gas inlet/exhaust ports and the ambient atmosphere must be within ± 1 kPa. The pressure difference between the inlet port and exhaust port must be such that the inlet port is a negative pressure of 1 kPa or less.
- Install the Gas Detector vertically. (Inlet port and exhaust port must be in downward direction.)
- Locate the detector tip (the tip of the gas sampling pipe) to be appropriate for the specific gravity of the gas to be detected. It must also be placed in a location where the target gases are likely to accumulate.

Type of gas	Installation height
Heavier than air	Not more than 30 cm above floor level
Equivalent to air	75 to 150 cm above floor level
Lighter than air	Near the ceiling

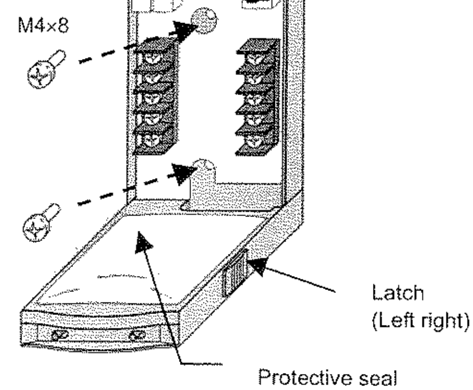
6-1 Installing the Main Unit

(1) Determine the installation point and attach the base unit using two M4 × 8 screws.

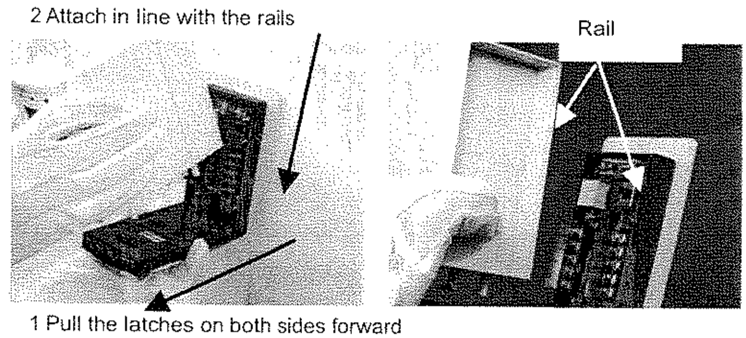
(2) Run a cable through the cable entry (the cutout hole near the bottom of the base unit) and connect to the terminal board. (Refer to 6-2 *Wiring Instructions.*)

(3) To attach the sensor unit, refer to *9-2 Attach/Replacing the Sensor Unit.* To attach it after attachment of the base unit, proceed to step 4.

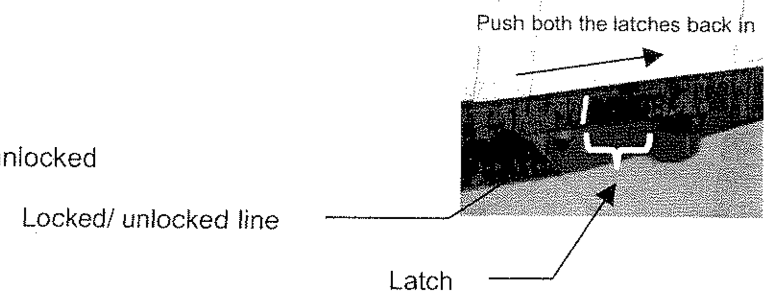
(4) Remove the protective seal before attaching the main unit.



(5) Pull back the latches on both the left and rights sides of the bottom of the base unit, and attach the main unit inserting from the top side first.



(6) Push both the latches on the left and right hand sides of the base unit back in until the locked/unlocked line can be seen



⚠ Warning

Be sure to push the latches back as far as they will go. If the latches are not back behind the locked/ unlocked line, normal gas detection will not be performed.

Note

- The protection seal on the base unit is to protect the connector and internal piping when attaching the base unit. This seal is not necessary after the main unit is attached. Please dispose of it properly in accordance with company disposal regulations.
- If multiple units are to be mounted in a row, ensure that there is sufficient space between each unit (at least 3 cm on either side is recommended) to allow the main unit to be removed and reattached.

6-2 Wiring Instructions

Terminal Board	Sign	Polarity	Function
TB1	P	+	Power supply (24 V DC)
	N	–	
	G	+	Gas concentration output (4-20 mA DC)
	H	–	
	E		Ground
TB2	ZA1		Gas alarm contact output (1st level) (no voltage contact 1a) Rated load: 125 V AC or 30 V DC, 0.5-A resistance load
	ZA2		Gas alarm contact output (2nd level) (no voltage contact 1a) Rated load: 125 V AC or 30 V DC, 0.5-A resistance load
	ZC		ZA1, ZA2 common
	TA	+	Trouble alarm (Open collector: N/C) Rated load: 30 V DC, 30-mA resistance load
	TC	–	Trouble alarm common

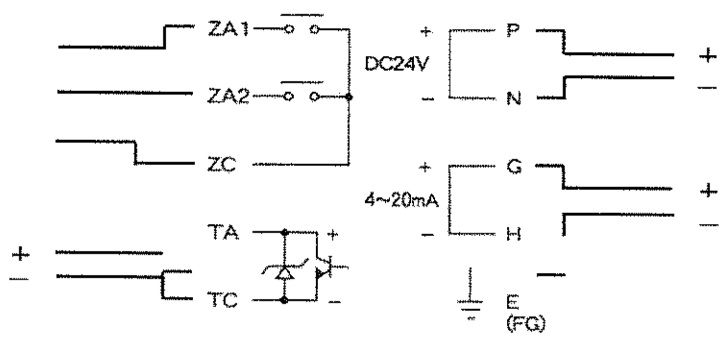


Figure 6 Terminal strip

⚠ Warning

- Be especially careful regarding the polarity of the trouble alarm (TA: plus, TC: minus.) as the circuit protection diodes are internalized, if the polarity is reversed, the trouble warning signal will not be output.
- To avoid electric shock, always disconnect the power supply before performing any wiring operations.
- Ensure that the unit is properly grounded.

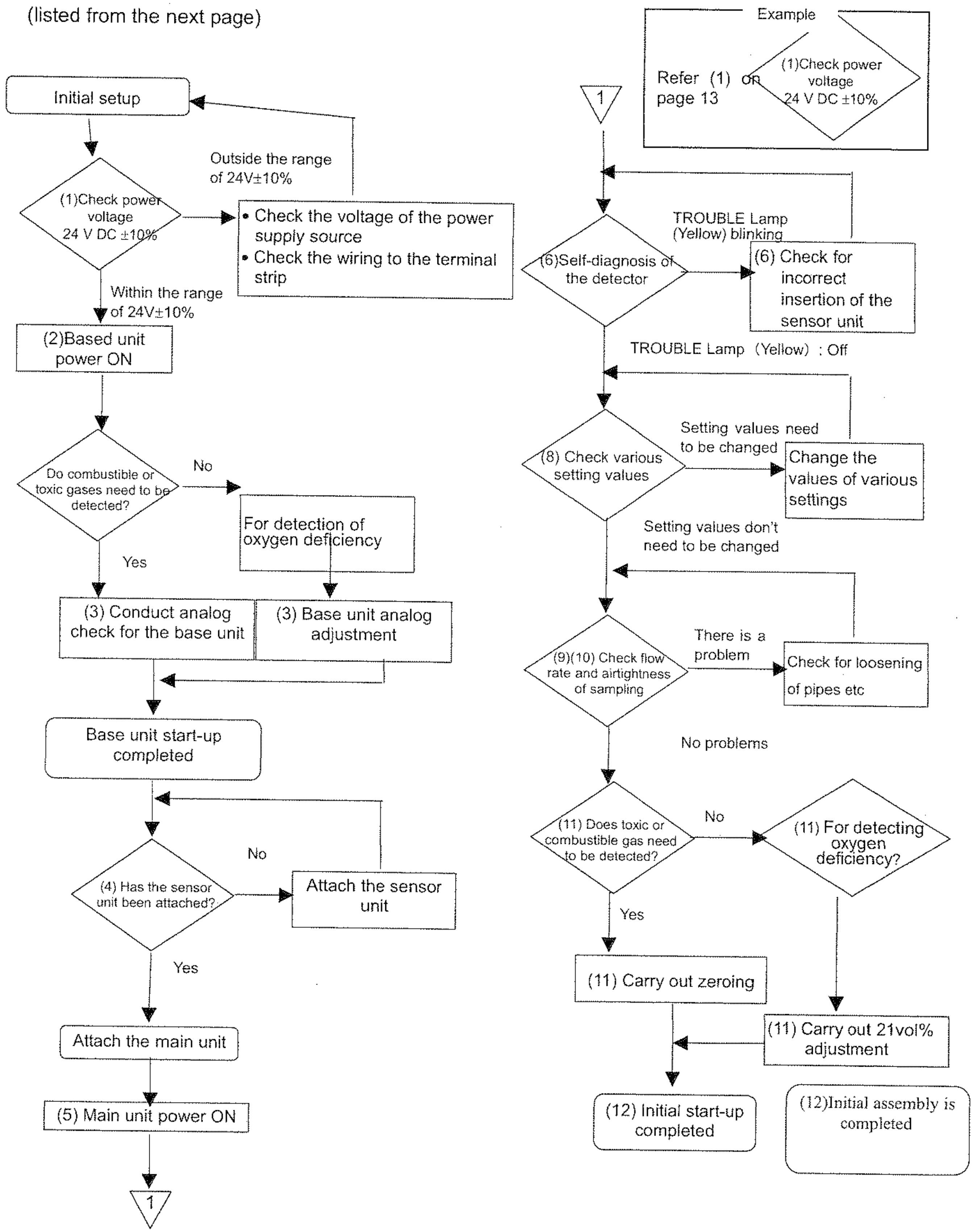
⚠ Caution

- Do not lay cables near sources of electrical noise, such as high-capacity transformers, motors or power supplies.
- Ensure that the cables on the external device side and the gas detector side are correctly connected.

7 Operation

7-1 Operation Procedures

Carry out operations in the following manner. Refer to the items inside each box for more detailed instructions (listed from the next page)



⚠ Warning

- Verify that the power supply voltage is 24 V DC ±10%.
- Before operating the Gas Detector, verify that the sensor unit correctly displays the type of gas to be detected and the full-scale value.

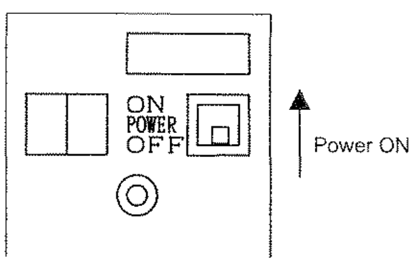
⚠ Caution

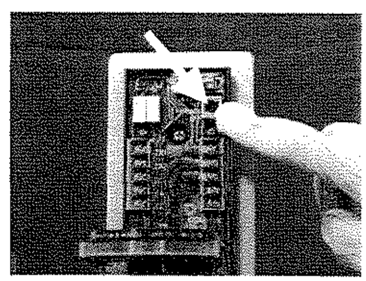
- Before turning the power ON, check that all connections are correct. Refer to *6-2 Wiring Instructions* and the separate Delivery Specifications, if available.

Proceed with operation in the following manner.

(1) Verify that the power supply voltage (the voltage between the P and N of the terminal block) is 24 V DC ±10%.

(2) Switch the base unit power ON.



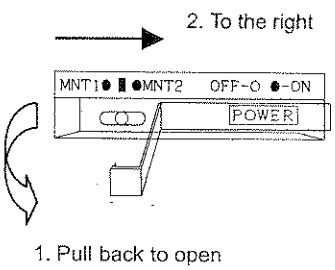


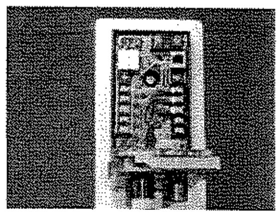
(3) Analog adjustment in maintenance mode 2

The analog output of the main unit changes when the maintenance switch is set to 2.

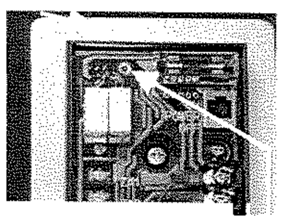
Adjustment should be carried out based on the following instructions as the analog output also differs depending on the sensor unit being used. For details regarding maintenance modes, refer to 7-5 *Maintenance Mode Settings and Operating Instructions.*

Toxic gas sensor unit	:	CDS-7
Combustible gas sensor unit	:	CHS-7
Oxygen sensor unit	:	COS-7
		(Value when at full scale 25vol%)



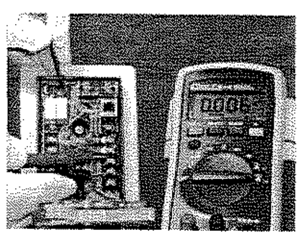


To set to maintenance mode 2 (MNT2)



Analog adjustment volume for maintenance mode 2

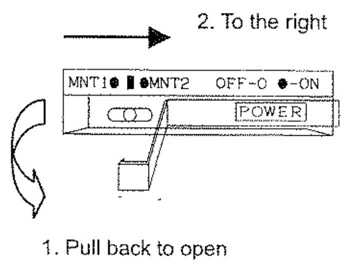
The tester tests the current range G= plus H= minus

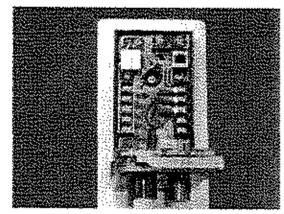


Measure the analog output (current) of "G" and "H" on the terminal board TB1 using a tester, etc.
If it falls within the range shown below, go on to the next step.
If it is not within the range shown below, use the analog adjustment volume for maintenance mode 2 to bring it into this range.

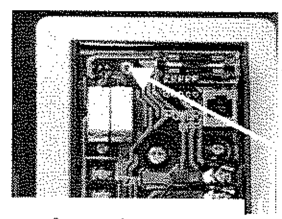
Model of sensor unit	Adjustment range
CDS-7	3.92 to 4.08 mA
CHS-7	3.92 to 4.08 mA
COS-7	17.32 to 17.48 mA

Oxygen sensor unit	:	COS-7
		(Value when at full scale50vol%)
***MUST BE ADJUSTED**		



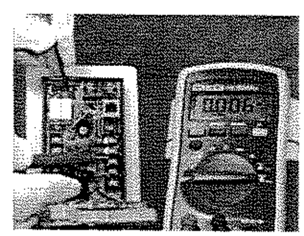


To set to maintenance mode 2 (MNT2)



Analog adjustment volume for maintenance mode 2

The tester tests the current range G= plus H= minus



Measure the analog output (current) of "G" and "H" on the terminal board TB1 using a tester, etc.
Adjust it to within the range of 10.64 to 10.80 mA by using analog adjustment volume for maintenance mode 2.

For toxic gas sensor unit: CDS-7, or
combustible gas sensor unit : CHS-7

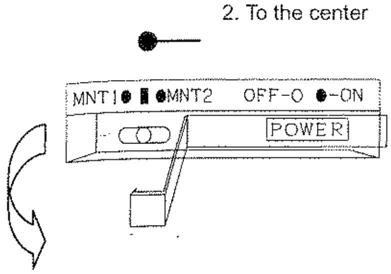
Analog output	Gas concentration
20mA	Full scale
4mA	0ppm
0mA	

Oxygen sensor unit : COS-7
(When full scale value is <u>25vol%</u>)

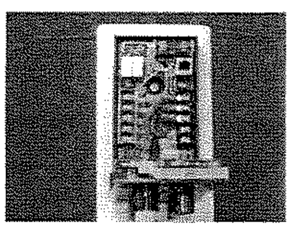
Analog output	Oxygen concentration
20mA	25%
17.4mA	21%
4mA	0%
0mA	

Set analog output to 17.4mA as the regular oxygen concentration is 21%.

2. To the center



1. Pull back to open



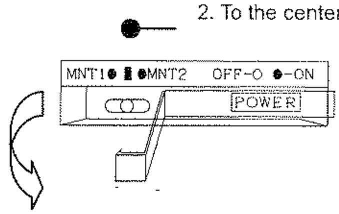
Set to normal mode (center)

Oxygen sensor unit : COS-7
(When full scale value is <u>50vol%</u>)

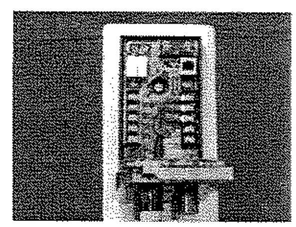
Analog output	Oxygen concentration
20mA	50%
10.7mA	21%
4mA	0%
0mA	

Set analog output to 10.7mA as the regular oxygen concentration is

2. To the center



1. Pull back to open



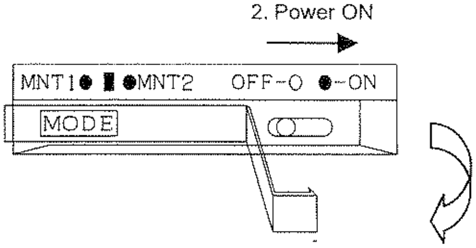
Set to normal mode (center)

(4) If the sensor unit is not attached, refer to *9-2 Attach/Replacing the Sensor Unit*, and attach the sensor unit.

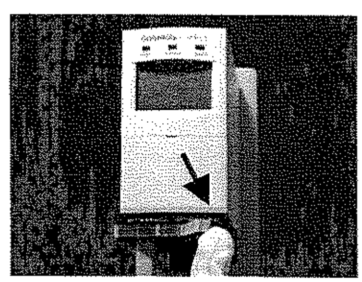
(5) Switch the main unit power ON

*Refer to *6-1 Installing the Main Unit.*

2. Power ON



1. Pull back to open

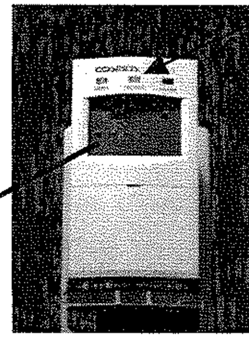


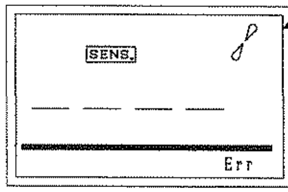
(6) Begin self-diagnosis after the front lamp and the LCD screen have been on for over one second.

When using the main detector for the first time, or when a new sensor unit with different settings (sensor units for which the target gases and full scale values, etc., are different) has been attached:

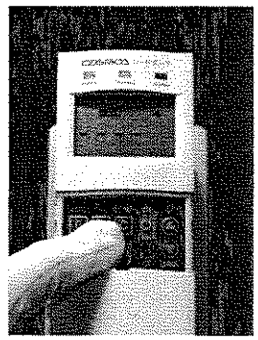
The TROUBLE lamp (Yellow) will blink.
Also $\boxed{\text{SENS.}}$ will be displayed at the top of the LCD screen and Err on the bottom right.

The TROUBLE lamp (Yellow) will blink





Open the cover on the operation section of the main body and hold down the key switch "COMM" for over one second.



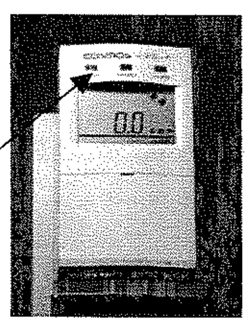
→To (7)

When the sensor unit has been replaced, or when a sensor unit with the same settings (sensor units for which the target gases and full scale values etc are the same) has been attached:

→To (7)

(7) When "Good" is displayed at the bottom right of the LCD screen, it will go into initial power delay mode (POWER lamp blinks) for 30 seconds. It will then return to normal operation state, and the POWER lamp will come on. The detected gas concentration will be displayed in the middle of the screen.

POWER lamp (Green)
Blinks (30 secs)→On



(8) Check the various setting values

The values of the various settings can be checked by pressing the up/ down switch, "△" or "▽" on the main unit.
The setting values are displayed in the bottom right hand corner of the LCD screen.
They may sometimes difficult to distinguish due to the types of alphabet letters used.

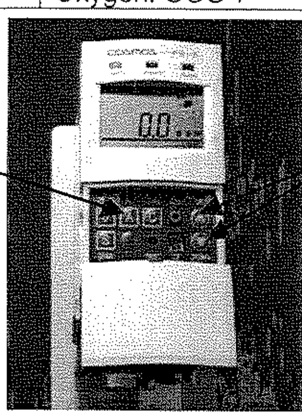
LCD Screen Display	The function to be set	Remarks	Default value Toxic : CDS-7 Combustible: CHS-7	Default value Oxygen: COS-7
d1 **	Time delay1	Time delay (secs.) of the gas alarm contact (1st level)	d1 0	d1 0
d2 **	Time delay2	Time delay (secs.) of the gas alarm contact (2nd level)	d2 0	d2 0
az	Analog output (base)	(*For our maintenance purposes only)	–	–
as	Analog output (span)	(*For our maintenance purposes only)	–	–
zs *	Zero suppression, or 21vol% suppression	Displays the percentage of the full scale value (rounded to the percent)	zs 5	zs 2
H-H L-L H-L	Alarm mode	1st: Upper limit, 2nd: upper limit warning 1st: Lower limit, 2nd: lower limit warning 1st: Upper limit, 2nd: lower limit warning	H-H	L-L
Con *	Pyrolyzer failure alarm.	0: Off 1: On	Con 0	Con 0
CG **	Calibrated gas concentration	(*For our maintenance purposes)	CG 40	CG 84
nEt *	The existence of DeviceNet unit	0: Non-existent 1: Existent	nEt 0	nEt 0
F ***	Display of f value	(*For our maintenance purposes)	–	
FL ***	Displays rate of flow	Shows the current rate of flow (mL/min)	–	
P ***	Sensor unit output	(*For our maintenance purposes)	–	
At *	Auto 21vol% adjustment	0: No 1: Yes		At 1

The values of alarm settings can be checked by pressing the alarm setting switch "AL".
"AL1 displayed" → "AL2 displayed" → "Normal" → "AL1 displayed" → (Repeat)

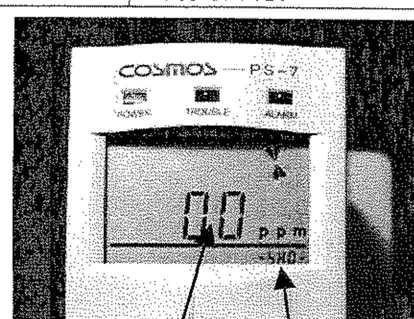
The percentage of the full scale value for the current alarm values will be displayed in the bottom right hand corner of the LCD screen (in units of 1%), and the alarm set value at the current gas concentration is displayed in the middle of the screen.

LCD Display Screen	Default value		Explanation of the default value
A1 **	Toxic: CDS-7 Combustible: CHS-7	A1 10	10% of F.S.
	Oxygen: COS-7	A1 72	72% of F.S.
A2 **	Toxic: CDS-7 Combustible: CHS-7	A2 20	20% F.S.
	Oxygen: COS-7	A2 76	76% of F.S.

Alarm point setting switch



Up/down switch



Center of the screen

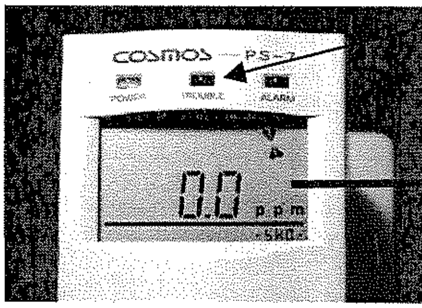
Bottom right of the screen

Refer to the separate PS-7 Operation Instructions for Administrators to change the values of various settings.

(9) Verifying the sampling flow rate (Check flow rate)

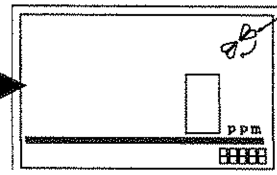
Check to see that the flow rotation rate is high, and the TROUBLE lamp (yellow) is off.

If the flow rotation is high, then it is flowing at the designated rate (0.5 L/min).



TROUBLE lamp (yellow) Off

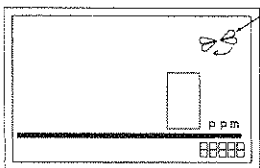
Rotates quickly



Note

–Clogged display–

Rotates slowly

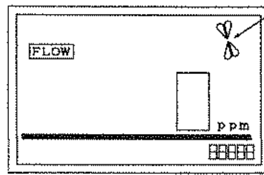


• Slowly rotating flow rate.

A "clogged display" will be shown when the load on the pipes is high. This could mean "the pipes are clogged, " "the filter is clogged, " or "the load is too high, " and monitoring of gas concentration will continue even when the "clogged display" is shown.

–Warning that flow rate is decreasing–

Stops rotating



• No rotation.
• FLOW is displayed on the LCD screen.
• TROUBLE lamp (yellow) blinks.
• Trouble warning is activated.

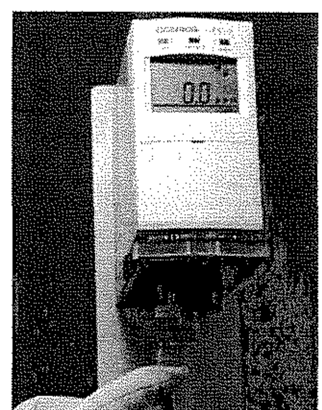
When the flow is not at the designated rate, a warning that the flow rate is decreasing is output.

(10) Verifying airtight seal

Disconnect the gas sampling pipe from the gas inlet and block the inlet with a finger completely.

The flow rotation rate will then slow. By keeping the inlet blocked off, it will eventually stop, and then check to make sure the TROUBLE lamp (yellow) is blinking. (The warning that the flow rate is decreasing is generally set to a delay time of 10 seconds.) FLOW will be displayed on the LCD screen.

If the flow rate rotation stops, and the TROUBLE lamp (yellow) does not come on, please check to ensure the sensor unit is properly attached to the main unit. (Refer to 9-2 Attach/Replacing the sensor unit). Also, check to ensure that the latches at the bottom of the base unit are correctly locked back behind the locked/ unlocked line.



Block the inlet

When the pipes have been returned to normal, recheck to see that the flow rotation rate is high.

(11) Adjusting the Zero/21 vol% setting (Zeroing for the CDS-7, CHS-7, and 21vol% adjustment for the COS-7)

After power is applied to the main unit, and the appropriate time period has passed (depending on the type of sensor unit), press the appropriate key switch from the below table. Then, be sure to do a readjustment to increase precision.

Sensor Unit	Initial adjustment	Readjustment	Zero / 21ol% adjustment key switch
Toxic gas sensor unit CDS-7	30 minutes after power ON	24 hours after power ON	Maintenance mode1 or 2 + ZERO switch *1
Oxygen sensor unit COS-7			Maintenance mode1 or 2 + SPAN switch *2
Combustible gas sensor unit CHS-7	1 day after power ON	7 days after power ON	Maintenance mode1 or 2 + ZERO switch *1

Note

Factors such as the atmosphere of the installation location may cause the Zero/21 vol% setting to take longer to stabilize (the time until re-adjustment) than the time indicated in the above table.

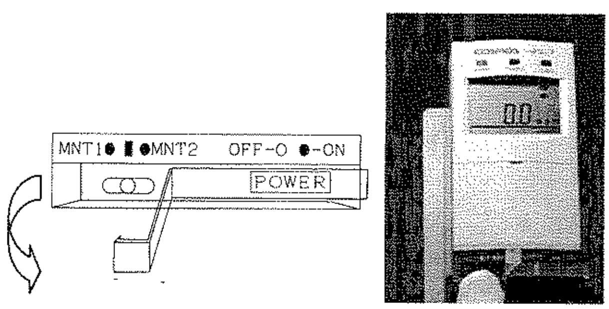
–Zeroing–

For the:

Toxic gas sensor unit: CDS-7

Combustible gas sensor unit: CHS-7

1. Set to maintenance mode (MNT1 or MNT2).



Pull back to open

Left: Maintenance1 (MNT1)

Center: Normal mode

Right: Maintenance 2 (MNT2)

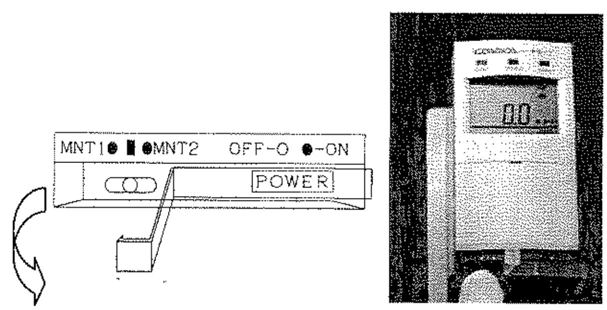
*For details regarding maintenance modes, refer *7-5 Maintenance Mode Settings and Operating*

–21vol% Adjustment–

For the:

Oxygen sensor unit: COS-7

1. Set to maintenance mode (MNT1 or MNT2).



Pull back to open

Left: Maintenance1 (MNT1)

Center: Normal mode

Right: Maintenance 2 (MNT2)

*For details regarding maintenance modes, refer to *7-5 Maintenance Mode Settings and*

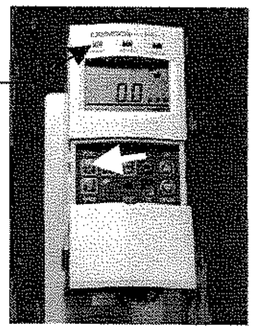
For the:

Toxic gas sensor unit: CDS-7

Combustible gas sensor unit: CHS-7

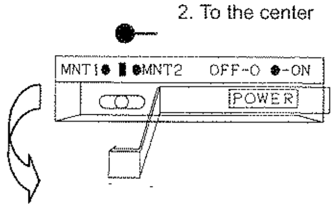
2. Hold down the ZERO Key for over a second.
   It is complete when the POWER lamp (green) blinks once.

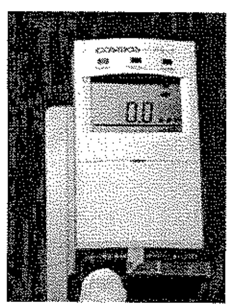
It is complete when the POWER lamp (green) blinks once.



3. Set back to normal mode (Center)

2. To the center





1. Pull back to open

* Be sure to do a readjustment after the appropriate time period has passed to increase precision.

Poisonous gas sensor unit: After 24 hours

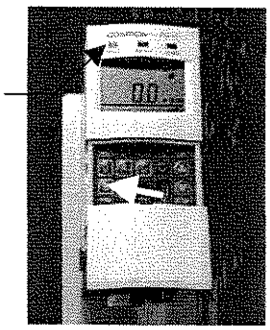
Flammable gas sensor unit: After 7 days

For the:

Oxygen sensor unit: COS-7

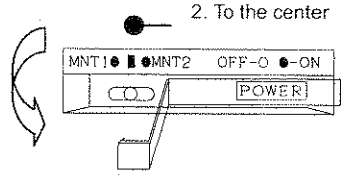
2. Hold down the SPAN Key for over a second.
   It is complete when the POWER lamp (green) blinks once.

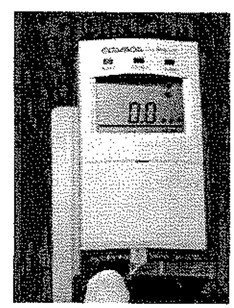
It is complete when the POWER lamp (green) blinks once.



3. Set back to normal mode (Center)

2. To the center





1. Pull back to open

* Be sure to do a readjustment after the appropriate time period has passed to increase precision.

Oxygen sensor unit: After 24 hours

⚠ Warning

Zeroing and 21vol% adjustment must be carried out in a clean environment. If they are done in a gas-filled environment, the correct level of gas concentration detected will not be given.

(12) Affix the seal showing target gases to be detected in a clearly visible place on the front of the main body.

–Normal operation state–

POWER lamp (Green): On
TROUBLE lamp (Yellow): Off
ALARM lamp (Red): Off

Detected gas concentration

Flow rate: High rotation

Seal showing target gases to be detected

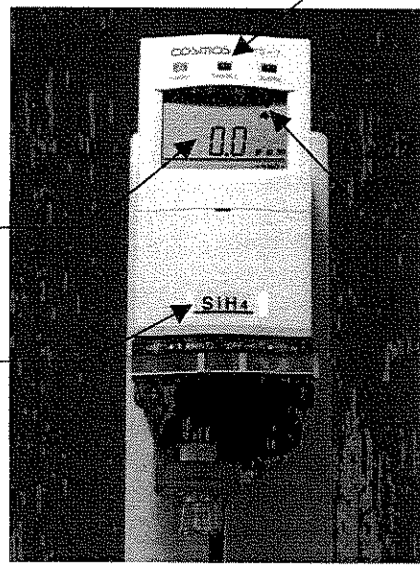


Figure 7 Normal operation state

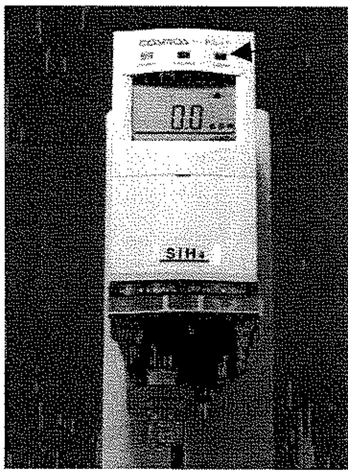
	Normal	Trouble	Gas alarm (1st stage)	Gas alarm (2nd stage)
LED	Green light	Yellow blink	Red blink	Red blink
LCD screen		FLOW SENS CONV	ALARM1	ALARM1 ALARM2
Alarm contact (ZA1)	OFF	OFF	ON	ON
Alarm contact (ZA2)	OFF	OFF	OFF	ON
Trouble alarm (TA)	ON	OFF	ON	ON

7-2 Gas Alarm Operating Instructions

When the concentration level of detected gas exceeds that of the preset alarm level, the alarm contacts are activated after a set time delay, the ALARM lamp (red) blinks, and ALARM1 or ALARM2 is displayed on the LCD screen.

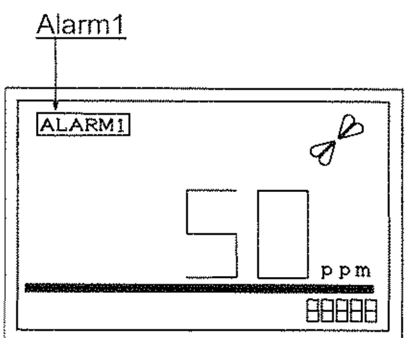
* During the alarm time delay, ALARM1 or ALARM2 blinks on the LCD screen, but the alarm contacts are not activated, and the ALARM lamp (red) does not blink.

When the concentration of detected gas drops back below the preset alarm level, it will automatically return to normal.

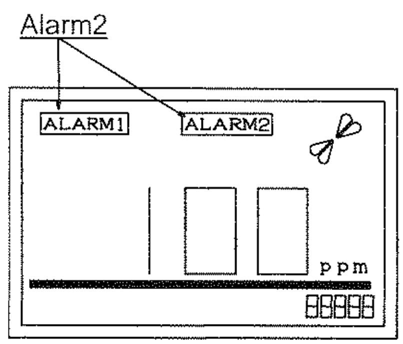


The ALARM lamp (red) will blink with the gas alarm (1st level), or gas alarm (2nd level)

–Gas alarm (1st level) –



–Gas alarm (2nd level)–



※ When the 2nd level gas alarm is activated, both the ALARM1 and ALARM2 will turn on.

O: On △: Blinking ●: Off

	Alarm level	LCD Screen	POWER Lamp (Green)	TROUBLE Lamp (Yellow)	ALARM Lamp (Red)	Remarks
1	Gas alarm (1st level)	ALARM 1	O	●	△	
2	Gas alarm (2nd level)	ALARM 1, ALARM 2	O	●	△	

Note

The relationship between 1st level and 2nd level alarm values of each alarm mode is as follows:

H – H mode (1st level: Upper limit, 2nd level: Upper limit)

Full Scale

2nd level gas alarm : ALARM 1 , ALARM 2 is displayed.
Alarm contacts ZA1 and ZA2 are activated
Alarm value is set by entering A2 **

1st level gas alarm : ALARM 1 is displayed.
Alarm contact ZA1 is activated
Alarm value is set by entering A1 **

0ppm ⇐ Normal state (No gas is detected)

L – L mode (1st level: Lower limit, 2nd level: Lower limit)

25vol%

21vol% ⇐ Normal state (No gas is detected)

1st level alarm : ALARM 1 is displayed.
Alarm contact ZA1 is activated.
Alarm value is set by entering A2 **

2nd level alarm : ALARM 1, ALARM 2 is displayed.
Alarm contact ZA1 and ZA2 are activated.
Alarm value is set by entering A1 **

0 vol%

H – L mode (Upper limit, Lower limit)

50vol%

Upper alarm : ALARM 2 is displayed.
Alarm contact ZA2 is activated.
Alarm value is set by entering A2 **

21vol% ⇐ Normal state (No gas is detected)

Lower alarm : ALARM 1 is displayed.
Alarm contact ZA1 is activated.
Alarm value is set by entering A1 **

0 vol%

7-3 Trouble Alarm Operating Instructions

The trouble alarm will be activated in the following situations. (The open collector will be ON in normal mode, and OFF during trouble or when the power is disconnected.) The TROUBLE lamp (yellow) will blink, and analog output will drop to below 0.6 mA. When the problem is remedied, the trouble alarm will automatically return to normal.

(1) Decrease in the rate of flow

When the flow is not at the designated rate, it is assumed that it is decreasing. FLOW is displayed on the LCD screen, and the flow rate rotation stops. Causes for a decrease in flow rate can include the clogging of filter elements, the clogging of pipes, the load being too high, deterioration of the pumps, etc.

(2) Sensor trouble

SENS. will be displayed on the LCD screen in the following situations:

- When the base output of the sensor unit has decreased significantly
- When the sensor has been disconnected. (For combustible gas sensor unit: CHS-7.)

(3) When a sensor unit has been inserted wrong

The settings, full scale values, and target gases to be detected are recorded in a detector after its first use. When a sensor unit with different settings information is inserted, this is determined to have been inserted wrong, and SENS. is displayed on the LCD screen. The concentration of the detected gases is displayed as: "- - - -"

(4) Disconnection of the pyrolyzer

When the pyrolyzer has been disconnected after used, CONV. is displayed on the LCD screen.

(5) Disconnection of the power source

When the power source has been cut, all lamps (green, yellow, and red) will turn off, and all operations will cease.

(6) A blown fuse

When a fuse has blown or is disconnected, the power source becomes cut, and all lamps (green, yellow, and red) will turn off, and all operations will cease

Note

When the trouble alarm is activated while using the oxygen sensor unit COS-7, the analog output is reduced to less than 0.6 mA. When the host system setting is the lower limit alarm, trouble will occur if the analog output from the main unit drops to less than 0.6 mA within one second from the time that the lower limit alarm is *not* activated. To avoid this, set it so that the lower alarm limit is not activated.

○: On △: Blinking ●: Off

	Type of trouble	LCD display	POWER Lamp (green)	TROUBLE Lamp (yellow)	ALARM Lamp (red)	Remarks
1	Decrease in rate of flow	FLOW	○	△	●	The flow rate rotation is stopped
2	Sensor trouble	SENS.	○	△	●	
3	Incorrect insertion of the sensor unit	SENS.	○	△	●	The gas concentration display shows "- - - -"
4	Pyrolyzer failure	CONV.	○	△	●	
5	Disconnection of the power source	(Nothing)	●	●	●	
6	Blown fuse	(Nothing)	●	●	●	

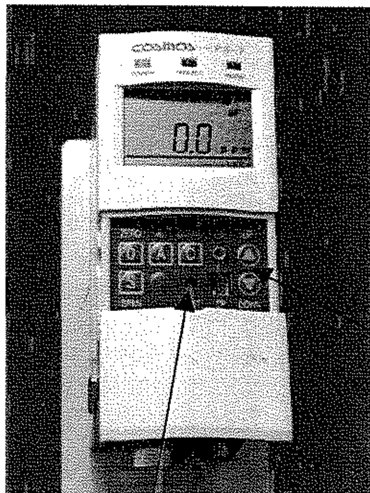
7-4 Test Mode Settings and Operating Instructions

(1) Settings

Press the "TEST" key switch on the front of the main unit.

When this is pressed once, it will go into test mode. When it is pressed again, it will return to normal mode.

*Test mode will automatically be released after 10 minutes.



Can be set with the UP/DOWN keys.

Press with the stick for test.
When pressed once, it will go into test mode, when pressed again it will return to normal.

(2) Operating Instructions

$\boxed{\text{TEST}}$ is displayed on the LCD screen.

In test mode, the value of the analog output (4-20 mA) can be set to units of 0.16 mA (1% units of the full scale value).

The value of the analog output can be changed using the "UP/DOWN" keys.

⚠ Caution

The alarm check conducted with the test switch will also activate the gas alarm contacts. For this reason, if alarm contacts are used for interlocking with external devices, verify that the interlock be released prior to conducting the alarm test.

Be sure to conduct alarm testing after changing settings in either maintenance mode. (Refer to 7-5 *Maintenance Mode Settings and Operating Instructions.*)

Also, conduct inspections on the gas detection devices only after informing those involved.

7-5 Maintenance Mode Settings and Operating Instructions

(1) Settings

There are two types of maintenance modes. (See the table below for the functions of each.)

Set the maintenance switch at the bottom of the front of the main unit to 1 (left), or 2 (right).

Either MNT1 or MNT2 will be displayed on the LCD screen.

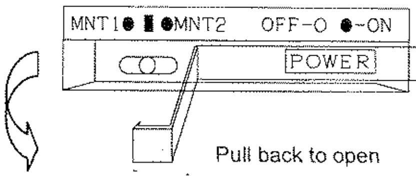
Move the maintenance switch to the center position to return to normal mode.

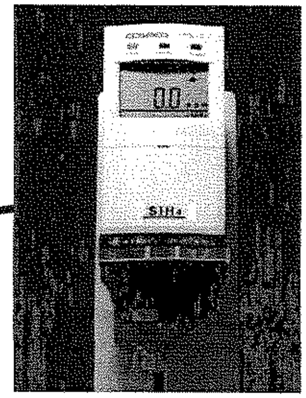
Set to maintenance mode.

Left: Maintenance mode 1

Center: Normal mode

Right: Maintenance mode 2





(2) Operating instructions

When on maintenance mode 1, neither the gas alarm contacts, nor the trouble alarm are activated.
When on maintenance mode 2, neither the gas alarm contacts, nor the trouble alarm are activated. And the analog output will be fixed to either 4.0 mA or 17.4 mA.

In both maintenance modes, the trouble lamp (yellow) blinks, and the concentration value of detected gas is displayed on the LCD screen.

	Alarm contacts	Trouble alarm	Analog output	TROUBLE Lamp (yellow)	LCD screen
Maintenance mode 1	Not activated (Fixed OFF)	Not activated *(Fixed ON)	Output based on the concentration value of the detected gas	Blinks	Concentra- tion value of detected gas
Maintenance mode 2	Not activated (Fixed OFF)	Not activated *(Fixed to ON)	Fixed to 4mA or 17.4 mA.	Blinks	Concentra- tion value of detected gas

⚠ Caution

*1 In both maintenance mode, the trouble alarm is activated when the power source is switched off on the main unit. (Trouble alarm : OFF)

*2 The analog signal may change when the power source is switched off on the main unit.

⚠ Warning

Be sure to check that it is set to normal mode (center) during regular operations (monitoring gas concentration.) When regular operations are carried out in maintenance modes 1 or 2, the alarm contacts and trouble alarms will not work. In maintenance mode 2, the analog signal will not change from 4 mA.

Note Both maintenance modes 1 and 2 function only on the base unit. Even when there is no main unit, analog output of 4mA is possible on maintenance mode 2, which enables a loop check during setup.

8 Maintenance and Inspection

- The Gas Detector unit does not normally require gas calibration to be performed on site. Gas calibration is performed by New Cosmos, so the user is only required to replace the sensor unit every six months. (This does not apply to the CHS-7 Combustible Gas Sensor Unit.)
- The following table provides an inspection timetable for various components of the Gas Detector unit.
  Daily inspections refer to inspections that should be undertaken by the user everyday.
  Periodic inspections refer to inspections that should be performed every six or twelve months by either the user or an authorized representative of New Cosmos.

Important

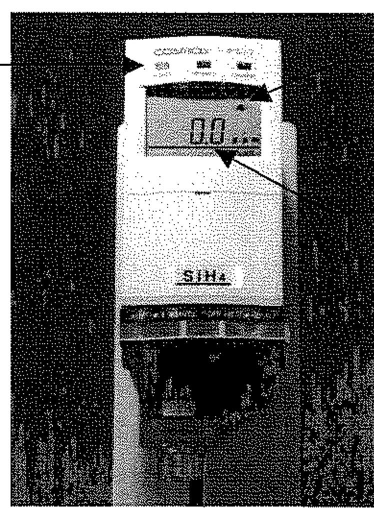
Regular replacement of the sensor unit and other relevant components is vital for maintaining the reliability of the Gas Detector unit. Users can replace the sensor unit by themselves, or have it replaced at regular intervals by singing a contract with New Cosmos.

Frequency and Content of Inspections

Content of Inspection	When starting up or relocating	Periodic inspection		Daily inspection
		Every 6 months	Every 12 months	
(1) Gas concentration indicator inspection	○	○		○
(2) Sampling flow rate inspection	○	○		
(3) Inspection of airtight seal of internal assembly	○	○		
(4) Replacement of filter element		○		
(5) Pipe line inspection	○			
(6) Attachment and replacement of sensor unit	○	○		
(7) Loop inspection using Test switch			○	

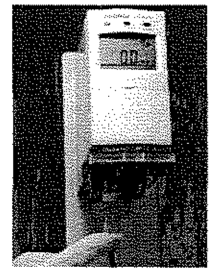
(1) Gas concentration indicator inspection

Verify that the gas concentration value is indicated on the LCD screen and the unit is functioning normally.



(2) Sampling flow rate inspection (Flow rate inspection)

Check that the flow rate on the LCD screen is rotating quickly. (Refer to *7-1 Operation Procedures* (9)). If the flow rate is rotating slowly or has stopped, check the filter element, and replace if clogged or dirty. (See *9-1 Replacing the Filter Element.*) If it still is not right after replacing the filter element, check to make sure the pipes are not clogged, or the load is not too high, etc.



(3) Inspection of airtight seal

Carry out an inspection of the airtightness of the internal assembly while referring to *7-1 Operation Procedures* (10).

(4) Replacement of filter element

Check to ensure the filter elements are not clogged or dirty at least once every 6 months, and replace if necessary. Filter elements can get dirtier easier depending on the surrounding environment. When the display shows that the filter is clogged (the flow rate is on slow rotation), check the filter element and change if necessary. (Refer to *9-1 Replacing the Filter Element FE-1.)*

(5) Pipe inspection

Inspect the gas sampling pipe at startup or when the installation has been augmented or relocated. If the pipe is not correctly connected, it will not be possible to maintain the required sampling flow rate or to take gas samples from the target location.

(6) Attachment and replacement of sensor unit

Install a new sensor unit at startup and replace it every six months thereafter. (This does not apply to the CHS-7 Combustible Gas Sensor Unit.) (Refer to *9-2 Attach/Replacing the Sensor Unit* on page 29.)

(7) Loop inspection using Test switch

By pressing the "TEST" key switch on the front of the main unit with a long thin tip, such as that of a ball point pen, the analog output value can be set at will, so please check the host system. When "TEST" is pressed again, output returns to normal. (Refer to *7-4 Test Mode Settings and Operating Instructions.*)

⚠ Caution

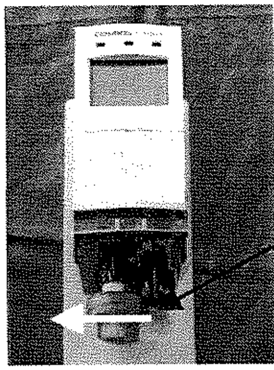
The alarm check conducted with the Test switch will also activate the gas alarm contact. For this reason, if alarm contacts are used for interlocking with external devices, be sure to check that the interlock be released prior to conducting the alarm test. Also, be sure to carry out alarm testing with the test switch after setting in maintenance mode. (Refer to *7-5 Maintenance Mode Settings and Operating Instructions.*)
Relevant personnel should also be notified of the inspection in advance.

9 Replacing Consumables

- The Gas Detector is designed to allow users to replace consumables.
- Contact your local dealer to purchase consumables, or if further instruction is needed regarding their installation and replacement.

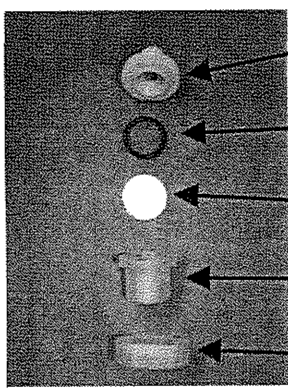
9-1 Replacing the Filter Element (FE-1)

Use the following procedure to replace the filter element if it becomes dirty or clogged.



Loosen the fastening nut of the filter unit (MF-50) and remove the gas sampling pipe.

Rotation direction to loosen the fastening nut.



Main body side of the filter unit

O-ring

Replace with a new filter element (FE-1)

Suction hole in the filter unit

Fastening nut

Don't forget the O-ring!

Rotation direction to tighten the fastening nut.

Return the filter unit gas intake to its original position and tighten the fastening nut to secure the gas sampling pipe. Do not forget to place the O-ring beneath the new filter.

9-2 Attach/Replacing the Sensor Unit

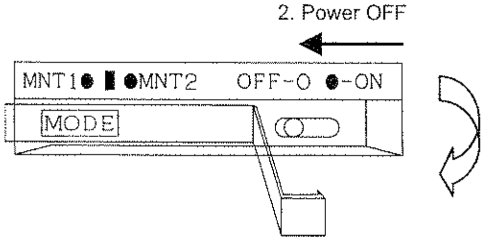
⚠ Warning

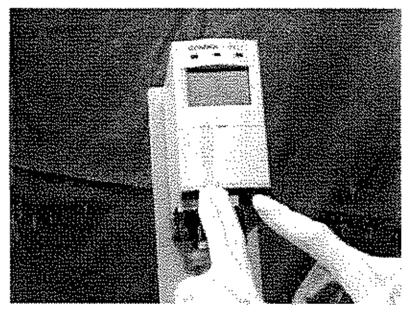
Verify that the detected gas type and the full-scale value of the new sensor unit are the same as the sensor unit being replaced. Be sure to check that its expiration date has not passed. (There is no expiration date displayed for the Combustible Gas Sensor Unit CHS-7.)

⚠ Caution

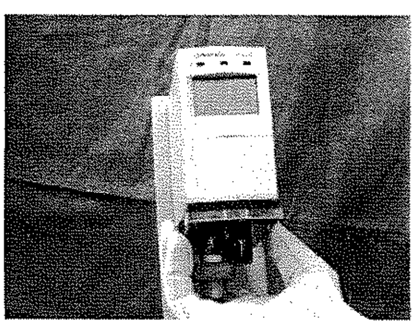
- The sensor unit must be replaced every six months. (This does not apply to the CHS-7 Combustible Gas Sensor Unit.) Always replace sensor units that have reached their service life.
- The shelf life of a new sensor unit is stated on its bag. The replacement sensor unit must be installed before the shelf life has expired.
- Turn off the power source before carrying out any replacements.
  However, when the power switch to the main unit is turned off to replace the sensor unit, the trouble alarm output (open collector) is also turned off. If alarm contacts are used for interlocking with external devices, verify that the interlock be released prior to conducting the alarm test.

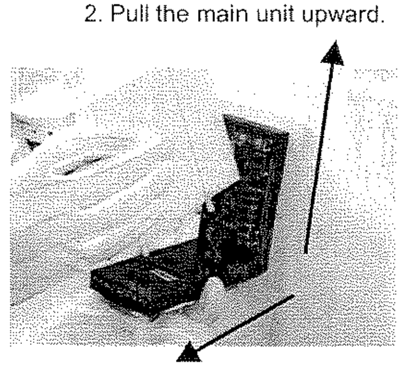
1. Turn off the power source to the main unit





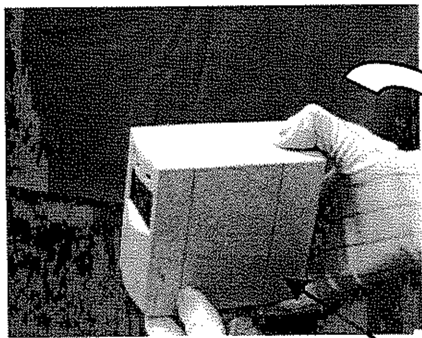
2. Pull both the two latches at the bottom of the base unit back, and (while they are still pulled back) release the main unit, pulling from the top.

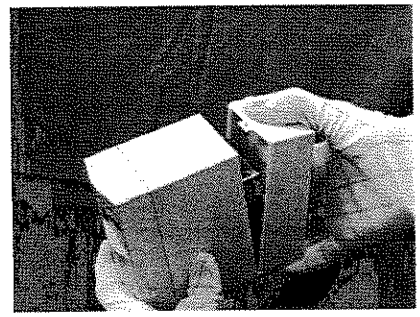




3. Press back while pushing on the middle of the upper section of the main body cover with your thumb, and remove the cover.

Remove by turning.

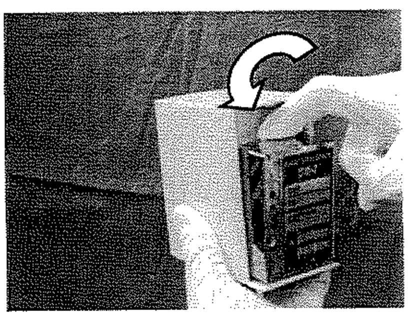




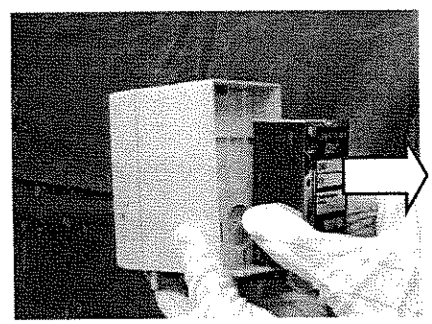
The axis is here (fulcrum).

4. Insert a finger in the gap between the main body and the top of sensor unit, and pull back slightly. Then grasp the sides of the sensor unit, and pull out.

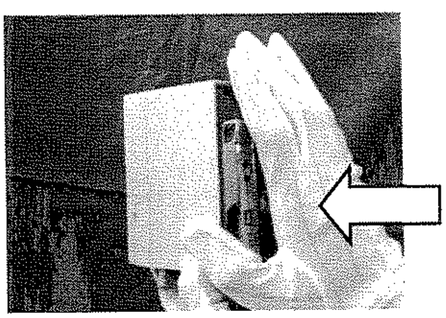
Insert a finger, and pull slightly



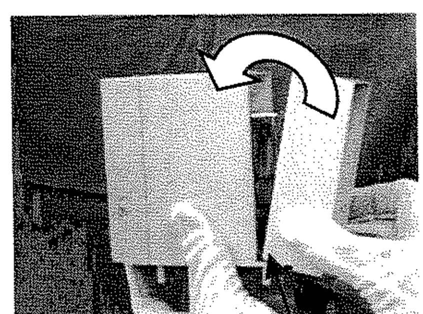
Pull out grasping the sides



5. Insert the new sensor unit, then reattach the main body cover.



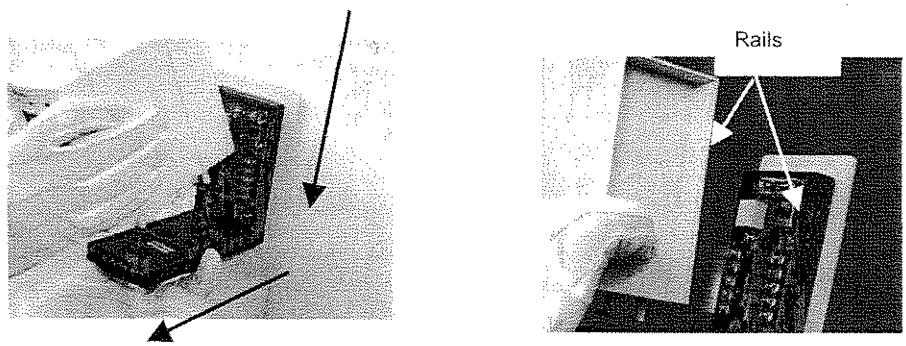
Push in as far as it will go with the palm of your hand.



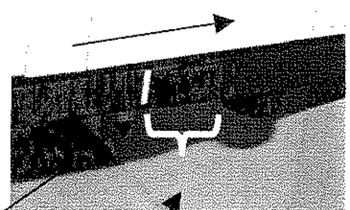
The axis is here (fulcrum).

> ⚠ **Warning**
>
> If the sensor unit is improperly attached, it will not be made airtight and will fail to detect gas correctly. Be sure to attach it in as far as it will go.

6. Pull back the latches on both the left and rights sides of the bottom of the base unit, and attach the main unit inserting from the top side first.



7. Push both the latches on the left and right hand sides of the base unit back in until the locked/unlocked line can be seen



> ⚠ **Warning**
>
> Be sure to return the latches right back in. If the latches are not behind the locked/ unlocked line, gas detection will not work properly.

Note

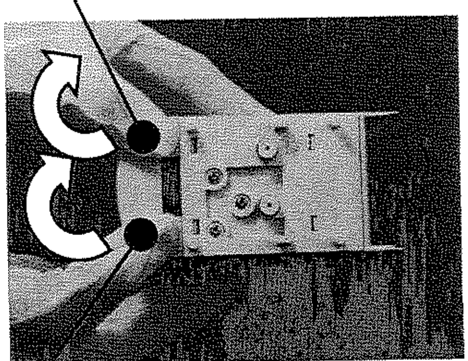
Please return used sensor units to your authorized dealer.

9-3 Replacing the Sampling Unit

> ⚠ **Caution**
>
> Always turn OFF the power supply before attempting to replace the sampling unit.
> However, if the power switch to the main unit is turned off to replace the sampling unit, the trouble alarm output (open collector) will also turn off. If alarm contacts are used for interlocking with external devices, verify that the interlock be released prior to replacing the unit.

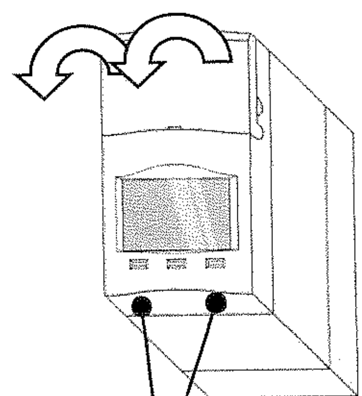
1. Remove the sensor unit as described in *9-2 Attach/Replacing the Sensor Unit.*
2. Press back while pushing on the lower section of the main body cover with both thumbs, and remove the front panel.

The position to push from



The position to push from. Push the lower section of the front panel with both thumbs and remove.

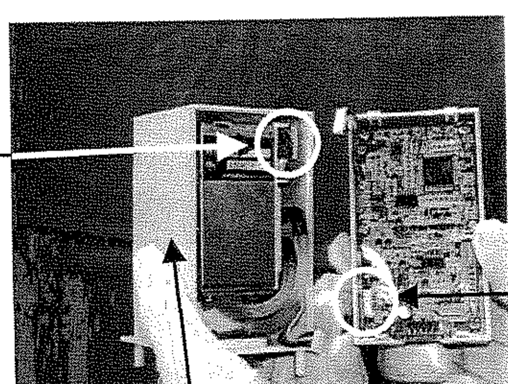
Direction to push with thumb



The axis is here (fulcrum).

3. Remove the two connectors on the back of the front panel.

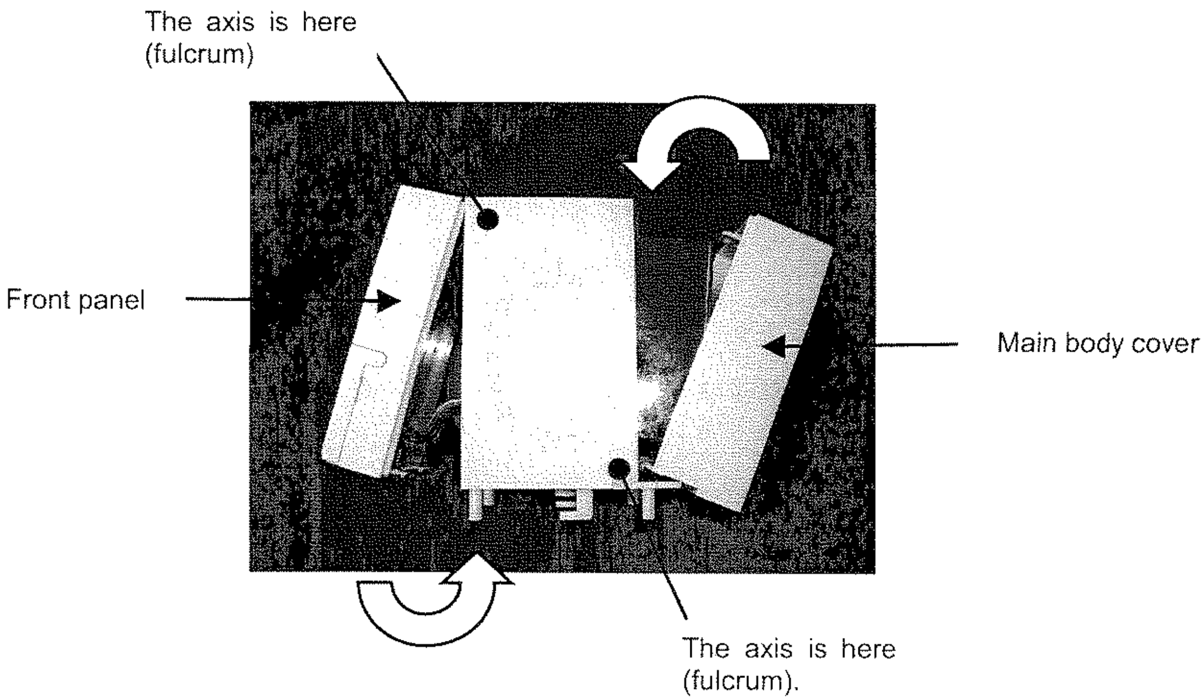
Pull out the connectors on the pump side.



Pull out the connectors on the front panel.

Sampling unit

4. Connect the 2 front panel connectors to the new sampling unit, and reattach the front panel. After inserting the sensor unit, reattach the main body cover.



*Be careful not to pinch the cables.

⚠ Warning

If used when not inserted properly, the sensor unit will not be airtight, and will therefore not detect gases properly. Be sure to attach it on as far as it will go
Also, when connecting the sampling unit with the front panel, be careful that the connector cables are not pinched by the case.
Also, when attaching the front panel onto the sampling unit, be careful that the connector cables are not pinched by the case.

The following is the same as the procedure from step 6 onward in *9-2 Replacing the Sensor Unit.*

5. Pull back the latches on both the left and rights sides of the bottom of the base unit, and attach the main unit inserting from the top side first.

6. Push both the latches on the left and right hand sides of the base unit back in until the locked/unlocked line can be seen

Note

Please return used sampling units back to your authorized dealer.

10 Troubleshooting

- If a problem occurs, check the following before contacting a service or sales representative.

Problem	Cause	Remedy	Reference
The POWER lamp (green) does not come on when the power is turned on	The power switch on the base unit is turned OFF.	Turn the power switch to the base unit ON.	7 Operation Procedures
	The power switch on the main unit is turned OFF.	Turn the power switch to the main unit ON.	7 Operation Procedures
	Wiring is not properly connected.	Check wiring and tighten terminal connections.	6-2 Wiring Instructions
	The connector harness is not connected properly.	Check and reattach the connector.	9-3 Replacing the Sampling Unit
	The fuse has blown.	Replace the fuse.	5 Description
The TROUBLE lamp (yellow) is blinking	The filter element is clogged.	Replace the filter element.	9-1 Replacing the Filter Element FE-1
	Pump is defective.	Replace the pump unit.	9-3 Replacing the Sampling Unit
	Gas sampling pipe is blocked.	Remove the blockage.	
	The connector harness is not connected properly.	Check and reattach the connector.	9-3 Replacing the Sampling Unit
	A sensor with different setting has been inserted.	Change the settings on the main unit, or change the sensor.	7-1 Operation Procedures
	Defective sensor unit.	Replace the sensor unit.	9-2 Attach/Replacing the Sensor Unit
	Sensor unit is not installed.	Install the sensor unit.	9-2 Attach/Replacing the Sensor Unit
	The output of the flow sensor was not stable when power was turned on.	Turn the power on, and leave for about 30 minutes until it stabilizes.	7-1 Operation Procedures
The "__" indication and the detected gas concentration value blink alternately.	It is set to either maintenance mode 1 or 2.	Set to normal mode (center).	7-5 Maintenance Mode Settings and Operating Instructions
There is no electrical output from the alarm contacts.	It is set to either maintenance mode 1 or 2.	Set to normal mode (center).	7-5 Maintenance Mode Settings and Operating Instructions
	Wiring is not properly connected.	Check wiring and tighten terminal connections.	6-2 Wiring Instructions
The analog output won't change from 4mA.	The maintenance switch is set to 2.	Set to normal mode (center).	7-5 Maintenance Mode Settings and Operating Instructions

Contact your local dealer if none of the above procedures remedy the problem or if the problem is not listed.

11 Specifications

Model	PS-7
Principle	Electrochemical sensor, hot-wire semiconductor sensor, galvanic cell sensor
Sampling method	Pump suction type (0.5 L/min, suction flow automatically controlled)
Gas sampling pipe*1	Teflon OD6/ID4 mm, maximum tube length 20 m.
Concentration display	4-digit digital LCD display (incl. units) 20-segment bar graph
Alarm settings	As per specifications
Alarm accuracy	• Combustible gas ±25% of preset alarm point under identical conditions • Toxic gas ±30% of preset alarm point under identical conditions • Oxygen deficiency ±1 vol% under identical conditions
Response time	• Combustible gas Within 30 sec using test gas concentration 1.6 times that of preset alarm point • Toxic gas Within 60 sec. using test gas concentration 1.6 times that of preset alarm point • Oxygen deficiency Within 5 sec. to reach 18 vol% reading (at 20 ±2°C) from an atmosphere concentration of 10 vol% (Gas sampling pipe length and communication times not included in any of the above.)
Alarm display	• Gas alarm (1st and 2nd stage) ALARM lamp (red) blinking: LCD display ALARM1 or ALARM2 is displayed • Trouble alarm Decreased rate of flow TROUBLE lamp (yellow): LCD display FLOW displayed : The flow rate rotation is stopped Sensor trouble TROUBLE lamp (yellow) blinking: LCD display SENS. is displayed The sensor unit is inserted incorrectly TROUBLE lamp (yellow): LCD screen SENS. is displayed Pyrolyzer is disconnected TROUBLE lamp (yellow) blinking: LCD screen CONV. is displayed
External output	• Analog output 4-20mA DC (common negative with power supply) *Resistance for detecting current to be less than 300Ω including circuit resistance. • Alarm contacts (1st and 2nd stages) 1a no-voltage contact/auto reset *Rated load: 125 V AC or 30 V DC, 0.5-A resistance load • Trouble alarm Open collector/auto return/auto reset (Normal close: Normally ON, during trouble OFF, and OFF during shut-off of power supply. *Rated load: 30 V DC, 30mA resistance load Activated by decline of flow rate, sensor error, when the sensor unit has been inserted incorrectly, pyrolyzer is disconnected, power off, or blown fuse. The analog output is smaller than 0.6 mA, and the gas alarm is not activated.
Applicable cable	Shielded control cable (8 to 11 mm dia.) x2
Cable length	Maximum length not exceeding 500 m
Operating Temp	0-40°C (avoid radical temperature fluctuation), 30-85% RH (no dew condensation)
Power requirement	24 V DC ±10%
Power consumption	Approximately 7 W (Approximately 10 W with convertor attached)
Dimensions	W62 × H124 × D143 mm (projected portion excluded)
Weight	Approximately 1.0 kg
Installation	Wall mount type

*1 Teflon tubing is recommended. However, this may differ if the unit is to be used to detect highly adsorbent gases. Contact your authorized dealer for information and assistance.
For product improvement purposes, the above specifications may be subject to change without notice.
Any specifications issued separately take precedence over those stated above.

12 Warranty

New Cosmos Electric Company Limited, warrants its gas detection products against any defects in materials and workmanship under normal use and operating conditions, for a period of one year from the date of purchase. (Except toxic and oxygen sensor unit)

All obligations and liabilities under this product warranty are limited to repairing or replacing at the manufacturer's option of the allegedly defective items returned to us, with carrier charges prepaid. All repairs and replacements are made subject to our factory inspection of the returned items.

No liability is accepted for the consequential damages or reinstallation labor. Defects as defined in the above shall not include decomposition by chemical reaction (including corrosion).

New Cosmos Electric Company Limited, shall not assume responsibility for contingent liability arising from alleged failure of any of its products and accessories.

13 Detection Principles

13-1 Electrochemical Sensor

In an electrochemical method, electrolytic reactions are carried out selectively on target composite gases, and the ensuing electrolytic current is measured by a gas sensor.

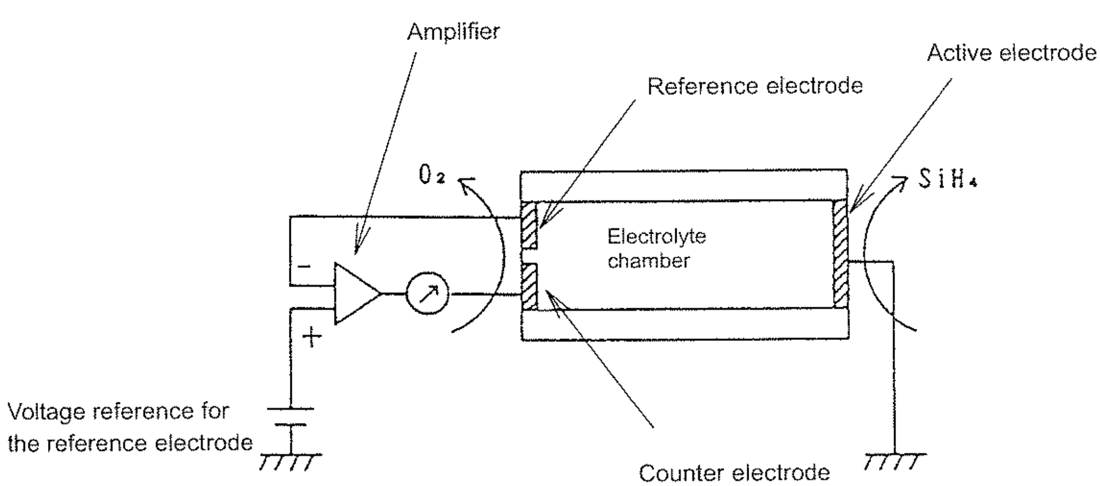
The gas sensor consists of three electrodes (active, reference, and counter electrodes), electrolyte, and a potentiostat circuit. The electrode is a gas permeable membrane (to permeate gas and not electrolyte) treated with a catalyst. When SiH4 contacts the active electrode, the following reaction occurs on the electrode:

$$SiH_4+4H_2O \rightarrow H_4SiO_4+8H^++8e^- \qquad (1)$$

while the following reaction occurs on the counter electrode:

$$2O_2+8H^++8e^- \rightarrow 4H_2O \qquad (2)$$

and current flows to the external circuit. To make the reaction selective and the generated current porportional to the concentration of SiH4, the potential of the active electrode is detected by the reference electrode and, during the electrolysis reaction, the active electrode is maintained at a constant potential by the potentiostat circuit. (Refer to the following illusration.)



13-2 Hot-wire Semiconductor Sensor

In the hot-wire semiconductor method, a semiconductor sensor is designed to measure the change of electrical conductivity initiated by adsorption of the electrons of combustible gases onto the surface of a metal oxide semiconductor heated with a platinum filament. When the semiconductor adsorbs these electrons, the electron concentration increases and the conductivity of the semiconductor rises. As a result, the temperature of the semiconductor declines, and the resistance of the platinum filament decreases. This change is measured as a deviation voltage with a Wheatsone bridge.

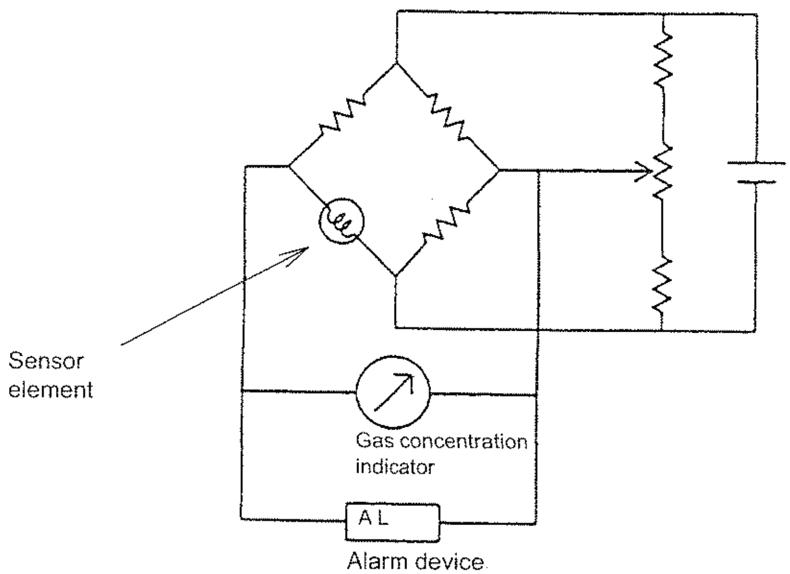


Figure 9

13-3 Galvanic Cell Sensor

The galvanic cell sensor consists of noble metal (Pt, Ag) electrode, a base metal (Pb) electrode, and electrolyte. The noble metal electrode contacts the air through a Teflon membrane.

Since a potential difference is produced between the two electrodes, the following reaction occurs when a load resistor is connected:

Noble metal electrode $O_2+2H_2O+4e^- \rightarrow 4OH^-$

Base metal electrode $2Pb \rightarrow 2Pb^{2+}+4e^-$

As a result, a current proportional to the concentration of oxygen in the air flows from the noble metal electrode to the base metal electrode through an external circuit. Since the current generated is dependent on temperature, a thermistor is used to compensate for the atmospheric temperature changes.

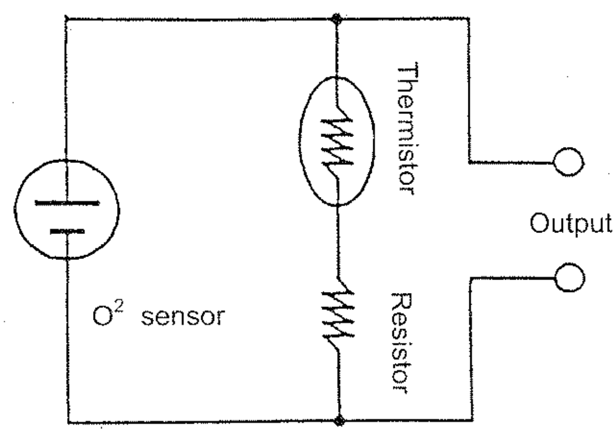


Figure 10

Note

The galvanic cell sensor gives an output according to the partial pressure of the oxygen in the air (the oxygen concentration is usually 21vol%.) Therefore, when the atmospheric pressure changes, the partial pressure of the oxygen will change, and when there is no change in the oxygen concentration (21vol%), this may effect the output values from the sensor.

14 Glossary

Gas detector:	Detects the gas concentration level, and converts it into an electric signal.
Target gases for detection:	The target gases for which the gas concentration level is detected, and indications or warnings are given.
Detection range:	The concentration range within which the level of target gases can be detected, and indications or warnings given.
Alarm delay:	The time between when a level of gas concentration higher (or lower) than the preset alarm values come into contact with the gas detector, and when the alarm goes off.
Explosion-proof construction:	Construction to ensure that electrical components do not become an ignition source and do not ignite surrounding flammable air.
Maintenance inspection:	Inspections conducted to ensure that the instrument is able to continue carrying out the functions demanded of it.

Part of this terminology list is quoted from gas detection monitor terminology definitions from the Industrial Gas Detectors Monitor Association.

Manual Revision History

Edition No.	Date	Revisions
GAE-018-00	August 2004	

Additional copies of this Operation Manual are available.

Contact the following address for ordering information.

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DOD Technologies, Inc

740 McArdle Drive

Unit C

Crystal Lake, IL 60014

Phone 815-788-5200

Fax 815-788-5200

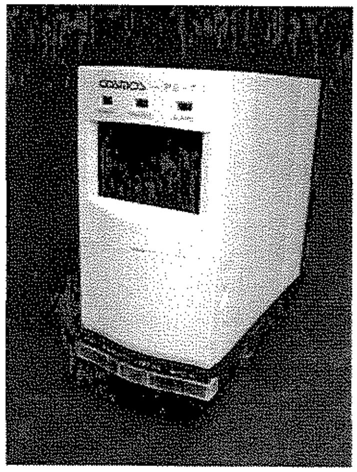
www.dodtec.com

EXTRACTIVE GAS DETECTOR

OPERATION MANUAL

Model PS-7

For Administrators



- Operate this unit only after reading and fully understanding the content of this manual.
- This Operation Manual was written for administrator use. Instructions for the basic operations of this unit are provided separately in the standard Operation Manual. Refer to the Operation Manual when necessary.

NEW COSMOS ELECTRIC CO.,LTD.

DOD Technologies, Inc.
Innovative Life Safety Systems & Services

740 McArdle Drive, Unit C – Crystal Lake, IL 60014

815-788-5200 Phone 815-788-5300 Fax www.dodtec.com

Some of the settings on this unit (alarm settings, etc.) are password protected.

This Operation Manual explains the following items:

- Passwords
- Changing settings

1 Passwords

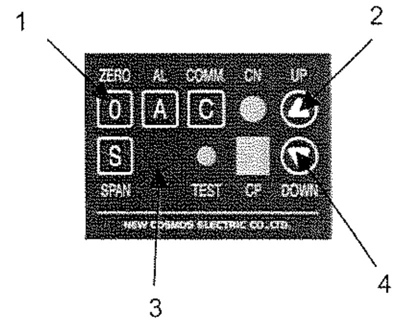
1-1 Password-protected Settings

- Span adjustment (Refer to *2-1 Span Adjustment*)
- 21vol% adjustment (Refer to *2-2 21Vol% Adjustment*)
- The values of various settings (Refer to *2-3 Changing Setting Values*)
- The values of alarm settings (Refer to *2-4 Changing the Alarm Settings*)

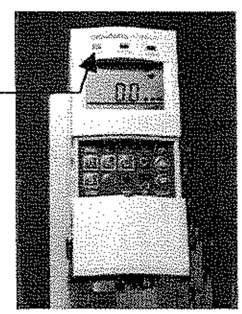
1-2 Releasing the Password Lock

(1) Press these key switches in the following order.

1. ZERO switch
2. UP switch
3. Special command switch
4. DOWN switch



(2) The password lock is released when the POWER lamp (green) blinks once.



(3) The password lock is automatically reactivated 10 minutes after it has been released.

> ⚠ **Warning**
>
> Important tasks, such as changing alarm settings, span adjustment, etc., can be carried out once the password lock is released. Take the utmost care regarding confidentiality of the password.

2 Changing Settings

2-1 Span Adjustment

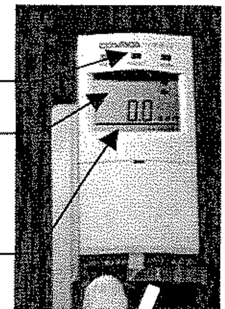
Toxic gas sensor unit : CDS-7
Combustible gas sensor unit : CHS-7

(1) Set to maintenance mode (MNT1 or MNT2).

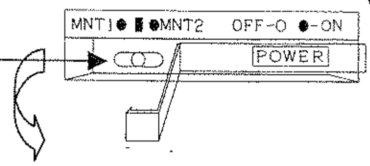
TROUBLE lamp (yellow) blinks.

The "__" indication and the concentration value of the detected gas blink alternately.

MNT1 or MNT2 is displayed at the bottom of the LCD screen.



Left: Maintenance 1 (MNT1)
Center: Normal mode
Right: Maintenance 2 (MNT2)

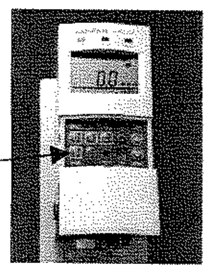


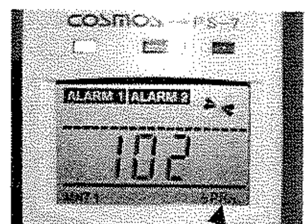
Pull back to open

(2) Release the password lock. (Refer to *1-2 Releasing the Password Lock.*)

(3) Press the SPAN switch.

SPAN switch



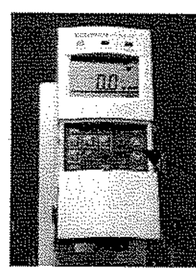


SPAN is displayed at the bottom right of the LCD screen.

(4) Let the calibration gas through.

(5) Use the UP/DOWN switch to adjust the concentration indication on the screen to that of the calibration gas concentration.

(6) Once adjustments have been done, press the SPAN switch again. The SPAN indication in the bottom right of the LCD screen will go off, and the span adjustment will be completed.



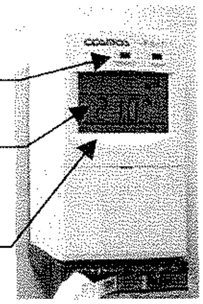
UP/DOWN switch

(7) Remove the calibration gas, check that the detected gas concentration is under that of the alarm value, and restore to the normal mode (by switching the maintenance switch to the center).

2-2 21Vol% Adjustment

Oxygen sensor unit: COS-7

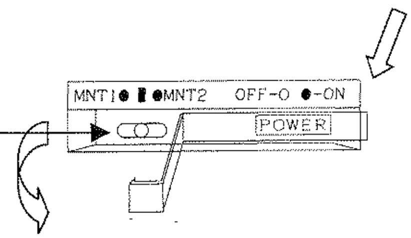
(1) Set to maintenance mode (MNT1 or MNT2).



Left: Maintenance 1 (MNT1)

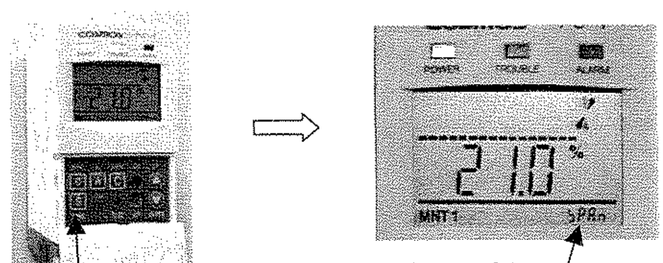
Center: Normal mode

Right: Maintenance 2 (MNT2)



(2) Release the password lock. (Refer to *1-2 Releasing the Password Lock.*)

(3) Press the SPAN switch.



(4) Let the calibration gas through.

(5) Use the UP/DOWN switch to adjust the concentration indication on the screen to that of the calibration gas concentration.

(6) When the adjustment is completed, press the SPAN switch again. The SPAN indication in the bottom right corner of the LCD screen will then disappear, and the 21vol% adjustment is complete.

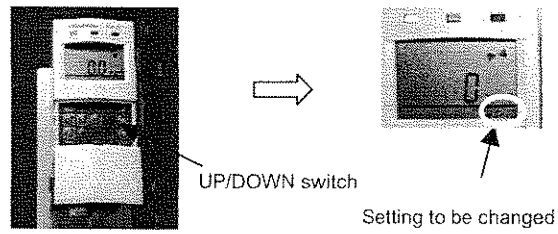
(7) Remove the calibration gas and confirm that no alarm is displayed(ALARM 1 , ALARM 2 is not shown). Then, restore to the normal mode by switching the maintenance switch to the center.

2-3 Changing Setting Values

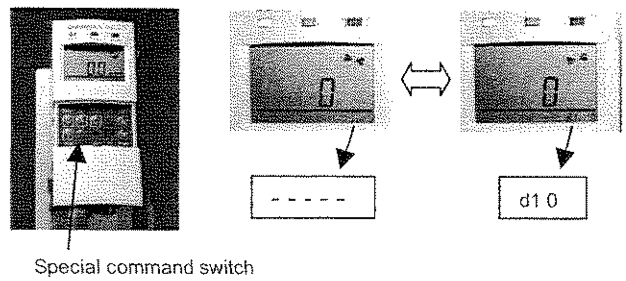
Some of the setting values of the unit can be changed. Those that can be changed are listed in the table below. The method for changing them is explained here.

(1) Release the password lock. (Refer to *1-2 Releasing the Password Lock.*)

(2) Press the UP/DOWN switch ("△" or "▽") until the setting you wish to change ("LCD Screen Indication" in the table below) is displayed at the bottom right of the LCD display.



(3) Then press the special command switch, and the setting to be changed ("LCD Screen Indication" in the table below) and "—" will flash alternately.



(4) Change the value by using the UP/DOWN switches ("△" or "▽"). When you are done, press the special command switch again, and the alternating display in the bottom right corner of the LCD display will become constant. The process is now finished.

LCD Screen Indication	The function to be set	Remarks	Default value		Adjustable Range
			Toxic: CDS-7 Combustible : CHS-7	Oxygen: COS-7	
d1 **	Time delay 1	Time delay (secs.) of the gas alarm contact (1st level)	d1 0	d1 0	0 to 99 sec
d2 **	Time delay 2	Time delay (secs.) of the gas alarm contact (2nd level)	d2 0	d2 0	0 to 99 sec
az	Analog output (base)	(*For our maintenance purposes only)	-	-	-
as	Analog output (span)	(*For our maintenance purposes only)	-	-	-
zs *	Zero suppression, or 21vol% suppression	Displays the percentage of the full scale value (rounded to the percent)	zs 5	zs 2	0 to 30%
H-H L-L H-L	Alarm mode	1st: upper limit, 2nd : upper limit warning 1st : lower limit, 2nd : lower limit warning 1st : upper limit, 2nd: lower limit warning	H-H	L-L	H-H L-L H-L
Con *	Pyroletic converter failure alarm	0 : Off 1: On	Con 0	Con 0	0 or 1
CG **	Calibration gas concentration	(*For our maintenance purposes only)	CG 40	CG 84	-
nEt *	The existence of a DeviceNet unit	0 : Non-existent 1: Existent	nEt 0	nEt 0	0 or 1
F ***	Display of f value	Calibration gas type in lower right of LCD f value in center of LCD	(Depending on the sensor unit)		
FL ***	Displays rate of flow	Shows the current rate of flow (mL/min)	(Depending on the rate of flow)		
P ***	Sensor unit output	(*For our maintenance purposes)	-		
At *	Auto 21vol% adjustment	0 : Off 1: On	--	At 1	0 or 1
xxx		Type of sensor unit (Normal display)	(Depending on the sensor unit)		

⇧ When the DOWN switch is pressed, it will move up one.

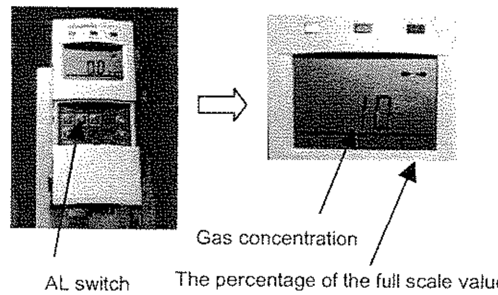
Each time the UP switch is pressed, it will move down the table to the next item. ⇩

2-4 Changing the Alarm Settings

The values of alarm settings on this unit can be changed. The method for changing them is explained here.

(1) Release the password lock. (Refer to *1-2 Releasing the Password Lock.*)

(2) Press the AL switch until the alarm setting to be changed is displayed on the LCD display. (The bottom right of the screen, as in the table below.) The alarm setting for the actual gas concentration is displayed in the middle of the screen, and the percentage of the full scale value is displayed in the bottom right corner

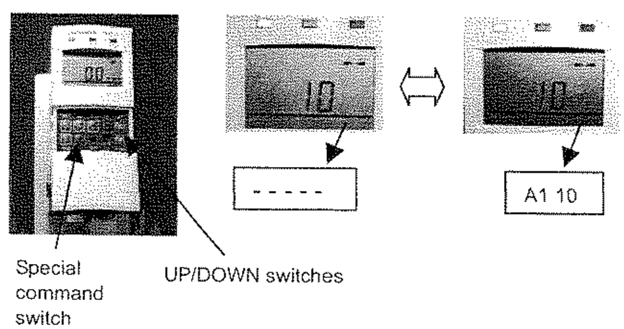


LCD Display Indication (Lower right)	Default value		Explanation of the default value	Adjustable Range
A1 **	Toxic : CDS-7 Comb. : CHS-7	A1 10	10% F.S.	0 to 100% F.S.
	Oxygen: COS-7	A2 72	72% F.S.	
A2 **	Toxic : CDS-7 Comb. : CHS-7	A2 20	20% F.S.	0 to 100% F.S.
	Oxygen: COS-7	A2 76	76% F.S.	

* Pressing the AL switch changes to 1st level → 2nd level→ Normal display.

* The A2 value should be greater than the A1 value in any case.

(3) Press the special command switch. The setting to be changed and the "—" indication will then flash alternately.



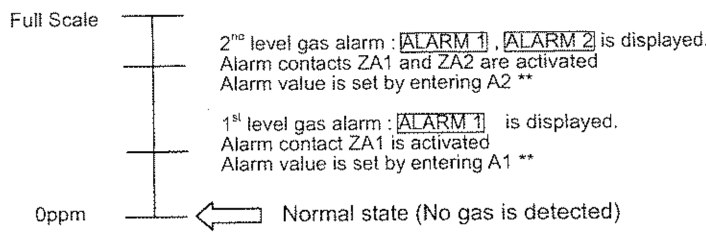
(4) Change the value by using the UP/DOWN key "△" and"▽".
When you are done, press the special command switch again, and the alternating display in the lower right corner of the LCD display will become constant. The process is now finished.

(5) When this is finished, press the UP/DOWN switches ("△" or"▽") again to return to the normal display.

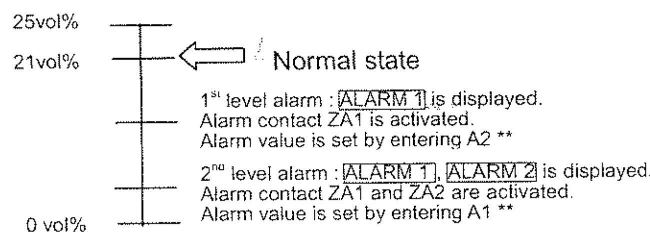
Note

The relationship between 1st level and 2nd level alarm values of each alarm mode is as follows:

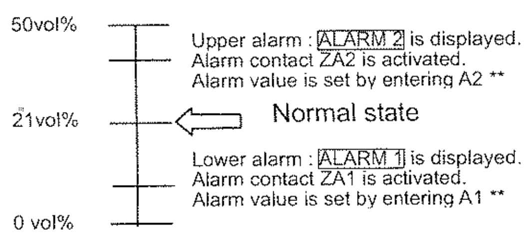
H – H mode (1st level: Upper limit, 2nd level: Upper limit)



L – L mode (1st level: Lower limit, 2nd level: Lower limit)



H – L mode (Upper limit, Lower limit)



* A2 value should be always greater than A1 value.

Manual Revision History

Edition No.	Date	Revisions
GAE-019	July 2004	

Additional copies of this Operation Manual are available.

Contact the following address for ordering information.

Manufacturer:
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Unit C
Crystal Lake, IL 60014
Phone 815-788-5200
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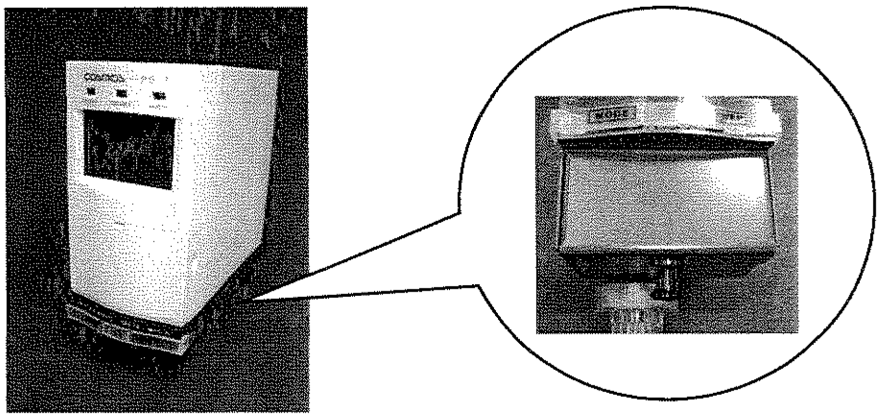
www.dodtec.com

EXTRACTIVE GAS DETECTOR

Model PS-7

PYROLYZER

OPERATION MANUAL



- Be sure to store this operation manual in a convenient location, and consult it whenever necessary.
- Operate this unit only after reading and fully understanding the content of this manual.
- This Operation Manual was written for the pyrolyzer(option). Instructions for the basic operations of this unit are provided separately in the standard Operation Manual. Refer to the Operation Manual when necessary.

NEW COSMOS ELECTRIC CO.,LTD.

DOD Technologies, Inc.

Innovative Life Safety Systems & Services

740 McArdle Drive, Unit C – Crystal Lake, IL 60014

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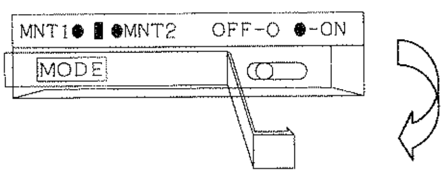
Attach/Replacing the pyrolyzer

⚠ Caution

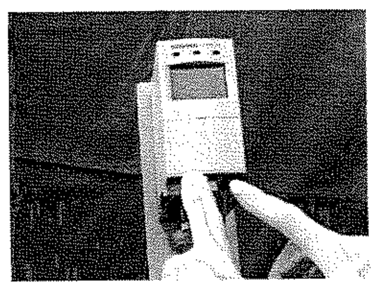
- The sensor unit and pyrolyzer must be replaced every six months. Always replace sensor unit and pyrolyzer that have reached their service life. (The shelf life of the units is stated on its packing).
- Be sure to check that the serial number of the pyrolyzer equals to the serial number of the sensor unit.
- The replacement sensor unit and pyrolyzer must be installed before the shelf life has expired.
- Turn off the power source before carrying out any replacements.
  However, when the power switch to the main unit is turned off to replace the sensor unit, the trouble alarm output (open collector) is also turned off. If alarm contacts are used for interlocking with external devices, verify that the interlock be released prior to conducting the alarm test.

1. Turn off the power source to the main unit

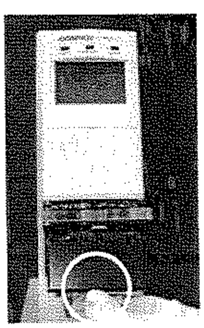
2. Power OFF



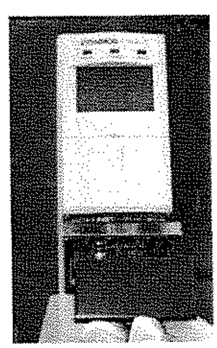
1. Pull back to open.



2. Pull the cover lock knob down and release the lock. And after pulling it down further below, pull back the pyrolyzer case cover and remove it.



1.Pull the cover lock knob down and release the lock.

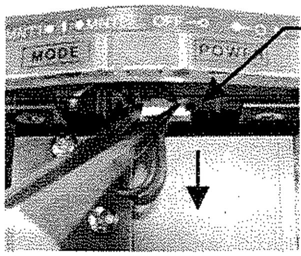


2. While pulling down the knob, pull down the pyrolyzer case cover.

3. Pull back to remove the cover.

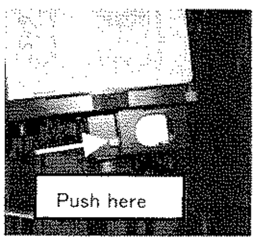
Cover lock knob

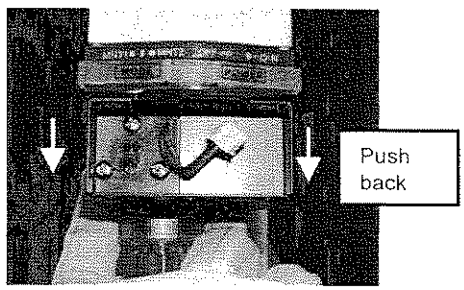
3. Removing the old pyrolyzer.　Pull out the connector.
   When it is newly installed and there is no pyrolyzer, refer to 6.

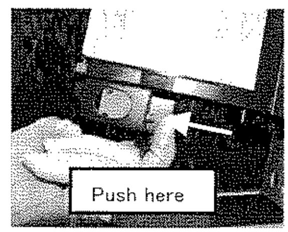


Pull downwards.
Hold the connector and pull out.
Do not pull the connector cable.

4. Push the 2 protrusions behind the pyrolyzer with your forefinger and middle finger.



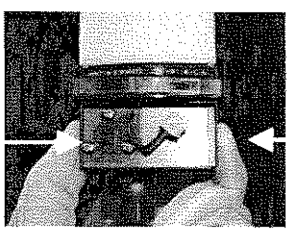




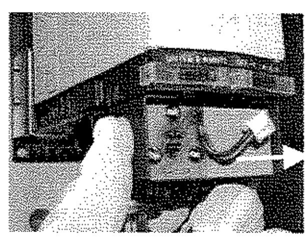
Left side　　　　Front view　　　　Right side

5. Hold the both sides of the pyrolyzer, and remove it.

Hold here

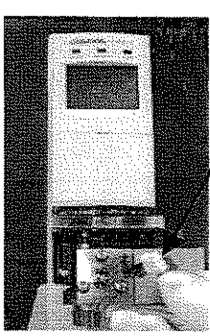


Hold here



Pull back and remove.

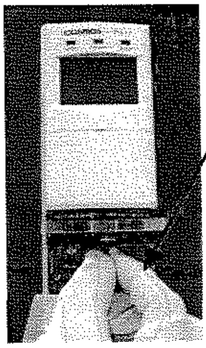
6. Insert the new pyrolyzer.　Push the gray part with your finger as shown below, and insert
   it completely. (Push it in as far as it will go.)　Be sure to check that the serial number of the
   pyrolyzer is equal to the serial number of the sensor unit.



Move the connector
upwards

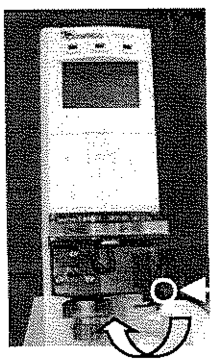
Push the gray
part.

7. Connect the connector of the pyrolyzer.

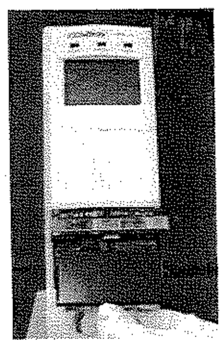


Connect the connector

8. Put the pyrolyzer case cover. Push the cover lock knob upward, and lock the pyrolyzer.



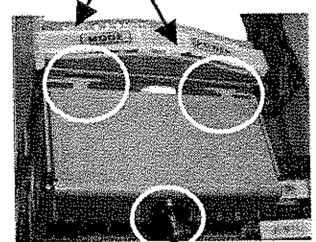
Insert so that it slides along the rails



Upward

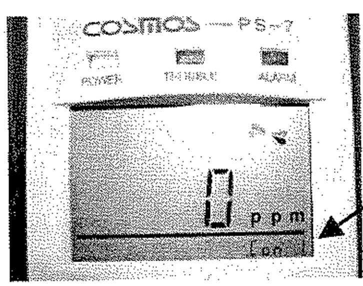
Enlarged

To gaps



Push the cover lock knob upwards, and lock the pyrolyzer

9. Switch the main unit power ON. Press the up/ down switch, "△" or "▽" on the main unit, and verify that the pyrolyzer failure alarm is ON.



The alarm is ON when CON 1. (OFF when CON 0)

⚠ Warning

Be sure to check that the pyrolyzer failure alarm is set to ON. When regular operations are carried out at the failure alarm OFF, the failure alarm will not work.

Note

Please return the used sensor units and pyrolyzer to your authorized dealer.

Manual Revision History

Edition No.	Date	Revisions
GAE-020	August 2004	

Additional copies of this Operation Manual are available.

Contact the following address for ordering information.

Manufacturer:
New Cosmos Electric Co., Ltd.
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DOD Technologies, Inc.
Innovative Life Safety Systems & Services

PS-7000
16 Channel Controller

Instruction Manual

Warning: Read & understand contents of this manual prior to operation. Failure to do so could result in serious injury or death.

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SECTION 1

IMPORTANT SAFETY ISSUES

The following symbols are used in this manual to alert the user of important instrument operating issues:

This symbol is intended to alert the user to the presence of important operating and maintenance (servicing) instructions.

This symbol is intended to alert the user to the presence of dangerous voltage within the instrument enclosure that may be sufficient magnitude to constitute a risk of electric shock.

WARNINGS:

- **Shock Hazard** - Disconnect or turn off power before servicing this instrument.
- NEMA 4X wall mount models should be fitted with a locking mechanism after installation to prevent access to high voltages by unauthorized personnel (see Figure 6.2).
- Only the combustible monitor portions of this instrument have been assessed by CSA for C22.2 No. 152 performance requirements.
- This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.
- **WARNING- EXPLOSION HAZARD**- SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.
- **WARNING- EXPLOSION HAZARD**- DO NOT REPLACE FUSE UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.
- **WARNING- EXPLOSION HAZARD**- DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.
- Use a properly rated CERTIFIED AC power (mains) cable installed as per local or national codes
- A certified AC power (mains) disconnect or circuit breaker should be mounted near the controller and installed following applicable local and national codes. If a switch is used instead of a circuit breaker, a properly rate CERTIFIED fuse or current limiter is required to installed as per local or national codes. Markings for positions of the switch or breaker should state (I) for on and (O) for off.
- Clean only with a damp cloth without solvents.
- Equipment not used as prescribed within this manual may impair overall safety.

1.0 GENERAL DESCRIPTION

The DOD Technologies. Inc. PS-7000 Sixteen channel Controller is designed to display and control alarm event switching for up to sixteen sensor data points. It may also be set as an eight channel controller for applications needing fewer inputs. Alarm features such as *ON* and *OFF* delays, *Alarm Acknowledge*, and a dedicated horn relay make the PS-7000 well suited for many multi-point monitoring applications. Data may be input to the PS-7000 by optional analog inputs or the standard Modbus® RTU *master* RS-485 port. A Modbus RTU *slave* RS-485 port is also standard for sending data to PC's, PLC's, DCS's, or even other PS-7000 Controllers. Options such as analog I/O and discrete relays for each alarm are easily added to the addressable I^2C bus. Option boards have 8 channels and therefore require 2 boards for 16 channel applications.

A 240 x 128 pixel graphic LCD readout displays monitored data as bar graphs, trends and engineering units. System configuration is through user friendly menus and all configuration data is retained in non-volatile memory during power interruptions. The PS-7000 front panel is shown below in Figure 1.0 displaying the 8 channel bar graph screen. Additional data screens are shown in Figure 2.0.

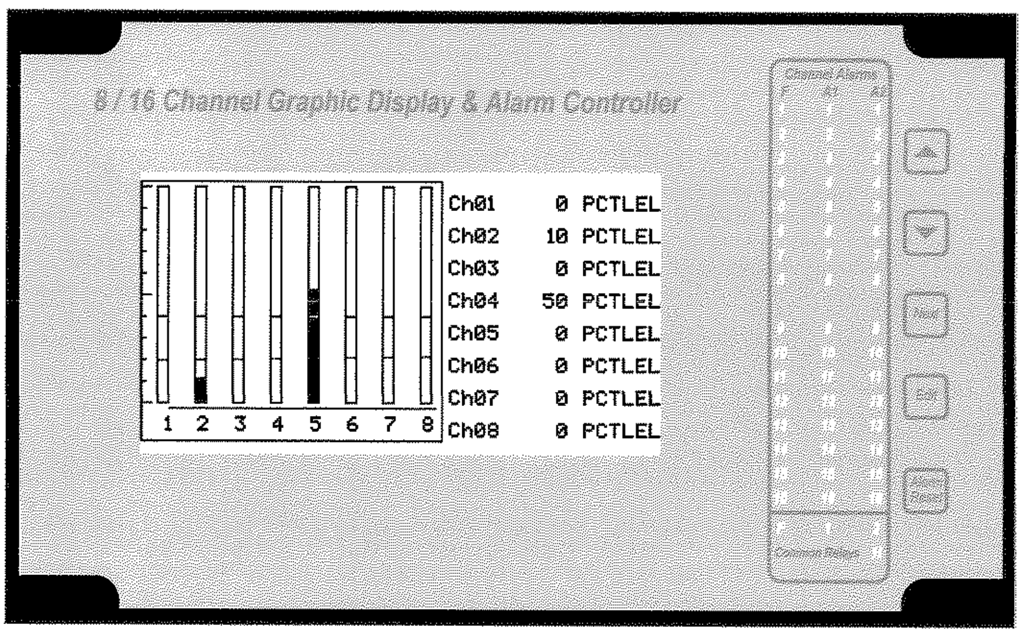


Figure1.0

1.1 DATA DISPLAY SCREENS

The PS-7000 Controller offers 3 graphic displays for depicting the monitored data. These are Bar Graphs, 24 Hour Trend and Combination. Each is shown in Figure 2.0.

1.1.1 TREND SCREEN

The PS-7000 Trend screen shown in Figure 2.0 displays a 24 hour trend of input data for the channel selected. Horizontal tic marks are each hour and vertical tic marks are each 10% of full scale. Dashed lines indicate alarm levels. The graphic LCD is 240 pixels wide so each pixel represents 1/10 hour, or 6 minutes worth of data. The trend is 100 pixels high so each represents 1% of full scale in amplitude. Since each data point must be collected for 6 minutes before it may be displayed, it is likely input values will fluctuate during this interval. Therefore, MAX, MIN and AVERAGE values are stored in RAM memory for each 6 minute subinterval. To accurately portray the trend, a vertical line is drawn between MIN & MAX values for each 6 minute subinterval. The AVERAGE value pixel is then left blank, leaving a gap in the vertical line. This is demonstrated in the *noisy* area of the 24 hour trend in Figure 2.0. If the MAX & MIN values are within 2% of each other there is no need for the vertical line and only the AVERAGE value pixel is darkened as in the *quiet* areas.

The top portion of each trend screen indicates channel #, real time reading in engrg. units, measurement name, range, and MIN, MAX & AVERAGE values for the preceding 24 hour period. The SI field on the top right indicates number of seconds remaining in the current 6 minute subinterval.

1.1.2 BAR GRAPHS SCREEN

The PS-7000 Bar Graphs screen shown in Figure 2.0 allows all active channels to be viewed simultaneously. Both engineering units values and bar graph values are indicated in real time. Lines across the bars indicate the alarm trip points making it easy to identify channels at or near alarm. A feature in the Systems menu tree allows new alarms to always force the LCD to the bar graphs screen. This is useful for applications requiring channels with alarms to be displayed.

1.1.3 COMBINATION SCREEN

The PS-7000 Combination screen shown in Figure 2.0 offers a view of a single channel but displays the data as a 10 minute trend, bar graph and large engineering units. It is also useful for testing inputs for stability since MAX, MIN & AVERAGE values refresh each time this screen is selected. For example, to test stability over a one hour period for an input, begin timing as soon as the channel is selected. One hour later record the MAX, MIN & AVERAGE values. The difference between MAX & MIN indicates peak to peak excursions over the one hour period and AVERAGE is the average for the hour. Longer or shorter tests may also be run. The numeric value shown below the bar-graph indicates number of minutes samples have been taken. After 999 minutes the AVERAGE buffer overflows and the error message *UPDATE* appears in the AVERAGE field. Exiting this screen resets the buffer and clears the error message.

1.2 SPECIFICATIONS:

1.2.1 150 WATT AC – 24VDC POWER SUPPLY

*110-120 VAC @3.2A max
*220-240VAC @ 1.6A max
* A slide switch on the front of the power supply selects AC input range.
The 10-0172 150 watt power supply (Figure 3.8) is for powering the PS-7000 and up to 16 detectors. A minimum of 5 watts per channel is available for powering of external transmitters.

1.2.2 RELAYS

Common relays are standard for ALARM 1, ALARM 2, FAULT and HORN. Discrete relays are optional. All relays are rated at 5 Amp for 28 VDC and 250 ~VAC **RESISTIVE** loads. IMPORTANT: Appropriate diode (DC loads) or MOV (AC loads) snubber devices must be installed with inductive loads to prevent RFI noise spikes. Relay wiring should be kept separate from low level signal wiring.

1.2.3 AMBIENT TEMPERATURE RANGE

-25 to 50 degrees C

1.2.4 HUMIDITY RANGE

0 TO 90% R. H. Non-Condensing.

1.2.5 ALTITUDE

Recommended up to 2000 meters

1.2.6 HOUSINGS

- General purpose panel mount weighing 7 lbs and including hardware for 19" rack mounting (Figure 6.1).
- *NEMA 4X wall mount in fiberglass enclosure weighing 17 lbs (Figure 6.2).
- *NEMA 7 wall mount suitable for DIV 1&2 Groups B,C,D weighing 110 lbs (Figure 6.4).

*Includes non-intrusive magnetic keypad.

1.2.6a NON-INTRUSIVE MAGNETIC KEYPAD

The PS-7000 operator interface includes five front panel *touch* keys. A magnetic keypad option offers these five keys with adjacent magnetic keys. This option is included as a standard item when ordering NEMA 4X weather resistant or NEMA 7 explosion-proof enclosures. It is useful in applications where it may be inconvenient to open the enclosure's door to access the *touch* keypad.

1.2.7 APPROVALS

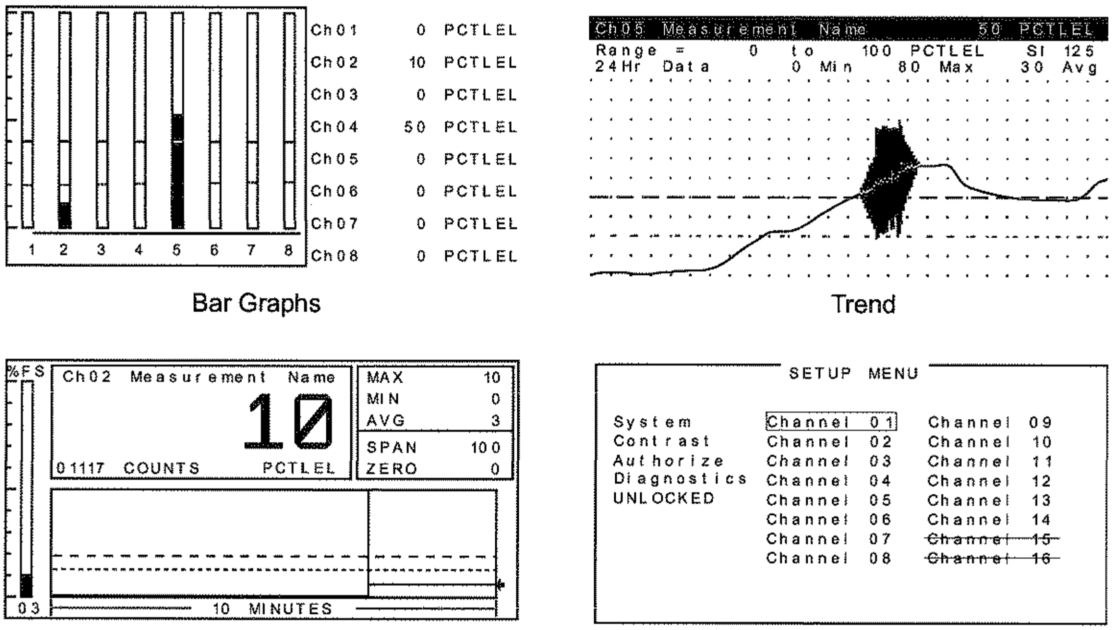
CSA C22.2 No 1010.1 and ISA S82.02; CSA C22.2 No 152 for combustibles; UL 1604 / C22.2 No 213 (Div 2 Groups A,B,C,D); EN55011 & EN61000 (CE Mark). CSA File # = 219995 and may be seen at: CSA-International.org.

SECTION 2

2.0 BASIC OPERATION

The PS-7000 offers 3 graphic screens for viewing monitored data and a *Set-Up* menu screen for operator interface to configuration menus. They are shown below in Figure 2.0. The *Bar Graphs* screen allows viewing of all active channels simultaneously. The *Trend* screen displays a 24 hour trend one channel at a time. The *Combination* screen displays a bar graph, large engineering units and a 10 minute trend one channel at a time. Input channels may be displayed in sequence with the **UP/DOWN** keys. The **NEXT** key switches between the 3 graphic data screens. When PS-7000 power is applied, the graphic LCD returns to the screen active when power was last removed.

Setup menus are entered by pressing **EDIT** from any data screen, and scrolling to the desired menu using the **UP/DOWN** keys. Pressing **EDIT** again enters the selected menu's tree of variables. This *Setup* mode may be exited manually by pressing **NEXT,** or automatically when no keys are pressed for 5 minutes. Alarm relays and front panel alarm LED indicators remain active during the *Setup* mode. An **AUTHORIZE** menu offers a password feature to prevent tampering with PS-7000 parameters.



Bar Graphs | Trend | Combination | Setup

Figure 2.0

2.1 SETUP MENU CONFIGURATION

Variables inside *system* and *channel* menu trees allow optimum PS-7000 configuration for a wide range of demanding multi-point monitoring applications. Access to menus is via the *Setup* mode by pressing **EDIT** and activating the *Setup* screen shown in Figure 2.0. Menu trees are provided for each of the 16 channels and another for system variables. Select the desired menu by scrolling with **UP/DOWN** and **EDIT** to enter the menus.

2.1.1 CHANGING MENU VARIABLES USING THE KEYPAD

Upon entering a menu, a pointer controlled by the **UP/DOWN** keys indicates the selected variable. Some are simple ***YES/NO*** or ***ON/OFF*** entries toggled by pressing the **EDIT** key. Others, such as *Measurement Name* and *Eunits* fields may have many ASCII character possibilities. Allowed ASCII characters are as follows: ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz blank space !"#$%&'()*+,-./0123456789:;<=>?@. **EDIT** places a cursor over the item and **UP/DOWN** scrolls through each allowed entry. The **NEXT** key moves the cursor to the next position within a field. When the field is complete, **EDIT** clears the cursor and loads it into non-volatile memory where it is retained indefinitely. With no cursor present, **NEXT** closes open menus in reverse order and returns the LCD to the most recent data display.

2.2 CHANNEL CONFIGURATION MENUS

Figure 2.1 illustrates the menu tree for configuring *Channel* variables. These items affect only the specific channel selected. *System* specific variables are in the menu tree shown in section 2.3.

CHANNEL MENUS TREE

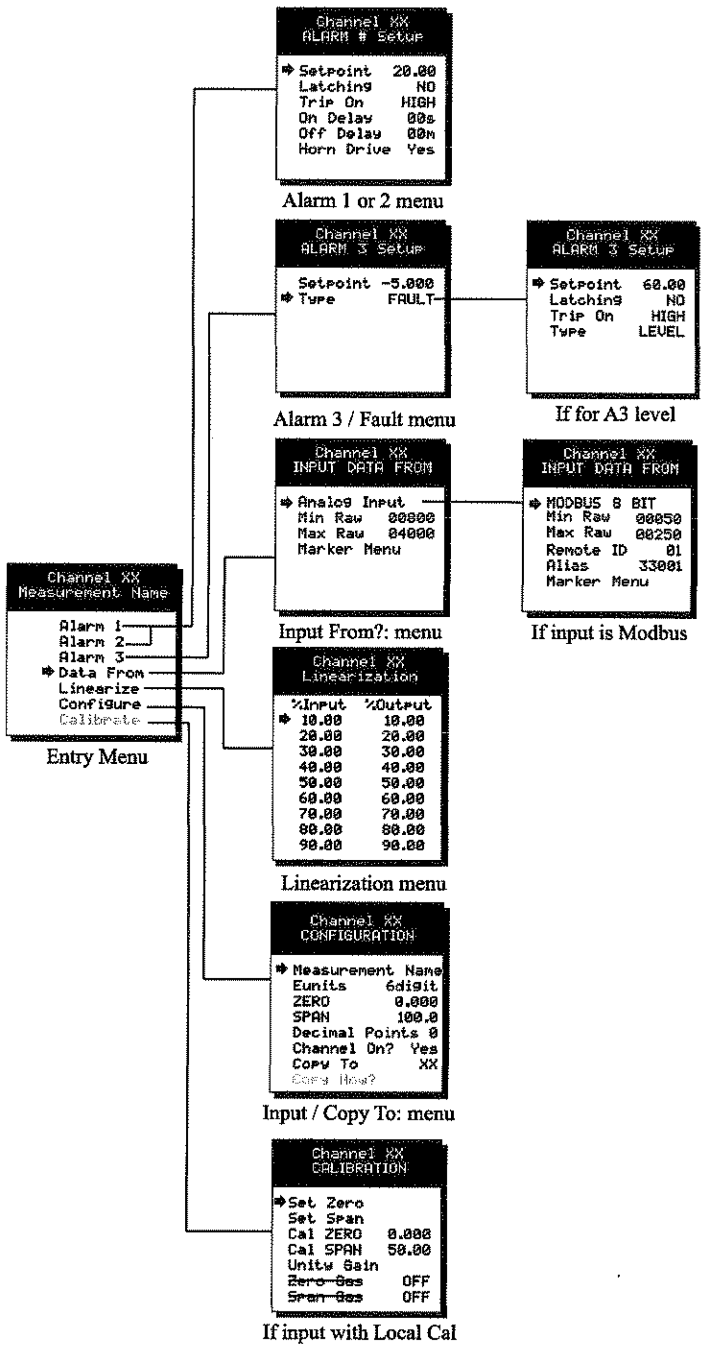


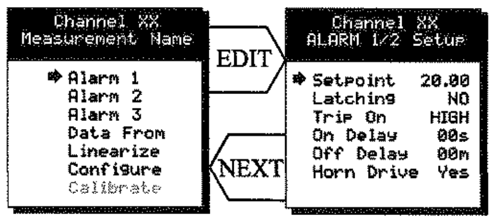
Figure 2.1

2.2.1 *CHANNEL SETUP ENTRY MENU*

The *entry menu* shown on the left side of Figure 2.1 allows access to all configuration variables for the selected channel. These are, **Alarm 1**, **Alarm 2**, **Alarm 3**, **Data From? Linearize**, **Configure** and **Calibrate**.

2.2.2 *ALARM 1 / ALARM 2 / HORN RELAY SET-UP MENU*

Alarms 1 and 2 are identical except A1 may not be *acknowledged* and front panel LED indicators are yellow while A2's are red. Since their configuration menus are the same only one is shown in Figure 2.2 for clarity.



Entry Menu Alarm 1 or 2 menu

Figure 2.2

The first entry determines the **Setpoint** value where the alarm trips. It is entered in engineering units. For example, if a channel monitors 0-50 ppmH2S and the alarm must trip at 10 ppm, the correct entry is 10.00.

- **Latching** determines either manual or automatic alarm reset operation. **YES** requires a manual **Alarm Reset** to unlatch the alarm even though an alarm condition no longer exists. **YES** also causes this alarm group's common relay, front panel LED, and optional discrete relay to latch. **NO** allows all outputs for this alarm to automatically reset as soon as the alarm condition clears.
- **TRIP ON.** is set to **HIGH** for increasing alarms or **LOW** for decreasing alarms to determine if the alarm activates upon exceeding or falling below the setpoint.
- The **ON DELAY / OFF DELAY** entries allow **ON** and **OFF** time delays affecting how long the setpoint must be surpassed before an alarm event transition occurs. **ON** delays are limited to 10 seconds while **OFF** delays may be as long as 120 minutes. Delays are useful in many applications to prevent nuisance alarms and unwanted cycling into and out of alarm conditions.
- The **HORN ON** entry allows linking this alarm to the common horn relay. **NO** causes the alarm to have no effect upon the horn relay. Entering **YES** causes this alarm to turn the horn relay on steady, or, to pulse it depending upon horn configuration in they system menu (see section 2.3.1).

Discrete LED indicators on the front panel indicate the status of each alarm and relay. Any *new* alarm event causes the associated LED to flash until **Alarm Reset** occurs causing an *acknowledged* steady on condition. Operators should recognize *new* alarms by a <u>flashing</u> LED. **Alarm Reset** also *acknowledges*, or deactivates, the horn relay until another new alarm occurs.

All relays are rated at 5 Amp for 28 VDC and 250 ~VAC **<u>RESISTIVE</u>** loads. IMPORTANT: Appropriate diode (DC loads) or MOV (AC loads) snubber devices must be installed with inductive loads to prevent RFI noise spikes. Relay wiring should be kept separate from low level signal wiring.

2.2.3 ALARM 3 / FAULT ALARM MENU

The discrete channel alarms identified as Alarm 3/Fault may be configured either as a 3rd level alarm, or, as a Fault alarm indicating the input is out of range in the negative direction. When used as a level alarm, features such as on / off delays, latching, and trip direction are also available. It is important to understand that though discrete channel alarms (LED's & optional discrete relays) may be set as Alarm 3 level alarms, the common relay for this group is always a Fault alarm. The fault *out of range* threshold for the channel is the most recent Fault trip point entered prior to changing the menu to Alarm 3. The following example describes how to configure both the Fault *out of range* and Alarm 3 *level* trip points for a channel. ***Example:*** If the common Fault relay must trip as the input falls below negative 10% of full scale, and, the discrete alarms trip as the input exceeds a level, then the –10% Fault setpoint must be entered first. Toggle the *TYPE* menu entry to **FAULT** and enter –10.00% into the *setpoint* entry. Next, toggle the menu back to **LEVEL** and enter the desired Alarm 3 level *setpoint*. The -10% Fault value is retained in memory even though it no longer appears on the menu.

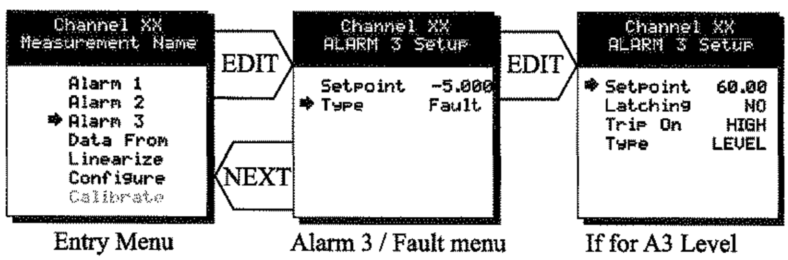
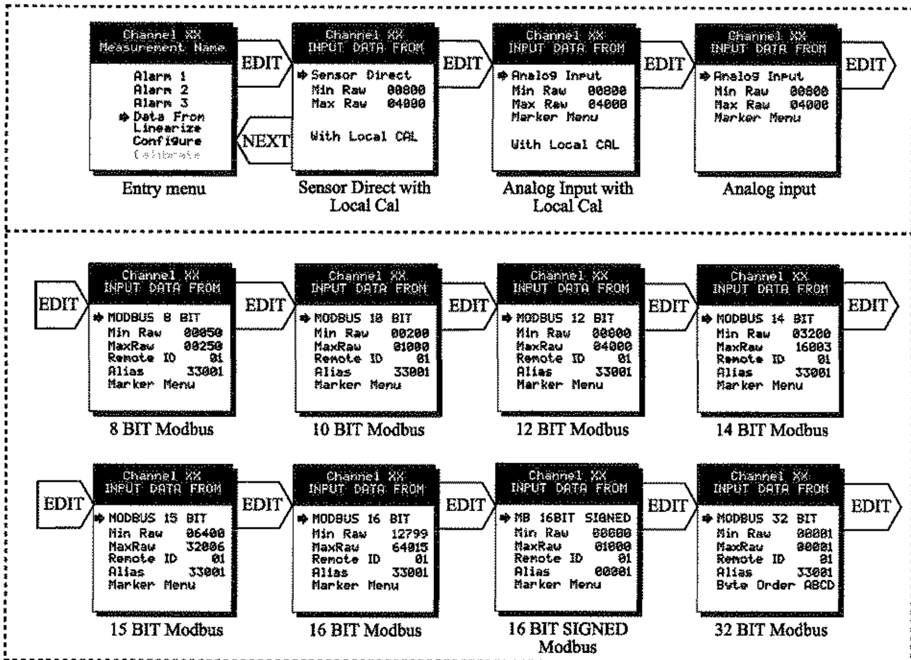


Figure 2.3

2.2.4 DATA FROM? MENU TO SET INPUT SOURCE

Each channel may be independently configured to accept input data from the Modbus RS-485 master port, or, from an analog input card attached to the I^2C bus (see Figure 2.4). **EDIT** toggles the *Data From*: entry between *Modbus RTU, Analog, Analog with Local Cal* or *Sensor Direct*. There are eight different Modbus possibilities available to accommodate the binary resolution and format of the input data (see Figure 2.4). Each *Modbus* menu selection also requests the RTU # and the Alias register # location of the data to be retrieved from the RTU. Alias register numbers define the location of the variable representing the input value and must be obtained from the manufacturer of the Modbus RTU device.

Analog should be selected when the channel's input comes from a transmitter or monitoring device with a ***calibrated*** output such as 4-20mA. *Analog with Local Cal* is available when the PS-7000 will be the point of calibration for the analog input. *Sensor Direct* is identical to *Analog with Local Cal* and both activate the PS-7000's *Cal Mode* features (see section 2.2.7). Problems may arise if calibrations are performed in two places upon the same signal so Cal Mode menus are only visible when *Sensor Direct* or *Analog with Local Cal* is selected. These selections should only be used when the input originates from a **non-calibrated** signal source such as the *Catalytic Bead Sensor Input* option described in section 3.1.3, or, our ST-49 Transmitter with a non-calibrated 4-20mA output. These applications require the PS-7000 to be used as the calibration point since the sensors have no *zero* or *span* controls.



12-Bit Analog Inputs may be direct from Sensor Input options or Voltage / Current Input options

The Modbus Master RS-485 port supports eight integer types, resolutions and formats.

Figure 2.4

2.2.4a MIN / MAX RAW COUNTS MENUS

The Min Raw and Max Raw counts entries included in the Input Data From: menu define the range of input counts that provide *Measurement Range* read-out values described in section 2.2.6b. This menu entry is determined by the A/D converter resolution of the channel's input. For example, if the input is a 10 bit Modbus® device with zero at 200 counts and 100% at 1000 counts, then this menu's MIN should be set at 200 and MAX at 1000. If communicating with the PS-7000's optional 12 bit Analog Input PCB the MIN should be 800 and the MAX 4000.

If the input device's resolution is unknown, the live counts variable on the bottom of the screen displays actual raw A/D counts currently being read by this channel. This reading may be used to test the input device for what A/D counts are provided for zero and 100% if these values are unknown. Forcing the input device to read zero should provide the A/D counts value needed to make this channel's display also read zero. Likewise, forcing the input device to read 100% should provide the A/D counts value needed to make the PS-7000 channel's display also read 100%.

If Modbus 32 BIT is selected, a Byte Order entry appears at the bottom of the menu. This determines WORD and BYTE alignment of data at the remote Modbus transmitter when sending its 4 byte IEEE Floating Point values. With the pointer on this entry, the

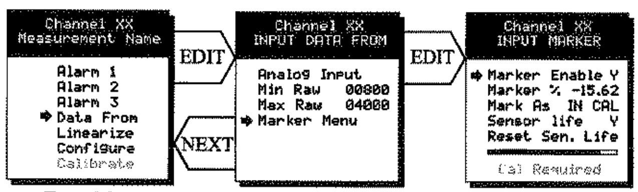
EDIT key toggles between the 4 possible modes. Min / Max Raw values are not used in this mode.

Note: Each *Data From*: item has a matching default Min/Max counts value of 20% to 100% with ± 5% over/under range applied. If the default value is incorrect for the input device it should be edited.

2.2.4b MARKER MENUS

Some transmitters or monitoring devices providing PS-7000 inputs also indicate special modes of operation, such as *Calibration, Maintenance or Fault,* by transmitting a special <4mA or negative “Marker” value. The PS-7000 offers channel Marker menus for detecting and indicating such events (see Figure 2.5). While active, the PS-7000diplays a 6-digit ASCII message to indicate the special event and if equipped with 10-0167 4-20mA output option, the PS-7000 also transmits the same <4mA value.

- **Marker Enabled** turns the marker feature ON and OFF
- The negative Marker value is entered into the **Marker %** field as a negative percent of full scale. For example, -15.62% of full scale detects a marker value of 1.5mA (1.5mA is -15.62% of full scale when 4-20mA is the range).
- The **Mark As** menu allows user entry of the 6-digit ASCII message to be displayed when the marker is detected.



Entry Menu | Input From?: menu | Marker menu

Figure 2.5

2.2.4c SENSOR LIFE DETECTION

Sensor Life should only be activated when the Marker event is *Calibration* and when a sensor life value is transmitted after each calibration. This feature is provided primarily for use when interfacing the PS-7000 to R. C. Systems' ST-48 Sensor Transmitters which may be configured to transmit sensor life values after each calibration (see Figure 2.6). For **Sensor Life** to record properly the monitor must perform as follows: After the *Calibration* Marker interval, 4.0mA transmits for 10 seconds to indicate its *calibration mode* is complete. The monitor then transmits between 4.0mA and 5.0mA for five seconds depending on remaining sensor life where 4.0mA = 0% and 5.0mA = 100% remaining sensor life. The PS-7000 reads this value and records it as the channel's **Sensor Life**. **Sensor Life** is stored in the PS-7000 modbus database and displayed as a bar-graph in the Sensor Info screen (see section 2.3.6). It is a useful tool for planning sensor replacement schedules.

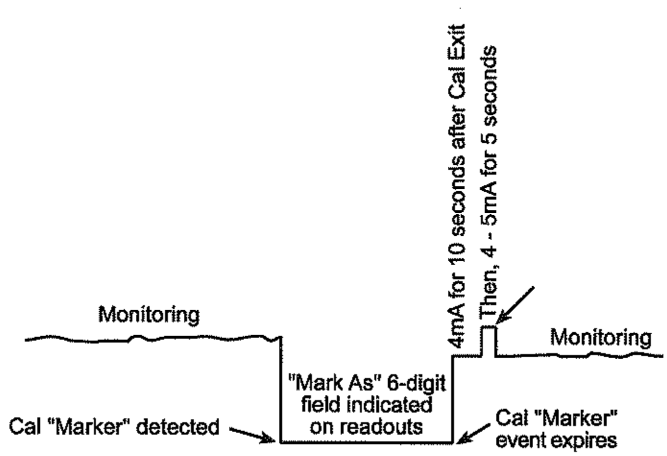


Figure 2.6

2.2.5 *LINEARIZATION MENU*

The linearization menu allows each channel to have its own linearization curve stored in the controller's non-volatile memory. Input versus output points must be entered in *percent of full scale* values. This means if the range is 0-200 ppmH2S then 100 ppm is 50% of full scale. Zero input will provide a zero output and 100% input a 100% output. Nine intermediate points may be entered to define the curve.

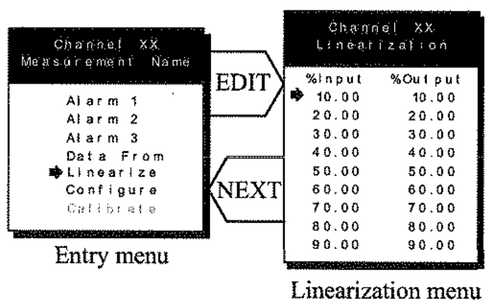


Figure 2.7

2.2.6 *CONFIGURE MENU*

From the entry level setup menu in Figure 2.8 the CONFIGURE menu may be entered for setting variables defining how the controller presents monitored data to the various graphic displays.

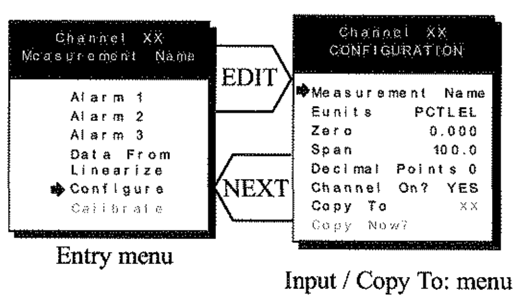


Figure 2.8

2.2.6a EUNITS / MEASUREMENT NAME ASCII DATA FIELDS

The first two items in this menu are for entering the 6 character *engineering unit* and 16 character *Measurement Name* ASCII fields. Eunits should define the units of measure for what this channel is to display. *Measurement Name* should describe the source of this data in the user's terminology. Section 2.1.1 of this manual describes how to use the front keypad to modify these fields.

2.2.6b INPUT MEASUREMENT RANGE

The **ZERO / SPAN** entries allow configuration of the measurement range displayed by this channel. Measurement Range works along with *A/D Counts* menus, described in section 2.2.4a, to define the range of the input signal's engineering units. For example, if a channel's input is 4-20mA from a transmitter monitoring 0 to 10ppm chlorine, then the **Zero** value should equal 0.000 and the **Span** value equal 10.00. The six ASCII engineering units previously entered are automatically displayed at the top of each menu as a reminder. Four digits must appear in this entry so trailing 0's may appear here that are not displayed on other data screens.

2.2.6c DECIMAL POINT RESOLUTION

Resolution of displayed channel values is configured in this menu by setting the number digits trailing the decimal point. Values are limited to a maximum of four digits, and a polarity sign. An auto-ranging feature displays the highest resolution allowed by this menu's decimal point entry. For example, if three decimal points are entered, and the range is 0 to 100ppm, the reading will be **0.000** at 0ppm and **100.0** at 100ppm. However, this may be undesirable due to the high resolution at zero unless the sensor's output is extremely stable. If decimal points are limited to one, the 0ppm reading becomes **0.0** and the 100ppm reading remains **100.0**. Resolution may be limited further by setting decimal points to 0. In the above example, this would cause 0ppm to display **0** and 100ppm to display **100**.

2.2.6d TURNING OFF UNUSED CHANNELS

The **Channel On?** entry determines if this channel is to be utilized. Turning it off will cause the controller to never process inputs applied to this channel and no alarms will be tripped or data displayed. Inactive channels have a line drawn through them on the Setup screen as indicated by channels 15 & 16 in Figure 2.0. If less than 9 channels are to be activated, the PS-7000 may be set for 8 channel mode, deactivating channels 9-16. This is done in the System Setup menu described in section 2.3.

2.2.6e COPY DATA TO?

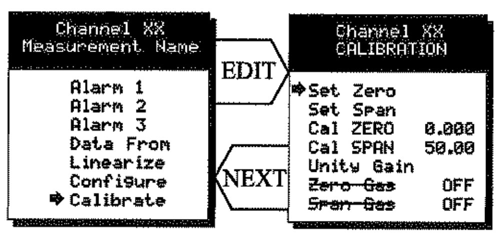
This menu simplifies the Setup procedure by allowing similar channels to be copied from one to another. For example, if all channels are identical except for the *Measurement Name* entry, channel 1 could be configured and copied to channels 2 – 16. Only *Measurement Name* then must be configured on channels 2 – 16. Use **EDIT** to increment channel numbers and **UP/DN** to point to **Copy Now?** Press **EDIT** once more to copy.

2.2.7 CAL MODE

IMPORTANT! Each channel's **CALIBRATION** menu is **inactive** unless it's *Input Data From:* menu, described in section 2.2.4, is set for *Analog with Local Cal* or *Sensor Direct*. PS-7000 CAL MODE features allow pushbutton calibration of zero and span values. This feature should be utilized only when there are no other zero/span controls within the monitoring system since it is inappropriate to calibrate a signal at more than one point. Therefore, if calibration is to be performed at another transmitter or monitoring device, the PS-7000 CAL MODE feature should not be used.

The CALIBRATION MENU allows entering the correct **Cal ZERO** & **Cal SPAN** set-point values needed to calibrate the sensor. These are entered in the same engineering units as input range. **Set Zero** & **Set Span** controls in this menu allow pushbutton calibration by moving the pointer to each and pressing the **EDIT** key. A live reading of the channel's value allows calibration checks to see if an adjustment is needed. Unintentional calibrations are reset by the **Unity Gain** menu item. **Unity Gain** resets zero offset to 0 and span gain to 1. It is useful for returning the calibration to a known starting place. Sensor aging may be monitored by recording zero and span readings at **Unity Gain** when it is new, and again at later dates when degradation may have occurred.

To check zero calibration, apply the ZERO calibration value to the sensor and observe the live reading. If the zero reading differs from the zero setpoint, a calibration is needed. To calibrate zero, move the pointer to **Set Zero** and press **EDIT**. A warning message explains that pressing **EDIT** again will change the zero calibration and any other key will exit. The procedure for span calibration is identical. For example, if an LEL combustible sensor is to be spanned with 50% LEL span gas, the span set-point must be 50%. If 45% LEL is to be used later, the span set-point must be changed to 45% to match the span calibration gas. If the reading is only 40% LEL with the 50% gas applied a span calibration is needed. Move the pointer to the **Set Span** entry and press **EDIT** twice. **Unity Gain** may be used at anytime to cancel incorrect calibrations and start again.

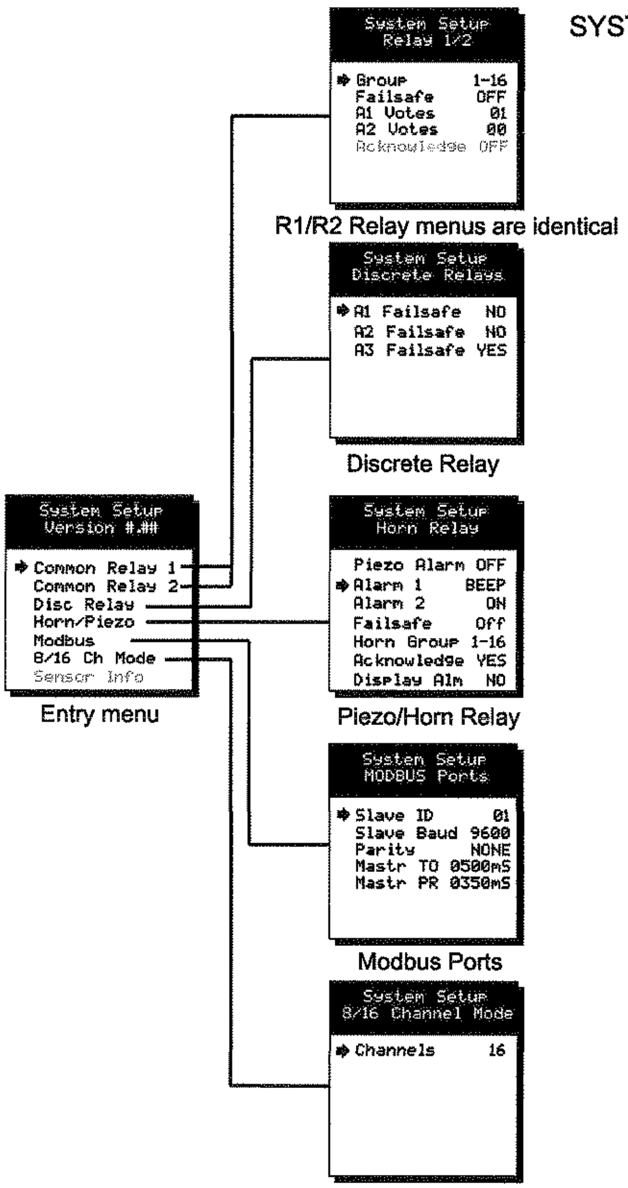


Entry Menu If input with Local Cal

Figure 2.9

2.3 SYSTEM CONFIGURATION MENUS

Some items needing configuration are not specific to a channel but affect the entire PS-7000 system. These are located in the system entry menu shown on the left side of Figure 2.10. System menus are accessed by pointing to the desired item and pressing **EDIT**.



SYSTEM CONFIGURATION MENUS

Votes entry determines the number channels needed to set Relay 1 or Relay 2.

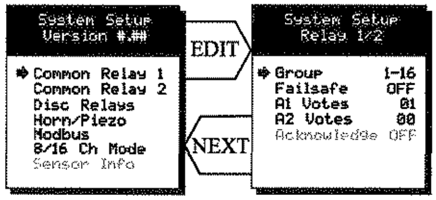
Acknowledge is disabled when no A2 Votes are entered

Figure 2.10

2.3.1 COMMON ALARM RELAYS 1 & 2

⚠ **<u>READ THIS SECTION CAREFULLY AND TEST ALL SETTINGS BY SIMULATING PS-7000 INPUT CONDITIONS THAT SHOULD ACTIVATE THESE ALARM RELAYS!</u>**

Common Relay 1 & **Common Relay 2** menus are identical and therefore discussed only once. It is very important to fully understand these menus since they determine the functions of each common relay.



Votes entry determines the number channels needed to set Relay 1 or Relay 2.

Acknowledge is disabled when no A2 Votes are entered

Entry menu R1/R2 Relay menus are identical

Figure 2.11

- The **Group** menu entry offers additional flexibility by controlling which channels trip this menu's common alarm relay. The 3 choices are **1-16**, **1-8** or **9-16**. Some applications have different types of sensors, or, sensors in different areas connected to the same PS-7000 Controller. In these cases, it may be undesirable for a sensor on channel 9 to trip the same relay as a sensor on channel 2. The **Group** menus may restrict this. For example, channels 1-8 might be set to trip common relay 1 while channels 9-16 trip common relay 2. Another possibility is channels 1-8 be set to trip common relay 1 while channels 9-16 trip relays on an optional discrete relay PCB configured for Alarm 1 (see section 3.2).
- **Failsafe** controls relay activation for this common relay. **Failsafe ON** causes the relay to de-energize during alarm conditions and energize when there is no alarm. Thereby, a power failure forces the relay contact to the alarm position. Note the common Fault relay is always failsafe and may be monitored separately to indicate loss of power conditions in many applications.
- **A1 and A2 Votes** allows creation of logical AND function equations that control common relay 1 & common relay 2. Default settings for common relay 1 are **A1 Votes = 01** and **A2 Votes = 00** which causes relay 1 to trip if any channel has an A1 level alarm active. Default settings for common relay 2 are **A1 Votes = 00** and **A2 Votes = 01** which causes relay 2 to trip if any channel has an A2 level alarm active. Example: If either default setting is modified such that **A1 Votes = 02** and **A2 Votes = 01,** then any two channels must have an A1 level alarm active and any one channel must have an A2 level alarm active to trip that relay. REMEMBER! One of the A1's and the A2 could be on the same channel. These level alarms must come from a channel included in the **Group** entry described above.
- Turning **Acknowledge ON** (not available on Alarm 1) allows the common relay to be deactivated during alarm conditions by an **Alarm Reset**. This is useful if an audible device is being driven by the relay.

All relays are rated at 5 Amp for 28 VDC and 250 ~VAC <u>**RESISTIVE**</u> loads. IMPORTANT: Appropriate diode (DC loads) or MOV (AC loads) snubber devices must be installed with inductive loads to prevent RFI noise spikes. Relay wiring should be kept separate from low level signal wiring.

2.3.2 10-0195 DISCRETE RELAY "FAILSAFE" MODE

10-0195 Discrete relay options may also be configured to function in a *Failsafe* mode using the System Setup menu shown in Figure 2.12. Entering YES causes these discrete relays to have energized coils when no alarm condition exists for the associated channel and de-energized coils when the alarm occurs. *Failsafe* is useful for indicating failed relay coils and loss of power conditions. **Important: 10-0195 zoning jumpers (see Figure 3.4) should not be used when Discrete Relays menus are set for failsafe.** Zoning jumpers cause ANY relay in the zone to energize ALL other relays in the same zone. Zoning of failsafe relays may be accomplished with wiring at the relay contact terminals.

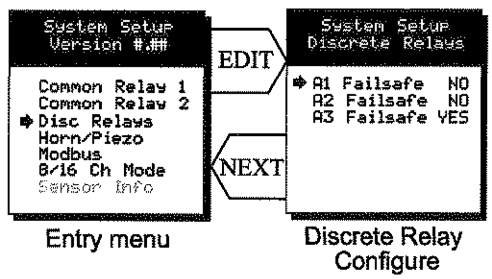


Figure 2.12

2.3.3 COMMON HORN RELAY & LOCAL PIEZO

The PS-7000 is equipped with a low decibel audible piezo which chirps when keys are pressed and may be configured to audibly indicate alarm conditions. The common horn relay is similar to the common A1 & A2 common relays.

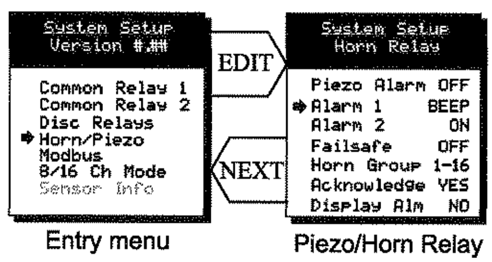


Figure 2.13

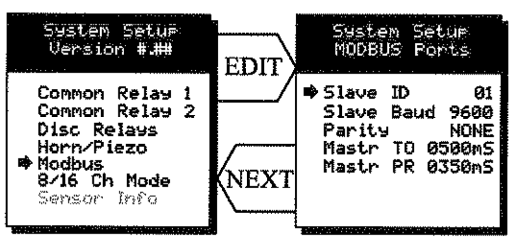
- Turning **Piezo Alarm ON** causes the audible piezo to duplicate the action of the horn relay. This feature may be used to provide a low decibel indication of the status of the system's horn.
- **Alarm 1 & Alarm 2** menus control how this alarm level from each channel will affect the common horn relay. Choices are **OFF**, **ON** or **BEEP** (one Hz. Pulsating). As an example, A2 conditions might pulse the horn (**BEEP**) and A1 conditions to cause a steady horn (**ON**). Any other combination of these 3 choices is possible for A1 and A2 levels affecting the horn relay. This feature is very useful since it allows the horn relay to serve as another level A1, level A2, or both; for channels 1-16, 1-8 or 9-16. Individual channel alarms may also be configured to not affect the Horn relay on a channel by channel basis (see section 2.2.2).

- **Failsafe** & **Horn Group** menu entries are identical to the descriptions for menus **Common Relay 1** & **Common Relay 1**in section 2.3.1.
- Turning **Acknowledge OFF** allows the common Horn relay to drive devices other than horns or sirens such as a light or a fan.
- **Display Alm YES** forces the LCD to display the Bar Graphs screen upon any new alarm. This feature is offered to satisfy applications requiring channels in alarm to be displayed automatically (all channels are displayed on the Bar Graphs screen).

2.3.4 MODBUS MASTER / SLAVE SERIAL PORT MENUS

The system Modbus menu allows setting RTU **Slave ID** address, **Slave Baud** rate and **Parity** for the comm2 *slave* Modbus serial port (comm1 *master* port ID settings are per channel as described in section 2.2.4). This slave port may be used to transfer PS-7000 data to a host device such as a PC, PLC, DCS or even another PS-7000. The slave port is addressable, allowing many PS-7000 controllers to be connected to a single RS-485 cable. Section 5 of this manual provides important information describing how to interface to the PS-7000's Modbus slave port.

The **Mastr TO** (master time out) and **Mastr PR** (master poll rate) menu items affect the PS-7000's *master* Modbus port. *Time out* sets length of time in milliseconds before a communications error. Three consecutive timeout errors must occur before a communication error is indicated. This item is useful for optimizing throughput to the PS-7000 from other slave RTU's. *Poll Rate* sets frequency of data requests to the RTU's in milliseconds. This is useful when an RTU is limited in how fast it may respond to consecutive data requests.



Entry menu Modbus Ports

Figure 2.14

2.3.5 EIGHT / SIXTEEN CHANNEL MODES

The system menu allows setting the PS-7000 controller to accept either 8, or, 16 channels. If 8 channels are selected by this menu they are channels 1-8 and 9-16 are disabled. One way PS-7000 cost is kept low is Input / Output option PCB's are arranged into groups of 8 channels. Therefore, users with less than 9 channels require only 1 PCB and do not pay for I/O hardware for 16 channels. If more than 8 channels are needed a second I/O option PCB may be required.

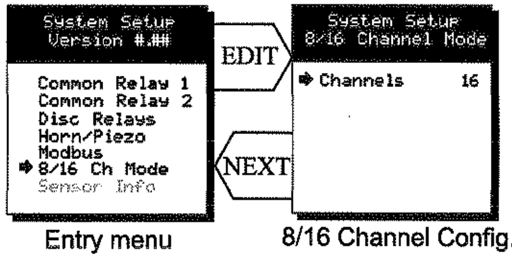


Figure 2.15

2.3.6 SENSOR INFORMATION

Sensor Info is available when at least one channel has **Sensor Life** activated in the **Marker** menu (see section 2.2.4b). The **Sensor Info** screen displays each channel's sensor status as illustrated in Figure 2.16. Channels with **Sensor Life** disabled indicate **Option Disabled** above the corresponding empty bar-graph. If **Sensor Life** is enabled, the channel will have its Measurement Name above the bar, or, an empty bar with a **Cal Required** label. **Cal Required** indicates no Calibration Marker value has been received by the PS-7000.

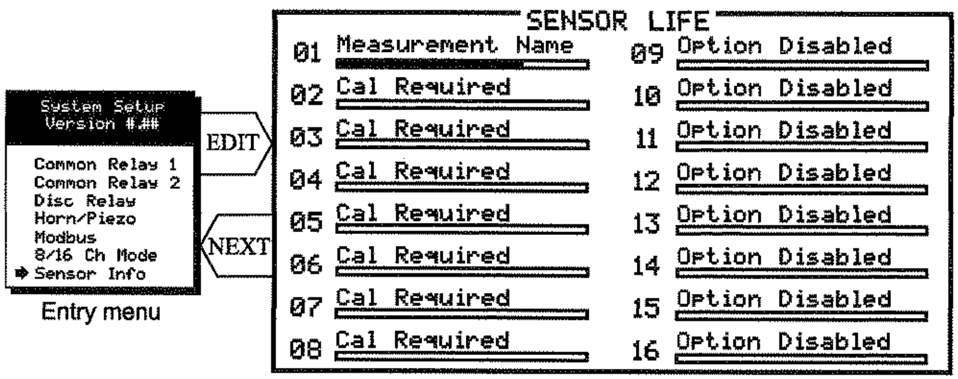


Figure 2.16

2.4 AUTHORIZATION MODE

A password entered in the **AUTHORIZATION** menu allows locking all menus. *Viewing* menus is not denied but attempts to *edit* variables flashes the ***Locked*** message on the LCD.

Authorized individuals locking the system should first enter a name, phone #, or other contact information into the 10 digit field. To lock or unlock the system the correct 4 digit authorization number must be entered into the **Enter Code** field. Point to the **Unlock System** entry and press **EDIT** to complete the unlock procedure. It is very important to remember the 4 digit code since the factory must be consulted if it is lost.

Figure 2.17

2.5 LCD CONTRAST ADJUSTMENT

The Setup menu item identified as **CONTRAST** allows users to adjust the LCD contrast to a level suitable to the ambient lighting. Selecting **CONTRAST** and pressing **EDIT** causes the **UP/DOWN** keys to increase and decrease LCD contrast.

SECTION 3

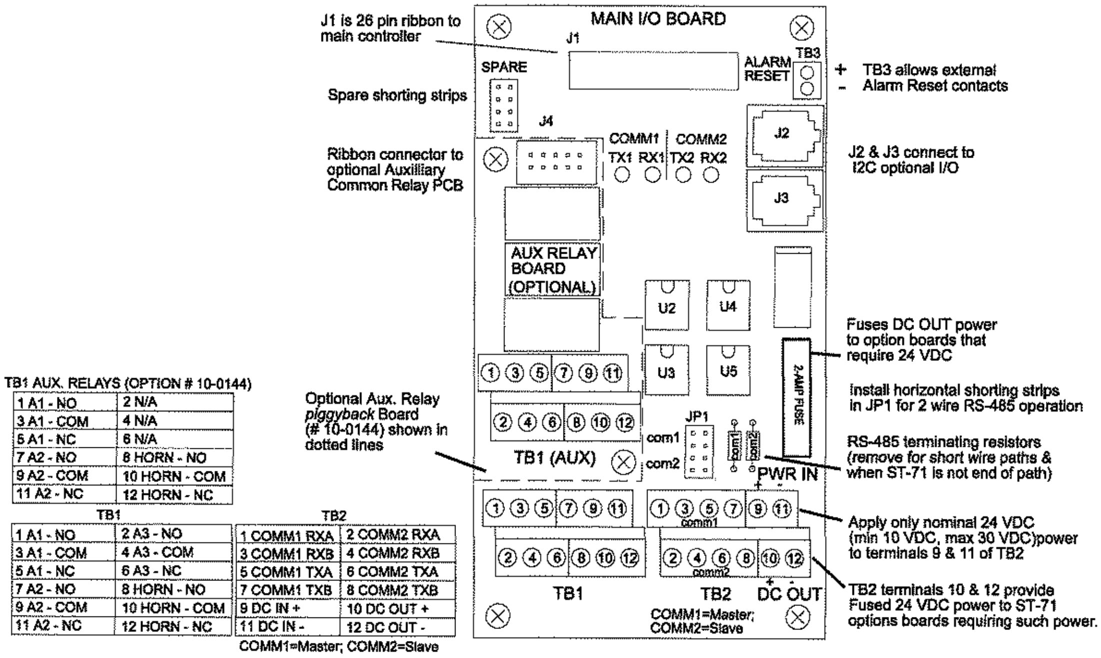
3.0 MAIN I/O INTERFACE PCB # 10-0142

The most basic PS-7000 Controller requires only the I/O PCB shown in Figure 3.1 for interfacing to field wiring. The PS-7000 primary power supply is applied to terminals 9 & 11 of TB2. This may be from 10 – 30 VDC. **WARNING! HIGH VOLTAGES SUCH AS 115 VAC APPLIED TO THESE TERMINALS MAY CAUSE SEVERE DAMAGE!** DC output terminals 10 & 12 on TB2 provide up to 500mA of output power for powering remote devices such as lamps, transmitters etc.

This PCB includes both ***master*** *(COMM 1)* and ***slave*** *(COMM 2)* RS-485 Modbus ports, 5 amp form C relays for each common alarm event (A1, A2, FAULT/A3 & HORN), and power supply I/O terminals. JP1 allows the RS-485 ports to be configured for 2 or 4 wire operation. A 26 pin ribbon cable connects the I/O PCB to the PS-7000 CPU and Display nest assembly. Two I^2C bus connectors allow addition of optional functions such as analog I/O and discrete alarm relays for each channel.

Horizontal jumpers installed in JP1 connect the RS-485 port's RX & TX lines, simplifying 2 wire daisy chains by providing additional terminals for incoming and outgoing cables. For example, installing the 2 COM 1 jumpers connects screw terminals 1 & 5 and terminals 3 & 7. Socketed RS-485 terminating resistors R6 (COMM 1) and R12 (COMM 2) are located on the MAIN I/O board. These resistors should be removed if communication wire lengths are very short (less than 25 feet), or, if the port is not at the end of the communication line.

An optional Auxiliary Relays *piggyback* PCB (part # 10-0144) may be added to the I/O PCB via ribbon cable J4. These add another form C contact set to the common A1, A2 and HORN alarms. Auxiliary Relay contacts are available at the TB1 (AUX) terminals shown in Figure 3.1.



Main I/O PCB WITH COMMON RELAYS #10-0142

Figure 3.1

3.1 INPUT / OUTPUT OPTIONAL PCB's

Telephone style RJ11 connections are used to add optional 8 channel analog and digital I/O. A screen appears briefly after power up indicating what options are connected and for which channels. This information is also available from the *Diagnostics Mode* described in Section 4.

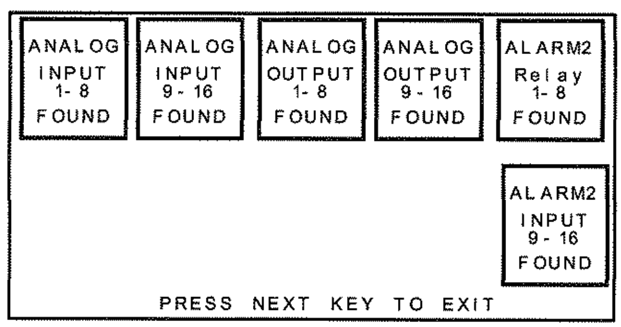


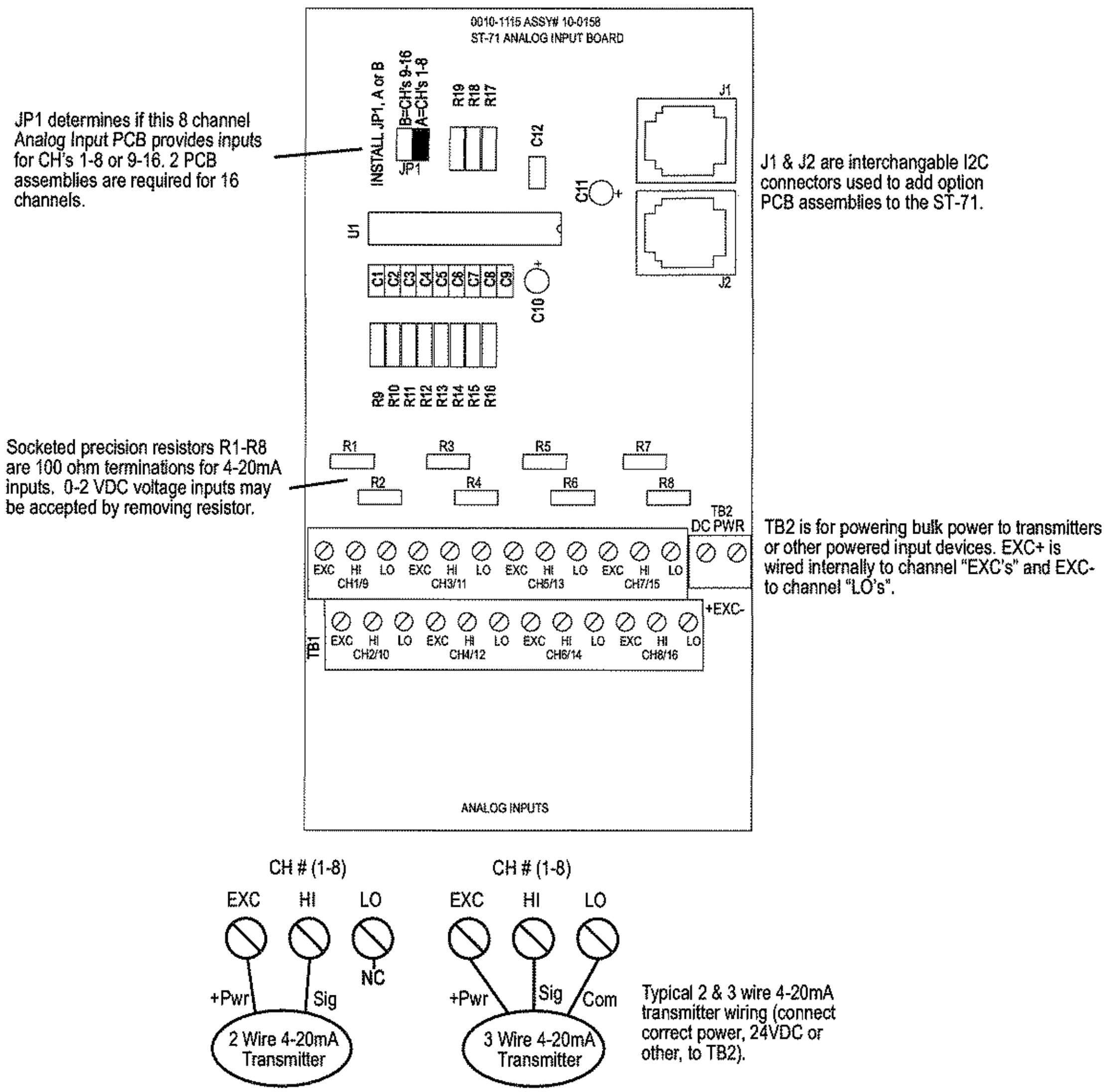
Figure 3.2

3.1.1 ANALOG INPUT PCB # 10-0158

Many transmitters or sensors have analog output signals and the 12 bit *Analog Input PCB*, shown in Figure 3.3, is provided to accept these. TB1, with 24 positions, offers 3 terminals per channel for distributing power and receiving analog inputs. These are **EXC** and **HI** / **LO** inputs. TB2, with only two positions, is for connecting the power supply for powering external transmitters. Precision 100 ohm resistors (R1 – R8) between each channel's **IN LO** and **IN HI** terminals are socketed termination resistors for 4-20mA inputs. These may be removed if voltage inputs are to be applied.

EXC and **IN LO** terminals are bussed together internally. **EXC** terminals are tied directly to TB2-1 (+) and **IN LO** terminals are tied to TB2-2 (-). Bussing allows transmitter power to be brought into the system at a single point (TB2) and distributed back out at each channel's **EXC / IN LO** terminals to simplify field wiring. Figure 3.3 includes typical wiring to 2 & 3 wire 4-20mA transmitters.

JP1 determines if the 8 analog inputs are applied to channels 1-8 or channels 9-16. Connecting more than 8 analog inputs requires 2 PCB's with one's JP1 set for channels 1-8 and the other set for channels 9-16.



8 Channel Analog Input Option #10-0158

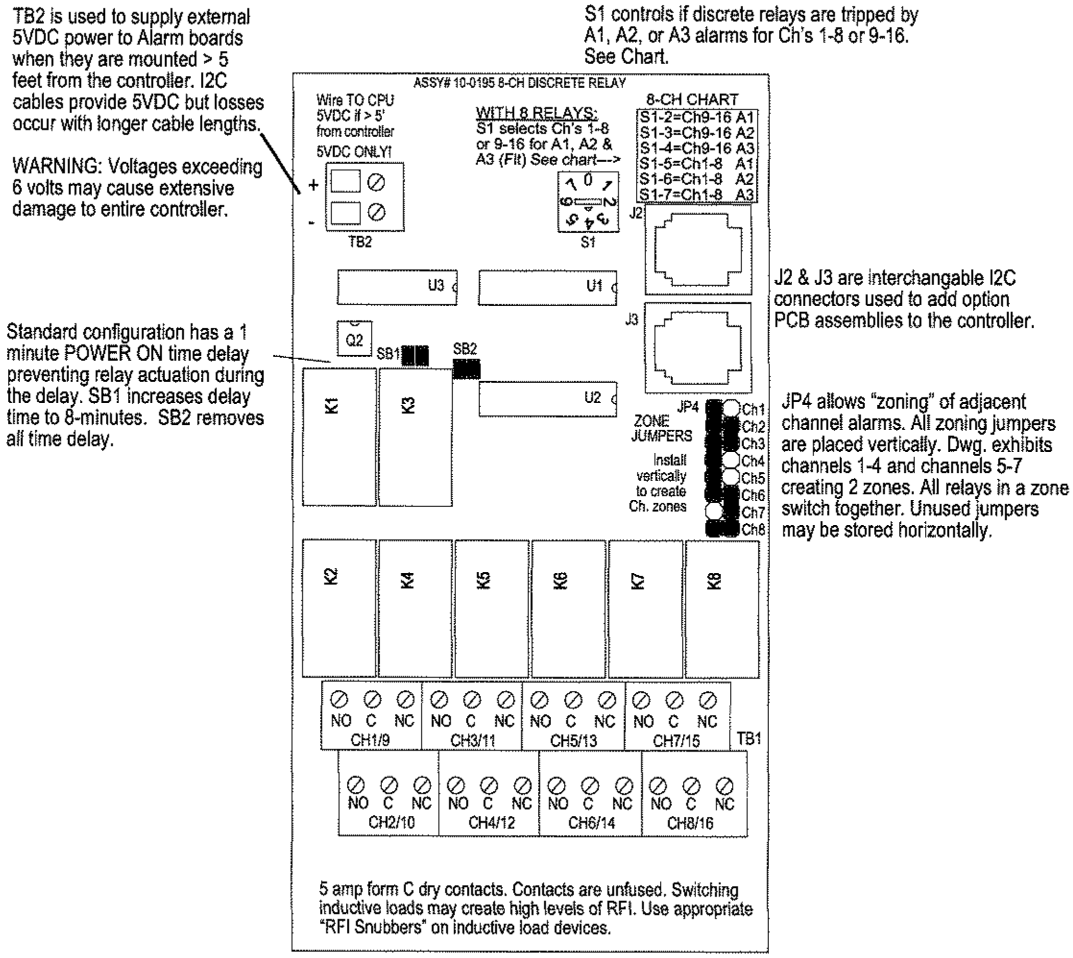
Figure 3.3

3.1.2 OPTIONAL DISCRETE RELAY PCB # 10-0195

An optional *Discrete Relay PCB*, shown in Figure 3.4, adds eight 5 amp (resistive) form C relays per sixteen channel alarm group (2 PCB's required when utilizing more than 8 channels). Each PCB may be configured via rotary switch S1 to function for ALARM 1, ALARM 2 or ALARM 3/FAULT for channels 1-8 or 9-16. A 1-minute time delay after power is provided to inhibit relay actuation until the system has had time stabilize. Alarm groups, or zones, may be created by connecting adjacent channels together using JP4 as shown. This creates a wire *OR* function with selected channels, causing *any* alarm included within the zone to actuate *ALL* zone relays. *Failsafe* operation of 10-0195 discrete relays may be programmed in the *system* menu as described in section 2.3.2. Many PS-7000 applications utilize the common alarm relays (see section 3.0) and do not require discrete relays for each of the 48 alarm events (16 A1's, 16 A2's & 16 A3's). If discrete relays are needed for all 48 alarms, then six PCB's are required.

5 VDC power to the discrete relay option PCB's is normally supplied from the PS-7000 Controller via the slender I^2C cables connected to J2 and J3. However, I^2C cables are limited in ability to carry this power further than a few feet without a significant voltage drop. Some PS-7000 applications with relays for all 48 alarms may require up to 6 boards. TB2 allows a heavier 5VDC power cable to be connected from terminals on the back of the PS-7000front panel assembly, bypassing the I^2C cable. A 20AWG pair connected to only one of the several TB2's is sufficient when these boards are in close proximity to each other.

All relays are rated at 5 Amp for 28 VDC and 250 ~VAC <u>**RESISTIVE**</u> loads. IMPORTANT: Appropriate diode (DC loads) or MOV (AC loads) snubber devices must be installed with inductive loads to prevent RFI noise spikes. Relay wiring should be kept separate from low level signal wiring.



8 Channel Discrete Relay Option #10-0195

Figure 3.4

*3.1.3 OPTIONAL *BRIDGE SENSOR INPUT BOARD #10-0191*

An optional 8-channel, 12 bit *Bridge Sensor Input* board allows these popular gas detectors to be connected directly to the PS-7000 without additional signal conditioning or transmitters. Up to four dual channel 10-0192 modules may be installed in each 8-channel 10-0191. Each 10-0192 channel is equipped with a bridge amplifier and balance potentiometer and an adjustable switching regulator for setting the correct sensor excitation voltage. A 3 position coarse gain jumper allows setting the gain of the bridge amplifier. Fault supervision circuitry forces the PS-7000 into a FAULT condition upon sensor failure or removal.

This option may also be configured to accept 4-20mA inputs for mixing bridge sensors and current loops into the same board. Placing any channel's 2 position LEL/4-20mA jumper into 4-20mA position and installing the associated precision 100 ohm socketed resistor allows 4-20mA signals to be applied to it's C & A terminals. The 10-0192 sensor modules are not required for channels accepting 4-20mA.

Channels receiving input data from this board should have the *Data From:* menu set for *Sensor,* as described in section 2.2.4. This activates *Cal Mode* menus described in section 2.2.9 needed to *zero* and *span* sensor readings. After performing the one time only *Initial Setup* as described below, all subsequent calibrations are by the PS-7000's electronic Cal Mode menus.

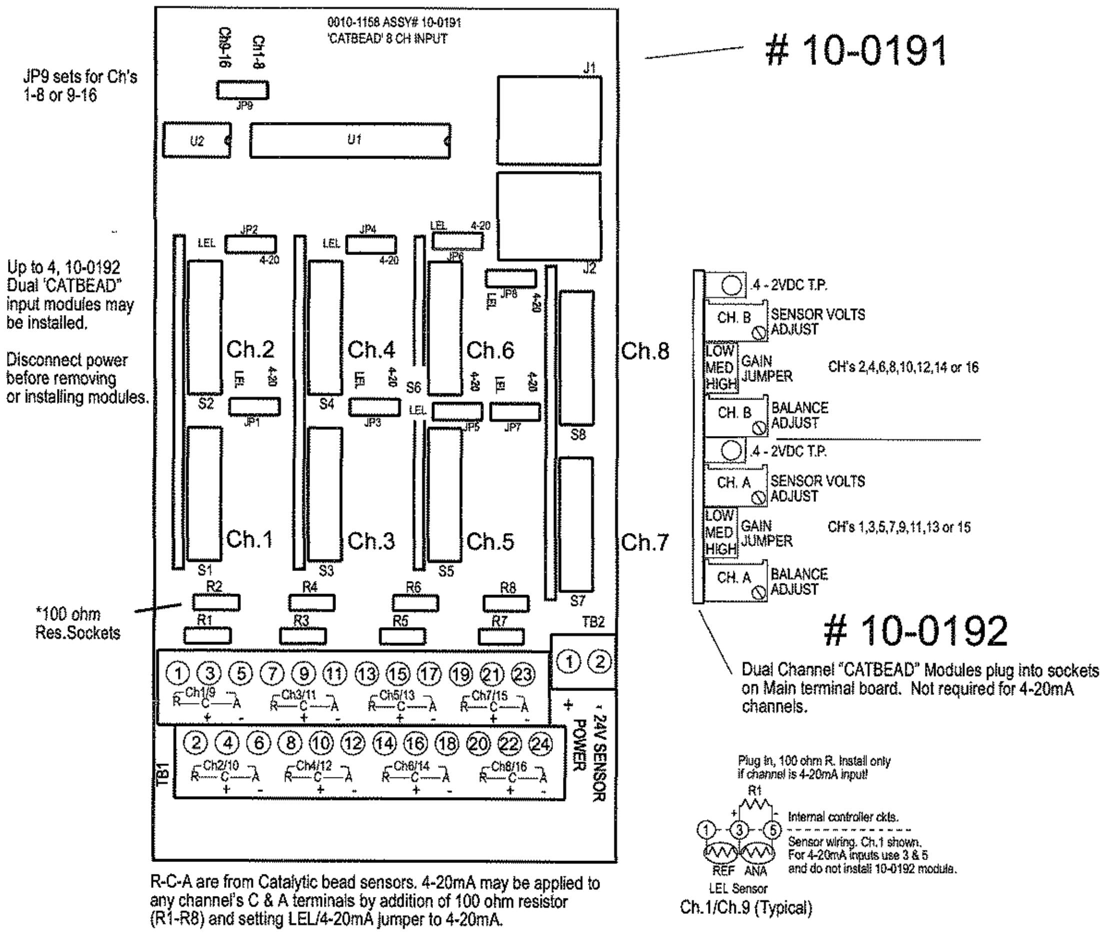
*Catalytic sensors connected directly to the PS-7000 should be limited to ranges of 0-1000ppm.

3.1.4 CATALYTIC BEAD SENSOR INITIAL SETUP

Catalytic bead sensors vary widely in power requirements and sensitivity. It is therefore important to configure each channel to match the sensor with which it will operate.

1. Prior to connecting sensors, apply power to the system. Note this PCB requires 24VDC power be connected to its TB2 terminals 1 & 2 as shown in Figure 3.5. Suitable fused power is available from the Main I/O board's TB2 terminal 10 & 12 (see Figure 3.1). Measure the voltage between each channel's A and R terminals and set the *Voltage Adjust* potentiometers for the correct sensor excitation voltage. This may range from 1.5 volts to 7.5 volts depending upon sensor specifications. **Sensors may be damaged by accidental over voltage conditions. It is recommended the *Voltage Adjust* potentiometer screws be covered by a dollop of RTV or similar material after completion of this procedure to avoid accidental over voltage conditions.**
2. Remove system power and connect sensor wires to the R-C-A terminals. Reapply system power and confirm correct voltage across each sensor's A & R terminals. Note: If sensor wires are long, it may be necessary to measure the excitation voltage at the sensor end to compensate for I^2R losses in the wiring.
3. With the minus voltmeter lead on TB2-2 (common), connect the plus lead to the channel's test point. With zero air on that sensor, adjust its *Balance* potentiometer for .4 volts at the test point.
4. Apply 50% LEL combustible span gas to the sensor and allow the test point voltage to stabilize. Two volts = 100% input to the A – D Converter and .4 volts = 0%. Therefore, 1.2 volts = 50%. Place the 3 position *Coarse LEL Gain* jumper into the position which reads between .8 volts and 1.2 volts on the test point with 50% LEL gas on the sensor. Gain settings for each jumper position are as follows: no jumper = 1, LOW = 7, MED = 21, HI = 41. Multiple jumpers have an additive affect upon gain, so the LOW and MED jumpers together provide a gain of 28.

Initial setup is now complete and normally only requires repeating if a sensor is replaced. Final calibration of this channel may now be performed using the PS-7000's electronic Cal Mode feature described in section 2.2.1.



8 Channel "CATBEAD" Sensor Option #10-0191 / 10-0192

Figure 3.5

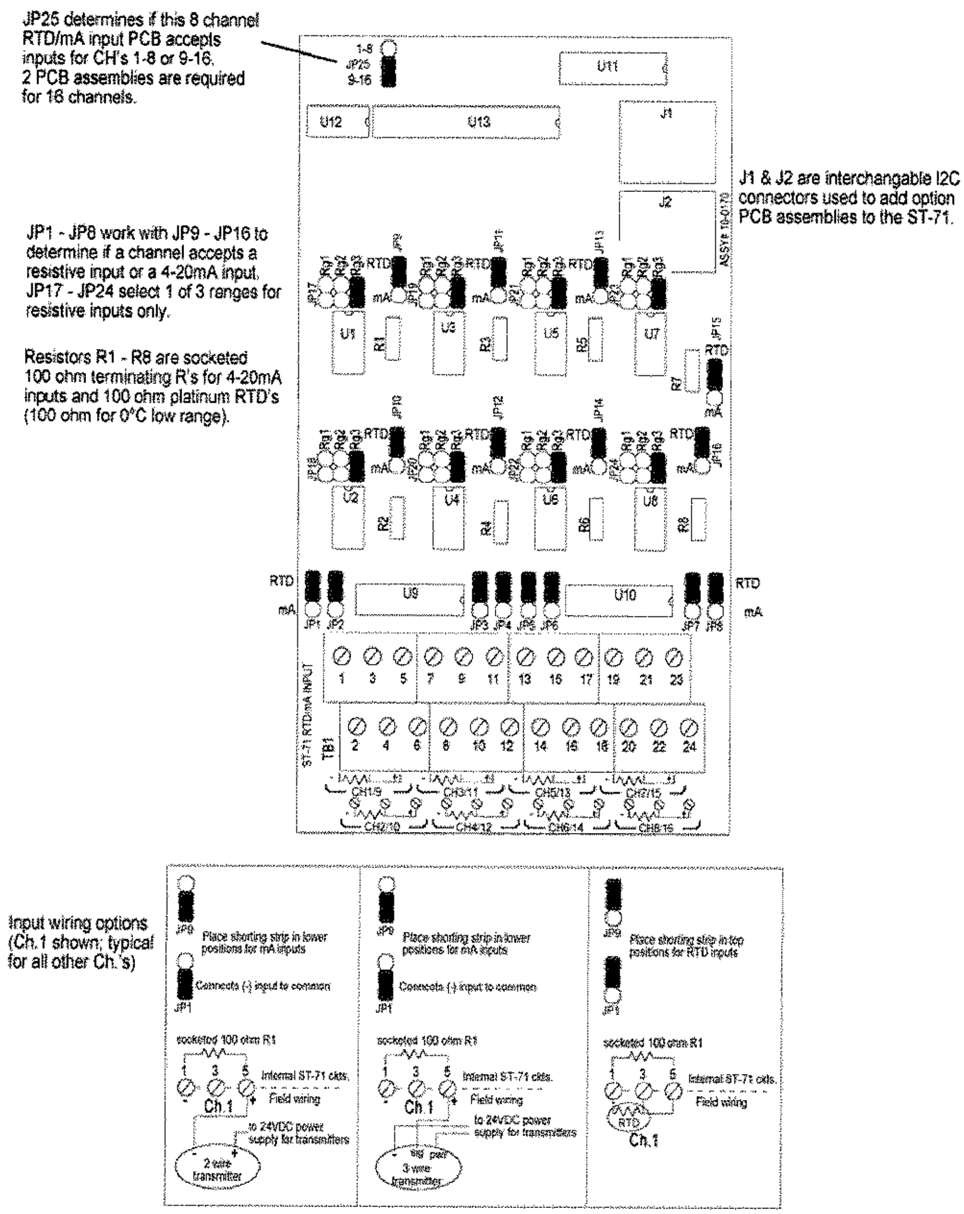
3.1.5 OPTIONAL RTD / 4-20mA ANALOG INPUT BOARD # 10-0170

An optional 12 bit *RTD Sensor Input* board, shown in Figure 3.6, allows these popular temperature sensors to be connected directly to the PS-7000 without additional signal conditioning or transmitters. A 3 position range jumper allows setting the gain of the input bridge amplifier for the three popular ranges of 0-100°C, 0-200°C or 0-400°C. Other ranges are available by special order.

Inputs may also be configured to accept 4-20mA signals, allowing mixing RTD sensors and current loops into the same board. Two jumpers per channel determine either a RTD or 4-20mA input. These dual position jumpers, JP1 – JP16, must both be placed into the UP position for RTD inputs or both in the DOWN position for 4-20mA inputs (see Figure 3.6).

Channels receiving input data from this board should have the *Data From:* menu set for *Sensor,* as described in section 2.2.4. This activates *Cal Mode* menus, described in section 2.2.9, needed to perform *zero* and *span* calibrations of RTD sensor readings.

Each channel must be calibrated individually by either simulating desired zero and span calibration resistance values or by actually placing the channel's RTD into an actual precision temperature generator. Ice water is an acceptable method for generating the 0°C zero temperature value. Upscale span values are best simulated with an RTD calibrator. Since RTD's are stable and repeatable of over long time periods calibrations normally only need to be performed upon initial installation. Since the PCB has 8 channels, two are required for 16 channel applications. JP25 configures inputs for channel groups 1-8 or 9-16.



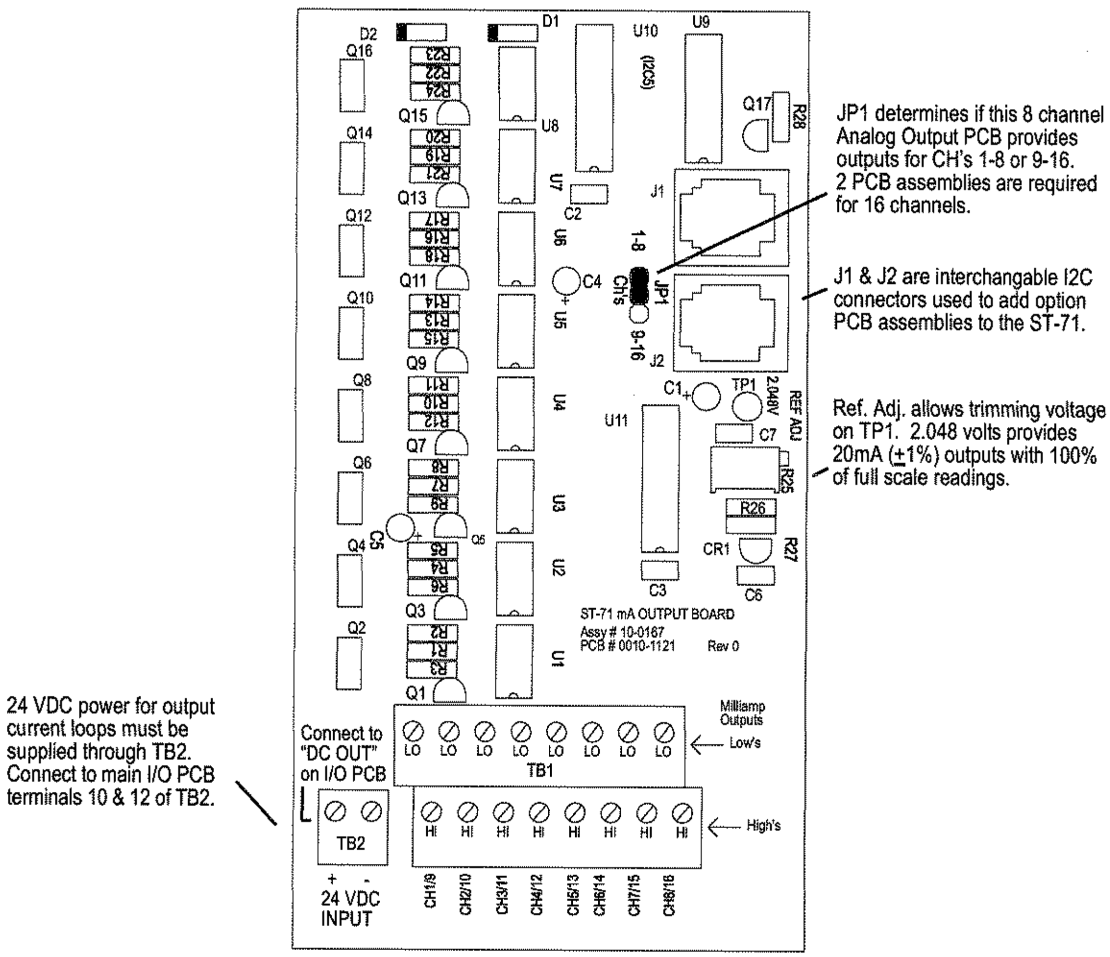
8 Channel Resistive / 4-20mA Input Option #10-0170

Figure 3.6

3.1.6 OPTIONAL 4-20mA ANALOG OUTPUT BOARD #10-0167

An optional 10 bit 4-20mA analog output board, shown in Figure 3.7, may be connected to the I^2C bus. Each channel's output will transmit 4mA for 0% readings and 20mA for 100% readings. Loop drive capability depends upon the level of the PS-7000's primary DC power supply. With at least 20 volts DC primary power they are capable of driving 20mA through a 750 ohm load. Outputs are self powered and DC power should not be provided by the receiving device. Note: This PCB requires nominal 24VDC power be connected to TB2 terminals 1 & 2 as shown in Figure 3.7. Suitable power is available from the PS-7000 Main I/O board's TB2 terminal 10 & 12 (see Figure 3.1).

Since the PCB has 8 channels, two are required for 16 channel applications. JP1 configures the outputs for channels groups 1-8 or 9-16.



8 Channel 4-20mA Output Option #10-0167

Figure 3.7

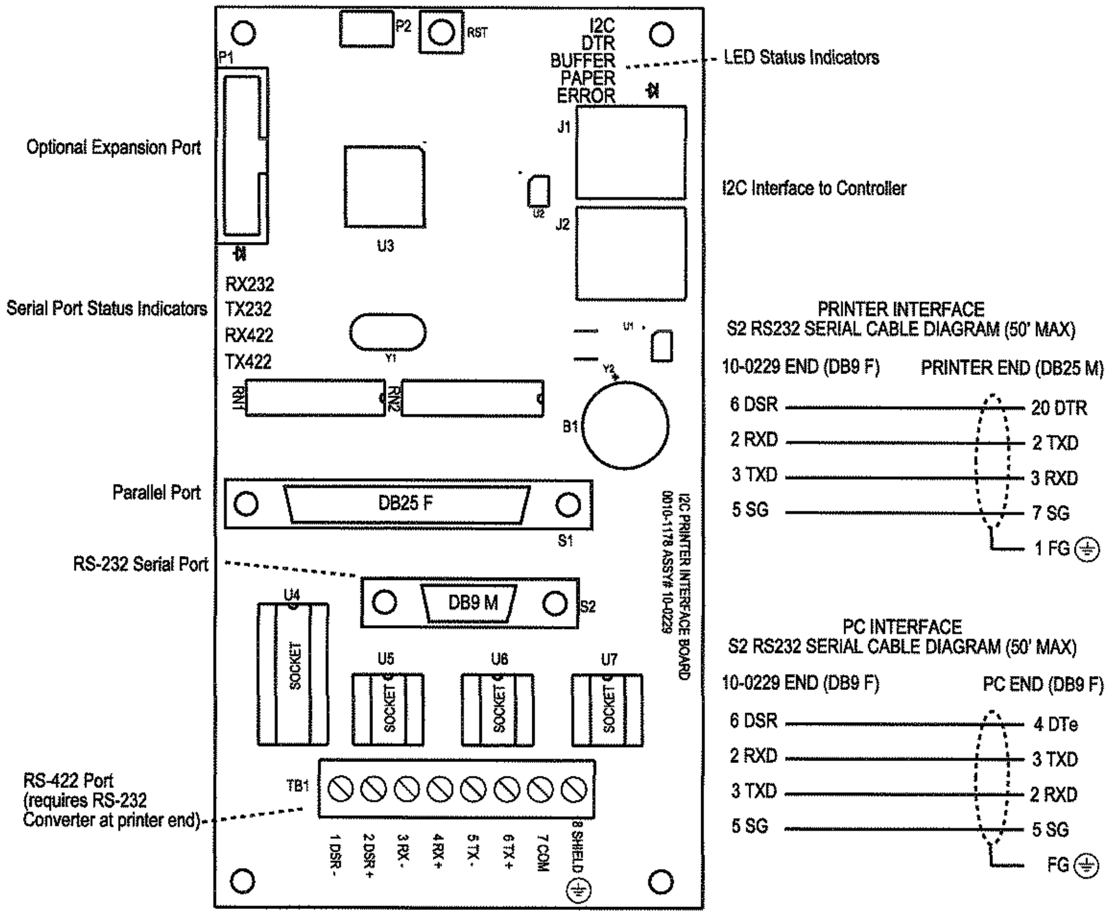
3.1.7 OPTIONAL CLOCK / PRINTER INTERFACE BOARD # 10-0229

When equipped with the 10-0229 Clock / Printer Interface option, shown in Figure 3.8, the PS-7000 Controller is capable of automatically printing time & date stamped alarm events to a 24 PIN dot matrix printer such as the Panasonic KX-P1131. The cable interface between the PS-7000 and the KX-P1131 may be either parallel or serial. Parallel interfaces only allow 6 feet of separation while the RS-232 serial interface allows up to 50 feet. Distances up to 4000 feet may be obtained using the 10-0229 printer interface option's RS-422 port but requires an additional tri-port RS-422 / RS-232 converter at the printer end of the cable.

The 10-0229 Printer Interface may also be connected to a PC running HyperTerminal or other communications software as an alternative to hard copy printing of the data. Printer / PC cable schematics are shown in Figure 3.8. Printer settings for serial interfaces are 9600 baud, 8 data bits, no parity and one stop bit. Communications software settings are 9600 baud, 8 data bits, no parity, one stop bit and FlowControl = Hardware. Printer diagnostic red LED's indicate printer faults such as out of paper, overflowed buffer or loss of communications. Green LEDs flicker to confirm good communications between the PS-7000 and printer during print attempts.

Examples of printed alarm events are shown below. The format of each event, from left to right, is DATE, TIME, 16 character ASCII channel ID from the PS-7000, PS-7000 channel #, alarm #, IN or OUT status. A buffer in the PS-7000 retains the most recent 30 – 35 printed events. It is possible to dump the entire buffer to the printer from the menu shown in Figure 3.9. This is useful if printer problems have occurred causing missed printouts.

```
05/22/03 08:21:00 Storage Tank 103 Chnl  1 Alarm 2  IN
05/22/03 08:21:01 Storage Tank 103 Chnl  1 Alarm 2 OUT
05/22/03 09:12:01 Storage Tank 103 Chnl 13 Alarm 1  IN
05/22/03 09:13:00 Fuel A Flow      Chnl  9 Alarm 1  IN
05/22/03 09:13:05 Storage Tank 103 Chnl  1 FAULT    IN
05/22/03 09:13:05 Fuel Dock        Chnl  2 FAULT    IN
05/22/03 09:40:10 Storage Tank 103 Chnl 13 Alarm 2  IN
05/22/03 09:40:14 Fuel Dock        Chnl  2 FAULT   OUT
05/22/03 09:40:14 Trans Pump 103   Chnl  3 FAULT   OUT
05/22/03 09:40:14 Storage Tank 103 Chnl  1 FAULT   OUT
05/20/03 11:53:37 Fuel A Flow      Chnl  9 Alarm 1 OUT
```



PRINTER INTERFACE OPTION # 10-0229

Figure 3.8

3.1.7a CLOCK / PRINTER SYSTEM SET-UP MENU

Detection of the 10-0229 on the I2C bus causes the Clock/Printer System Setup menu item to appear. Selecting it and pressing EDIT brings up the menu shown at right in Figure 3.9. **Date / Time** menu entries allow setting of correct local time and date. The **ALARM PRINT ON/OFF** entry allows printing to be discontinued if turned to OFF. **PORT** allows selection of RS-232, RS-422 or the parallel port. With only one port able to be activated at a time. **BUFFER DUMP** allows immediate printing of all the 30-35 stored events. **PRINT CONFIG** allows immediate printing of all channel variables such as channel ID's, Engrg. Units etc. **PRINTER READY / ERROR** indicates the functional status of the printer.

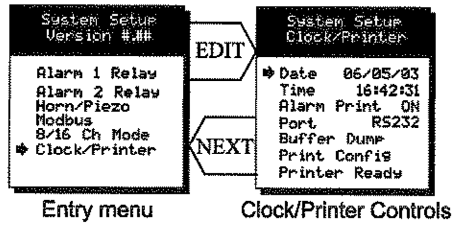
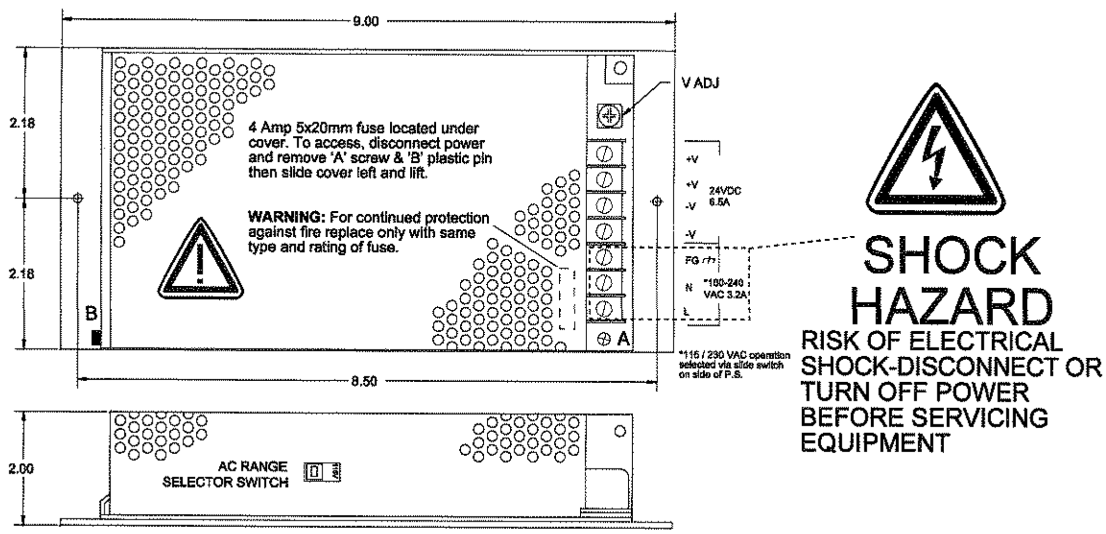


Figure 3.9

3.1.8 24VDC 150 WATT POWER SUPPLY

The PS-7000 Controller comes with a 150 watt AC / DC power supply. (115VAC or 230 VAC selected via slide switch). When ordered from the factory, it is pre-wired to provide 24VDC primary power for the PS-7000 controller as well as any transmitters or monitors that may be connected by the end user.



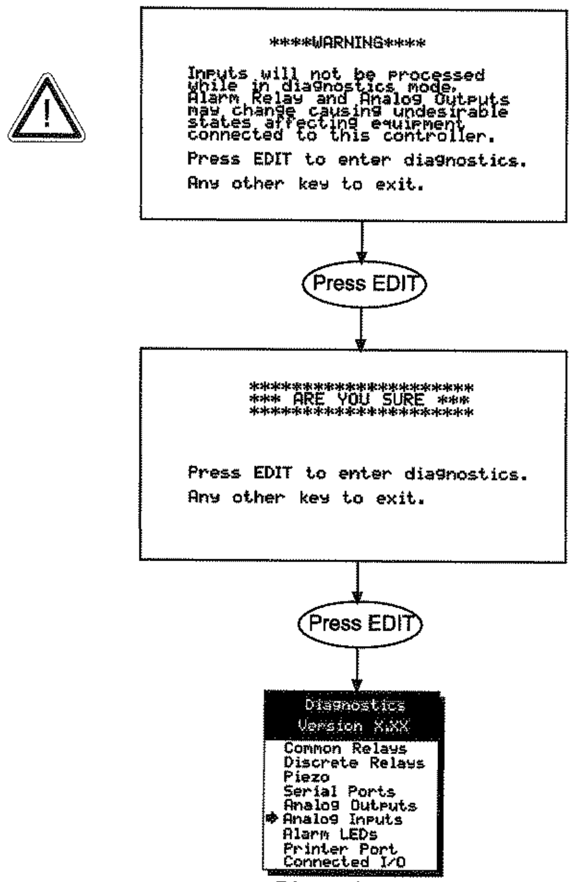
150 Watt 24 VDC Power Supply Option # 10-0172

Figure 3.8

SECTION 4

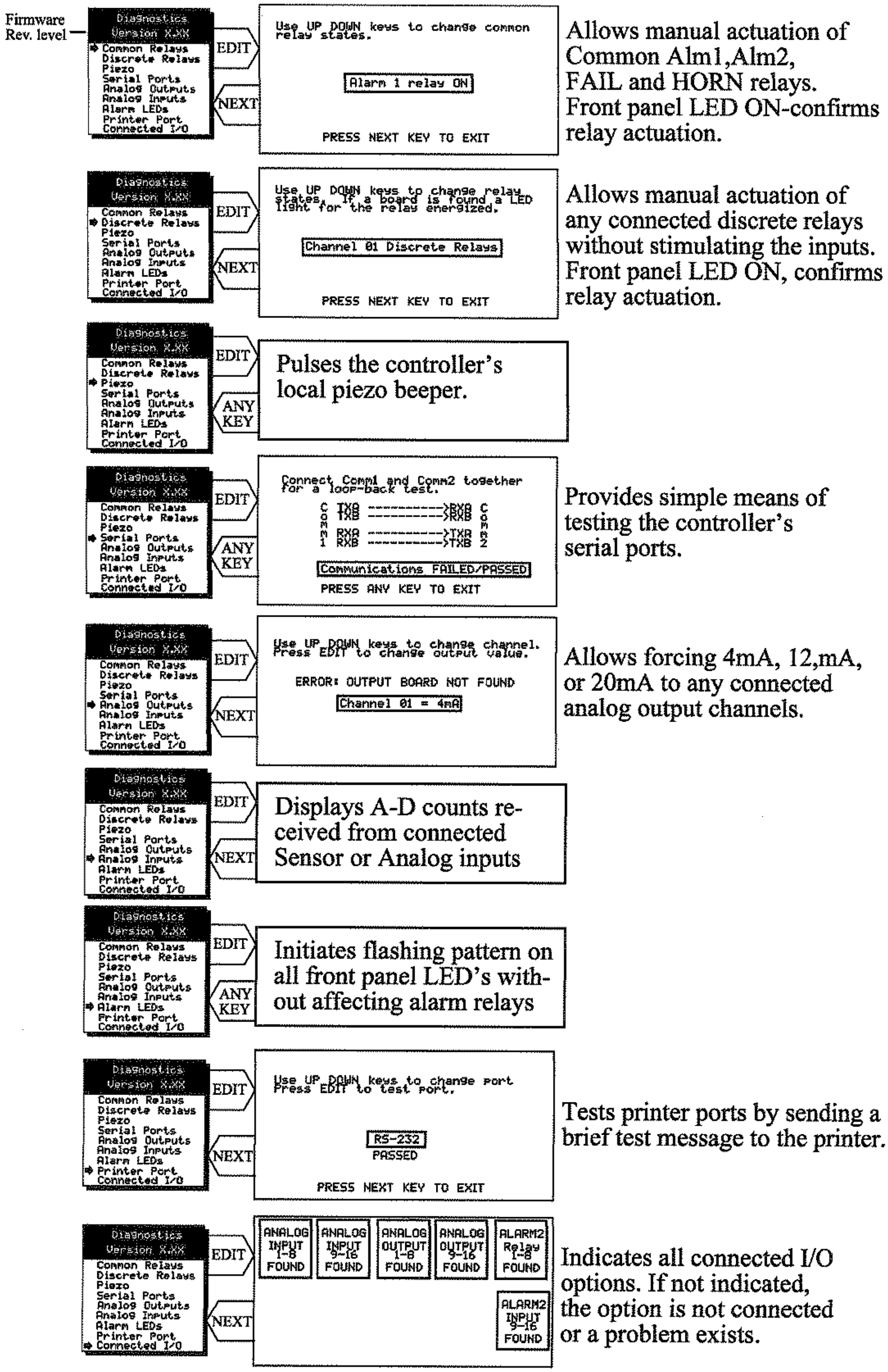
4.0 SYSTEM DIAGNOSTICS

A *System Diagnostic Mode* shown in Figures 4.1 and 4.2 may be entered during normal operation from the Setup menu. The entry menu indicates firmware revision and offers useful routines for testing front panel LED's, relays, serial ports and analog I/O. It is exited manually by pressing **NEXT** and automatically if no keys are pressed for 5 minutes. It is very important to understand that **CHANNEL INPUT DATA IS NOT PROCESSED DURING THE DIAGNOSTICS MODE**. It is possible to miss important input values while utilizing this mode and appropriate safeguards should be in place. However, the Diagnostics Mode can prove invaluable when testing I/O since relays and analog outputs may be stimulated without driving inputs to precise levels.



Diagnostics menu

Figure 4.1



Firmware Rev. level
Diagnostics
Version X.XX
Common Relays
Discrete Relays
Piezo
Serial Ports
Analog Outputs
Analog Inputs
Alarm LEDs
Printer Port
Connected I/O
EDIT
NEXT
ANY KEY
Use UP DOWN keys to change common relay states.
Alarm 1 relay ON
PRESS NEXT KEY TO EXIT
Allows manual actuation of Common Alm1,Alm2, FAIL and HORN relays. Front panel LED ON-confirms relay actuation.
Use UP DOWN keys to change relay states. If a board is found a LED light for the relay energized.
Channel 01 Discrete Relays
PRESS NEXT KEY TO EXIT
Allows manual actuation of any connected discrete relays without stimulating the inputs. Front panel LED ON, confirms relay actuation.
Pulses the controller's local piezo beeper.
Connect Comm1 and Comm2 together for a loop-back test.
TXB ---------->RXB
RXB ---------->TXB
Communications FAILED/PASSED
PRESS ANY KEY TO EXIT
Provides simple means of testing the controller's serial ports.
Use UP DOWN keys to change channel. Press EDIT to change output value.
ERROR: OUTPUT BOARD NOT FOUND
Channel 01 = 4mA
Allows forcing 4mA, 12,mA, or 20mA to any connected analog output channels.
Displays A-D counts received from connected Sensor or Analog inputs
Initiates flashing pattern on all front panel LED's without affecting alarm relays
Use UP DOWN keys to change port Press EDIT to test port.
RS-232
PASSED
PRESS NEXT KEY TO EXIT
Tests printer ports by sending a brief test message to the printer.
ANALOG INPUT 1-8 FOUND
ANALOG INPUT 9-16 FOUND
ANALOG OUTPUT 1-8 FOUND
ANALOG OUTPUT 9-16 FOUND
ALARM2 Relay 1-8 FOUND
ALARM2 INPUT 9-16 FOUND
Indicates all connected I/O options. If not indicated, the option is not connected or a problem exists.

Figure 4.2

SECTION 5

5.0 MODBUS RS-485 PORTS

The PS-7000 is equipped with *Master* (COMM 1), and *Slave* (COMM 2), modbus RTU ports. Port configurations are described in sections 2.2 and 2.3 of this manual. Section 5.0 defines register locations of data available via the PS-7000 slave port.

5.1 MODBUS SLAVE REGISTER LOCATIONS

The following tables describe the PS-7000's modbus slave database. Any portion of this data may be read by a modbus master device such as a PC, PLC or DCS. Since the modbus port is RS-485, many PS-7000s may be multi-dropped onto the same cable.

Memory Integer ASCII:

Notes: ASCII may be read 2 characters at a time or in strings using a multiple register read.

Sixteen character channel tag name:

Type	Channel	First	Last	Read FC	Write FC	Notes
Channel Tag	1	40401	40408	3	n/a	2 characters per register
Channel Tag	2	40409	40416	3	n/a	2 characters per register
Channel Tag	3	40417	40424	3	n/a	2 characters per register
Channel Tag	4	40425	40432	3	n/a	2 characters per register
Channel Tag	5	40433	40440	3	n/a	2 characters per register
Channel Tag	6	40441	40448	3	n/a	2 characters per register
Channel Tag	7	40449	40456	3	n/a	2 characters per register
Channel Tag	8	40457	40464	3	n/a	2 characters per register
Channel Tag	9	40465	40472	3	n/a	2 characters per register
Channel Tag	10	40473	40480	3	n/a	2 characters per register
Channel Tag	11	40481	40488	3	n/a	2 characters per register
Channel Tag	12	40489	40496	3	n/a	2 characters per register
Channel Tag	13	40497	40504	3	n/a	2 characters per register
Channel Tag	14	40505	40512	3	n/a	2 characters per register
Channel Tag	15	40513	40520	3	n/a	2 characters per register
Channel Tag	16	40521	40528	3	n/a	2 characters per register

Six character Eunits Tag:

Type	Channel	First	Last	Read FC	Write FC	Notes
EUNITS	1	40529	40531	3	n/a	2 characters per register; 3 registers per channel
EUNITS	2	40532	40534	3	n/a	2 characters per register; 3 registers per channel
EUNITS	3	40535	40537	3	n/a	2 characters per register; 3 registers per channel
EUNITS	4	40538	40540	3	n/a	2 characters per register; 3 registers per channel
EUNITS	5	40541	40543	3	n/a	2 characters per register; 3 registers per channel
EUNITS	6	40544	40546	3	n/a	2 characters per register; 3 registers per channel
EUNITS	7	40547	40549	3	n/a	2 characters per register; 3 registers per channel
EUNITS	8	40550	40552	3	n/a	2 characters per register; 3 registers per channel
EUNITS	9	40553	40555	3	n/a	2 characters per register; 3 registers per channel
EUNITS	10	40556	40558	3	n/a	2 characters per register; 3 registers per channel
EUNITS	11	40559	40561	3	n/a	2 characters per register; 3 registers per channel
EUNITS	12	40562	40564	3	n/a	2 characters per register; 3 registers per channel
EUNITS	13	40565	40567	3	n/a	2 characters per register; 3 registers per channel
EUNITS	14	40568	40570	3	n/a	2 characters per register; 3 registers per channel
EUNITS	15	40571	40573	3	n/a	2 characters per register; 3 registers per channel
EUNITS	16	40574	40576	3	n/a	2 characters per register; 3 registers per channel

Six character Value ASCII string:

Type	Channel	First	Last	Read FC	Write FC	Notes
ASCII Value	1	40577	40579	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	2	40580	40582	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	3	40583	40585	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	4	40586	40588	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	5	40589	40591	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	6	40592	40594	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	7	40595	40597	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	8	40598	40600	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	9	40601	40603	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	10	40604	40606	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	11	40607	40609	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	12	40610	40612	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	13	40613	40615	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	14	40616	40618	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	15	40619	40621	3	n/a	2 characters per register; 3 registers per channel
ASCII Value	16	40622	40624	3	n/a	2 characters per register; 3 registers per channel

Memory Floating Point:

Notes: Returned as 15 bit 2s complement with +- 5% over/under range applied.. Therefore, this must be considered when scaling values to be displayed at the modbus master. The following equation may be used to determine a value for display.

$$\text{Display Value} = \frac{\text{MODBUS Value [(Span Value -Zero Value) 1.1]}}{32767} + \{\text{Zero Value - [(Span Value - Zero Value) .05]}\}$$

Type	Channel	First	Last	Read FC	Write FC	Notes
Channel Value	1-16	33001-16	n/a	4	n/a	15bit 2s complement w/+- 5% over/under range

Analog Output:

Notes: 12 bit integer for Channel Reading value = 800 counts = zero value, 4000 counts = 100% value.

Type	Channel	First	Last	Read FC	Write FC	Notes
Channel Reading	1-16	31001	31016	4	n/a	12bit integer

Channel Status words contain configuration and status bits for a channel. They are as follows:

Type	Channel	First	Last	Read FC	Write FC	Notes
Channel Status	1-16	31017	31032	4	n/a	16bit integer (see bit by bit definition below)

Alarm 1 Trip	bit0	1 = Low	0 = High
Alarm 1 Horn Drive	bit1	1 = On	0 = Off
Alarm 3 Type	bit2	1 = Level	0 = Fault
Alarm 2 Horn Drive	bit3	1 = On	0 = Off
Linearize	bit4	1 = On	0 = Off
Alarm 3 Trip	bit5	1 = Low	0 = High
Input *Marker*	bit6	1 = Input *Marker* Detected	0 = Normal Mode
Channel Disable	bit7	1 = Disabled	0 = Enabled
Controller Channel *In Cal*	bit8	1 = Local Cal Mode	0 = Normal Mode
Modbus Data Type	bit9	1 = 4 byte float	0 = 2 byte integer
reserved	bit10	*reserved*	*reserved*
reserved	bit11	*reserved*	*reserved*
Alarm 1 Latch	bit12	1 = Latching	0 = Non latching
Alarm 2 Latch	bit13	1 = Latching	0 = Non latching
Alarm 3 Latch	bit14	1 = Latching	0 = Non latching
Alarm 2 Trip	bit15	1 = Low	0 = High

Alarm status words are bits packed into 16 bit integer where lsb = channel 1 alarm status and msb = channel 16 alarm status.

Alarm status (bit = 1 indicates alarm is active):

Type	Channel	First	Last	Read FC	Write FC	Notes
Alarm 1 Status	1-16	31033	n/a	4	n/a	packed 16bit integer
Alarm 2 Status	1-16	31034	n/a	4	n/a	packed 16bit integer
Alarm 3 Status	1-16	31035	n/a	4	n/a	packed 16bit integer
*Relay Status	n/a	31036	n/a	4	n/a	packed 16bit integer

*Note: Common Relay status bits (register 31036) are as follows.

Relay 1= bit0.
Relay 2= bit1
Fault Relay = bit2
Horn Relay = bit3

Type	Channel	First	Last	Read FC	Write FC	Notes
Cal Status	1-16	31037	n/a	4	n/a	packed 16bit integer
Trend Interval Timer	1-16	31038	n/a	4	n/a	16bit integer (Time in Seconds)
Fault Status	1-16	31039	n/a	4	n/a	packed 16bit integer

Alarm LED flashing status (bit = 1 indicates LED is flashing; "Acknowledge" clears all to 0):

Type	Channel	First	Last	Read FC	Write FC	Notes
Alarm 1 Status	1-16	31049	n/a	4	n/a	packed 16bit integer
Alarm 2 Status	1-16	31050	n/a	4	n/a	packed 16bit integer
Alarm 3 Status	1-16	31051	n/a	4	n/a	packed 16bit integer
Common LED Status	1-16	31052	n/a	4	n/a	packed 16bit integer

LCD Display Screen Displayed Integer:

Type	Channel	First	Last	Read FC	Write FC	Notes
LCD Screen	n/a	31053	n/a	4	n/a	8bit integer

Sensor Life

Type	Channel	First	Last	Read FC	Write FC	Notes
Sensor Life	1	31065	n/a	4	n/a	Signed 16bit integer
Sensor Life	2	31066	n/a	4	n/a	Signed 16bit integer
Sensor Life	3	31067	n/a	4	n/a	Signed 16bit integer
Sensor Life	4	31068	n/a	4	n/a	Signed 16bit integer
Sensor Life	5	31069	n/a	4	n/a	Signed 16bit integer
Sensor Life	6	31070	n/a	4	n/a	Signed 16bit integer
Sensor Life	7	31071	n/a	4	n/a	Signed 16bit integer
Sensor Life	8	31072	n/a	4	n/a	Signed 16bit integer
Sensor Life	9	31073	n/a	4	n/a	Signed 16bit integer
Sensor Life	10	31074	n/a	4	n/a	Signed 16bit integer
Sensor Life	11	31075	n/a	4	n/a	Signed 16bit integer
Sensor Life	12	31076	n/a	4	n/a	Signed 16bit integer
Sensor Life	13	31077	n/a	4	n/a	Signed 16bit integer
Sensor Life	14	31078	n/a	4	n/a	Signed 16bit integer
Sensor Life	15	31079	n/a	4	n/a	Signed 16bit integer
Sensor Life	16	31080	n/a	4	n/a	Signed 16bit integer

*Note: -2 = Disabled, -1 = CAL Required, 0-100 = Sensor Life

Coils

Notes: Set this coil to issue an alarm "Acknowledge" via modbus.

Type	Channel	First	Last	Read FC	Write FC	Notes
Alarm Reset	n/a	2001	n/a	n/a	5	write 0xff to high byte to set

Memory Discretes

Notes: May be read as single discrete or packed with multiple register read.

Type	Channel	First	Last	Read FC	Write FC	Notes
Chnl Alarm 1	1-16	12001-16	n/a	2	n/a	discrete, may be packed

Type	Channel	First	Last	Read FC	Write FC	Notes
Chnl Alarm 2	1-16	12017-32	n/a	2	n/a	discrete, may be packed

Type	Channel	First	Last	Read FC	Write FC	Notes
Chnl Alarm 3	1-16	12033-48	n/a	2	n/a	discrete, may be packed

Memory Reals

Notes: Real value represents float value without the decimal point such as 123.4 is returned as 1234. Decimal devisor is returned as 1, 10, 100, or 1000 for decimal position of 1, 2, 3, or 4, where 123.4 would return the value 10.

Type	Channel	First	Last	Read FC	Write FC	Notes
Zero Real	1-16	41001-16	n/a	4	n/a	zero real w/o decimal point
Zero DP	1-16	41017-32	n/a	4	n/a	zero real divisor
Span Real	1-16	41033-48	n/a	4	n/a	span real w/o decimal point
Span DP	1-16	41049-64	n/a	4	n/a	span real divisor
Alarm 1 Real	1-16	41065-80	n/a	4	n/a	alarm 1 real w/o decimal point
Alarm 1 DP	1-16	41081-96	n/a	4	n/a	alarm 1 real divisor
Alarm 2 Real	1-16	41097-112	n/a	4	n/a	alarm 2 real w/o decimal point
Alarm 2 DP	1-16	41113-28	n/a	4	n/a	alarm 2 real divisor
Alarm 3 Real	1-16	41129-44	n/a	4	n/a	alarm 3 real w/o decimal point
Alarm 3 DP	1-16	41145-60	n/a	4	n/a	alarm 3 real divisor
Fault Real	1-16	41161-76	n/a	4	n/a	alarm 3 real w/o decimal point
Fault DP	1-16	41177-92	n/a	4	n/a	alarm 3 real divisor

24 Hour Trend Database:

The 24 hour MAX, MIN and AVERAGE trend data may be retrieved over the Modbus serial interface. Each channel consists of 240 MAX, MIN and AVERAGE values, or, one value for every 1/10 hour (6 minutes). Since there are 16 channels this database equals 3,840 registers in addresses 33017-36857. Due to the large size, MAX, MIN or AVERAGE values may only be retrieved one at a time. To improve bandwidth the master may retrieve the database in blocks of 120 registers at a time (one half of a channel's data). The C1 only updates these 3,840 registers upon receiving an update command from the Modbus master.

Type	Channel	First	Last	Read FC	Write FC	Notes
Update MIN	n/a	2065	n/a	n/a	5	Moves 24 hour MIN data trend to trend data base
Update AVG.	n/a	2066	n/a	n/a	5	Moves 24 hour MIN data trend to trend data base
Update MAX	n/a	2067	n/a	n/a	5	Moves 24 hour AVG data trend to trend data base

This update requires several seconds. Therefore, a data ready register is available to notify the master upon completion.

Type	Channel	First	Last	Read FC	Write FC	Notes
MIN Ready	n/a	12065	n/a	2	n/a	0 = data ready; 1 = update in progress
AVG. Ready	n/a	12066	n/a	2	n/a	0 = data ready; 1 = update in progress
MAX Ready	n/a	12067	n/a	2	n/a	0 = data ready; 1 = update in progress

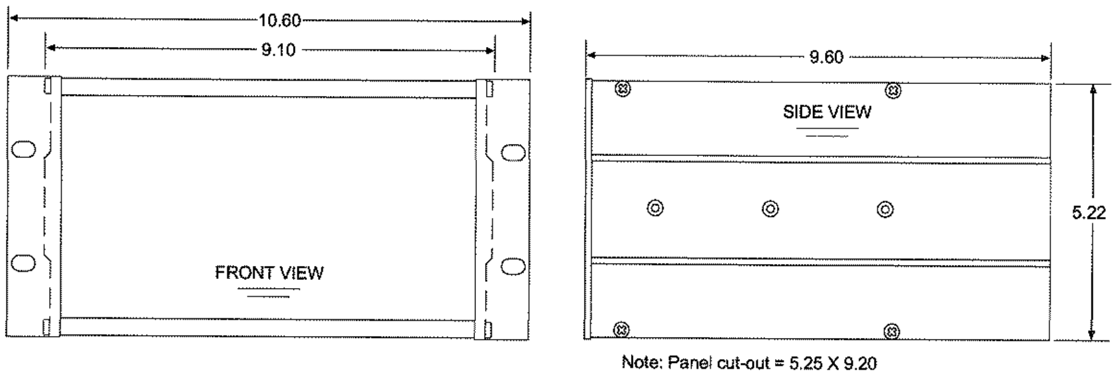
Trend database registers

Type	Channel	First	Last	Read FC	Write FC	Notes
24 hr Trend	1-16	33017	36857	5	n/a	Transfers 24 hour trend for MAX, MIN or AVG.

SECTION 6

6.1 PS-7000PM PANEL / RACK MOUNT ENCLOSURE

The PS-7000PM shown in Figure 6.1 is a half width 19" rack enclosure. It is supplied with hardware that allows mounting in either a full width 19" rack style cabinet or it may be panel mounted in a rectangular cutout. Only two 8 channel I/O option PCB's such as analog input or discrete relays may be mounted directly to the back of the enclosure. Additional 8 channel I/O option PCB's must be located external from the assembly on another mounting plate. A 3 foot length of I^2C cable is also supplied for this purpose. Weight is approximately 7 pounds. Properly ground the enclosure and follow national and local electrical codes.

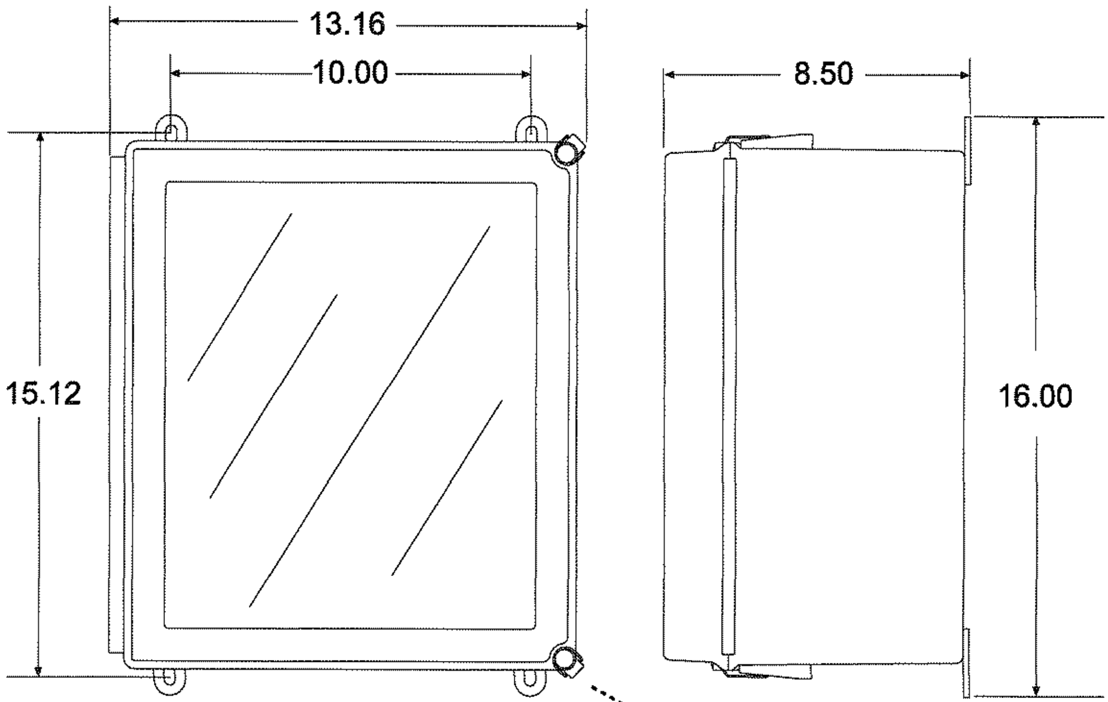


RACK / PANEL MOUNT
(19" RACK SPREADER PLATES &
PANEL MOUNT BEZAL NOT SHOWN)

Figure 6.1

6.2 PS-7000N4 NEMA 4X WALL MOUNT ENCLOSURE

The PS-7000N4 shown in Figure 6.2 is a fiberglass NEMA 4X wall mount enclosure. Seven, 8 channel I/O option PCB's, such as analog input or discrete relays, may be mounted inside this enclosure. It is suitable for mounting outdoors but an above mounted weather deflector shield is recommended. Weight is approximately 17 pounds. Figure 6.3 provides important warning information concerning correct grounding procedures for non-metallic enclosures. Conduit entries are not provided so installers may place entries as needed. Bottom or lower side areas are recommended. Care must be taken to avoid drilling into circuit boards mounted inside the enclosure. Properly ground the enclosure and follow national and local electrical codes.



Note: 4 mounting holes are .31 diameter

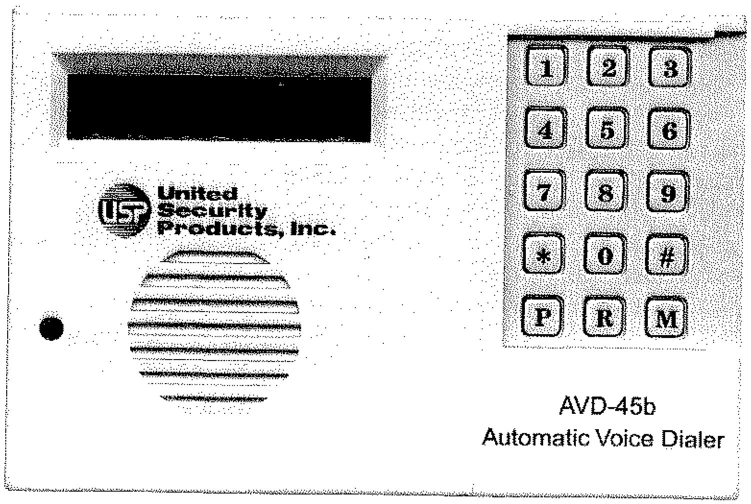
SHOCK HAZARD

ADD LOCKING DEVICE TO
CLASP ON BOTTOM RIGHT SIDE
TO PREVENT CONTACT WITH
DANGEROUS VOLTAGES.
REMOVE AC POWER BEFORE
SERVICING EQUIPMENT.

NEMA 4X WALL MOUNT

Figure 6.2

United Security Products
Model AVD-45b
Automatic Voice Dialer



Patents Pending

Installation and Instruction Manual

INTRODUCTION

Thank you for purchasing United Security Products Model AVD-45b, the single channel voice dialer that can be incorporated into hard wired or wireless security systems or used as a stand-alone unit. This versatile dialer can be easily expanded to operate in conjunction with an alarm, temperature or water level sensor, or any other sensor that can provide the appropriate trigger.

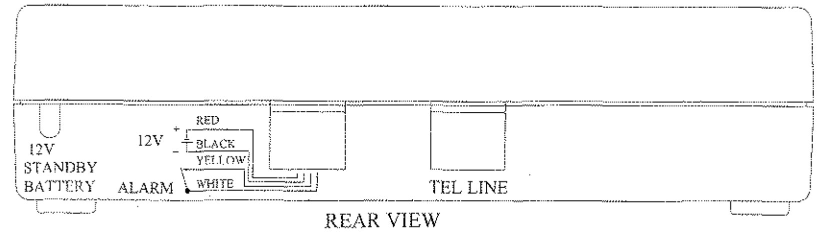
The AVD-45b is compatible with continuous, momentary, normally closed (NC) and normally open (NO) dry contact or voltage sensors. The dialer is intended for operation through non-digital telephone lines and can be programmed to store up to 4 numbers to sequentially dial any combination of standard (voice) telephones, most cellular telephones, alpha/voice pagers and/or numeric pagers. The dialer features busy-line and no answer detection to ensure timely transmission of the recorded message of up to 16 seconds.

This manual describes how to set up, install and operate the AVD-45b. Please read the entire booklet before operating the dialer. For specific questions or problems, contact a USP Technical Service Representative at (858) 597-6677, Monday – Friday, 7:30 AM - 4:00 PM, Pacific Standard Time.

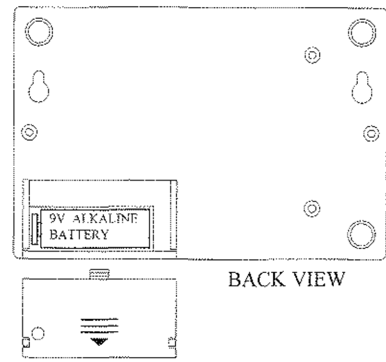
Package Contents

- Model AVD-45b Automatic Voice Dialer
- 7-foot, 2-conductor jacket telephone cable with RJ11 plug attached
- 7-foot jacketed, 4 conductor power/alarm cable

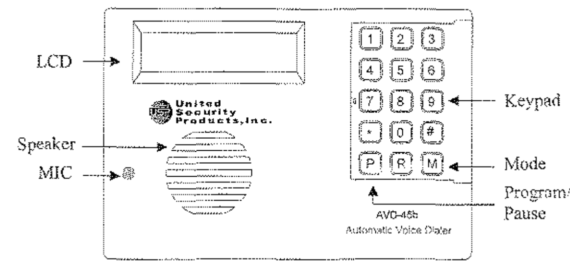
AVD-45b PANEL DISPLAY



REAR VIEW

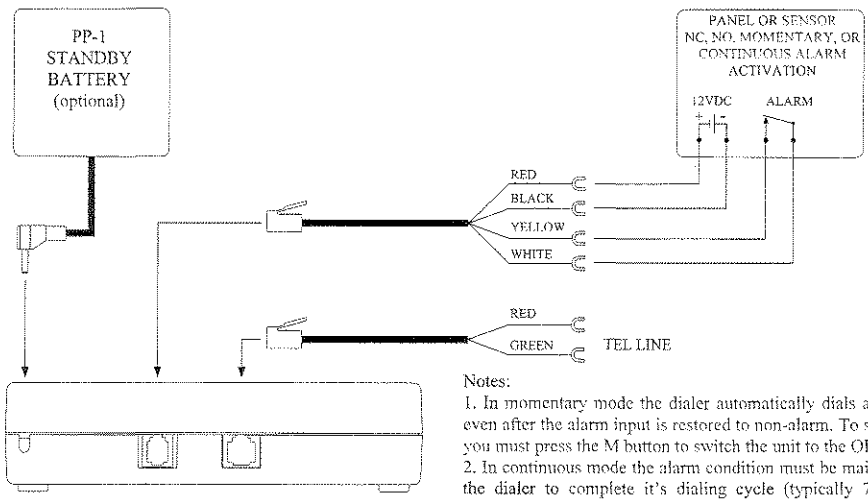


BACK VIEW



FRONT VIEW

N.C./N.O. DRY CONTACT ACTIVATION HOOKUP



Make sure unit is set to "OFF" prior to wiring and phone line hook-up.

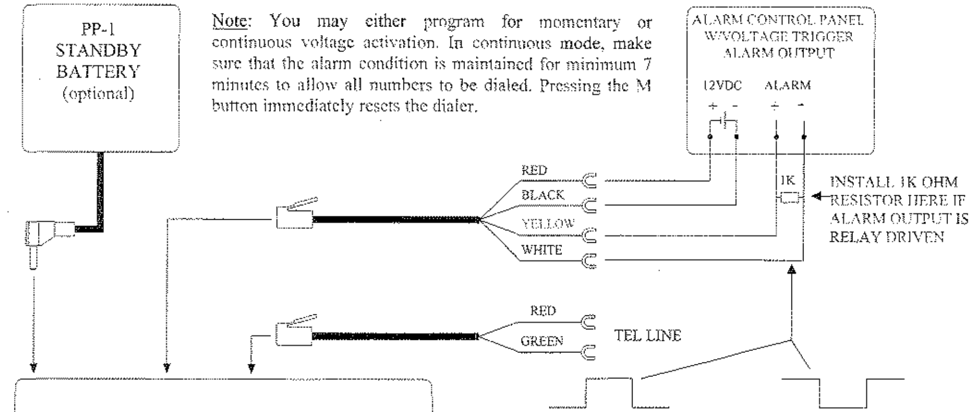
Notes:

1. In momentary mode the dialer automatically dials all numbers even after the alarm input is restored to non-alarm. To stop dialing you must press the M button to switch the unit to the OFF mode.
2. In continuous mode the alarm condition must be maintained for the dialer to complete it's dialing cycle (typically 7 minutes). Dialing stops when the alarm input is restored to non-alarm or by pressing the M button.
3. Match the power cables colored wires to the corresponding outputs on the alarm panel. Do the same for the telephone cable.

VOLTAGE LEVEL ACTIVATION HOOKUP

WHEN THE ALARM OUTPUT VOLTAGE IS RELAY DRIVEN, YOU MUST ADD A 1K RESISTOR ACROSS ALARM OUTPUT TERMINALS. HOOK UP DIALER AS SHOWN BELOW.

Note: You may either program for momentary or continuous voltage activation. In continuous mode, make sure that the alarm condition is maintained for minimum 7 minutes to allow all numbers to be dialed. Pressing the M button immediately resets the dialer.



Alarm when voltage goes from 0 to +V (5 to 28Vmax). Program for N.C. operation.

Alarm when voltage goes from +V (5 to 28Vmax) to 0. Program for N.O. operation.

Make sure unit is set to "OFF" prior to wiring and phone line hook-up.

Match the power cables colored wires to the corresponding outputs on the alarm panel. Do the same for the telephone cable.

IMPORTANT: Before operating the AVD-45b, make sure wiring is correct and power is set within specified limits. Recording and data recall can be performed without connection to a telephone line. We strongly recommend that final testing be performed under simulated alarm conditions, and that confirmation of transmission be obtained from the numbers dialed.

Model AVD-45b stores and dials up to 4 telephone numbers and/or pager numbers. Each number may contain up to 28 digits, including a maximum of 10 "pause" segments (a pause is 2 seconds long and counts as a digit) and an optional "pound" tone for pager dialing.

Once a connection is made, the dialer will deliver a recorded voice message of up to 16 seconds or a numeric code for pager messaging. The dialer will repeat the voice message two times per call, to ensure that a full message is delivered. If the phone number is busy or not answered within 8 rings, the AVD-45b will automatically dial the next programmed number.

Assuming an uninterrupted alarm (a minimum 7 minutes if programmed in continuous mode), the dialer will go through the numbers a second time, and call in an attempt to deliver the message twice to each programmed number. If any numbers are busy or unanswered, the dialer will continue calling (up to 10 times per programmed number) in an attempt to deliver the voice message or until the alarm condition is terminated. In the TEST mode only, the respective location numbers and telephone numbers will appear in the LCD to show the calls are in process.

NOTE: If any numbers are used for alpha/voice pager designations that require operator assistance, the pager service should be notified, to ensure proper interpretation of the message.

How to store phone numbers

Follow these directions to store up to 4 telephone numbers in the dialer's memory. Please remember that local ordinances may prohibit automatic dialing of police, fire departments and other emergency agencies.

The AVD-45b will call up to 4 numbers. This can be any combination of regular telephones, cellular telephones or pagers. The 4 numbers being called will be stored in locations 1-4. Any of locations 1-4 can store up to 28 digits and dial a telephone or pager. If dialing less than 4 numbers, simply leave the latter location(s) empty and the unit will automatically skip them.

To program telephone numbers:

1. Supply power to the AVD-45b.
2. The AVD-45b has four modes (PROGRAM, TEST, OPERATE, and OFF) indicated in the upper part of the LCD. Make sure the unit is in the "PROGRAM" mode. If it is not, press the MODE ("M") button to change modes.

To store "voice" telephone numbers in memory locations 1 through 4 (see p. 9 for pagers)

1. At the "PROGRAM: NUMBERS" prompt, press "1" (YES).
2. Press all the digits of the first number to be dialed. Check the LCD while programming to make sure the correct numbers are pressed.
3. After inputting the entire phone number (1 + area code if needed), press the PROGRAM/PAUSE ("P") button (momentarily), then the "1" key. This will store the number in location 1.
4. Repeat step 1, then press all the digits for the second number to be dialed. Check the LCD, press the PROGRAM/PAUSE ("P") button (momentarily), then the "2" key. This will store the number in location 2.
5. Repeat the process, if needed, for locations 3 and 4.

NOTE: Pauses are only used when dialing a pager, in which case during the OPERATE mode the stored voice message will not be played.

Example 1: Store telephone number 1-800-555-1212 in Location 1.

Press:

Program/Pause (Press momentarily)

[1] [8] [0] [0] [5] [5] [5] [1] [2] [1] [2] [P] [1]

Example 2: Store telephone number 555-1212 in Location 2.

Press:

Program/Pause (Press momentarily)

[5] [5] [5] [1] [2] [1] [2] [P] [2]

Follow the steps above to store the desired numbers in Memory Locations 3 and 4.

Note: If you enter the wrong number or wish to change a programmed number, press the MODE ("M") button until "PROGRAM: NUMBERS" prompt appears, enter "1" (YES) and enter the number then the location (see example 1 or 2 above).

To completely erase numbers already stored in memory locations:

1. Set dialer to "PROGRAM: NUMBERS" prompt.

2. Press "1" (YES).

3. Press PROGRAM/PAUSE (momentarily).

4. Press the number (1,2,3 or 4) for the memory location to be erased.

To store a pager number and numeric code

1. With the dialer at the "PROGRAM: NUMBERS" prompt, press "1" (YES).
2. Enter all the digits of the pager number to be dialed. Check the LCD to insure the correct numbers are pressed.
3. After inputting the entire pager number (1 + area code if needed), press the PROGRAM/PAUSE ("P") button and hold it down for about 2 seconds. A "P" will appear in the LCD following the number. If more pauses are required, simply repeat the process by releasing the "P" button and pressing it again for 2 seconds. Up to 10 pauses are allowed.
4. After the pause sequence, input the numeric code to be delivered. This is the code that will be displayed on the pager. (Note: Some pager services require a "#" sign at the end of the numeric message for proper transmission. Also make sure that the total length of the number including pauses and "#" does not exceed 28 characters).
5. Finally, press the PROGRAM/PAUSE ("P") button (momentarily), then the "1" key. This will store the number, pauses and the numeric code in location 1.
6. Repeat step 1, then press all the digits for the second pager number to be dialed. Check the LCD, input pause(s), input the numeric code, then press the PROGRAM/PAUSE ("P") button (momentarily) and the "2" key. This will store the number in location 2.
7. Repeat the process, if needed, for locations 3 and 4.
8. You may store pager number and numeric code in any memory location (1-4).
9. When testing the pager operation, it is recommended that the AVD-45b be in the "OPERATE" mode, connected to a phone line and the input triggered.

NOTE: A pause counts as one digit. Up to 10 pauses are allowed.

Example 1: Store pager number 555-1212 and numeric message 911 in Location 1.

Press:

[5] [5] [5] [1] [2] [1] [2] [P] (Program/Pause — Hold for 2 seconds) [9] [1] [1] [P] (Program/Pause — Press momentarily) [1]

Example 2: Store pager number 1-800-555-1212 with access code 3 and numeric message 911 in Location 2.

Press:

[1] [8] [0] [0] [5] [5] [5] [1] [2] [1] [2] [P] (Program/Pause — Hold for 2 seconds)

[3] (Access Code) [#] [9] [1] [1] [#] (Enter if required by provider) [P] (Program/Pause — Press momentarily) [2]

Note: If you enter the wrong number or wish to change a programmed number, press the MODE button until "PROGRAM: NUMBERS" prompt appears, enter "1" (YES) and enter the number then the location (see example 1 or 2 above).

Programming Tone/Pulse and PBX

1. Press the "M" key until "PROGRAM: NUMBERS" appears in the LCD, then press "2".
2. Press "1" (YES) at the "PROGRAM: T-LINE" prompt.
3. Press "1" (TONE) for touch tone phone service.
   Press "2" (PULSE) for pulse (rotary) phone service.
4. After selecting TONE or PULSE, the LCD will display "PROGRAM: PBX".
5. Press "1" (ON) to set for PBX phone system, then enter the PBX digit 0-9 (This will allow the unit to dial the PBX digit, wait for a dial tone, then dial the stored number).
   Press "2" (OFF) to set for regular phone system (Waits for a dial tone, then dials the stored number).

Programming Exit and Entry Delay

1. Press the "M" key until "PROGRAM: NUMBERS" appears in the LCD, then press "2" three times.
2. Press "1" (YES) at the "PROGRAM: DELAYS" prompt.
3. Press "1" (ON) for a 60 second Exit delay (This provides a 60 second exit delay, after the AVD-45b is set in the "OPERATE" mode, before the unit will react to a sensor trip, allowing time to exit).
   Press "2" (OFF) for no Exit delay (This will allow the unit, when set in the "OPERATE" mode, to react immediately to a sensor trip.
4. After selecting the Exit delay, the LCD should display "ENTRY DELAY".
5. Press "1" (ON) for a 20 second Entry delay (This provides a 20 second entrance delay, after any exit delay time has elapsed, before the unit will react to a sensor trip, allowing time to shut off).
6. Press "2" (OFF) for no Entry delay (This will allow the unit to react immediately to a sensor trip, after any exit delay has elapsed.

NOTE: When using the AVD-45b with an alarm panel that already has Exit/Entry delays programmed, EXIT and ENTRY should be programmed for "OFF" unless an additional delay is needed.

7 Immediately after selecting Exit and Entry delays, the LCD displays input options; N.O./N.C. for either normally open or normally closed contact operation. Select by entering 1 or 2, depending on the type alarm contact used; select N.O. when input is shorted or N.C. when input opens during an alarm.

8 Next, select either 1(MOM) or 2(CONT) for momentary or continuous activation. Note: A momentary alarm must be 0.5 seconds or longer for the dialer to dial all numbers in sequence, including all attempts to re-dial. In the continuous mode the dialer stops dialing immediately when the input is restored to a non-alarm state. Therefore, an alarm condition in the CONT mode must last long enough (7 minutes or longer) to allow all numbers to be properly dialed.

How to record outgoing voice message

An outgoing message (OGM) of up to 16 seconds may be programmed into the AVD-45b. Once recorded, this message will be repeated during activation 2 times, in sequence (starting with Location 1), to each number designation. For best results, the OGM should be written down, practiced and timed before recording.

1. Press the "M" key until "PROGRAM: NUMBERS" appears in the LCD, then press "2" twice.
2. Press "1" at the "PROGRAM: OGM" prompt.
3. Locate the microphone on the lower left corner of the AVD-45b. For best results when recording, speak about 12 inches from the microphone in a clear and normal voice.
4. Press "*" key to initiate the recording process. "RECORDING" will appear in the LCD when recording. The "*" key must be held down for the entire time of recording.
5. When the "*" key is released the message will be stored. Once the 16 seconds have elapsed, "DONE" will appear in the LCD.
6. If you wish to change the OGM, repeat the preceding steps. The new OGM will automatically replace the previous message.

To verify telephone numbers and OGM without phone line connection

Follow these directions to ensure the correct telephone numbers have been properly stored and the recorded message satisfactory.

1. Press the "M" key until "TEST: T-LINE appears.
2. Press "1" (YES). The LCD will display the T-LINE configuration.
3. Press "1" (YES) at the "TEST: CHANNEL" prompt. The LCD will display the Delay configuration, then the number stored in Location 1 followed by either the OGM or pager code.
4. This process will be repeated for each stored Location. Any empty Location will be skipped.
5. Press the "M" key three times to return to the program mode.

To verify telephone numbers and OGM with phone line connection

NOTE: A complete test should be performed in the "OPERATE" mode to ensure proper operation.

1. Before conducting an actual test under "OPERATE" mode, contact each of the designated emergency numbers (Locations 1 through 4) to advise people that you are conducting a test. After the test, verify that they received the message.
2. Apply power to the unit.
3. Press the "M" key until "OFF" appears in the LCD.
4. Connect the AVD-45b to an active phone line.
5. Make sure the sensor is in a non-alarm condition.
6. Press "M" until "OPERATE" appears in the LCD.
7. Trigger the sensor to simulate an alarm condition. If there are any delays programmed, the AVD-45b will wait until they elapse before activating and dialing.

8. The AVD-45b will sequentially dial the programmed Locations (1-4). If there is no number stored in a location, it will be skipped. The OGM will be delivered when the AVD-45b receives an answer. (The OGM will not be played through the speaker.) For pager numbers, the pager code will be transmitted instead of an OGM.
9. The AVD-45b will automatically go through the next programmed Location repeating the same process.

The AVD-45b is now ready for operation.

Utilizing the EEPROM and CPU memory cell components, the AVD-45b will retain its' memory in the event of a power loss. The internal 9-volt alkaline battery will provide stand by power for approximately 4 hours of operation. If more battery backup is needed, an optional rechargeable power pack (USP part# PP-1 or PB12P Combination AC Adaptor/Rechargeable battery) is available and plugs into the AVD-45b, providing up to 24 hours of stand by power.

IMPORTANT INFORMATION

LOCATION

Place the dialer on a flat level surface or mount the unit on the wall, away from extreme cold or heat, direct sunlight, excessive humidity and away from equipment that generates a strong magnetic field. Avoid placing near large metal objects and areas that produce smoke, dust or mechanical vibrations.

CARE

Clean the housing with a soft cloth lightly moistened with water or mild detergent solution. Never use solvents such as alcohol or thinner. Do not allow liquids to spill into the unit.

OPTIONAL BACKUP

To ensure continuous operation during power outages, hookup to a 12VDC backup battery pack as recommended.

CAUTION

Do not use the dialer if a gas leak is suspected or during lightning.

PROBLEMS

If liquid or a foreign object penetrates the unit, disconnect it immediately and contact your installer or other qualified technician.

Before calling USP, please make sure ...

- You have read this manual and understood how to operate the dialer.
- Your (analog) phone line is working. Note: Dialer will not operate on digital phone systems.
- You checked out the entire system.

If you still have questions or concerns, call USP Technical Service Department between the hours of 7:30 AM and 4:00 PM, PST, Monday through Friday.

IMPORTANT INFORMATION

Federal Communications Commission Radio And Television Interference Statement For A Class 'B' Device

This equipment generates and uses radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class 'B' computing device in accordance with the specifications in Subpart B of FCC Rules and Regulations (as outlined in the Code of Federal Regulation, Title 47), which are designed to provide reasonable protection against such interference in a residential installation.

User Instructions

If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off, then on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate radio or television.
- Increase the separation between the equipment and receiver.
- Connect the equipment into a different outlet so that the equipment and receiver are on different branch circuits.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by United Security Products, Inc. will void the warranty.

FEATURES SUMMARIZED

- Non volatile (EEPROM) memory for voice message and phone numbers
- Calls up to 4 phone numbers, any combination of telephones or pagers
- Sends up to 16 second voice message to telephones or numeric code to pagers
- Record your own message in any language
- Easily change message and phone numbers without a programmer
- Voice chip technology (no tape required)
- Ability to program up to 10 (2-second) pauses and pound (#) for pager dialing
- Returns to call unanswered numbers
- 2 X 16 character LCD window
- Internal playback speaker for voice message
- Programmable Exit and Entry delay
- Internal 9V battery backup
- Works with PBX or regular phone system
- Tone or Pulse dialing
- NC, NO, momentary, continuous or voltage activation
- Internal protection against transient overload conditions

DIALER ACCESSORIES

Consult factory for availability and pricing

24V APPLICATION: AVD-45b/F

- **For this option the dialer is configured to operate at 24VDC to 32VDC max. All other specifications apply.**
- **AC-2 AC/DC ADAPTOR (500mA)**
  Plugs into regular 110VAC outlet to provide the dialer with the required 12VDC primary power.
- **PP-1 BACKUP BATTERY PACK**
  Plugs into 12V Standby Battery jack. Built-in rechargeable battery for up to 24 hours of uninterrupted standby.
- **PB12P Combination AC Adaptor/Rechargeable battery for extended operation for up to 24 hours of uninterrupted standby.**

FCC PART 68

INFORMATION SUPPLIED TO THE USER

This equipment complies with Part 68 of the FCC Rules. The FCC Part 68 Label is located on the bottom of the enclosure. It contains the FCC Registration Number for this equipment. If requested, this information must be provided to your telephone company. The BEN is useful to determine the quantity of devices you may connect to your telephone line and still have those entire devices ring when your telephone number is called. In most, but not all areas, the sum of the RENs of all devices connected to one line should not exceed five (5.0). To be certain of the number of devices you may connect to your line, as determined by the BEN, you should contact your local telephone company to determine the maximum BEN for your calling area. Connection to the telephone network should be made by using standard modular telephone jacks, type RJIIC. The BJIIC plug and/or jacks used must comply with FCC Part 68 rules. If this telephone equipment causes harm to the telephone network, the telephone company will notify you in advance that temporary discontinuance of service may be required. But if advance notice isn't practical, the telephone company will notify the customer as soon as possible. Also, you will be advised of your right to file a complaint with the FCC if you believe it is necessary. The telephone company may make changes in its facilities, equipment, operations or procedures that could affect the proper functioning of your equipment. If they do, you will be notified in advance in order for you to make necessary modifications to maintain uninterrupted service. This equipment may not be used on coin service provided by the telephone company. Connection to party lines is subject to state tariffs. If trouble is experienced with this unit, please contact customer service at the address and phone listed below. DO NOT DISASEMBLE THIS EQUIPMENT. IT does not contain any user serviceable components.

Attn: CUSTOMER SERVICE DEPT. United Security Products * 11025 Sorrento Valley Court * San Diego, CA 92121 (858) 597—6677

Model AVD-45b Automatic Voice/Pager Dialer

SPECIFICATIONS:

Power requirements:	9-18VDC
Current draw (OPERATE mode - Stand By):	28mA
Current draw (OPERATE mode - Alarm):	100mA
Activation:	1. NO or NC, Momentary or Continuous dry contact Activation. 2. Voltage Activation: 0 to +V (NC operation) or +V to 0 (NO operation). Note: +V limited from 5 to28VDC
Phone numbers stored:	Up to 4
Max. digits/phone number:	28 (including pauses)
Programmable pauses (2 sec./pause):	up to10 for pager dialing (each pause counts as 1 digit)
Operating temperature range:	-18 to 55 C (0 to 130 deg F)
Dimensions (inches):	6.0 x 4.0 x 1.5
Weight (ounces):	10 oz.
Mounting:	Wall or Flat Surface
Case Material:	ABS
Color:	White
Warranty:	1 year

Note: Design and specifications subject to change without notice.

United Security Products, Inc.

11025 Sorrento Valley Court
San Diego, CA 92121
(800) 227-1592 (858) 597-6677 Fax: (858) 455-0036 E-Mail: usp@ix.netcom.com

GEM-500 Gas Extraction Monitor

Operation Manual

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Chapter 1-Getting Started

Unpacking the GEM-500

The GEM-500 unit is normally shipped in a protective hard case with a foam interior. This offers excellent protection. When properly sealed, the case is watertight. There is a pressure relief valve by the handle on the case. Normally this is kept closed. If there is a change in elevation, the case may not open until the pressure is equalized by turning the pressure relief valve.

We strongly recommend that the GEM-500 be transported in its protective case. The hard case has room to store all the components for the GEM-500 and we recommend that they be kept together. When shipping a GEM-500 back to LANDTEC for calibration or service, always ship it in this hard case unless LANDTEC sends you a special protective Styrofoam shipping unit.

Carefully unpack the contents of the GEM-500, inspect and inventory them. The following items should be contained in your package:

- Hard carrying case (when opening the hard case, it may be necessary to open the pressure relief vent)
- The GEM-500 unit
- GEM-500 Operation Manual
- Warranty/Registration Card and other instructional information
- Soft carrying case with replaceable protective window and carrying strap
- External (striped) sampling hose assembly (5 ft.) with external filter/water trap assembly
- Clear 1/4" Tygon pressure tubing sampling hose (5 ft.)
- Spare internal filter element
- Chrome-plated brass male connector (hose barb) connects to clear tubing
- Polypropylene male connector (hose barb) connects to striped tubing
- Spare external filter element
- 110-volt Nickel-Cadmium battery charger with special charging plug
- ~~VHS video cassette - "Using the GEM-500"~~
- GEM-500 download software disk on 3 1/2 inch floppy disk (optional)
- RS-232 serial cable for computer/printer data downloading (optional)
- Temperature probe (optional)

Immediately notify shipper if the GEM-500 unit or accessories are damaged due to shipping. Contact LANDTEC if any items are missing. If you have any questions, please contact LANDTEC technical support at (800) 821-0496 or (213) 722-8202. Complete the Registration/Warranty Card and return it to LANDTEC. The model and serial numbers are located on the back of the GEM-500 unit.

Attaching the Hose Assembly

The GEM-500 hose assembly comes fully assembled but it needs to be connected to the GEM-500.

Connect the striped hose with the external filter/water trap assembly to the static pressure/sampling port on the GEM-500 (See Figure 1.1). The port on the top left corner of the GEM-500.

Connect the clear tubing to the impact pressure port on the GEM-500 (See Figure 1.1). This port is located on the bottom left corner of the GEM-500. As previously warned, DO NOT block the exhaust port (See Figure 1.1).

Quick Connect Fittings

The quick connect fittings will simplify the taking of wellfield readings. They are easy to install in your landfill gas extraction system and on perimeter probes. Many different types are available. LANDTEC carries fittings used on its equipment for your convenience.

The GEM-500 comes with quick connect fittings for the Accu-Flo™ wellhead. Connect the chrome male connector to the end of the clear tubing. Connect the polypropylene (the almond colored) fitting that has a male connector to the striped tubing.

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Watch the GEM-500 Video

We strongly recommend that you watch the video provided—Using the GEM-500™ before proceeding.

Must Do's Before Using the GEM-500

Read Chapter 3 of this manual.

Proper operation of the GEM-500 requires the following functions to be completed before proceeding.

- Charge the unit with the battery charger
- Check the Time/Date
- Perform a Zero Pressure
- Field Calibrate the unit

Calibration Gases

Calibration gases are required to field calibrate the GEM-500. Portable Calibration Gas Kits and 12-unit cylinder cases are available from LANDTEC or can be obtained from a specialty gas company. (See Chapter 2-Field Calibration)

Special Keying Functions

Entering an ID code with Letters and Numbers

Use blue toggle key to shift back and forth between number mode and letter mode. When in number mode, use number KEYS to enter numbers. When first switched to letter mode, use arrow KEY 1-UP ARROW or KEY 6-DOWN ARROW to scroll to desired letter, then press KEY 0 to enter the letter on the display. Repeat this process for all letters. Before any new ID code can be entered, the first four character spaces will be filled with the characters used in the previous ID code. If different characters are desired, remove these characters by using the backspace function below.

Backspace Function

To change or correct an entry error use the KEY 0 as a backspace by holding it down for one second. In normal use, this key is quickly pressed and released.

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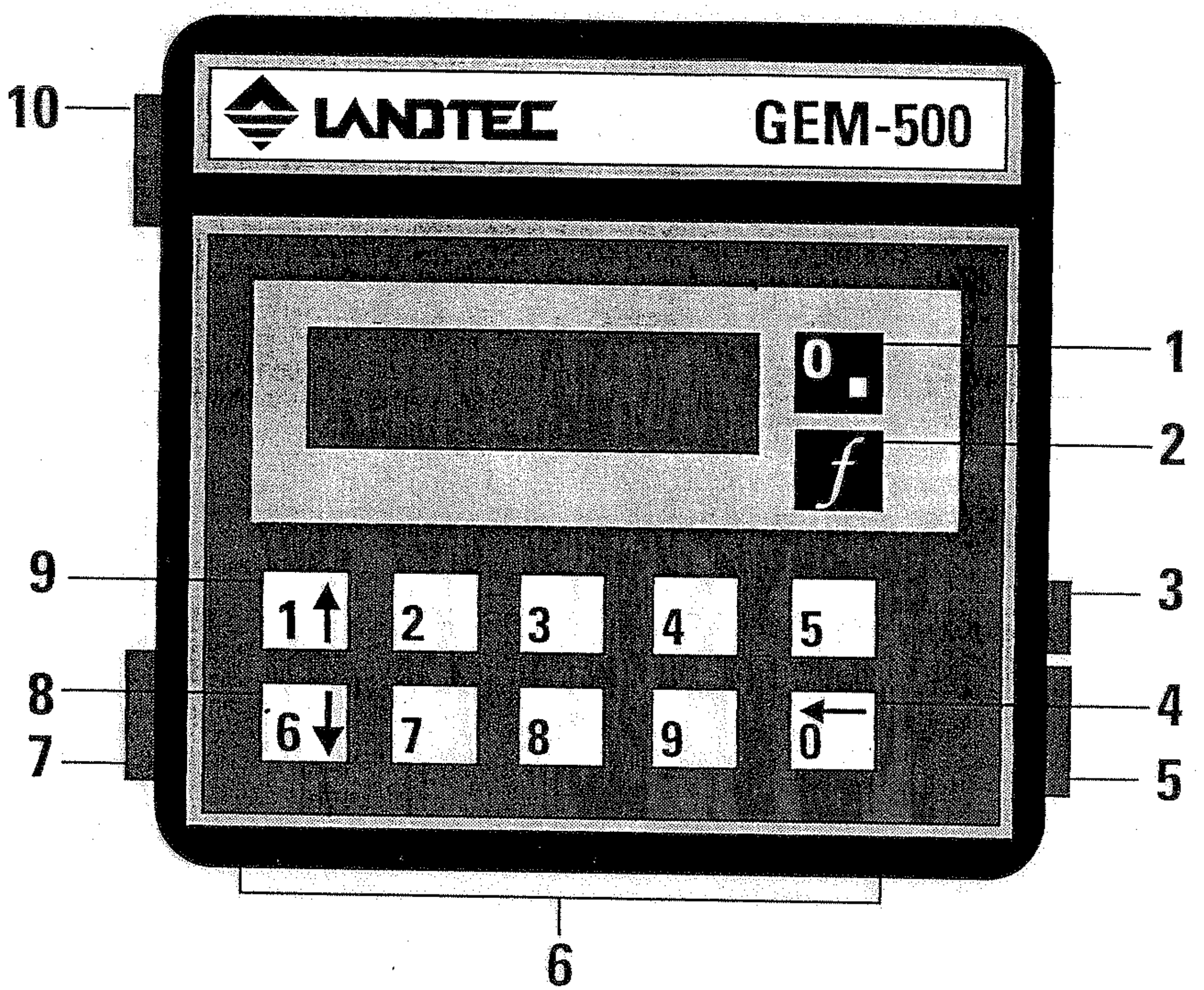
GEM-500 Keyboard and Port Descriptions

Figure 1.1



1. Red On/Off Key—Turns unit on or off.
2. Blue Number/Letter Toggle Key—Enables well ID code to be entered by toggling between number and letter mode.
3. RS232 Port—Used for battery recharging, data downloading and temperature readings.
4. Backspace/Exit Key—Acts as backspace key when pressed and held for one second, to correct for user entry of wrong number/letter, returns to previous procedure or steps back one layer of menus, usually to the main menu screen. The last function of this key is similar to the escape key in many computer programs.
5. Exhaust Port—This port must be kept clear. If blocked while operating, over pressurization and damage to internal components and case could occur.
6. Numeral Keys—Enters numerals 1 through 9.
7. Impact Pressure Port—Measures impact pressure when connected to wellhead impact pressure port (upstream connection for orifice) by tubing.
8. Cursor-Down Key—Enters numeral 6, and scans lines of information or screens.
9. Cursor-Up Key—Enters numeral 1, and scans ines of information or screens by moving up or toward the beginning of a list or alphabet.
10. Static Pressure/Sampling Port—Measures static pressure when connected to wellhead staticpressure port by tubing. Inlet for gas sampling instruments.

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Chapter 2-Field Calibration

Field Calibration is menu-guided and can be completed in about ten minutes. The pump remains running during the calibration procedure to streamline the procedure and conserve calibration gas. The GEM-500 contains a calibration map which is accessed by its microprocessor for baseline reference data. This reference data was programmed into the GEM-500 during the factory calibration using various traceable gas mixtures in an environmental chamber. At any time, the GEM-500 can be reset by returning to the "factory settings." This clears the GEM-500 of any user calibration settings and restores the GEM-500 to its original factory calibration.

The factory calibration has been designed to give the best possible results over a wide range of conditions. However, the instrument's accuracy can be improved in specific operating ranges by performing a "field calibration."

Most field instruments are calibrated or adjusted prior to taking a series of gas or pressure readings. They may also be checked for calibration during the reading and after readings are taken in order to verify the accuracy of the data collected.

It is important to field calibrate the GEM-500 on-site after the instrument has stabilized at working temperature. For this reason, a GEM-500 that was calibrated in the cool of the morning may not read as accurately at the hottest part of the day.

Note: Field calibration of the GEM-500 will improve the data collected in the range of the calibration gases used. Less accurate readings of concentrations outside the calibrated range may occur. For example, a GEM-500 field-calibrated using 60% CH4 and 40% CO2 will give improved readings for the higher concentrations, but may provide less accurate readings at very low concentrations (which are not common in LFG).

Calibration Gas/Span Gases

Field calibration requires two calibration gas mixtures; a methane/carbon dioxide mixture (50% CH4 and 50% CO2) and a oxygen/carbon dioxide mixture of less than 6% oxygen (low levelsof oxygen.) As with methane, the closer the composition of the calibration gas to the expected conditions, the greater the accuracy. A 5/95 mixture of oxygen and carbon dioxide (5 % O2 and 95% CO2) is typical. Any calibration gas mixtures near the expected measurement range that is free of oxygen can be substituted for the first calibration gas mixture. Any calibration gas mixture with a 2% to 5% concentration of oxygen (O2) may be substituted for the second mixture.

Zero Methane

Calibration of the GEM-500 starts by establishing the bottom point of the methane gas curve. The methane (CH4) is zeroed prior to taking readings at the start of each day. To set a zero point, the GEM-500 is given a methane-free gas sample—often air is used. This establishes a zero point. This function significantly improves the GEM-500's CH4 accuracy over the entire range. It is essential that the gas analyzer be clear of CH4 at the time of zeroing. Care must be taken if the GEM-500 is to be zeroed on a landfill site because there are situations where methane, which is odorless and colorless, could be in the atmosphere.

After the Zero methane function, the GEM-500 recalculates 16 methane calibration points on its methane gas curve and stores the revised data in its memory. The GEM-500 does not need to be have the CH4 zeroed every time it is switched on because the most recent calibration data is stored in protected memory.

Span Methane

A field calibration spans the methane range prior to taking readings at the start of each day. The best results are obtained after the instrument has stabilized at its working temperature. The procedure alters the methane calibration at all concentrations and stores the revised data in protected memory. Depending on which CH4 range is spanned, sampling errors at a much higher or lower concentration may occur.

Note: The Zero Methane should be set before setting the Methane Span.

Span Carbon Dioxide

Field calibration spans the CO2. It should be spanned prior to taking readings at the start of each day after the instrument has stabilized at its working temperature. The procedure alters the calibration at all concentrations and stores the revised data in protected memory. Landfill gas contains high concentrations of CO2. As with methane, there are similar sampling errors outside the range spanned.

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Zero Oxygen

This function is essential where low concentrations of oxygen are expected (below 6%). Normally there is very little oxygen in LFG. A procedure explained below zeroes the oxygen prior to beginning daily gas sampling. This establishes the zero point of an oxygen curve that is stored in the GEM-500's permanent memory.

Span Oxygen

The oxygen calibration map contains two span curves, one for oxygen below 7% and one for oxygen above 7%. The proper curve is automatically selected. If a calibration gas with less than 7% oxygen is used, the lower span curve is adjusted. If the calibration gas has more than 7% oxygen, the higher calibration curve is adjusted. Due to the resolution of the GEM-500's processor at higher concentrations, the GEM-500 may not display the exact concentration entered. As discussed below, this effect can be reduced by altering the entered value so that the displayed value is as close to the actual value as possible.

Note: The 02 Oxygen should be set before setting the Oxygen Span.

Equipment

To perform a field calibration, the following items are required.

1. Cylinder of 50/50 (50% CH4 and 5B0% CO2) calibration gas
2. Cylinder of 5/95 (5% O2 and 95% CO2) calibration gas
3. Pressure regulators for the above cylinders capable of regulating in the range of 0 - 5 psig fitted with connectors suitable for 1/4" Tygon tubing.
4. Regulator/flowmeter capable of measuring in the range 60 - 600 cc per minute maximum with fittings suitable for 1/4" Tygon tubing.
5. Interconnecting lengths of 1/4" Tygon tubing.

All this equipment is available from LANDTEC. Other types of tubing can be used but the connections must be airtight and secure. The equipment is set up as shown in Figure 2.1.

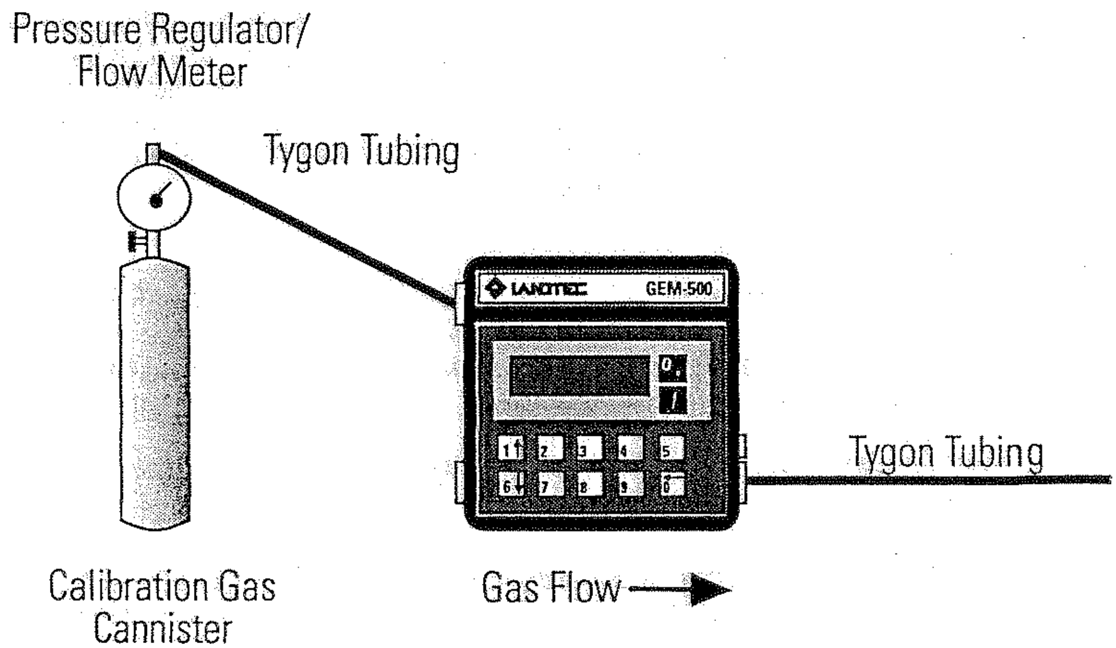

Figure 2.1

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Setting Up the Equipment

As described and shown in the Equipment Section, begin assembly of the GEM-500:

1. Connect the methane/carbon dioxide (CH_4 /CO_2) calibration gas cylinder to the pressure regulator.
2. Connect a 24" piece of 1/4" Tygon tubing to the flowmeter outlet. Do not attach this to the GEM-500 until instructed.
3. Connect a second 24" of 1/4" Tygon tubing to the exhaust nozzle of the GEM-500. Direct the exhaust away from you and out of the immediate area.

5. If the regulator has not been preset, set the pressure adjustment on the regulator off its lowest setting. Turn the calibration gas cylinder valve 1/4 turn. Adjust the regulator discharge pressure to 2 psig and the flow meter to 300 cc per minute. Block the discharge hose that will attach to the GEM-500. The regulator discharge pressure should not climb to over 3 psig. Turn off the cylinder valve.

Note: This procedure will be duplicated for the second span gas when Oxygen is calibrated. The Oxygen/Carbon Dioxide calibration gas cylinder will be substituted for the Methane/Carbon Dioxide calibration gas.

General Utilities KEY 5-Gas Calibration

The GEM-500 is factory calibrated. For greater accuracy, a Field Calibration can be performed. To improve accuracy, all standard landfill gas instruments are field calibrated and zeroed prior to every use. This function is done from the General Utilities Menu of the GEM-500 which is explained in Section 3. Because of the importance of Gas Calibration, this function has been made a separate section. To get to the General Utilities Screen on the GEM-500, see Section 3, Using the Menu Screens.

1. Press KEY 1-General Utilities at the Main Menu Screen (See Figure 2.2).

Figure 2.2

```
1-General Utilities
2-Read Gas Levels
3-View/Print Data
4-Download Data
```

2. The General Utilities Screen appears as shown in Figure 2.3.

Figure 2.3

```
1-Check Time/Date
2-Zero Pressure
3-Memory
9-More          0-Exit
```

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3. The gas calibration function is not on the first General Utilities Screen. To reach this screen, press KEY 9-More and KEY 5-Gas Calibration (Figure 2.4). You could also select KEY 5 while at the General Utilities Screen to proceed directly to the gas calibration screen.

Figure 2.4

4-USA/Metric Units 5-Gas Calibration 6-Gas Alarms 9-More 0-Exit

4. After selecting KEY 5-GAS CALIBRATION on the General Utilities Sub-Menu Screen, the first Gas Calibration Screen appears as shown in Figure 2.5.

Figure 2.5

1-CH_4 Calibration 2-CO_2 Calibration 3-O_2 Calibration 4-Factory Settings

5. There are four possible choices. The first choice field calibrates methane. The second choice calibrates carbon dioxide. The third choice calibrates oxygen. The fourth choice returns the GEM-500 from a field calibration established by the user to the original factory settings.
6. Each of these calibration options will now be reviewed in order.

Methane (CH4) Calibration - Zero CH4

1. Pressing KEY 1-CH4 Calibration on the Gas Calibration Screen brings up the Methane Calibration Screen (Figure 2.6).

Figure 2.6

1-Zero CH_4 2-Calibrate CH_4 Span 0-Previous Menu

2. Pressing KEY 1-Zero CH4 brings up the Zero Methane Screen (Figure 2.7). A methane percentage will not display until the IR Bench warms up. A plus or negative sign may appear on the far left of the display. This symbol can be ignored.

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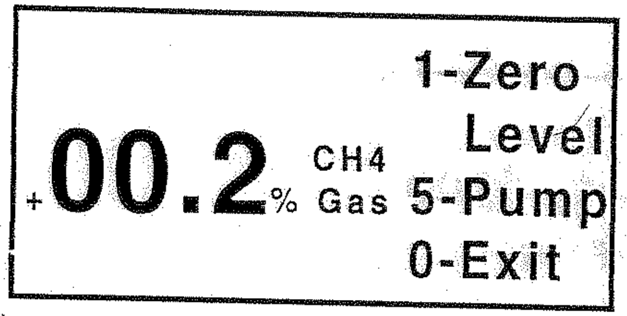

Figure 2.7

Note: Do not perform this procedure in the presence of methane.

3. Press KEY 5-Pump. This turns on the sample pump in the GEM-500. There should be no calibration gas hoses attached to the GEM-500 during this procedure. The GEM-500 will be drawing in a sample of normal air—which must be free of methane. Allow the pump to run for FIVE MINUTES to stabilize the instrument to operating temperature and purge the sensors with air. (If the GEM-500 has already reached operating temperature by having been used and is at operating temperature, the pump can be operated for two minutes but when in doubt, let it run for the full five minutes.)

4. Press KEY 1 - Zero level and one of the following screens (Figure 2.8 or Figure 2.9) will be displayed for three seconds before returning to the Zero Methane Screen shown in Figure 2.7.

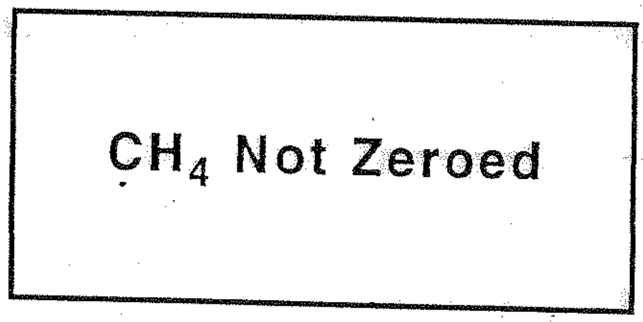

Figure 2.8

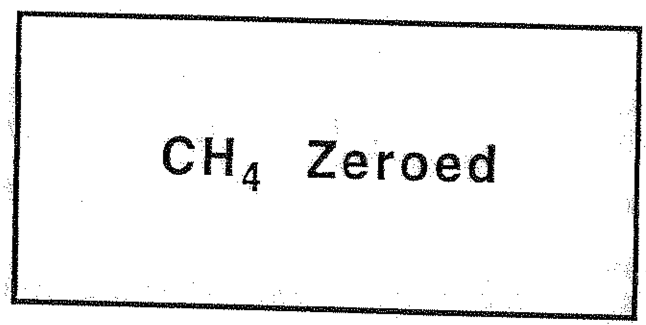

Figure 2.9

5. If the CH4 Not Zeroed Screen (Figure 2.8) was displayed, return to the Gas Calibration Screen by pressing KEY 0-Exit. Recheck that no methane was present and re-zero the methane. If problem continues, proceed to instructions contained in this section for Factory Settings.
6. If the CH4 Zeroed OK Screen (Figure 2.9) appeared, press KEY 0-Exit to return to the Methane Calibration Screen (Figure 2.10). Press KEY 2-Calibrate CH4 Span and proceed to the next section.

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Figure 2.10

1-Zero CH_4
2-Calibrate CH_4 Span
0-Previous Menu

WARNING: The GEM-500 is not certified as intrinsically safe. The following procedure MUST NOT be done in a confined area (such as well vaults, underground and indoors) or where there is any chance of sparking or ignition. No smoking, exposed lighting, or other sources of ignition should be in the area. On the GEM-500, ensure that exhaust gas is safe, not blocked and properly vented away from you. Ensure that no leaks are present. Unless all above conditions are maintained, an explosion could occur resulting in serious injury or death.

CH4 Calibration - CH4 Span

1. Read warnings above before proceeding with the next steps.
2. After selecting KEY 2-Calibrate CH4 Span on the Methane Calibration Screen, the following CH4 Span Screen appears (Figure 2.11).

Figure 2.11

+00.0% CH4 Gas
1-Enter gas con
5-Pump
0-Exit

3. Connect the 1/4" Tygon tubing from the calibration gas regulator/flow meter to the GEM-500 gas sample/impact port (Figure 1.1). Attach, if not already attached, the Tygon tubing to the exhaust port of the GEM-500. Direct the exhaust away from you and out of the immediate area.
4. Press KEY 5-Pump if the pump is not already running, on the CH4 Span Screen shown above. This turns the GEM-500's pump on.
5. Turn on the calibration gas mixture of methane and carbon dioxide.
6. Check the calibration gas flow (300 cc) and pressure (2 psig) to make sure they are correct. (See Setting Up the Equipment)
7. Allow the calibration gas to flow into the GEM-500 for two minutes.
8. After two minutes, read the methane Gas Concentration on the screen. It should be stable and not changing more than a few tenths of one percent.
9. Press KEY 1-Enter Gas Con and input the methane concentration of the calibration gas from the keyboard of the GEM-500 (Figure 2.12). Enter the percentage as three digits XX.X%. 60% methane would be input as 600. The GEM-500 will automatically place a decimal point in the proper position. After the percentage is entered, press KEY 0-Exit.

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Enter Concentration
of Calibration Gas
CH_4 ?-.-%
0-Exit

Figure 2.12

10. The next screen is the Caution Re-Calibrate Screen (Figure 2.13).

Caution Re-calibrate
Are you sure?

1-Yes 2-No

Figure 2.13

11. Press KEY 1-Yes and one of two messages will appear (Figure 2.14 or Figure 2.15). If the Calibration OK Screen appears proceed to step 13.

Calibration gas NOT
accepted. Refer to
operating manual.
Retry? 1-Yes 2-No

Figure 2.14

Calibration OK

Figure 2.15

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12. If the Calibration gas NOT Accepted Screen appears, several things could have happened. Press KEY 1-Yes and enter the percentage of methane in the calibration gas. It is possible the wrong percentage was input. If on a second attempt this has not worked, press KEY 0-No and return to the CH4 Calibration Screen. Start the procedure over again—Zero methane and then Calibrate methane. If there are still problems—proceed to the Factory Settings later in this section.
13. Press KEY 0-Exit and return to the CH4 Calibration Screen shown on the preceding page. If only CH4 is to be calibrated, the pump must be turn off. Press KEY 0-Exit again and step back to the Gas Calibration Screen. If CO2 is to be calibrated, go to the following CO2 calibration instructions. If no further calibration is required, perform step 14. The pump will remain running throughout the calibration procedure. You must return to the KEY 5-Pump screen to stop the pump.
14. Turn off the calibration gas cylinder. Remove the calibration gas hose attached to the gas sample/static pressure port on the GEM-500. Leave the exhaust port hose connected and turn on the pump and allow it to purge the GEM-500 with air for 60 seconds. Press KEY 5-Pump again. The pump will turn off and automatically return to the Calibrate Methane Screen.
15. Press KEY 0-Exit and return to the Gas Calibration Screen. You have successfully completed a methane Field Calibration.

Carbon Dioxide (CO2) Calibration

1. Because the carbon dioxide used in this calibration contains methane, the following warning must be adhered to before proceeding with the steps below.

    WARNING: The GEM-500 is not certified as intrinsically safe. The following procedure MUST NOT be done in a confined area (such as well vaults, underground and indoors) or where there is any chance of sparking or ignition. No smoking, exposed lighting, or other sources of ignition should be in the area. On the GEM-500, ensure that exhaust gas is safe, not blocked and properly vented away from you. Ensure that no leaks are present. Unless all above conditions are maintained, an explosion could occur resulting in serious injury or death.

2. Press Key 2 - CO2 Calibration on the Gas Calibration Screen (Figure 2.16).

Figure 2.16

1-CH_4 Calibration
2-CO_2 Calibration
3-O_2 Calibration
4-Factory Settings

3. There is no Zero CO2 function as there is in the methane or oxygen calibration procedures. The following CO2 Span Screen will appear (Figure 2.17).

Figure 2.17

1-Enter
gas con
+00.0% CO2 Gas 5-Pump
0-Exit

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4. Press KEY 1-Enter Gas Con and the Enter Concentration Screen shown below appears. Input the carbon dioxide concentration of the calibration gas from the keyboard of the GEM-500 (Figure 2.18). Enter the percentage as three digits XX.X%. 40% carbon dioxide would be input as 400. The GEM-500 will automatically place a decimal point in the proper position. After the percentage is entered, press KEY 0 - Exit.

Figure 2.18

```
Enter Concentration
 of Calibration Gas
      CO2 ?-.-%
              0-Exit
```

5. The next screen, Figure 2.19, is the Caution Re-Calibrate Screen.

Figure 2.19

```
Caution  Re-calibrate
Are you sure?

1-Yes             2-No
```

6. Press KEY 1-Yes and one of two messages will appear (Figure 2.20 or Figure 2.21). If the Calibration OK Screen appears go to step 9 below.

Figure 2.20

```
Calibration gas NOT
accepted.  Refer to
operating manual.
Retry?  1-Yes  2-No
```

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Figure 2.21

```
Calibration OK
```

7. If the Calibration gas NOT Accepted Screen appears, several things could have happened. Press KEY 1-Yes and enter the percentage of carbon dioxide in the calibration gas. It is very possible the wrong percentage was input. If on a second attempt this has not worked, press KEY 0-No and return to the Gas Calibration Screen and proceed to the Factory Settings section for additional instructions.
8. If 02 is to be zeroed, go to the following 02 Calibration step.
9. Press KEY 0-Exit and return to the CO2 Calibration Screen shown on the prior page.
10. Turn off the calibration gas. Remove the calibration gas hose attached to the gas sample/static pressure port on the GEM-500. Leave the exhaust port hose connected. Allow the GEM-500 to purge with air for 60 seconds. Press KEY 5-Pump and the pump will automatically turn off, then push KEY 0-Exit to return to the Gas Calibration Screen.
11. You have successfully completed a carbon dioxide Field Calibration. Immediately proceed to the next function, KEY 3-02 Calibration.

Oxygen (02) Calibration - Zero 02

1. There are two calibration gas mixtures used for the calibration of oxygen. The methane/carbon dioxide calibration gas previously used to calibrate the methane and carbon dioxide is used to Zero oxygen because there is no oxygen in the mixture. A second calibration gas with a mixture of oxygen and carbon dioxide will be used to set the oxygen level in the next section. Because the calibration gas used in this calibration contains methane, the warning below must be followed before proceeding with the following procedure.

   WARNING: The GEM-500 is not certified as intrinsically safe. The following procedure MUST NOT be done in a confined area (such as well vaults, underground and indoors) or where there is any chance of sparking or ignition. No smoking, exposed lighting, or other sources of ignition should be in the area. On the GEM-500, ensure that exhaust gas is safe, not blocked and properly vented away from you. Ensure that no leaks are present. Unless all above conditions are maintained, an explosion could occur resulting in serious injury or death.

2. Press Key 3-02 Calibration on the Gas Calibration Screen (Figure 2.22).

Figure 2.22

1-CH_4 Calibration
2-CO_2 Calibration
3-O_2 Calibration
4-Factory Settings

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3. The Oxygen Calibration Screen will appear (Figure 2.23).

Figure 2.23

1-Zero O_2
2-Calibrate O_2 Span
0-Previous Menu

4. Pressing KEY 1-Zero O2 will bring up the Zero Oxygen Screen (Figure 2.24).

Figure 2.24

+00.2% O2 Gas
1-Zero Level
5-Pump
0-Exit

5. Read the oxygen Gas Concentration on the screen. It should be very near 00.0 % and not changing more than a few tenths of one percent.

Note: Even if the screen displays 00.0% oxygen, proceed with step 11 below, the Oxygen must be zeroed anyway.

6. Press KEY 1-Zero level and the one of following screens (Figure 2.25 or Figure 2.26) are displayed for three seconds before returning to the Zero Oxygen Screen shown above. If the O2 Zeroed Screen was displayed proceed to step 13 below.

Figure 2.25

Level NOT Zeroed
Please refer to
Operating Manual

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O_2 Zeroed

Figure 2.26

7. If the Oxygen NOT Zeroed Screen was displayed, return to the Oxygen Calibration Screen. Recheck that the calibration gas contains no oxygen. The gas used should have been a mixture of methane and carbon dioxide only. Connect the correct gas and re-zero the oxygen. If the problem continues, proceed to instructions contained in this section for Factory Settings.
8. If the Oxygen Zeroed OK Screen appeared, turn off the calibration gas.
9. Remove the hose to the GEM-500 from the flow regulator. Let the pump run for at least 60 seconds to purge the instrument with air. Press KEY 5-Pump to turn off the pump.
10. Press KEY 0-Exit to return to the Oxygen Calibration Screen Shown below and proceed to the next section.

02 Calibration - 02 Span

1. From the Gas Calibration Screen, press KEY 2-Calibrate 02 Span and the Oxygen Calibration Screen (Figure 2.27) will appear.

1-Zero O_2
2-Calibrate O_2 Span
0-Previous Menu

Figure 2.27

2. Press KEY 2-Calibrate 02 Span on the Oxygen Calibration Screen will appear (Figure 2.28).

		1-Zero
		Level
+00.0%	O2 Gas	5-Pump
		0-Exit

Figure 2.28

Note: The calibration gas used in this procedure is a mixture of oxygen and carbon dioxide. The oxygen concentration by volume can be 2-5% with the remainder CO2.

3. Change the Calibration Gas mixture to Oxygen/Carbon Dioxide. Install the regulator/flow meter on the new Calibration Gas mixture as directed previously in the section Setting Up the Equipment. Check and adjust the gas flow to 300 cc and pressure to 2 psig. Turn off the gas.

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4. Connect the 1/4" Tygon tubing from the calibration gas regulator/flowmeter to the GEM-500 gas sample/static pressure port (Figure 1.1). Attach, if not already attached, the Tygon tubing to the exhaust port of the GEM-500. Direct the exhaust away from you and out of the immediate area.
5. Press KEY 5-Pump on the O2 Span Screen shown above. This turns the GEM-500's pump on.
6. Turn on the calibration gas mixture of oxygen and carbon dioxide.
7. Check the calibration gas flow (300 cc) and pressure (2 psig) to make sure they are correct.
8. Allow the calibration gas to flow into the GEM-500 for two minutes.
9. After two minutes, read the oxygen Gas Concentration on the screen. It should be stable and not changing more than a few tenths of one percent.
10. Press KEY 1-Enter Gas Con and input the oxygen concentration of the CALIBRATION GAS (typically 5%) from the keyboard of the GEM-500 (Figure 2.29). Enter the percentage as three digits XX.X%. 5% methane would be input as 050. The GEM-500 will automatically place a decimal point in the proper position. After the percentage is entered, press KEY 0-Exit.

Enter Concentration
of Calibration Gas
O_2 ?-.-%
0-Exit

Figure 2.29

11. The next screen to appear, Figure 2.30, is the Caution Re-Calibrate Screen.

Caution Re-calibrate
Are you sure?
1-Yes 2-No

Figure 2.30

12. Press KEY 1-Yes and one of two screens will appear (Figure 2.31 or Figure 2.32). If the Calibration OK Screen appears proceed to step 14.

Calibration gas NOT
accepted. Refer to
operating manual.
Retry? 1-Yes 2-No

Figure 2.31

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Re-Calibrated OK

Figure 2.32

13. If the Calibration gas NOT Accepted Screen appears, several things could have happened. Press KEY 1-Yes and enter the percentage of oxygen in the Calibration Gas. It is possible the wrong percentage was input. If on a second attempt this has not worked, press KEY 0-No and return to the oxygen Calibration Menu. Start the procedure over again —Zero oxygen and then Calibrate oxygen. If there are still problems—proceed to the Factory Settings section in this section.
14. Press KEY 0-Exit and return to the Oxygen Calibration Screen shown on the following page.
15. Turn off the Calibration Gas. Remove the Calibration Gas hose attached to the gas sample/static pressure port on the GEM-500. Leave the exhaust port hose connected. Allow the GEM-500 to purge with air for 60 seconds. Press KEY 5-Pump and the pump will turn off.
16. Optional Step - The GEM-500 was just calibrated on 1-7% oxygen scale. The 7-21% scale can be calibrated using normal air. While on the Oxygen Calibration Screen press KEY 5-Pump and allow it to run for 60 seconds. The screen will appear as shown in Figure 2.33. Repeat steps 10 - 14 above. For step 10, enter an 02 concentration of 21.0% even though the screen will seldom reach more than 20.6%. You have just calibrated the upper oxygen scale.

+**20.6**% O2 Gas

1-Zero Level
5-Pump
0-Exit

Figure 2.33

17. Turn off the pump by selecting KEY 1, KEY 2 or KEY 3 from the Gas Calibration Screen then press KEY 5-Pump and KEY 0-Exit to return to the Gas Calibration Screen. You have successfully completed an oxygen Field Calibration.

Factory Settings Calibration

As previously mentioned, the GEM-500 can be returned to its original Factory Settings Calibration. This procedure eliminates the field calibration done in the above procedures. It is sometimes necessary to bring the GEM-500 back to factory settings before trying to field calibrate the unit. If for some reason sampling conditions change radically, overall accuracy of the GEM-500 could improve by returning to the factory settings.

1. From the Gas Calibration Screen, Figure 2.34, press KEY 4-Factory Settings.

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1-CH_4 Calibration
2-CO_2-Calibration
3-O_2 Calibration
4-Factory Settings

Figure 2.34

2. The Caution Screen, Figure 2.35, shown below will be displayed. If KEY 0 - No is pressed, screen represented in Figure 2.36 will appear for two seconds and the Gas Calibration Screen will return.

CAUTION Return to
Factory Setting of
Calibration & Zero
1-Yes 2-No

Figure 2.35

Factory Setting
NOT Set

Figure 2.36

3. Press KEY 1-Yes and the screen shown in Figure 2.37 is displayed for three seconds before returning to the Gas Calibration Screen shown in step 1.

Factory Setting
Set OK

Figure 2.37

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4. After loading the factory setting, the methane and oxygen calibration **must be rezeroed prior to use.**

After Completing Gas Calibrations

Additional General Utilities functions should be addressed after the GEM-500 is field calibrated. These functions are available from the General Utilities Menu and include:

- Check Time/Date—to make sure the data collected is properly date stamped.
- Check Memory—to see if there is enough space in the GEM-500 for the reading you plan to do. Otherwise the memory will have to be cleared.
- Set Gas Alarms—if you wish to have the GEM-500 alert you to unusual gas conditions.

After completing the gas calibrations, you can begin to read gas levels. Go to Chapter 5-Read Gas Levels, of this manual.

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Chapter 3-Using Menu Screens

Starting Up the GEM

This procedure is the same each time the GEM-500 is turned on by pressing the Red ON/OFF Key. The following steps will allow you to proceed to the Main Menu Screen of the GEM.

Note: If the GEM is turned on and no additional keys are pressed within 15 minutes, the unit will turn off automatically to save power. No stored data will be lost.

1. Turn unit on by pressing the RED KEY-On/Off.
2. The Warning Screen will appear for five seconds. This is a reminder that the GEM-500 is not to be used in confined areas such as vaults, excavations or indoors. An explosion could result causing serious injury or death.

Figure 3.1

WARNING! DO NOT use in confined spaces-UNIT not certified intrinsically safe

3. Service Contract Screen may appear for five seconds if activated by LANDTEC. Otherwise the Not Covered Screen can be displayed. The GEM-500 is a portable scientific field instrument that does require factory maintenance and calibration at recommended six month intervals under normal landfill usage.

Figure 3.2

This Analyzer is not covered by a Service Contract Next Service due:

Figure 3.3

This Analyzer has a Service Contract Next Service due: (date)

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The LANDTEC/Contrast Screen follows and allows the user to adjust the contrast of the characters on the liquid crystal display screen. Press and hold KEY 1-Cursor-Up Arrow to increase contrast. Press and hold the KEY 6-Cursor-Down Arrow to decrease the contrast. Adjust the contrast as necessary. Press the KEY 0 to exit to the next screen.

```
      LANDTEC
      GEM-500
   (800) 821-0496
↑↓ -Contrast   0-Exit
```

Figure 3.4

4. Following is the Main Menu Screen. All the GEM-500's functions are accessed from the Main Menu Screen. All future instructions about GEM-500 functions will start with from this screen.

```
1-General Utilities
2-Read Gas Levels
3-View/Print Data
4-Download Data
```

Figure 3.5

GEM-500 Menu Screens Tree

The overall menu screens structure is displayed below:

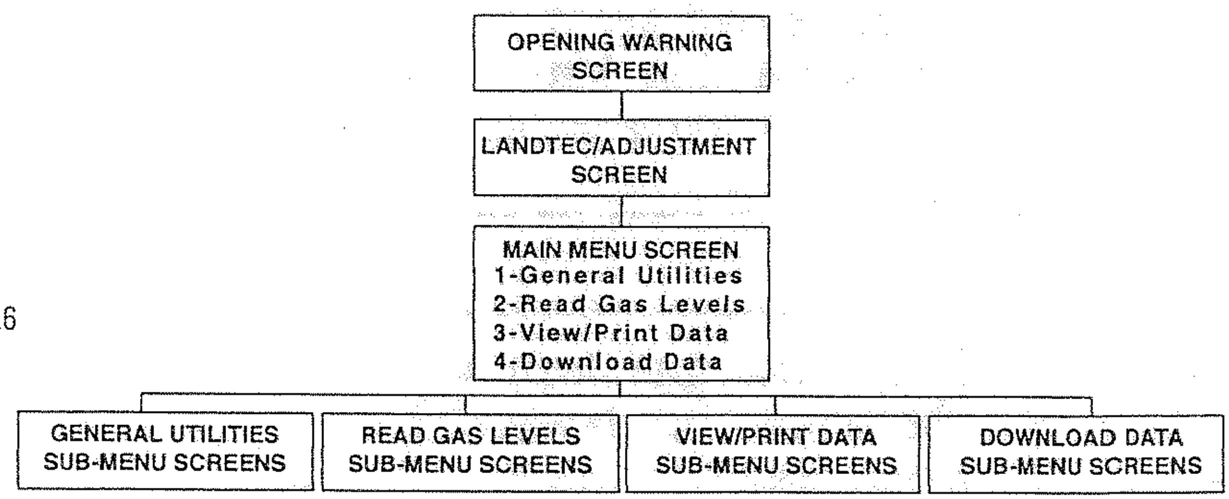

Figure 3.6

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Review of the Main Menu and Sub-Menu Screens

The Main Menu Screen has four major functions which have the following specific actions:

General Utilities

Refer to Chapter 4 for further information. The General Utilities function has sub-menu screens that allow house-keeping and other maintenance including:

1. CHECK TIME/DATE: Used to check or set time and date.
2. ZERO PRESSURE: Zeros pressure transducers.
3. MEMORY: Check memory available and clears all data and ID information.
4. USA/METRIC UNITS: Select either USA standard or metric measurement units.
5. GAS CALIBRATION: Allows methane, carbon dioxide and oxygen to be field calibrated by the user with calibration gas mixtures for increased accuracy (Discussed in Section 2).
6. GAS ALARM: Sets gas alarm levels.
7. ID MAINTENANCE: Used to view, edit or delete existing ID information and to enter new ID information.

Read Gas Levels

Refer to Chapter 5 for further information. Read Gas Levels function allows gas, pressure, flow and BTU readings to be viewed and recorded. Sub-menu screens include:

1. Read GAS with Existing ID code - has three linked screens.
2. Read GAS without ID code.

View/Print Data

For further information, refer to Chapter 6. View/Print Data function allows previously stored data to be scanned on the GEM display screen, individually displayed or printed via the optional RS-232 cable to a serial printer.

Download Data

The Download Data function allows stored data to be downloaded via the optional RS-232 cable to a personal computer in a format that can be uploaded into other programs including spreadsheets and LANDTEC's data base management program. See Chapter 7 for further information.

Note: The KEY 0-Backspace will act as an exit or escape key at the end of each sub-menu and return you to the main menu screen.

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Chapter 4-General Utilities Functions

Read Chapter 3 on how to get to the Main Menu Screen. Also see the GEM-500 Menu Screen Tree which is a diagram located in Chapter 3.

Press KEY 1-General Utilities on the Main Menu Screen. There are seven options available that are displayed on three sub-menu screens as shown below. Select the desired function by pressing the appropriate key. The desired option does not need to be displayed in order to select it. For example, if the first screen is displayed, entering KEY 5 will bring up the Gas Calibration Sub-Menu which is located on the second screen. From any of these Sub-Menus, if the KEY 0-Exit is pressed, then the Main Menu Screen will re-appear (Figure 4.1).

1. CHECK TIME/DATE: Used to check or set time and date.
2. ZERO PRESSURE: Zero's pressure transducers.
3. MEMORY: Check memory available and allows clearing of all data and ID information.
4. USA/METRIC UNITS: Select either USA standard (Imperial) or metric (SI) measurement units.
5. GAS CALIBRATION: Allows methane, carbon dioxide and oxygen to be field calibrated by the user with a special gas mixture for increased accuracy.
6. GAS ALARM: Sets gas alarm levels.
7. ID MAINTENANCE: Used to view, edit or delete existing ID information and to enter new ID information.

Figure 4.1

```
1-General Utilities
2-Read Gas Levels
3-View/Print Data
4-Download Data
```

General Utilities Menu

By pressing KEY 1 on the Main Menu Screen, the General Utilities Menu Screen (Figure 4.2) will appear.

Figure 4.2

```
1-Check Time/Date
2-Zero Pressure
3-Memory
9-More      0-Exit
```

As shown, three General Utilities functions are shown on each General Utilities Menu Screen. By pressing KEY 9, the next screen of utility functions is displayed (Figure 4.3).

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```
4-USA/Metric Units
5-Gas Calibration
6-Gas Alarms
9-More      0-Exit
```

Figure 4.3

Press KEY 9 again for one more screen of General Utilities functions (Figure 4.4). As previously mentioned, any function number can be pressed while any screen is displayed. Pressing KEY 9 displays the list of functions again. Pressing the KEY 0 returns you to the Main Menu Screen.

```
7-ID Maintenance


9-Back      0-Exit
```

Figure 4.4

General Utilities Screen Tree Diagram

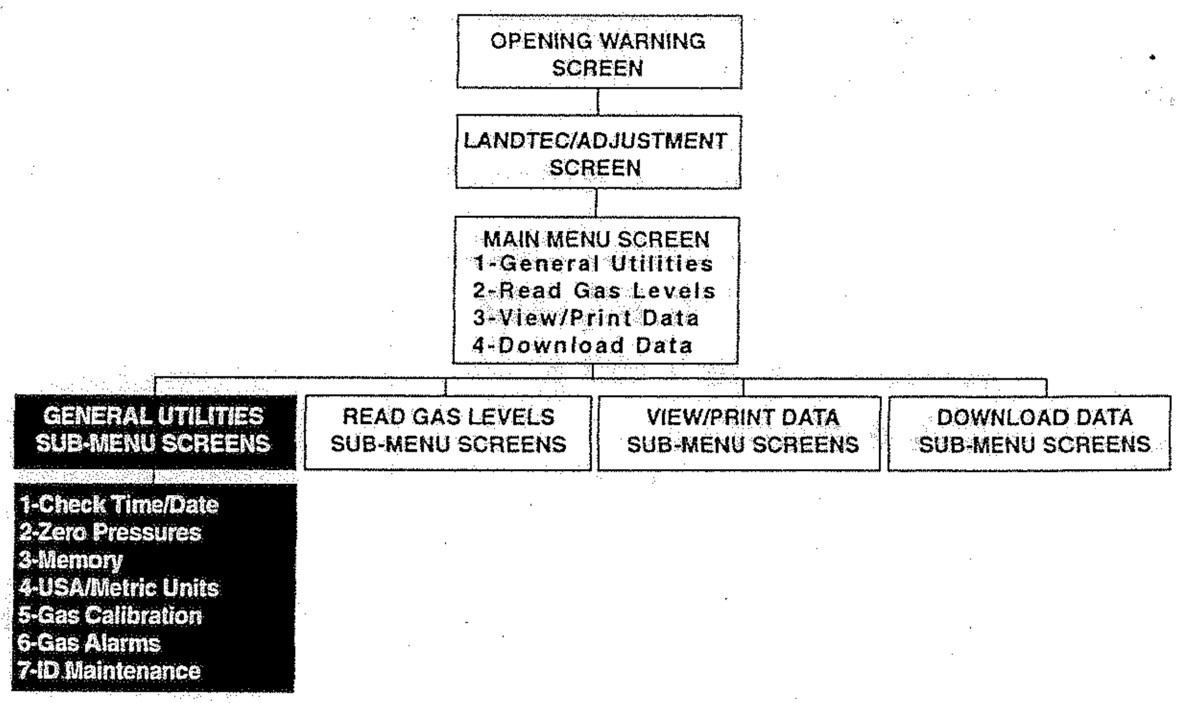

Figure 4.5

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General Utilities KEY 1-Check Time/Date

There is an internal clock and calendar in the GEM-500 unit which is powered by a secondary battery. This maintains the clock function even when the GEM-500 is off. The battery can only be changed by an authorized factory service representative.

As each reading is stored in the GEM-500, it is time and date stamped. Both the clock and calendar are set by LANDTEC, however, they should be set to the local time zone the first time and checked weekly thereafter.

1. Press KEY 1 on the Main Menu Screen for the General Utilities Sub-Menu Screen. This takes you to the General Utilities Sub-Menu Screen (Figure 4.6). Press Key 1 on the General Utilities Sub-Menu Screen as shown below for the Check Time/Date function.

```
1-Check Time/Date
2-Zero Pressure
3-Memory
9-More       0-Exit
```

Figure 4.6

2. The following Set Time/Date Screen is displayed (Figure 4.7). Press KEY 1 to proceed.

```
15:46:07   09/07/93

1-Set Time/Date
             0-Exit
```

Figure 4.7

3. The time and date are displayed on the top line of the screen. A 24-hour clock is used. If after 12 noon, add 12 to the hour to convert it to a 24-hour format. Example: 3 p.m. is 12+3= 15 00 hours. The time format is Hours: Minutes. Seconds. The date format used in the example is in U.S. calendar format (see note below).
4. If CHECK TIME/DATE is ok, end procedure by pressing KEY 0-Exit and returning to the General Utilities Sub-Menu Screen. Otherwise if CHECK TIME/DATE is wrong, press KEY 1, and set CHECK TIME/DATE in the next step.
5. Set the time and date as shown on Figure 4.8 by entering numbers from the GEM-500 keyboard. Press the KEY 0-Set when done.

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Figure 4.8

```
?h:mm:ss  mm/dd/yy

Enter New Time/Date
              0-Set
```

NOTE: If necessary to correct an entry error, use 0 KEY (exit) as Backspace Key by holding it down for 1 second. In normal use, 0 KEY is quickly pressed and released. In above screen for time: hh = hours, mm = minutes, ss = seconds and date: mm = months, dd = days, yy = years. CHECK TIME/DATE is in U.S. calendar format.

6. One of two screens will be displayed. Both are shown below. If the date is valid, Figure 4.9 will display for three seconds. If the time or date is invalid the second screen will appear as shown on Figure 4.10. The Time/Date is invalid when impossible numbers are entered into a field. For example mm=15 is an invalid month. Return to step 5 above and re-enter the correct time and date as instructed.

Figure 4.9

```
Time/Date Set OK
```

Figure 4.10

```
Invalid Time/Date
Please enter again
```

General Utilities KEY 2-Zero Pressure

The GEM-500 measures atmospheric pressure as part of the LFG flow calculation. To properly measure pressure and the vacuum used in landfill gas extraction systems, the pressure transducers must be reset to zero before using the GEM-500. This is done to compensate for atmospheric pressure changes due to local weather conditions and changes in elevation.

This procedure should be done prior to doing any READ GAS LEVELS as shown in Chapter 5 unless the static and differential pressures read 00.0. The ZERO PRESSURE function is also contained on the READ GAS LEVELS Sub-Menu Screen. Whenever the pressure transducer readings are not zero and you know they should be, use this procedure. As a general rule this procedures should be done each time the GEM-500 is used.

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1. Press KEY 1-General Utilities at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Press the KEY 2 for Zero Pressure on the General Utilities Sub-Menu Screen as shown in Figure 4.11.

```
1-Check Time/Date
2-Zero Pressure
3-Memory
9-More       0-Exit
```

Figure 4.11

3. Figure 4.12 displays the current readings of the Static and Differential pressure transducers. If both pressures do not read 00.0 DISCONNECT ANY HOSES IF ATTACHED TO A WELLHEAD and press KEY 1-Zero Pressures.

```
      Static  +00.2"H20
Differential -0.30"H20
1-Zero Pressures
              0-Exit
```

Figure 4.12

Note: Units displayed will be inches of water column or MB depending on measurement unit selected (USA or metric).

4. After the pressures have been zeroed, Figure 4.13 will appear for three seconds. Then the Zero Pressure Screen in step 3 appears.

```
   Zeroed OK
```

Figure 4.13

5. Press the KEY 0 - Exit to end procedure and return to General Utilities Sub-Menu Screen.

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General Utilities KEY 3-Memory

Caution: This function can erase all stored data.

Each GEM-500 ID point and all readings taken at that ID point are stored in the GEM-500's memory. Eventually the memory becomes full. After each day's readings are completed, the memory function should be checked. Normally the readings for the day are Downloaded to a PC or are printed out (see functions 3 & 4 on the Main Menu in Section 3). If the memory becomes full, a MEMORY FULL message is displayed. When this happens, the memory must be cleared.

The GEM-500 can store many ID points. It is therefore possible to use it on several landfills. As stated in the warning above, once cleared, the data cannot be restored.

1. Press KEY 1 at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Then press the KEY 3 for Memory on the General Utilities Sub-Menu Screen (Figure 4.14).

Figure 4.14

```
1-Check Time/Date
2-Zero Pressure
3-Memory
9-More      0-Exit
```

3. The following screen—Number of Free Readings Screen, allows for two choices: Press KEY 1 - Clear Readings to erase all gas/etc. data readings or Press KEY 2 - Clear ID Info to erase All ID Code Numbers and Flow Data that have accumulated in the GEM-500 from ID MAINTENANCE and READ GAS functions.

   Press the KEY 0 - Exit to escape from the procedure and return to the General Utilities Sub-Menu Screen without clearing any information.

Figure 4.15

```
 0479 Free Readings
1-Clear Readings
2-Clear ID Info
           0-Exit
```

4. After making your choice of 1 or 2 on the screen above, the following screen appears. As a final safety check, you must input the numeric value 0102 from the GEM-500 keyboard to clear the memory. IF YOU DECIDE NOT TO CLEAR THE MEMORY AT THIS POINTùTURN THE GEM-500 OFF BY PRESSING THE RED ON/OFF KEY. Do Not Input 0102 unless you want to proceed.

   Caution: This step erases stored data. You may want to print the memory out or download the data first so it is not lost.

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Figure 4.16

CAUTION! DATA WILL BE LOST Enter 0102 to clear ?

5. Enter 0102 from the keyboard and press the KEY 0 - Exit. The Clearing Memory Screen appears for 3 seconds if the memory was erased.

Figure 4.17

Clearing Memory

After displaying the above, the Number of Free Readings Screen shown in Step 4 above is re-displayed. Press the 0 Key to Exit to the General Utilities Menu Screen.

General Utilities KEY 4-USA/Metric Units

The GEM-500 can display and story data in 2 units of measureùMetric (SI) or Imperial (USA). This function allows for the setting of the unit of measure. Normally once set, it does not need to be changed.

1. Press KEY 1-General Utilities at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Since function 4-USA/Metric Units is not on the first General Utilities Screen, press the KEY 9-More for the next screen.
3. Press the KEY 4-USA/Metric Units on the General Utilities Sub-Menu Screen as shown in Figure 4.18.

Figure 4.18

4-USA/Metric Units 5-Gas Calibration 6-Gas Alarms 9-More 0-Exit

4. The Measurement Units Screen appears as shown in Figure 4.19. Press the KEY 1 to change from one unit to the other. (It acts a toggle switching from one to the other.) If the GEM-500 is currently displaying USA measurement units (Imperial — Btu's, Standard Cubic Feet, Fahrenheit temperatures, etc.) it switches to Metric. When done, press the KEY 0-Exit Key to return to the General Utilities Sub-Menu Screen.

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Measurement Units
Set to Metric (USA Std)
1-Change to Metric (USA)
0-Exit

Figure 4.19

General Utilities KEY 5-Gas Calibration

Please refer to Chapter 2-Field Calibration for all information and instructions relating to the Gas Calibration function.

General Utilities KEY 6-Gas Alarm

The GEM-500 has two alarm options that can warn the operator if a gas sample contains concentrations of Methane below established levels or Oxygen above preset levels. If the alarms are activated, there is a beeping and the affected gas blinks when displayed on the Read Gas Levels Screens.

1. Press KEY 1 at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Then press the KEY 9-More. Press the KEY 6-Gas Alarms on the General Utilities Sub-Menu Screen as shown in Figure 4.20.

4-USA/Metric Units
5-Gas Calibration
6-Gas Alarms
9-More 0-Exit

Figure 4.20

3. The following screen is displayed (Figure 4.21). Chose one or two to change the methane gas or oxygen level. If no change in gas levels is required press the KEY 0-Exit to return to the General Utilities Sub-Menu Screen.

Methane Below 00.0%
Oxygen Above 22.2%
1-Change Methane
2-Change Oxygen

Figure 4.21

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4. If KEY 1-Change Methane is pressed the following screen will appear (Figure 4.22). Using the numbered keys on the GEM keyboard input the new 3 digit level for methane (CH_4). All three digits must be entered (XX.X%), the decimal point is automatically inserted. Press KEY 0-Exit.

```
CH4 Level is   00.0%
Level Required ?.0%

Enter level
```

Figure 4.22

Note: Screens shown in steps 4 and 5 display current alarm levels of methane (CH_4) and oxygen (O_2). During the Read Gas Levels procedure, if the GEM receives CH_4 gas at or below these levels, or O_2 gas at or above these levels, then an audible warning sound will occur to alert operator.

5. If KEY 2-Change Oxygen is pressed Figure 4.23 will appear. Using the numbered keys on the GEM keyboard input the new three digit level for oxygen (O_2). All three digits must be entered and the decimal point is automatically inserted. Press KEY 0-Exit.

```
O2 Level is    00.0%
Level Required ?.0%

Enter level
```

Figure 4.23

Note: In steps 4 or 5, if necessary to correct an entry errors, use KEY 0-Exit to backspace by holding the key down for one second. In normal use, KEY 0 is quickly pressed and released to exit.

6. Press the KEY 0-Exit which returns you to the screen shown in Step 3 above. Press the KEY 0-Exit which will return you to the General Utilities Sub Menu Screen.

General Utilities KEY 7-ID Maintenance

The ID maintenance function allows each monitoring point on a site to be assigned a unique ID code. This code must be eight characters long. The characters can be any combination of letters and numbers. Typically, the landfill name or an abbreviation is used for the first four characters. After an ID code is entered (Step 4), you must also select the type of flow device (Accu-Flo, pitot tube, orifice plate) used at that ID location (Step 5). Depending on the flow device selected, you must also enter either: no data, pipe ID (inner diameter), or both orifice and pipe ID size.

1. Press 1 KEY at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Then press the 9 KEY for More and because function 7 is not displayed press the 9 KEY one more time. Press the 7 key - ID Maintenance on the General Utilities Sub-Menu Screen as shown in Figure 4.24.

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Figure 4.24

```
    Please Enter ID
Numbers/Letters
ID xxxx?
              0-Enter
```

3. The screen represented by Figure 4.25 is displayed. Press KEY 2-Enter New ID and go to Step 4. Press the KEY 1-View/Edit/Select to see, change or delete ID information. Go directly to Step 10. Press the KEY 0-Exit.

Figure 4.25

```
  ID Maintenance
1-View/Edit/Delete
2-Enter New ID
              0-Exit
```

4. After pressing KEY 2- Enter New ID the following screen (Figure 4.26) appears to allow the inserting of letters or numbers in the ID code.

Figure 4.26

```
    Please Enter ID
Numbers/Letters
ID xxxx?_ _ _
              0-Enter
```

5. Enter the new ID code as shown on the above screen using number or letters:
For numbers press Number KEYS.
For letters, press arrow KEY 1 or KEY 6.
Enter each letter by pressing KEY 0.
Use the BLUE KEY to switch between letters and numbers.
(See Keyboard Information in the Getting Started Section at the beginning of this Manual.) After the final digit is inserted the KEY 0-Enter is displayed. Press if ready to enter, otherwise press and hold the KEY 0 and use it as a Backspace Key.
6. WHEN AN EXISTING ID CODE IS ENTERED, THE SCREEN SHOWN IN FIGURE 4.27 WILL APPEAR. Press the KEY 1-Yes to proceed. If KEY 2 -No is selected, the GEM returns to screen shown in step 3 above.

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IDxxxx xxxx Already Exists, Overwrite?

1-Yes   2-No

Figure 4.27

7. The next screen displayed after step 5 is shown as Figure 4.28. It allows for the selection of a flow device. This choice is necessary for the GEM to calculate flow when readings are taken. The following choices are possible:
Accuflo - 1V (1 1/2" Accuflo Model 150 Vertical Wellhead)
Accuflo - 1 H (1 1/2" Accuflo Model 150 Horizontal Wellhead)
Accuflo - 2V (2" Accu-Flo Model 200 Vertical Wellhead)
Accuflo - 2H (2" Accu-Flo Model 200 Horizontal Wellhead)
Accuflo - 3V (3" Accu-Flo Model 300 Vertical Wellhead)
Accuflo - 3H (3" Accu-Flo Model 300 Horizontal Wellhead)
Orifice Plate (Orifice diameter and pipe inner diameter are also required
Pitot Tube - Pipe ID is required
User Input (Orifice diameter and Pipe ID also required)

Note: User input allows user to input flow in SCFM if known. A user without a flow device could use this screen to record velocity or other relevant data. (If using a Kurz meter, for example.)

Select Flow Device
Accuflo-1V
↑-Scroll Up
↓-Scroll Down   0-Cont

Figure 4.28

8. Press the KEY-0 to Continue. If an Orifice Plate, Pitot Tube or User Input flow device is selected, additional information will be required. If the pipe or orifice diameter screen appears, input the required size as necessary. Use the number keys on the GEM keyboard. The decimal point is automatically placed. Insert XX.XX inches or centimeters depending on the units selected. Press the KEY 0 to continue.

9. The ID Stored OK Screen is displayed for three seconds (Figure 4.29). The GEM then returns to the screen displayed in step 3 for additional ID input.

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Figure 4.29

```
ID Stored OK
```

10. To view ID information, press KEY 1 to scroll through stored ID codes and data.

Figure 4.30

```
ID ABCD1234      2-Edit
Accuflo-2V       3-Del
                 ↓↑-Scan
                 0-Exit
```

11. Press the arrow KEYS 1 and 6 to select desired ID codes (if not displayed).
    Press KEY 2-Edit to change flow data. Go to Step 7.
    Press KEY 3-Del to erase the ID code and its flow data. Go to step 11.
    Press KEY 0-Exit to return to ID Maintenance menu.

Figure 4.31

```
     Delete ID?
     ABCD0001
1-Yes           2-No
```

Note: In Step 10 the left side of screen displays an eight character ID code, with its related flow data below. Use arrow KEY 1 or KEY 6 to see all stored ID codes (and data) when more than one code is in memory. When a unique ID code is displayed, pressing KEY 2 (edit) allows that code's flow device and pipe/orifice data (if any) to be altered. Once KEY 2 is pressed the original "flow data" information is erased and new data must be entered. KEY 3 (del), is used as the initial command for the complete erasing of ID code and its flow data .

12. If the ID Data was erased by selecting the KEY 3-Del in the screen above the following screen will ask for confirmation. Press the KEY 1-Yes and the KEY 2-No.

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13. The screen shown below will appear for three seconds before returning to step 10 if the KEY 1-Yes was pressed.

ID Deleted

Figure 4.32

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Chapter 5-Read Gas Levels

This section instructs the operator in how to use the GEM-500 to collect data from LFG extraction system wells and other monitoring points. Several things should be done prior to beginning to collect data readings with the GEM.

The operator should be familiar with the following:

- Check the TIME/DATE (See General Utilities - 1)
- Charge the unit's nickel cadmium batteries (See Chapter 8 - Maintenance)
- Perform a ZERO PRESSURE (See General Utilities - 2)
- Perform a Field Calibration on the unit (See Section 2 - Field Calibration)

If the distance to the site where it will be used is great, put the GEM-500 in its protective hard case and secure it well. If the site is nearby, the soft case will offer enough protection. The GEM-500 is a sensitive measuring instrument. Vibration, shock and great temperature changes can alter the field calibration. It is suggested that the field calibration be performed just before using the instrument at the site. Additional calibration is sometimes necessary in the field during the day.

Warning

Review the warnings given in the beginning of this manual. The GEM-500 is NOT to be used in dangerous, explosive or confined atmospheres. Do not use it inside vaults, manholes, trenches or indoors. Do NOT block the exhaust port. If it is blocked while the pump is operating, the pressure could force the unit to over-pressurize and damage internal components and the case.

GEM-500 Hose and Wellhead Connection

The proper hoses must be connected from the GEM-500 to the wellhead in order to collect data. As mentioned in the Getting Started Chapter, the black striped Tygon hose with the external filter/water trap assembly was attached to the static pressure port on the GEM-500 (Figure 5.1). The almond colored male quick connect goes on the end of this tubing to read the static pressure on the Accu-Flo Wellhead.

The clear Tygon hose is connected to the impact port of the GEM-500. A chrome plated brass male fitting was put on the end of the clear tubing. This chrome fitting is used to measure the impact pressure at the wellhead.

On the following page are examples of the Accu-Flo Wellhead, both vertical and horizontal models. Note the locations of the Static Pressure Port, Impact Pressure Port, Temperature Gauge, and Gas Sample Port.

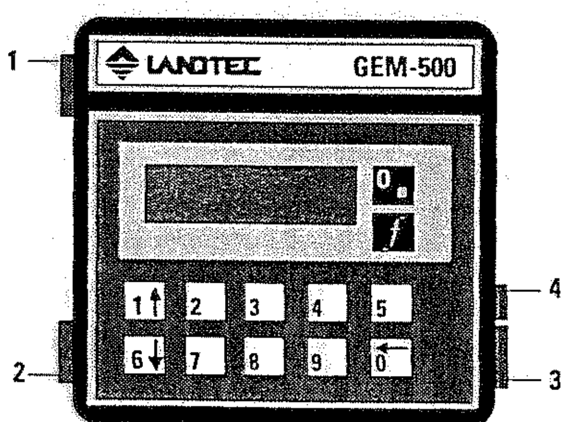

Figure 5.1

1. Static Pressure/Sampling Port—Measures static pressure when connected to wellhead staticpressure port by tubing.
2. Impact Pressure Port—Measures impact pressure when connected to wellhead impact pressure port by tubing.
3. Exhaust Port—This port must be kept clear. If blocked while operating, over pressurization and damage to internal components and case could occur.
4. RS-232 Port—Used for battery recharging, data downloading and temperature readings.

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LANDTEC Horizontal Accu-Flo Wellhead

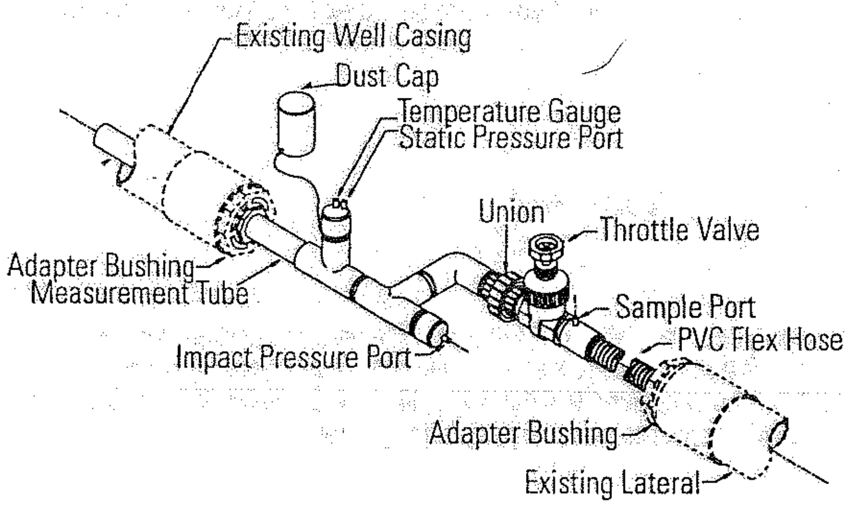

Figure 5.2

LANDTEC Vertical Accu-Flo Wellhead

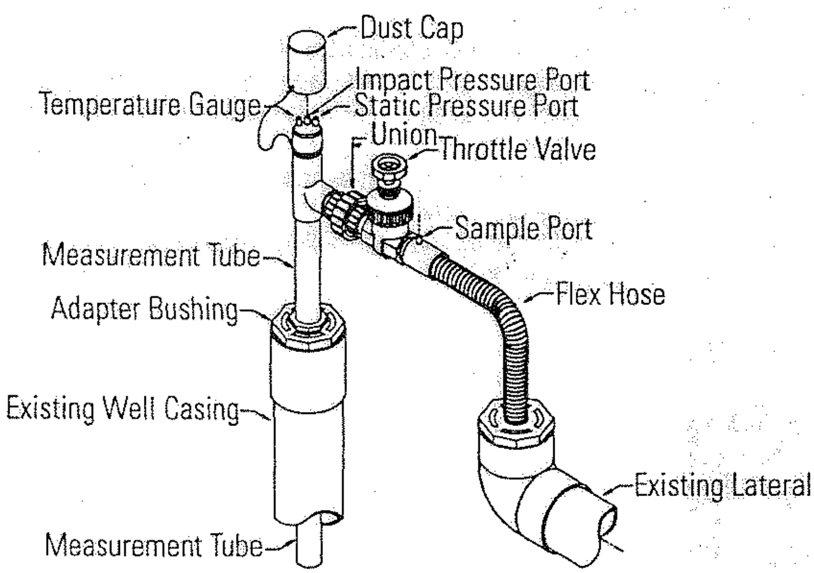

Figure 5.3

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Read Gas Levels Screen Tree Diagram

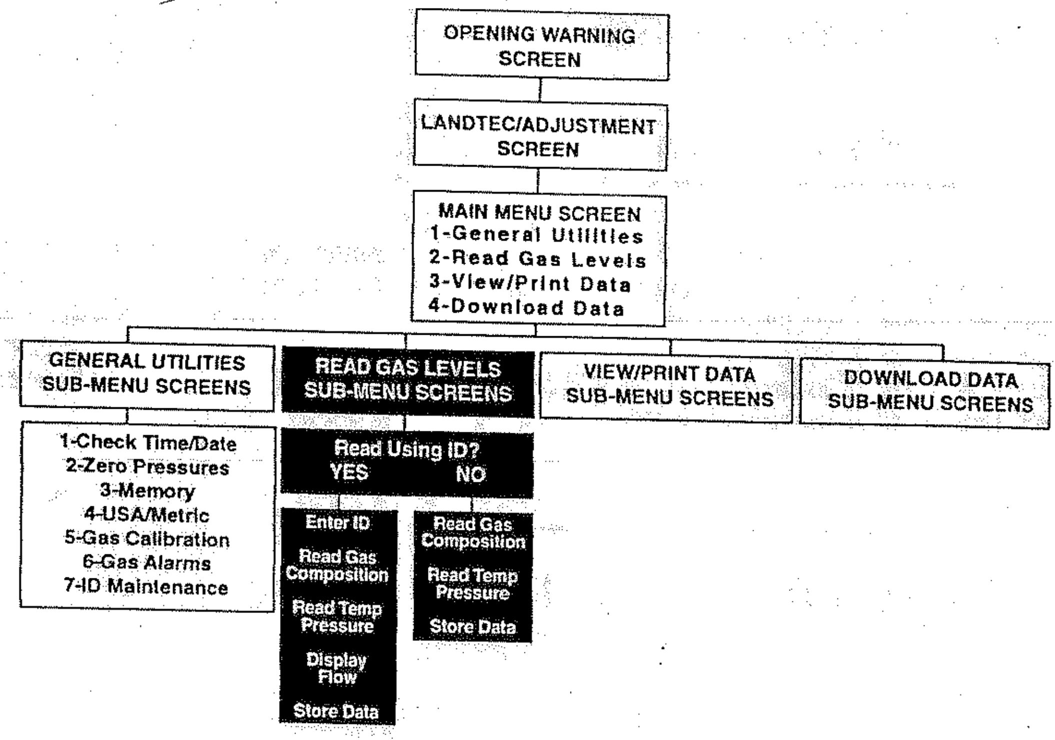

Figure 5.4

As shown in the screen tree diagram (Figure 5.4), there are two paths depending on whether or not an ID has been defined and stored in the GEM-500. Without the flow device, which is stored with the ID, it is not possible to calculate and display flow or store the data. IDs can be added during this procedure at several other points.

Read Gas Levels Menu

1. Press KEY 2 at the Main Menu Screen (Figure 5.5) for the Read Gas Levels Screen.

Figure 5.5

```
1-General Utilities
2-Read Gas Levels
3-View/Print Data
4-Download Data
```

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2. The Read Gas Levels Screen is displayed as shown in Figure 5.6.

Figure 5.6

```
Read Using ID?

1-Yes  2-No  0-Exit
```

3. The normal response to this screen is KEY 1-Yes. If the KEY 2-No is selected, gas flow cannot be calculated and the data cannot be stored because there is no ID with which to associate the data. By pressing KEY 0-Exit, the user is returned to the Main Menu Screen. Press the KEY 1-Yes and the Enter ID Screen (Figure 5.7) is displayed. If KEY 1-scroll is selected, the second screen below will appear (Figure 5.8). Press KEY 1 or KEY 6 to scroll through the ID information and press KEY 2 to select the desired ID. Selecting KEY 2-Manual will present the third screen (Figure 5.9). Note the arrow step and KEY 0-Enter only appear if letters have been selected.

Figure 5.7

```
Manually enter ID or
scroll through?

1-Scroll    2-Manual
```

Figure 5.8

```
1) ID XXXX XXXX
↓↑ - Scroll
 2 - Manual       0-Exit
```

Figure 5.9

```
Please Enter ID
Numbers/Letters
ID XXXX ?
↓↑  - Step       0-Enter
```

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4. An ID allows each monitoring point on a site to be assigned a unique identification. This code must be eight characters long. The characters can be any combination of letters and numbers. Typically, the landfill name or an abbreviation is used for the first four characters and one letter and three numbers for the second four characters. The well IDs and data displayed is used for example purposes only on the Enter ID Screen.
5. Enter ID code using number and/or letter mode:
For numbers, press Number KEYS
For letters, press KEY 1-Cursor-Up and or KEY 6-Cursor-Down.
Enter each letter by pressing KEY 0 Enter.
Use Blue Number/Letter Toggle KEY to switch between numbers and letters.
(See Chapter 1, The Keyboard Section for further information)
6. After the ID is input, one of two screens will appear. The No Reading for ID Screen (Figure 5.10) appears when the ID is not found (or because the correct ID was not entered). To re-enter the ID information, press KEY 1. Press KEY 2 to retry and re-enter to ID number. KEY 0-Abort returns you to the General Utilities Menu. When the ID is found in the GEM-500's memory, the screen in Figure 5.11 is displayed . Assuming the correct ID was found, press the KEY 1-Read to continue. If the ID codes is incorrect, press KEY 2-Retry and re-enter the information as described previously. To make corrections, press KEY 3-Edit and follow the procedures described in the ID maintenance section.

```
   No Reading for ID
       XXXX XXXX
1-Enter ID info
2-Retry        0-Abort
```

Figure 5.10

```
ID ABCD1234   1-Read
Accuflo-2V    2-Retry
              3-Edit
              0-Abort
```

Figure 5.11

7. Press the 1 KEY- Read Gas Levels and Figure 5.12 will appear.

```
CH4  00.0% | 1-LEL  2-Cont
CO2  00.0% | 5-Pump On/Off
O2   00.0% | 9-Last Data
BAL  00.0% |        0-Exit
```

Figure 5.12

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8. Press KEY 5-Pump to turn pump on and draw a gas sample from the wellhead into the GEM-500. Allow readings on left side of screen, to become stable before pressing KEY 2-Continue. A timer is located on the screen to monitor time pump is running. This will automatically turn off the pump. If you want to turn off the pump without proceeding to the next screen, press the KEY 5-Pump again and the pump will be turned off. Press KEY 1-LEL to display the Lower Explosive Limit Screen. Exit from the LEL Screen by pressing KEY 0-Exit.

00.0 % CH4 Gas	5-Pump ON/OFF
00.0 % CH4 LEL	0-Exit

Figure 5.13

The LEL screen is shown in Figure 5.13. The lower explosive limit of methane by volume in air is 5%. This means a five percent concentration is explosive. For safety reasons, some rules require that methane levels do not exceed 1% methane or 20% LEL or 1 1/4% methane which is 25% LEL. A 5% methane level is 100% of LEL. Press KEY 0-Exit to return to previous screen.

9. From the Read Gas Levels Screen (Figure 5.12) press KEY 2-Continue for the Temperature Screen (Figure 5.14). Press KEY 1-Enter Temperature as shown on the following screen (Figure 5.15). This is read from the temperature gauge on the Accu-Flo Wellhead. Enter the three digit temperature value using the Number KEYS. (XXXo F or C depending on units selected.) For example, if the gas temperature is 95 degrees enter 095. Note all digits must be entered. When done press KEY 0-Continue and return to the screen shown in Figure 5.14. Ensure the differential and static pressures are stabilized before continuing. Press the KEY 2 to continue.

T----°F	1-EnterTemp
SP+0.45"	3-ZeroPressure
DP-00.0"	9-Last Data
0-Back	2-Continue

Figure 5.14

Note: If the optional temperature probe is used, it should be plugged into the RS-232 port on the right side of the GEM. It will automatically display the gas temperature without having to enter it as shown below.

EnterTemp

?-- °F

Figure 5.15

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10. Press the 3 KEY - Zero Pressure before proceeding. This is necessary because by taking a LFG sample in the prior step, you have pressurized the impact port pressure transducers. Warning Disconnect hoses before zeroing screen will appear (Figure 5.16). Disconnect all the hoses from the wellhead. Press any key to continue.

Figure 5.16

```
WARNING: Disconnect
hoses before zeroing

Press any key
```

11. The following screen, which is also used in the General Utilities function, 2 - Zero Pressure will appear (Figure 5.17). Press KEY 1 to zero pressure. The Zeroed OK Screen is displayed for 3 seconds and then returns to the above screen. Press the KEY 0-Exit. This returns you to the Temperature/Pressure Screen.

Figure 5.17

```
      Static  +00.2"H20
Differential -0.30"H20
1-Zero Pressures
                0-Exit
```

Note: The units displayed will be inches of water column or MB depending on USA or Metric measurements units selected.

12. Press KEY 1 to zero pressure. The Zeroed OK screen is displayed for three seconds and then returned to previous screen (Figure 5.17) Press KEY 0-Exit. The Temperature/Pressure screen will appear (Figure 5.14).

13. Connect hoses as instructed previously. Allow instrument to read and press KEY 2-Continue which proceeds to the Flow/ Btu Screen (Figure 5.18). If no well I.D. exists, you can store at this point.

Figure 5.18

```
SCFM 0000 Btu OOO3/h REF
SCFM 0000 Btu OOO3/h ADJ
6-Store           8-Log
                  0-Back
```

Note: The units displayed will be SCFM (Standard Cubic Feet per Minute) and Btu (British Thermal Units) only if USA units are selected, otherwise units will be displayed in metric.

14. At this point, if you want to change the flow, adjust the control valve on the wellhead. Within a few seconds, the new flow is shown. When satisfied with the flow adjustment press the KEY 6-Store to display the Wellhead Comments Screen

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(Figure 5.19). Press KEY 0-Back to return to the prior screens and review or re-take data.

```
Select Comments
Flex Hose
↑ -Scroll Up      2-Select
↓ -Scroll Down    0-Cont
```

Figure 5.19

15. There are eight potential comments that can be noted on the Wellhead Comments Screen shown above: Flex Hose, Valve, Casing Height, Well Bore Seal, Labeling, Air Leakage, Water Blockage, and Other. These brief notations can be made to remind the operator of maintenance or problems encountered at or near this well ID. Press KEY 2-Select to add the condition displayed on the screen to the data that is stored when KEY 0-Store is pressed. The Readings Stored Screen (Figure 5.20) is displayed for three seconds before returning to Flow/Btu Screen.

```
Readings Stored
```

Figure 5.20

~~Read Gas -Logging Function~~

Automatic gas data logging is possible with a GEM-500 as long as the batteries are charged. The logging function requires that the well being logged have an ID stored in the GEM-500. The logging time interval is from five to 60 minutes.

1. The well to be logged must have an ID already stored in the GEM-500. See the General Utilities instructions for function KEY 7-ID Maintenance. ID's can also be input as shown above during the Read Gas function already discussed above.
2. The hose to the gas sample port to the GEM-500 must be connected.
3. The Logging Screen is accessed from the Flow/BTU Screen (Figure 5.21). Press KEY 8-Log.

```
SCFM 0000 Btu OOO3/h REF
SCFM 0000 Btu OOO3/h ADJ
6-Store              8-Log
                    0-Back
```

Figure 5.21

4. The Logging Interval Screen appears as shown in Figure 5.22. Input a time interval of five to 60 minutes between sampling intervals from the GEM-500 Keyboard. If an unacceptable time is input (i.e. less than five minutes or more than 60 minutes), an "Invalid Duration - Please Enter Again" message is displayed for three seconds before returning to Figure 5.22.

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Enter Required
Logging Interval
Min 05, Max 60 Mins
Interval = ??

Figure 5.22

5. The next screen (Figure 5.23) is used to select the running time of the GEM-500's pump. There are five choices ranging from 15 to 90 seconds as shown on the following screen (Figure 5.23). If an invalid time is input, an "Invalid Time - Please enter again" message will be displayed for three seconds before returning to the screen below. Input time and press KEY 0-Exit.

Select Running Time
for Pump
15, 20, 45, 60, 90 secs.
Time = ??

Figure 5.23

6. The Logging Screen is then displayed (Figure 5.24). Logging will continue as long as the battery power in the GEM-500 can power the pump. To end logging, press KEY 0-Stop Logging. When the logging function is ended, it returns to the Flow/BTU Screen (Figure 5.18). Note that unit will not operate accurately with charger plugged in and the last few readings before battery fails may be inaccurate.

LOGGING

0-Stop Logging

Figure 5.24

7. Press KEY 0-Stop Logging and the Flow/Btu Screen re-appears. Press KEY 0-Exit twice to return to the Main Menu.

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Chapter 6-View/Print Data

The GEM-500 can be connected to a standard 132-column serial computer printer and produce a hard copy of the data stored in the memory. An optional cable is required. The data can also be viewed on the GEM-500's screen. Normally the Print function is done daily or before the GEM-500's memory is cleared in the General Utilities function 3 - Memory.

Note: Never make data or electrical connections between the GEM-500 and printer, a computer or battery charger with the power on. Both units should be turned off and the connections made before turning them back on.

View Data

1. From the Main Menu, select KEY 3-View/Print Data from the Main Menu Screen as shown in Figure 6.1.

Figure 6.1

```
1-General Utilities
2-Read Gas Levels
3-View/Print Data
4-Download Data
```

2. The Select Screen appears as shown in Figure 6.2. Choose KEY 1-View Data or KEY 2-Print Data. To return to the Main Menu Screen press KEY 0.

Figure 6.2

```
Please Select
1-View Data
2-Print Data
0-Main Menu
```

3. Press KEY 1-View Data from the Select Screen and the View Data Screen (Figure 6.3) appears. Press KEY 1 (With Specific ID) to see only one data point. Press KEY 5 to scroll through all the data.

Figure 6.3

```
VIEW DATA

1. With Specific ID
2. All Data
```

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pressing KEY-1 (Figure 6.4) or manually entering ID by pressing KEY-3 (Figure 6.5).

```
ID XXXX XXXX
↓↑ - Scroll
2 - Select        0-Exit
```

Figure 6.4

```
Please Enter ID
F-Numbers/Letters
ID XXXX ----
```

Figure 6.5

5. Press KEY 1-View Data and the screen Enter existing ID code (already in memory) using number screen and/or letter screen:
   For numbers, press Number KEYS
   For letters, press arrow KEYS 1 or 6.
   Enter each letter by pressing KEY 0 (enter)
   Use Blue KEY to switch between letters and numbers.
   Press KEY 0 - Continue after entering ID.

6. If the data is not found, the following screen (Figure 6.6) is displayed.

```
No Reading for
XXXX XXXX

1-Another ID    O-Exit
```

Figure 6.6

7. If KEY 1 (With Specific ID) or KEY 5-All Data is selected in step 4 (above), the following screen (Figure 6.7) is displayed. Use KEYS 1 and 6 on the Keyboard to move up or down the data displayed. Press KEY 5 to toggle between the two screens of data available for each ID as shown previously.

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```
USE: ↓↑-Scan     0-Exit
2-Go First    7-Go Last
5-Change data screen
Any key to continue
```

Figure 6.7

8. There are two data screens for each ID as shown below (Figures 6.8 and 6.9). KEY 5 toggles between the two data screens. Press the KEY 1-UP Arrow or KEY 6-Down Arrow to scroll through the data. Press KEY 0 to exit.

```
     ID XXXX XXXX
TAKEN   09:45  06/10/92
CH4 45.3%    CO2 48.1%
O2  01.6%     BAL 5.0%
```

Figure 6.8

```
SP + 05.8"     DP  +0.00"
T  095°
Scfm 115   Btu 000/h ref
Scfm 435   Btu  000/h adj
```

Figure 6.9

Print Data

1. If data is to be printed, connect RS-232 cable (provided) from the GEM-500 RS-232 port to the printer converter. The converter should be connected so the arrows point towards the printer as indicated on converter label. Connect the converter to the 25-pin input port of 80 column printer (Figure 6.10). To support RS-232 communications, the printer should have the following settings selected: Baud Rate-2400, Data Bits-8, Parity-none, one stop bit. Turn printer on. Turn GEM-500 on.

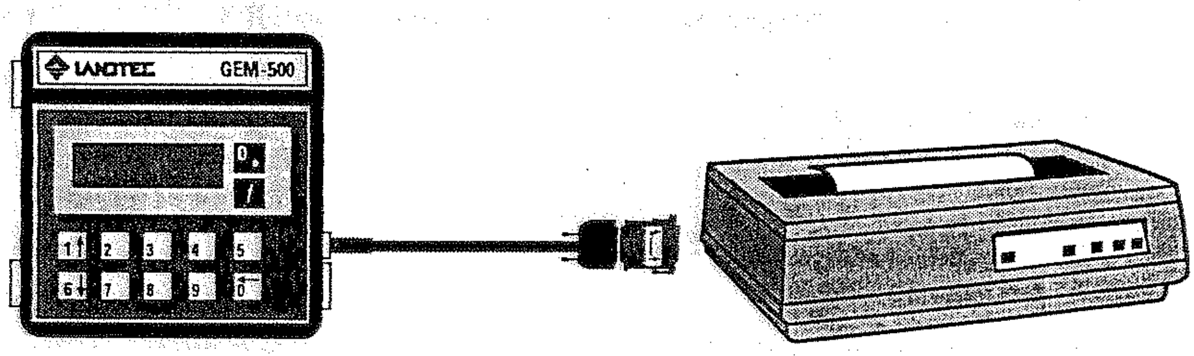

Figure 6.10

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3. The Select Screen appears as shown below (Figure 6.11). Choose KEY 1-View Data or KEY 2-Print Data. To return to the Main Menu Screen press KEY 0.

Figure 6.11

```
Please Select
1-View Data
2-Print Data
0-Main Menu
```

4. Press KEY 2-Print Data and the next screen will appear (Figure 6.12). Press KEY 1-With Specific ID to print only one data point. Press KEY 5 to print all the data.

Figure 6.12

```
PRINT DATA

1. With Specific ID
2. All Data
```

5. The next screen (Figure 6.13) shows the results if KEY 1 is pressed. To scroll through the ID list, press KEY-1 or KEY 2 to manually enter the ID.

Figure 6.13

```
Manually Enter ID or
Scroll Through?

1-Scroll    2-Manual
```

6. If KEY-2 is pressed, the following screen (Figure 6.14) is displayed. Enter existing ID code (already in memory) using number screen and/or letter screen.

   For numbers, press Number KEYS
   For letters, press arrow KEYS 1 or 6.
   Enter each letter by pressing KEY 0 (enter)
   Use Blue KEY to switch between letters and numbers.
   Press KEY 0 - Continue after filling in ID.

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Please Enter ID
Numbers/Letters
ID XXXX----

Figure 6.14

Note: In the steps below, if the printer cannot print (no paper, etc.) a printer-error screen will appear on the GEM-500. Press KEY 6-RETRY or press KEY 0-Exit to end

7. If KEY 5-All Data is selected in step 2, the following screens are displayed depending on the stage of printing (Figures 6.16, 6.17 or 6.18).

Printing-Please Wait

Figure 6.16

Printing Aborted

0-Exit

Figure 6.17

Printing Complete

0-Exit

Figure 6.18

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The report format is shown below. The stored data is sorted by time, date, and ID

Time	Date	ID	CH4	CO2	O2	Bal	Pressures	Old			Adjusted	
		%	%	%	%	Stat	Diff	Temp	Flow	BTU	Flow	BTU
						" H2O	" H2O	_F	Scfm	/cf	Scfm	/cf

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Chapter 7-Download Data

This procedure covers the electrical connection of the GEM unit to IBM PC compatible host computer via an RS-232 cable, installation of the GEM software program (contained on READ_GEM floppy disk) into a file on the compatible host computer, calling up the file on the host computer's screen, and then downloading data from GEM unit into host computer by following instructions on the GEM's screen and on the computer.

Information is normally downloaded after each days' readings are taken. The stored data is also downloaded before the GEM's memory is cleared because it is full (see General Utilities -3 Memory).

Note: Never make data or electrical connections between the GEM and printer, a computer or battery charger with the power on. Both units should be turned off and the connections made before turning them back on.

The optional RS-232 cable is plugged into the GEM using a special plug. The temperature probe, battery charger and RS-232 cable all use the same input plug. Do not try and substitute any other cables or plugs than ones provided by LANDTEC. The plug end of the RS-232 cable that goes into the host computer is a standard serial cable. Plug it into the serial port when the computer is turned off.

Installing the Download Program on the Host Computer

LANDTEC's UNI-DOWN program software converts the binary data from the GEM-500 to ASCII format. Data in ASCII format can be imported into LOTUS* 1-2-3TM, Excel*TM and many other programs that accept comma delimited data files. LANDTEC is currently developing a pc based landfill data management system that will upload the GEM files into a database to produce management and regulatory reports.

1. Turn on host computer and go to DOS (Disk Operating System) prompt.
2. Insert LANDTEC's GEM download floppy disk into host computer floppy drive.
3. Install the GEM software into a sub-directory of your choice, using the drive of your choice, by typing the following instructions in bold face (assuming drive A was the floppy where the source diskette is located and C was chosen as the destination drive).
   C:\>MD GEM <ENTER>
   C:\>CD GEM <ENTER>
   C:\>GEM> COPY A:*.* <ENTER> C:\GEM<ENTER>
4. Remove the diskette in drive A. Store it in a safe place. You may want to make a duplicate of it as a backup.
5. GEM software program is now installed on the host computer.

Starting the Download Program on the Host Computer

1. Turn off the computer and attach the serial connector to COM Port 1 or 2 of the computer. Plug the RS-232 connector into the GEM and connect the remaining end of connector to the RS-232 connector as shown in Chapter 6, Figure 6.10. Turn on the host computer.
2. At the C> prompt on the host computer, change to the GEM sub-directory by typing:
   C:\> CD GEM <Enter>
   C:\> READ_GEM<Enter> If connected to COM Port 1
   or READ_GEM COM2 <Enter> If connected to COM Port 2.
   or READ_GEM SPLIT <Enter> If time/date field to be split (see below)
   or READ_GEM SPLIT COM2 <Enter> If time/date field to be split on COM Port 2
   The preferred version is READGEM SPLIT.
3. The next screen to appear is shown as Figure 7.1. The screen is somewhat confusing. The message on the right side is discussing a feature in the software which selectively downloads data by ID Code, by time or by date. If the GEM contains data from two different landfills, OTAY and OXND, by filling in the first part of the code below with OXND XXXX, only the data from OXND will be downloaded.

Note: If only the data taken on a specific day were desired, by filling in the date in the proper field, would download only that data from the GEM. This might be in response to a request for listing all the reads taken on a specific day. It is similar for selecting a specific time. Various fields may be combined in any manner for a selective sort of GEM data on this screen.

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GEM Readings Transfer Utility Version 1.1 09/06/93

Please prepare to download readings from the GEM readout:
1) Switch on the GEM.
2) Connect RS-232 link to COM 1.
3) Press KEY 0.
4) Select option 4-Download data by pressing KEY 4.
5) Wait for data to be received.

WAITING

Press RETURN to download all data from the unit. Press "?" to examine data. It is also possible to store only data based on the following: Code, Time, Date. Using the arrow keys, position the cursor then enter the correct digit. Only files where the data entered corresponds to the data in a file will be downloaded. Where "X" equals any digit.

Code	Time	Date
**** ****	**:**	**/**/**

Landfill Control Technologies

Press ESC to exit.

Figure 7.1

4. When done with any selective sorting discussed in step 3, press the Enter Key on the host computer and proceed as follows.

5. Turn on the GEM after the RS-232 Cable has been connected to both the computer and the GEM. Press the RED ON/OFF switch on the GEM. After the normal Warning Screen the RS-232 MODE Awaiting Instruction Screen appears (Figure 7.2). Press KEY 0 to proceed to the Main Menu Screen. Press KEY 4 - Download Data and the screen shown below appears on the GEM.

RS-232 MODE

Awaiting Instruction from computer

Figure 7.2

6. Meanwhile, the host computer's screen appears as shown in step 3 above. A message appears on the right side saying Reading Download xxx. As each record is read the xxx digits keep increasing until all the data is read into a temporary file in the host computer.
7. By pressing the Shift, the data can be scanned on the host computer (Figure 7.3). The data scan screen is shown below. The down cursor arrow (or up cursor arrow) can be used to scroll through each ID record that was downloaded.

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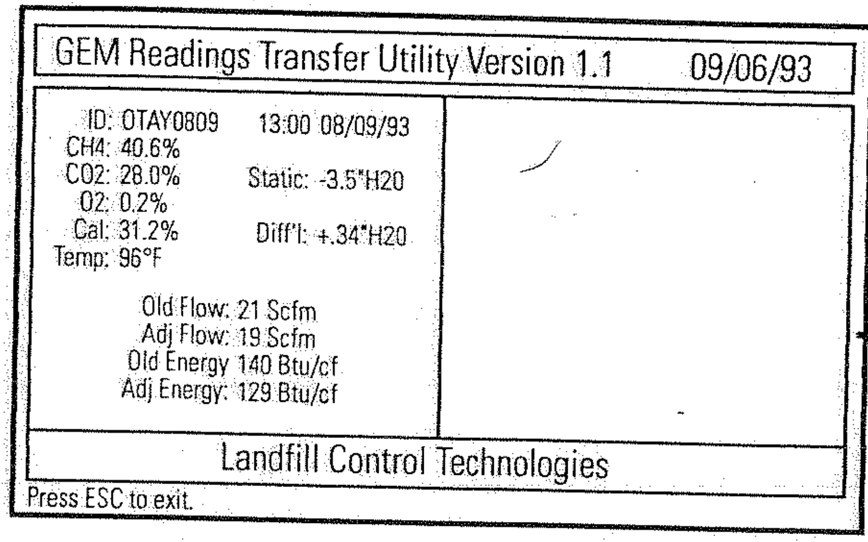

Figure 7.3

8. This step is CRITICAL. Press the <Enter> key on the host computer. A box is displayed and a file name of up to eight characters plus three character extension must be input. Press <Enter> after inputting file name. Otherwise, the temporary file in the host computer is not saved. An example is shown as Figure 7.4.

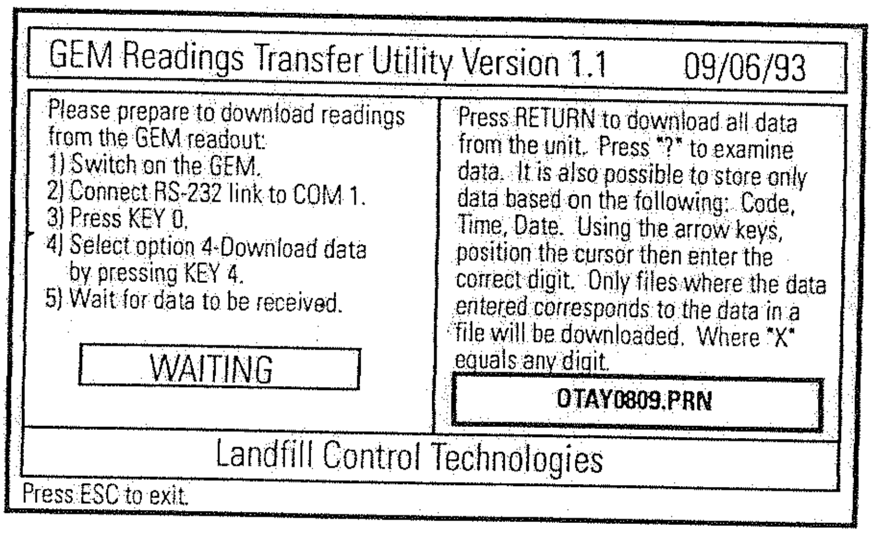

Figure 7.4

9. The GEM can be turned off after the data is downloaded. It can now be unplugged and returned to service or re-charged with the battery charger as required.
10. By pressing the ESC key SEVERAL TIMES on the host computer. You can back out of the download program to the DOS C> prompt.
11. A daily back-up or download is strongly recommended.

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Chapter 8-GEM-500 Well ID Manager

This software allows ID information to be sent to and from the GEM readout. ID information can be entered on a computer, stored to disk, and transferred to the GEM. ID information in the GEM can be downloaded to the computer, edited, stored to disk, and sent back to the GEM.

User Control

The software is controlled from a menu of options. The user selects the option using the cursor keys. A detailed description of the menu appears at the bottom of the screen. Main menu options include:

- Well ID Function
- User Defined Comments
- Clear Function
- Show GEM Memory Statistics
- Configure
- Exit

Connecting the Computer to the GEM

Connect the RS-232 download lead to the desired COM port of your computer, and connect the 'Lemo' connector to your GEM. Select option 4-Download from the main menu of the GEM.

Installing the software on a hard disk

Insert the disk in drive A: and create a directory on the hard disk for the software, and copy the program file on to the hard disk:

C:\> MD GEM	[Enter]	Create a directory
C:\> COPY A:*.* GEM	[Enter]	Copy the files
C:\> CD GEM	[Enter]	Change to the directory
C:\> IDBRIDGE	[Enter]	Run the software

Select the Set default COM port option from the menu on the PC software. Select either COM1 or COM2. The software is now ready for communications.

Well ID Functions

Create New ID Set

This option allows a completely new ID set to be created ready for transfer to GEM or storage to disk. The Well ID Functions window is displayed. You may now enter well ID information. See the Edit ID Information section for details about entering and editing ID data.

Edit ID Information

The option also ID data to be edited using the computer, ready for saving to disk or transfer to GEM. The currently loaded ID set is displayed. If there are more IDs than fit in the screen the user can scroll through the list using the Page Up and Page Down keys. All ID codes must have 8 characters and the characters must be either A..Z or 0..9. To select a flow type use the left or right cursor keys to select the flow type field. A list of available flow types is displayed, use the up and down cursor keys to select the desired type and the press Enter or left/right cursor key to store the selection. It is only possible to move the cursor on to a different ID when a valid entry has been made. A beep sound is made if an ID entry is invalid. Correct the mistake before continuing. Press F2 to store the changes to the ID information into the computer's memory. You will now need to either select Save IDs to disk or Send IDs to GEM option.

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Send IDs to GEM

This option allows the currently loaded (from GEM or disk) ID set to be transferred to the GEM. The user will be prompted to select option 4-Download on the GEM if this has not already been done. The data will then be sent to the GEM. The ID codes will be displayed as they are transferred.

Receive IDs from GEM

This option allows IDs already stored in the GEM to be downloaded to the computer for storage to disk or editing. The software will prompt the user to select option 4-Download if this has not already been done. The ID code for each GEM ID will be shown as the computer receives it. Once all of the IDs have been read they will be shown in the edit screen. You can now edit the data, or press Esc to return to the main menu. To store the data to disk select the Save IDs to disk option. For editing ID data see the description under Edit ID Information.

Save IDs to Disk.

This option will store to disk, in an 'ASCII' file, the currently loaded ID information. Cursor must be under last code entered (use arrow key) to save ID. A file selector is displayed for the user to select a file. Enter a new filename or select a previously saved file. Then press enter, the file has now been stored. The files are stored to disk in an ASCII format. The file can be edited using any ASCII text editor, i.e. one that does not introduce control characters into the file. When editing these files manually it is important to note that the flow types must be one of the following, and must be entered correctly. Also for Orifice Plates the first value is the Pipe Inside Diameter.

Flow Types
ACCUFLO-1V
ACCUFLO-1H
ACCUFLO-2V
ACCUFLO-2H
ACCUFLO-3V
ACCUFLO-3H
ORIFICE PLATE
PITOT TUBE
USER INPUT

Note: The file name entered should always have the extension .IDM. unless the user specifically enters something different, however only files with the IDM extension are displayed in the file list.

Load IDs from Disk

This option allows previously saved data to be loaded into the computer for editing or transfer to GEM. The software will display a file selector showing all files with the filename extension IDM (all ID files must have this extension). Use the cursor keys to select the desired file and press Enter. If you know the filename you may type the name directly. Once the file is loaded, the Edit option shows the ID information. You can press Esc to return to the main menu.

Note: If an ID that already exists is sent to the GEM, the one in the memory of the GEM will be overwritten. If the ID does not already exist it will be appended to the list in the GEM. Transfer will be aborted if there is insufficient memory in the GEM to store all ID codes and an error message will be displayed on the PC.

Clear Functions

Clear IDs in GEM

This option will delete the ID information in the GEM. Select the option and press F1 to delete the ID information.

Clear readings in GEM

This option will delete the readings in the GEM. Select the option and press F1 to delete the all readings.

Clear User Defined Comments in GEM

Erases user defined comments in GEM.

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Show GEM Memory Statistics

This option shows how much unused memory the GEM has, also the amount of memory used by IDs and by readings. The available memory is shared between readings and IDs, so the more IDs in the GEM, the less memory is available for data.

NOTE: If changes have been made to the ID information the computer will warn the user before either Exiting, Loading IDs from disk, or receiving IDs from the GEM. This option should be used with caution as it is not possible to retrieve the data once it has been deleted.

Configure

Configuration File

The configuration file contains the default parameters for Data Directory, COM port, and Units (metric or imperial).

File Format (GEM.INI)
[GEM ID Manager]
Path=directory name
Port=n
Units=type
where, n is either 1 for COM1 or 2 for COM2
type is either 'metric' or 'imperial'

Set Units to Imperial/Metric

This option is swaps between metric and imperial units when editing the ID information. The state of this option is stored to disk in a configuration file and so will be used the next time the software is loaded.

Set Data Directory

The default data directory is used to define which path name is used for Load IDs from disk and Save IDs to disk options. The path name is stored in a configuration file and is used next time the software is loaded.

Set default COM Port

This option allows either COM1 or COM2 to be used for RS-232 communications. Press '1' for COM1 or '2' for COM2. This setting is stored in a configuration file.

Sort Well IDs

Option On/Off enables well IDs to be sorted alphabetically after being received from the GEM.

User Defined Comments

1. Create new comments. Create new set of user defined comments.
2. Edit Comments.
3. Send comments to GEM.
4. Receive comments from GEM.
5. Save comments to disk.
6. Load comments from disk.

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Chapter 9-Maintenance

Servicing

The unit has been electronically and functionally tested before leaving the factory. It is recommended that with normal usage, the GEM-500 be serviced every six months for routine factory servicing, maintenance and re-calibration.

Cleaning

The polycarbonate membrane panel may be wiped clean with soapy water and a damp cloth if required. We do not recommend any other cleaning agents. Protect the GEM-500 by keeping it in its protective soft case.

Sunlight and Heat

The unit should not be left out in direct sunlight for long periods of time as this will raise the temperature inside the case which could cause damage to components. The GEM-500 may not operate or may operate erratically if it gets too hot. Let it cool before trying to use it.

Dustcaps

Always keep the protective dust caps in place when ports and connectors are not in use.

Filters

The unit is equipped with two filters. One filter is external to the GEM-500. It is in-line in the sample hose. The filter is easily accessed by unscrewing the filter holder. A second filter is inside the GEM-500 and is located just inside the sample port inlet. This filter can be accessed by unscrewing (counter-clockwise) the port using a screwdriver or a small coin. Both filter holders are sealed with o-rings. Periodically inspect the o-rings to check their condition. Replace the o-rings if they become nicked, cut, swelled or otherwise damaged. The GEM-500 unit is shipped with a spare filter of each type. Only genuine LANDTEC filters should be used.

Replace the filter when the sample pump has difficulty drawing a sample of gas into the unit and a "Flow Fail" message appears on the screen and a continuous audible warning is heard.

If the filter becomes wet a "Flow Fail" message appears on the screen and a continuous audible warning also be heard.

Storage and Travel

Store the GEM-500 in its protective hard case when taking it from site to site. This offers maximum protection and brings along all the required accessories for the GEM-500. The GEM-500 is a delicate instrument. When charging the battery overnight, the GEM-500 can be stood upright or laid flat. If the unit is to be stored for a long period, charge the internal batteries prior to storage. Re-charge the unit every two months during storage and store flat or the oxygen sensor may ultimately dry out. This condition can be corrected with normal use.

Battery Charging

Please follow these instructions carefully.

1. The internal battery pack of the GEM-500 is designed to be recharged many times but as with all nickel-cadmium cells, certain rules should be observed or the batteries will not provide their full power or operating time.
2. Let the batteries almost fully discharge before re-charging. Do not top off an almost full battery charge or memory patterns will be established and the battery will not provide its full capacity.
3. When charging the batteries, let them charge at least 12 hours, 14 hours is preferred.
4. Never let the batteries charge for more than three or four days.
5. Disconnect the charger from the GEM-500 after the batteries have charged.
6. Never try to operate the GEM-500 while the batteries are re-charging.

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Note: Heat from the battery compartment makes the front of the GEM-500 (where the GEM-500 label is located) warm to the touch while the batteries are charging.
Note: If the GEM-500 is repeatedly given small "top-off" charges, the battery capacity can be reduced. To restore the battery to full capacity, totally discharged the unit and then charge it for a full 14 hour period. Prior to recharging the unit, run the pump to completely discharge the battery.

Battery Shut-Off

A circuit within the GEM-500 continuously monitors the battery voltage. If the battery voltage falls below a pre-determined level, the unit will automatically shut itself off in order to prevent memory loss. If the unit shuts itself of, the unit requires a full charge of 14 hours to restore the battery to its maximum level.

Battery Low Symbol

There is a Battery Symbol used on the top right corner of the GEM-500's display screen. It displays as the battery capacity reaches about 10% of full charge. There are only about 30-45 minutes of full pump power left in the GEM-500 when the symbol is displayed.

Automatic Power-Off

The GEM-500 has an automatic power-off timer to conserve battery power. If no key is pressed for 15 minutes, the unit will automatically switch itself off (no stored readings will be lost).

Emergency Battery Power

In emergencies, the GEM-500 may be operated with 6 "C" sized alkaline batteries. To use alkaline cells, remove the nickel-cadmium battery pack by using a Phillips screw driver on the back battery compartment of the GEM-500. Insert the alkaline battery "C" cells.

WARNING: Do not use the battery charger for standard alkaline batteries—they can explode if re-charged.

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Chapter 10-Troubleshooting

The GEM-500 does not turn on or operates erratically

The unit may be too hot

Do not leave in car trunks or expose to high temperatures.

The batteries are so low that they will not display any screens

This is done to protect the GEM-500's memory. Recharge the unit for 14 hours.

The GEM-500 Displays ****** or >>>> in Some Fields

The GEM-500 substitutes the symbols because there is no valid information to display. Typically a temperature needed to be input or a pressure reading is required to calculate flow. If data is missing the symbols are substituted.

The Screen Says "FLOW FAIL" With a Continuous Audible Warning

One or more of the GEM-500's filters are blocked and need to be changed. The filters may be dirty or wet. Change the filters as instructed in Section 8 - Maintenance.

The Carbon Dioxide Readings Drift Erratically

Leave the GEM-500 in its soft case. Do not place a heat source (including placing the GEM-500 on very hot soil, or the palm of your hand being placed on the back of the GEM-500) on the back of the GEM-500 below the battery compartment. If it persists after the above problems have been corrected, perform a Field Calibration.

The Readings Taken by GEM-500 are Not What is Expected

Use Calibration Gas to test your GEM. With its known composition, you will immediately know the if the GEM-500 is in calibration. Field Calibration may be necessary. Once you have extablished the accuracy of the GEM-500 on calibration gas, you should accept the results it is providing.

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Chapter 11-Measurement Units and Specifications

Measurement Units

Screen 1

Type	Displayed As	USA (Imperial)	Metric (SI)
Methane	CH_4%	% by volume	% by volume
Carbon Dioxide	CO_2%	% by volume	% by volume
Oxygen	O_2%	% by volume	% by volume
Balance	BAL	% by volume	% by volume

Screen 2

Type	Displayed As	USA (Imperial)	Metric (SI)
Methane	CH_4%	% by volume	% by volume
Lower Explosive Limit	CH_4% LEL	% of 5% CH_4	% of 5% CH_4

Screen 3

Type	Displayed As	USA (Imperial)	Metric (SI)
Static Pressure	SP"	"w.c. (H_2O)	mb (millibar)
Differential Pressure	DP"	"w.c. (H_2O)	mb (millibar)
Temperature	T °F/°C	°F (degrees Farenheit)	°C (degrees Celsius)

Screen 4

Type	Displayed As	USA (Imperial)
Old (past) BTU	BTU OLD	per cubic foot
Old (past) BTU	KJ OLD	per cubic meter
Old (past) Gas Flow	scfm Feet	std. cubic feet per min.
Old (past) Gas Flow	scfm OLD	std. cubic meters per min.
Adj. (present) BTU	BTU ADJ	per hr.
Adj. (present) BTU	KJ ADJ	per hr.
Adj. (present) Gas Flow	scfm ADJ	std. cubic feet per min.
Adj. (present) Gas Flow	scfm OLD	std. cubic meters per min.

Operating Temperature

10 to 104° F/-10 to 40° C

Range and Resolution

	Sensor Range Imperial	Resolution Imperial
Methane	0-100%	0.1
Carbon Dioxide	0-50%	0.1
Oxygen	0-25%	0.1
Pressure-Differential	0-10 "w.c.	0.01
Pressure-Static	0-100 "w.c.	0.1

Accuracy

Concentration	% Methane by Volume	% Carbon Dioxide by Volume	% Oxygen by Volume
5% (LEL CH_4)	0.5%	0.5%	1.0%
15% (UEL CH_4)	1.0%	1.0%	1.0%
100%	3.0%	3.0%	n/a

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Chapter 12-Field Operations

Landfill Gas Generation

A brief overview of the theory of landfill gas generation and methane recovery follows.

Initially, when decomposable refuse is placed into a municipal solid waste landfill, the refuse is emplaced with air from the surrounding atmosphere. Through a natural process of bacterial decomposition the oxygen from the air is consumed and an anaerobic (oxygen free) environment is created within the landfill. This anaerobic environment is one of several conditions necessary for the formation of methane.

If oxygen is reintroduced into the landfill, those portions are returned to an aerobic (oxygen present) state and the methane producing bacteria population are destroyed. A period of time must pass before the productive capacity is returned to normal. Since there is some methane of a given quality within the landfill void space, a decline in methane quality is only gradually apparent depending upon the size of the landfill.

Carbon dioxide is also produced under either an aerobic or anaerobic conditions. Under static conditions, the landfill gas will be composed of roughly half methane and half carbon dioxide with a little nitrogen.

As air is introduced into the landfill, the oxygen is initially converted to carbon dioxide and a nitrogen residual remains. Measurement of residual nitrogen is usually a good indicator of the anaerobic state of the landfill, however, it cannot be directly measured. It can however be assumed and estimated, using a subtraction basis, as the balance gas. Hence, measurement of carbon dioxide is an intermediary step. Because carbon dioxide levels may fluctuate depending on the changing concentrations of the other constituent gases, carbon dioxide levels are not evaluated directly but are considered in light of other data.

In evaluation of residual nitrogen, allowances must be made if there has been any air leakage into the gas collection system or if there has been serious overpull. If enough air is drawn into the landfill, not all oxygen is converted into carbon dioxide and the oxygen is apparent in the sample. It is ideal to perform routine analysis of individual wells, as well as an overall well field composite sample, by gas chromatograph. This is not always practical at every landfill.

Under some conditions there may be a small amount of hydrogen in the LFG, (about 1 percent, usually much less). This may affect field monitoring response factors, but otherwise it can be ignored.

Subsurface Fires

If very large quantities of air are introduced into the landfill, either through natural occurrence or overly aggressive operation of the LFG system, a partly unsupported subsurface combustion of the buried refuse may be initiated. Subsurface fire situations are difficult to control or extinguish once started, present health and safety hazards, and can be quite costly. Therefore, prevention by good operation of the collection system and maintenance of the landfill cover is the best course of action. The presence of carbon monoxide is an indicator of poorly supported combustion within the landfill.

Techniques for Controlling Landfill Gas

There are many techniques for controlling landfill gas extraction. These techniques represent tools which are used together to control landfill gas. The Accu-Flo™ Wellhead is designed to work with all of these techniques. Below is a discussion of the individual techniques, how to use them and their limitations. Reliance on only a few of the techniques discussed can lead to misinterpretation of field data and mis-operation of the wellfield. Later we will discuss the best use of these techniques to optimize landfill gas control.

Controlling by Wellhead Valve Position

Unless the valve handle is calibrated for a given flow rate, this method is unreliable. The position of the valve handle alone does not provide sufficient information about the wellfield to control it. It is useful to note the relative position of the valve, and essential to know which valves are fully open or closed.

Controlling by Wellhead Vacuum

This technique relies on the relationship of well pressure/vacuum to flow for a given well. Reliance upon this method, however, can be misleading. This is because the square root relationship between flow and pressure is difficult to relate to while performing day-to-day wellfield adjustments. As decomposition, moisture, and other conditions change this method shows itself to be inadequate and imprecise.

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This method determines methane, nitrogen (balance gas) and other gas composition parameters at wellheads and at recovery facilities using portable field instruments and sometimes analytical laboratory equipment. Complete knowledge of gas composition (i.e., major fixed gases: methane, carbon dioxide, oxygen and nitrogen) is desirable. It is also necessary to check other gas parameters such as carbon monoxide to fully evaluate the condition of the wellfield. Reliance on this information can lead to mis-operation of the wellfield. Indications of excessive extraction often do not show up right away. This method often leads to a cycle of damage to the methane producing bacteria population and then to overcorrection. This cycling of the well and producing area of the landfill is not a good practice. It leads to further misinterpretation of the condition of the wellfield and has a disruptive effect on the operation of the wellfield. The use of analytical laboratory instrumentation such as a gas chromatograph is a valuable supplementary tool to verify gas composition. This normally requires collection of samples at the wellhead and analysis at some fixed location where the equipment is located. The drawbacks of this method as a primary means of obtaining information for wellfield adjustment are time expended, cost, and probably most important, responsiveness to the needs of the wellfield for timely adjustment. The laboratory analysis ownership of the equipment required is also costly. Some analysis is recommended for verification of field readings from time to time. A monthly sample of the composite gas composition at the inlet to the flare/gas recovery facility is recommended.

Controlling by Flow Rate

This is a more exact technique for determining and adjusting gas flow at individual wells. It requires using a fixed or portable flow measurement device at each wellhead to obtain data needed to calculate volumetric (or mass) flow rates. It is normally convenient to use cubic feet per minute, or per day, as a standard unit of measure for volumetric flow. It is important to distinguish between the volumetric quantity of landfill gas and the volumetric quantity of methane extracted from each well and the landfill in total. The two variables are somewhat independent of each other and it is the total quantity of methane extracted which we are interested in. It is possible for the total quantity of landfill gas extracted to increase while the total quantity of methane extracted decreases. To monitor this we can calculate the quantity of methane extracted, (LFG flow x percent methane) or the quantity of BTUs, (British Thermal Units, a standard measurement unit of heat energy), recovered per hour, (LFG flow x percent methane x BTUs per cubic foot of methane x 60 minutes per hour). It is conventional to measure BTU's per hour as a unit of time. There are approximately 1012 BTUs of heat per cubic foot of pure methane (like natural gas), although this figure varies a little among reference texts.

Measuring flow is an essential part of monitoring and adjusting a wellfield. The well should be adjusted until the amount of methane recovered is maximized for the long term. A greater amount of methane or energy can usually be recovered over the short term, however, this ultimately leads to diminishing returns. This is seen in stages as increased CO2 and gas temperature and later as increased oxygen from well overpull. In time, the methane will also decline. This is a result of a portion of the landfill, usually at the surface, being driven aerobic. In this portion of the landfill, the methane-producing bacteria will have been destroyed (due to the presence of oxygen). With the methane-producing capacity of the landfill reduced, the pore space in the area no longer producing may become filled with landfill gas equilibrating (moving in) from an unaffected producing area. This leaves the impression that more gas can be recovered from this area, and may lead to the operator opening the well or increasing flow.

Wellfield Monitoring

The frequency of LFG wellfield monitoring will vary depending upon field requirements and conditions. Normal monitoring frequency for a complete field monitoring session with full field readings (suggested normal and abbreviated field readings list follows) will vary from typically once a month to once a week. Well field monitoring should not normally be extended beyond one month. The importance of regular, timely monitoring cannot be overemphasized.

Typical Field Readings

- Name of person taking readings
- Date/time of each reading
- Methane (CH4)
- Oxygen (O2)
- Carbon dioxide (CO2)
- Balance Gas (primarily nitrogen N2)
- Wellhead gas temperature (flowing)
- Ambient temperature
- Static pressure (PS) (from GEM-500 or magnehelic)
- Velocity head (P or PT) (from GEM-500 or pitot tube and magnehelic)

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- Wellhead gas flow (from GEM-500, or pitot tube & magnehelic, or anemometer/velometer)
- Wellhead adjustment valve position (initial and adjusted)
- New wellhead vacuum and flow information after adjustment
- Calculation of each well's LFG and methane flow and sum total.
- Observations/comments.

Additionally, carbon monoxide (CO) or hydrogen sulfide (H2S) readings may be taken if problems are suspected. Supplementary monitoring once to several times a week may be performed using an abbreviated form of field readings.

Abbreviated Field Readings

- Name of person taking readings
- Date/time of each reading
- Methane (CH4)
- Oxygen (O2)
- Wellhead gas temperature (flowing)
- Ambient temperature
- Static pressure (Ps) (from GEM-500, GA-90 or magnehelic)
- Velocity head (P or Pt) (from GEM-500 or pitot tube and magnehelic)
- Wellhead gas flow (from GEM-500, or pitot tube and magnehelic, or anemometer/velometer)
- Wellhead adjustment valve position (initial and adjusted)
- New wellhead vacuum and flow information after adjustment.
- Observations/comments

Line vacuums and gas quality may be taken at key points along the main gas collection header and at subordinate branches. This helps to identify locations of poor performance, excessive pressure drop or leakage. Perform systematic monitoring of the wellfield, taking and logging measurements at each wellhead and major branch junction in the collection system.

During monitoring, examine landfill and gas collection system for maintenance issues. Record needed maintenance or unusual conditions. Examples of unusual occurrences or conditions are: unusual settlement, signs of subsurface fires, cracks and fissures, liquid ponding, condensate/leachate weeping from side slopes, surface emissions and hot spots, and liquid surging and blockage in the gas collection system. Field readings should be kept in a chronological log as well as turned into management on a timely basis.

Wellfield Adjustment Criteria

There are several criteria used in wellfield adjustment. The primary criteria is methane quality. Methane quality is an indicator of the healthy anaerobic state of the landfill and thus proper operation of the LFG collection system. However, a decline in the healthy productive state of the landfill is usually not immediately apparent from methane quality. Because of this we must consider several criteria at once.

Following are wellfield adjustment criteria for consideration.

- Methane quality (ranging from 46 percent upwards)
- The degree to which conditions within the landfill favor methane production. Typical conditions include: pH, temperature, general cover quality, moisture conditions, waste stream characteristics, placement chronology, insulation characteristics, etc.
- Oxygen quality (ranging below 1 percent, preferably less then 1/2 percent)
- Landfill cover porosity and depth in the proximity of the well
- Landfill construction factors including type of fill, size and shape of refuse mass, depth of fill, compaction, leachate control methods
- Seasonal, climatic, geographical, and recent weather, or other considerations, including seasonally arid or wet conditions, precipitation, drainage, groundwater
- Surrounding topologic and geologic conditions
- Proximity of the well to side slopes (within 150 to 200 feet and less may require conservative operation of the well)
- Nitrogen (typically 8 to 12 percent and less)
- Temperature (between ambient and about 130 °F.)

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- The design of the gas collection system
- Landfill perimeter gas migration and surface emission control, or energy recovery objectives
- Fluctuation in the diurnal cycle of atmospheric pressure.

Establishing Target Flows

For a given individual well, a target flow is established which will likely support maintenance of methane and oxygen quality objectives while maximizing the recovery of landfill gas. Typically small adjustments are made in flow to achieve and maintain quality objectives. The well must not be allowed to overpull. High well temperatures, (about 130 to 140 °F and greater), are an indication of aerobic activity and thus, well overpull. These effects may not be immediately apparent.

Well adjustment should be made in as small an increment as possible, preferably an increment of ten percent of the existing flow or less. There may be obvious conditions when this is not appropriate, such as when first opening up a well, or when serious overpull is recognized. Every effort should be made to make adjustment and operation as smooth as possible. Dramatic adjustments, or operating while switching between a high flow mode and a well shutoff mode is to be avoided.

Wellfield Optimization

Every effort should be made to continuously locate and correct or eliminate conditions, (e.g., gas condensate surging and blockage, settlement, etc.), which inhibit efficient operation of the gas collection system. This will allow well monitoring and adjustment to be significantly more effective.

Migration Control—Dealing with Poor Methane Quality

If methane and oxygen quality objectives cannot be maintained at a given well, such as a perimeter migration control well, then an attempt should be made to stabilize the well as closely as is practical, avoiding significant or rapid downtrending of methane or uptrending of oxygen.

It is not uncommon for perimeter migration control wells to be operated at less than 40 percent methane or greater than one percent oxygen. It should be recognized that these wells are likely in a zone where some aerobic action is being induced, and that there is some risk of introducing or enhancing the spread of a subsurface fire. Sometimes a judicious compromise is necessary to achieve critical migration control objectives or because existing conditions do not allow otherwise. Such situations should be monitored closely.

Wellfield Adjustment—Purpose and Objectives

The objective of wellfield adjustment is to achieve steady state operation of the gas collection system by stabilizing the rate and quality of extracted LFG in order to achieve one or several goals. Typical reasons for recovery of LFG and close control of the well field are:

- Achieve and maintain effective subsurface gas migration control.
- Achieve and maintain effective surface gas emissions control.
- Assist with proper operation of control and recovery equipment.
- Avoidance of well overpull and maintenance of a healthy anaerobic state within the landfill.
- Optimize LFG recovery for energy recovery purposes.
- Control nuisance LFG odors.
- Prevent or control subsurface LFG fires.
- Protect structures on and near the landfill.
- Meet environmental and regulatory compliance requirements.

Wellfield adjustment is partly subjective and can be confusing because it involves judgment calls based on simultaneous evaluation of several variables as well a general knowledge of site specific field conditions and historical trends. Wellfield evaluation and adjustment consists of a collection of tools and techniques which may be used in combination to achieve steady state wellfield operation.

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LANDTEC Technical Tips

Landfill Control Technologies regularly produces technical landfill related information and educational material. Please call LANDTEC to receive the current series of these Technical Tips.

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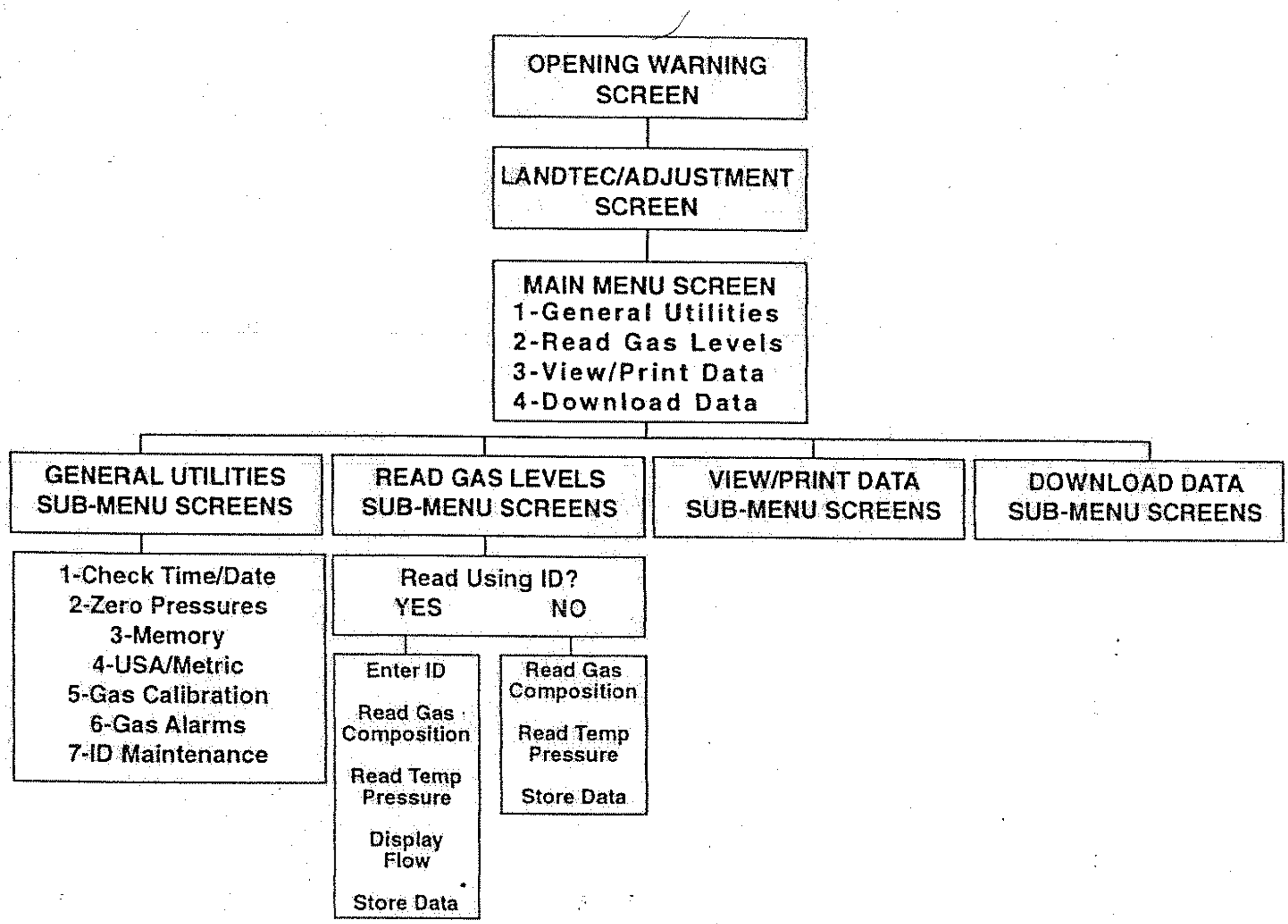
Chapter 13-Quick Start Screen Tree

Figure 13.1



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ppbRAE

PPB VOC MONITOR
PGM-7240

OPERATION AND MAINTENANCE MANUAL

(Document No: 025-4001)

Rev. C

CE

RAE SYSTEMS INC.
1339 Moffett Park Drive
Sunnyvale, CA 94089

November 2001

RAE SYSTEMS

ISO 9001 CERTIFIED

RAE Systems Product Line

- Gas Detection Tubes & Pumps
- SampleRAE Electronic Sampling Pump
- MultiRAE PLUS Multi-gas Monitors
- MultiRAE IR Multi-gas Monitors w / CO_2
- MultiRAE Confined Space Monitor
- QRAE PLUS Multi-gas Monitors
- QRAE Confined Space Monitor
- VRAE Five-Gas Monitors
- DRAE Two-Gas Monitors
- MiniRAE 2000 Portable VOC Monitor (PID)
- ppbRAE Portable ppb-Level VOC Monitor (PID)
- UltraRAE Specific Compound Monitor
- CDRAE Corona Discharge VOC Monitor
- ToxiRAE PLUS PID Monitor
- ToxiRAE PLUS Single Gas Monitors
- ToxiRAE PLUS Oxygen Monitor
- ToxiRAE PLUS Combustible Gas Monitor
- MiniRAE PLUS Classic PID
- ModuRAE Fixed System PID
- AreaRAE Wireless Multi-point, Multi-gas Detection Systems

How can I be informed and updated ?

Be sure to mail in your warranty card via e-mail, post or fax to get on RAE's private database (information is never supplied to others).

You will be updated on new products, technical advisory notices, new accessories and much more. Thank you for your purchase !

Table of Contents

⚠ ! WARNING ! ⚠

- Do NOT proceed before reading -

This manual must be carefully read by all individuals who have or will have the responsibility for using, maintaining or servicing this product.

The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions.

CAUTION!!!

To reduce the risk of electric shock, turn power off before removing the monitor cover. Disconnect the battery before removing the sensor module for service. Never operate the monitor while the cover is removed. Remove the monitor cover and sensor modules only in areas known to be non-hazardous.

The model PGM-7240 equipment is classified as intrinsically safety for use in class I, division 1, groups A, B, C, D, or non-hazardous locations only.

Special Notes

When the ppbRAE Monitor is turned on in ambient air, it may read a few hundred ppb depending on how much ionizable gases are trapped inside the detector chamber or in the ambient air. The reading should stabilize in a few minutes after the residual vapor in the detector chamber is cleared.

The battery of the ppbRAE monitor will discharge slowly even if it is turned off. If the monitor has not been charged for 5-7 days, the battery voltage will be low. Therefore, it is good practice to always charge the monitor before using it. It is also recommended to fully charge the monitor FOR AT LEAST 10 HOURS before first use. See Section 7 for more information on battery charging and replacement.

STATIC HAZARD:

Clean only with damp cloth.

DANGER RISQUE D'ORIGINE ELECTROSTATIQUE:

Nettoyer uniquement avec un chiffon humide.

CAUTION:

For safety reasons this equipment must be operated and serviced by qualified personnel only. Read and understand instruction manual completely before operating or servicing.

ATTENTION:

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

WARNING:

Use only RAE Systems battery packs, part nos. 012-3050, 012-3051 or 012-3052. This instrument has not been tested in an explosive gas/air atmosphere having an oxygen concentration greater than 21%. Substitution of components may impair intrinsic safety. Recharge batteries only in non-hazardous locations.

AVERTISSEMENT:

Utiliser seulement l'ensemble de batterie RAE Systems, la reference 012-3050, 012-3051 au 012-3052. Cet instrument n'a pas été essayé dans une atmosphère de gaz/air ayant une concentration d'oxygène plus élevée que 21%. La substitution de composants peut compromettre La sécurité intrinsique. Ne charger Les batteries que dans L'emplacements désignés non dangereuse.

WARNING:

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 used or put into service.

For maximum safety, the accuracy of the ppbRAE should be checked by exposing the sensor(s) to known concentration calibration gas before each day's use.

AVERTISSEMENT:

La calibration de toute instruments de RAE Systems doivent être testé en exposant l'instrument a une concentration de gaz connue par une procédure dietalonnage avant de mettre en service l'instrument pour la première fois.

Pour une securite maximale, la sensibilité du ppbRAE doit être verifier en exposant l'instrument a une concentration de gaz connue par une procédure dietalonnage avant chaque utilisation journalière.

1. GENERAL INFORMATION

The ppbRAE parts per billion (ppb) Volatile Organic Compound (VOC) Monitor (Model PGM-7240) is an extremely sensitive Photo-ionization Detector (PID) for real-time monitoring of volatile organic compounds (VOCs) at ppb levels. With its highly compact design, it is used as a broadband VOC gas monitor and datalogger for work in hazardous environments. The new RAE patented PID sensor has an increased sensitivity down to a few ppb, with reduced humidity interference, improved linearity, and an easily accessible lamp and sensor. Features are:

- **Lightweight and Compact**
  - Compact and light weight (19.5 oz. with battery pack) in a durable, rugged design.
  - Strong, built-in sample draw pump with stall feature preventing liquid from flowing into the monitor.

- **Dependable and Accurate**
  - Snap-in, field replaceable NMH rechargeable battery with smart battery charging.
  - Up to 10 hours of continuous monitoring with rechargeable battery pack.
  - Alkaline battery holder supplied.
  - Automotive charger available.
  - Continuously monitors VOCs at ppb levels.
  - Selectable cancel and show background of VOCs.
  - 102 built-in correction factors from a RAE list of 250+ chemicals.
  - Protective rubber boot included.

- **User Friendly**
  - Large keys operable with or without gloves.
  - Large easy to read display with back light.
  - Alarm activated.
  - Darkness or manually activated.
  - 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.
  - User selectable hygiene and survey modes.
  - Protected from EMI and RMI.

- **Datalogging Capabilities**

  15,000 point datalogging storage capacity for data download to Personal Computer (PC).

- **Specifications**

  The **ppbRAE** consists of a PID with associated microcomputer and electronic circuit. The unit is housed in a rugged ABS + PC case with a backlight 1 line by 8 character dot matrix LCD and 3 keys to provide easy user interface.

Table 1-1. General Specifications

PPB VOC Monitor Specifications	
Size	8.2"L x 3.0"W x 2.0"H or 21.8 cm L x 7.62 cm W x 5.08 cm H
Weight	19.5 oz with battery pack
Detector	Photo-ionization sensor with standard 10.6 eV or optional 9.8 eV UV lamp.
Battery	Rechargeable, compartmentized, field replaceable Nickel Metal Hydride battery pack.
Battery Charging	Up to 10 hours quick charge through the built-in smart charger.

Operating Hours	10 continuous hours
Display	Large LCD display, manual, auto back light, and alarm activated.
Range, Resolution, & Response Time (t_{90}):	*Isobutylene (calibration gas)* 0-9999 ppb 1 ppb <5 sec 10.0-99.9 ppm 0.1 ppm <5 sec 100-199 ppm 1 ppm <5 sec *(Note: When using a 9.8 eV lamp, the reading may fluctuate. For more stable, accurate results use a 10.6 eV lamp.)*
Measurement Accuracy:	*(Isobutylene with 10.6 eV lamp)* ±20 ppb or ±10% of reading
PID Detector	Easy access to lamp and sensor for cleaning and replacement.
Correction Factors	102 built-in VOC gases
Calibration	Two-point field calibration of zero and standard reference gas.
Background Display	User selectable to monitor or cancel background level.
Calibration Memory	Eight calibration curves, alarm limits, span values, and calibration date.
Robust inlet probe	Flexible 5" tubing
Large Keypads	One operation key and two programming keys.
Direct Readout	Instantaneous, TWA, STEL and peak values; battery voltage and elapsed time.
Intrinsic Safety	UL & cUL Class 1, Division I, Group A, B, C, D (US & Canada), EEx ia IIC T2 (Europe).
EM Interference	No effect when exposed to 0.43 W/cm^2 RF interference (5 watt transmitter at 12 inches).
Alarm Setting	Separate preset alarm limit settings for Low, High, STEL and TWA alarm.

Operating Mode	Survey or Hygiene, user selectable
Audible Alarm	90 dB buzzer
Visual Alarm	Flashing red LED
External Alarm	Optional plug in pen size vibration alarm.
Alarm mode	Latching or automatic reset (non-latching).
Datalogging	15,000 points with time/date. Header information include monitor serial number, user ID, site ID, date, and time.
Communication	Download data and upload instrument setup from PC through RS-232 link to serial port. Software compatible with Windows™ 95, 98 and NT.
Remote Control	Power On/Off and data logging through RS-232 port.
Analog Output	Calibrated output, user selectable full-scale range.
Sampling pump	Internal integrated flow rate 400 cc/minute
Low Flow Alarm	Auto shut off pump at low flow condition.
Temperature	14°F to 113°F (-10°C to 40°C)
Humidity	0% to 95% relative humidity (non-condensing)
Attachment	Wrist strap

2. OPERATION OF ppbRAE

The ppbRAE PPB VOC Monitor has a compact design for use as a broadband VOC gas monitor and datalogger for work in hazardous environments. It gives real-time measurements while activating alarm signals whenever the exposure exceeds preset limits. Prior to factory shipment the ppbRAE is preset with default alarm limits and the sensor is pre-calibrated with standard calibration gas. However, the user should calibrate the instrument before first use. After the monitor is fully charged and calibrated, it is ready for immediate operation.

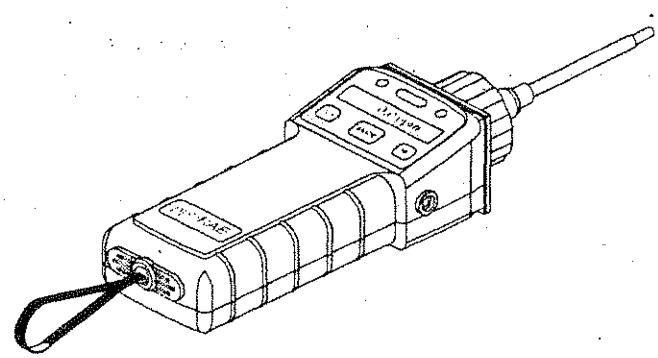


Figure 2-1. ppbRAE

2.1 Physical Description

The main components of the ppbRAE PPB VOC monitor include:

- Three keys for the user to interact with the monitor: 1 operation key and 2 programming keys for normal operation or programming of the monitor.
- LCD display with backlight for direct readout and calculated measurements.
- Buzzer and red LED's for alarm signaling whenever the exposures exceed preset limits.
- Wrist strap
- Charge contact for plugging directly to the charging station
- Gas entry and exit ports
- Serial communication port for PC interface
- External alarm and analog output port
- Protective rubber cover

2.2 Keys and Display

Figure 2.2 shows the LCD display and the keypad on the front panel of the monitor. The function of the 3 keys during normal operation are summarized below:

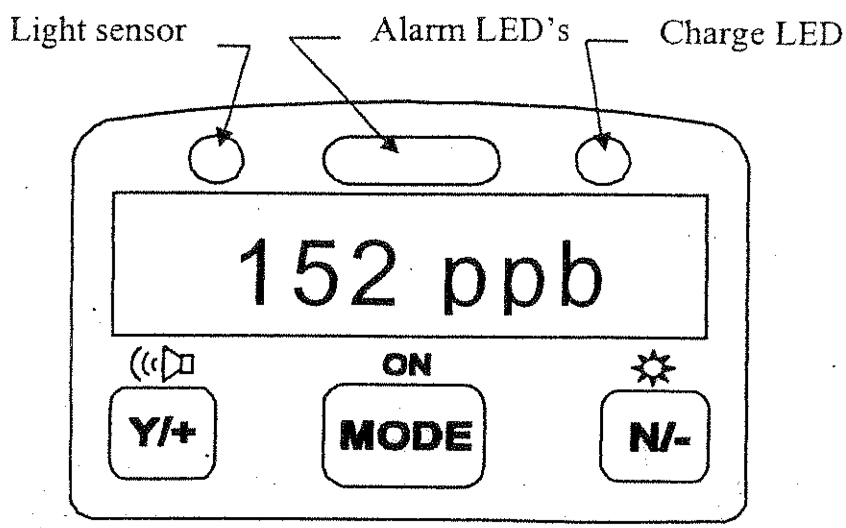


Figure 2-2. Liquid Crystal Display and Keypad

Key	Function in Normal Operation
[MODE]	Turns the power on/off and steps through the menu items.*
[N/-]	Toggles the back light on/off; negative acknowledgement/decrement of value.
[Y/+]	Starts the measurement; positive acknowledgement/increment of value.

* Press the **[MODE]** key momentarily to step through menu items. To save time, press any key while a message is scrolling to skip to the end of the message.

2.3 Power On/Off

To turn ON the ppbRAE monitor, press the **[MODE]** key for one second and release. The audio buzzer will beep once and the air pump will turn on. The display will show "ON!.." and then "Ver n.nn" to indicate the unit's current firmware version number. Displayed next are the serial number, model number, operating mode, current date and time, unit internal temperature, gas selected, high, low, STEL, TWA/AVG alarm limits, battery voltage, and shut off voltage. Also displayed are internal mode settings such as User mode, Alarm mode, datalog time remaining and log periods in the respective order.

To turn OFF the ppbRAE monitor, press and hold the **[MODE]** key for 5 seconds. The monitor will beep once per second during the power-down sequence with a count down timer showing the number of remaining seconds. The message "Off!.." flashes on the LCD display and the display will go blank indicating that the monitor is turned off.

Data protection during power off

When the monitor is turned off, all the current real time data including the 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. While the power is off, the real time clock will continue to operate until the battery is completely drained (usually in four to five days without recharging). If the battery is completely drained or is disconnected from the monitor for more than 30 minutes, the real time clock will be lost. In this case, the user needs to enter the real time clock information again, as described in Section 4, or send the clock information from the PC clock during configuration through the PC communication connection.

2.4 Operation

The **ppbRAE** PPB VOC monitor has two operation modes: **Survey** and **Hygiene** mode. The **Survey mode** allows the user to manually start and stop the monitoring/measuring operation and display certain exposure values. In the **Hygiene mode,** the monitor runs continuously after the monitor is turned on.

2.4.1 Survey Mode

After the monitor is turned on, it runs through the start up menu. Then the message **"Ready.."** is displayed (see figure below). At this point, the user has two options: (1) step through the operation menu, or (2) take a measurement.

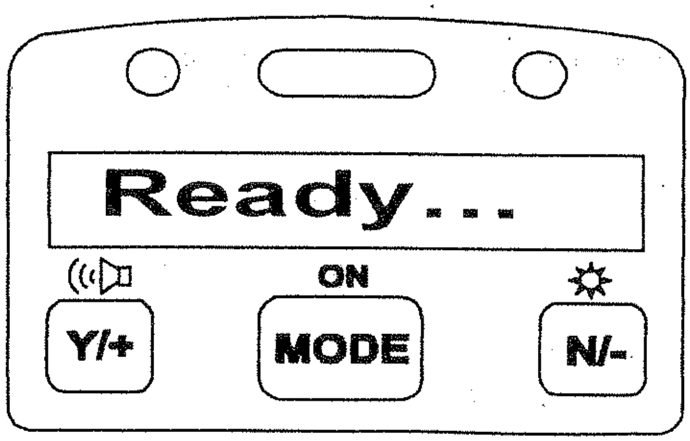


Figure 2-3. Survey mode Ready…

Press the **[MODE]** key to cycle through the idle operation menu. The PID sensor and pump are turned off during this idle operation.

Main operation menu displays include:

- **"Ready…"**
- **Avg reading**
- **Peak reading**
- **Run time**
- **Current battery voltage and shut down voltage**
- **Date, time, and temperature**

- **Log on/off?**
- **PC communication?**
- **Survey, Site ID, and Gas Name**

The displays are arranged in a "round robin" order:

To choose a specific display, press the **[MODE]** key one or more times until the desired display appears.

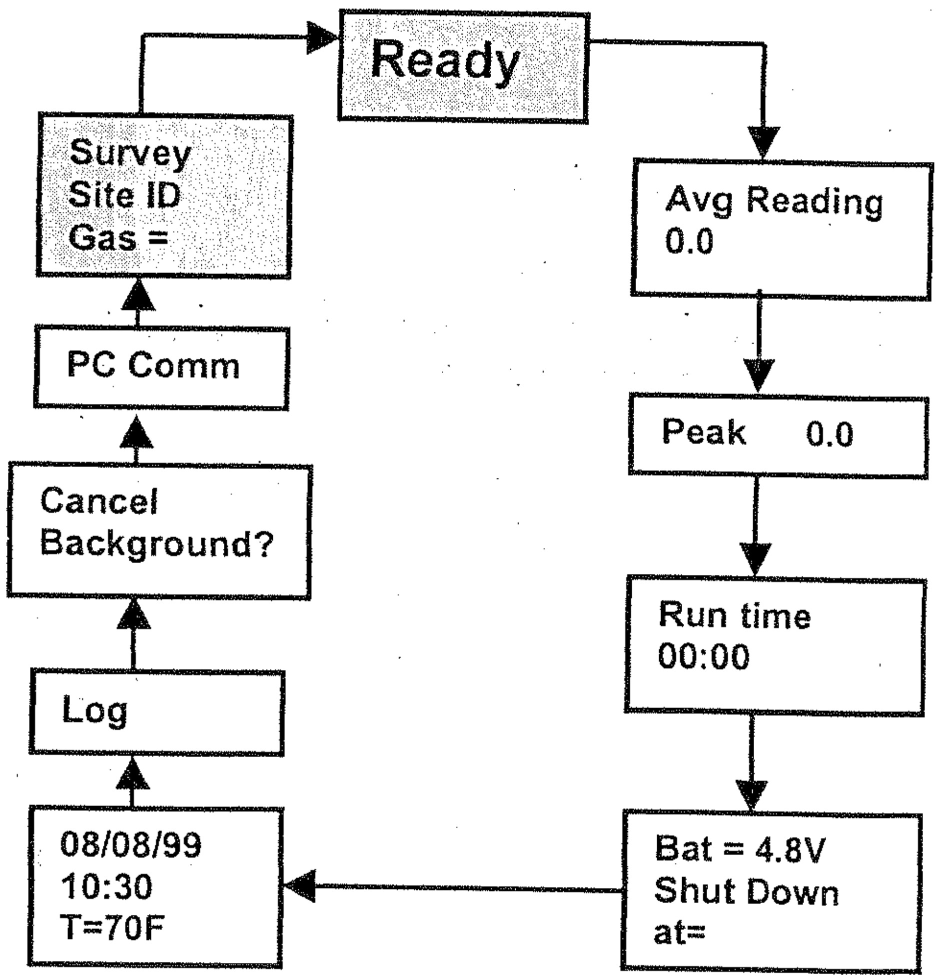


Figure 2-4. Survey Mode Flowchart

Note: To get back to "Ready" mode from any of the above displays, press the **[MODE]** key repeatedly until the "Ready" message reappears.

More details on the Main Operation Menu:

- **READY:** The monitor is ready to take a measurement. Press the **[MODE]** key to advance to the next menu display. Or Press the **[Y/+]** key to start a measurement. (Read "**Taking a Measurement**" on page 2-11 for details)
- **AVERAGE READING:** Running average since the start of the measurement.
- **PEAK READING:** The highest instantaneous reading since the start of the measurement. If the [Y/+] key is pressed while the peak reading is displayed, the unit will confirm the clear of the peak value. If the [Y/+] key is pressed again, the peak value will be cleared and the display will return to the "Ready" message or instantaneous reading.
- **RUN TIME:** The current measurement has been last.
- **CURRENT BATTERY VOLTAGE and SHUT DOWN VOLTAGE:** The present battery voltage is displayed.

  Note: A fully charged battery pack should show 4.8 volts or higher. When the battery voltage falls below 4.4 volts, a flashing "Bat" will appear as a warning message. When the battery voltage falls below 4.2 volts, there are about 20-30 minutes of run time left before the monitor turns off automatically.

  DATE, TIME, and TEMPERATURE: This menu displays the current date (month/day/year), time (24-hour format), and internal unit temperature in degrees Fahrenheit.
- **LOG ON/OFF?** Allows the user to start datalogging of the current measurement. A

superscript "L" flashes in the measurement display when datalogging is on.

Note: Before datalogging can be turned on, this function must be enabled as described in Section 4.6.4.

- **CANCEL BACKGROUND?:** The user has the option of reading the instantaneous data as an incremental value from the background readings. The count shown will be the amount detected, minus the background. The monitor will display "Cancel Background?" To accept this option, press the **[Y/+]** key, otherwise, press the **[N/-]** key to continue scrolling. If the background reading has already been cancelled, a superscript "+" flashes in the measurement display. To reinstate the background, scroll to where the monitor displays "Show Background?" and press the **[Y/+]** key. The datalog function will continue to record values that include the background whether or not it is shown in the instantaneous readings.
- **PC COMMUNICATION:** Allows the user to upload data from the ppbRAE to a Personal Computer (PC) or send/receive configuration information between a PC and the ppbRAE. Connect the monitor to a serial port of a PC, and start the ppbRAE application software. Press the **[Y/+]** key and the LCD displays "Pause monitor, ok?" Press the **[Y/+]** key one more time, the display shows "Comm..." The monitor is now ready to receive commands from the PC.
- **CURRENT OPERATING MODE:** The monitor displays the current operating mode (e.g. "Survey"), the site ID, the gas name and then returns to "Ready.."

To choose a specific display, press the **[MODE]** key one or more times until the desired display appears.

Taking a measurement:

There are two ways to start a measurement: (1)operating in the Hygiene mode and (2) manually starting and stopping measurement in the Survey mode. To start a measurement in the Hygiene mode, please refer to Section 4.7.1 on "Change Op mode." To start a measurement in Survey mode, the ppbRAE monitor must first be in the "Ready…" mode. This is the mode that the monitor normally powers up.

Measurement phases:

- **Ready**
- **Start measurement**
- **Measurement display and datalogging**
- **Stop measurement**

Ready:

The ppbRAE monitor is ready to start a sample.

Start Measurement:

Press the **[Y/+]** key to start the measurement cycle. Display will show the site ID and then the gas selected for measurement. The pump will start and the reading will be displayed.

Measurement Display and Datalog:

Instantaneous readings of the gas concentration in parts per billion (ppb) are updated every second. A flashing superscript "L" is displayed when datalogging is on. Datalog information is saved only after one full datalog period is completed (see Section 4.6.5).

Stop Measurement:

Press the **[MODE]** key and the display shows "STOP?" Press the **[N/-]** key to continue measurement and the

[Y/+] key to stop the measurement and datalog the event. The pump stops automatically when measurement is stopped.

Automatic Increment of Site ID:

Every time a measurement is taken, the site ID will be incremented by one automatically in the Survey mode.

Variable Alarm Signal:

During the Survey mode operation, if the measurement exceeds the lower limit, the buzzer, and flashing alarm will be activated.. The frequency of the alarm is proportional to the measurement value. When the measurement value is slightly above the low alarm, the buzzer and LED will beep and flash once a second. When the measurement value reaches the high alarm limit, the buzzer and LED will beep and flash 7 times per second.

2.4.2 Hygiene Mode

In the Hygiene mode, the unit will continuously take measurements, once the power is turned on. After the initial start-up sequence displaying the current monitor settings, the LCD continues to display the instantaneous readings.

The Hygiene operation menu displays include:

- **Real time readings in ppb**
- **Current TWA/Avg, STEL, and Peak values** (see **Section 4.6.6)**
- **Run time**
- **Current battery voltage and shut down voltage**
- **Date, time, and temperature**
- **Log on/off?**
- **Gas name**
- **PC communication?**
- **Hygiene**

To choose a specific display, press the **[MODE]** key one or more times until the desired display appears.

Note: To get back to instantaneous reading from any of the above displays, press the **[MODE]** key repeatedly until the "XX.X ppb" display appears.

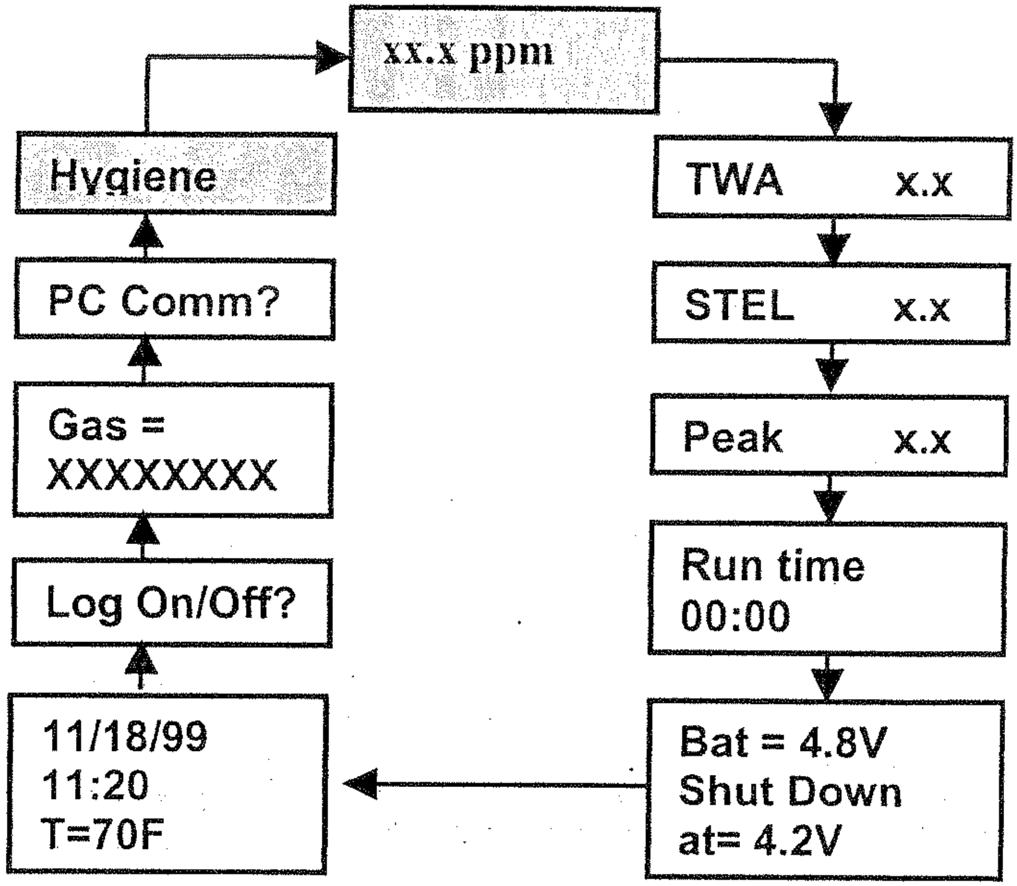


Figure 2-5. Hygiene Mode Flowchart

2.5 Alarm Signals

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

In addition, the ppbRAE will alarm if one of the following conditions occurs: Battery voltage falls below a pre-set voltage level (4.4 V), failure of the UV lamp, the pump stalls, or when the datalog memory is full. When the low battery alarm occurs, there will be approximately 20-30 minutes of operating time remaining. When the battery voltage falls below 4.2 V, the monitor will turn off automatically.

Table 2-1. Alarm Signal Summary

Condition	Alarm Signal
Gas exceeds "High Alarm" limit	3 beeps/flashes per second
Gas exceeds "Low Alarm" limit	2 beeps/flashes per second
Gas exceeds "TWA" limit	1 beep/flash per second
Gas exceeds "STEL" limit	1 beep/flash per second
Pump failure	3 beeps/flashes per second plus "Pump" message on LCD
PID lamp failure	3 beeps/flashes per second plus "Lamp" message on LCD
Low battery	1 flash per second, 1 beep per minute plus "Bat" message on LCD
Memory full	1 flash per second plus "Mem" message on LCD

Alarm Signal Testing:

Under normal non-alarm conditions, it is possible to test the ppbRAE LED and buzzer in the Special Diagnostic Mode (see Section 8 for details).

2.6 Preset Alarm Limits and Calibration

The ppbRAE portable VOC monitor is factory calibrated with standard calibration gas, and is programmed with default alarm limits. There are 102 gas settings stored in the library. Some examples of calibration and alarm limits are shown below. Refer to Section 4 for programming procedures to select a different gas, perform a calibration or set new alarm limits.

Table 2-2. Factory Calibration and Preset Alarm Limits (ppb)

Cal Gas	Span	Low	High	TWA	STEL
Isobutylene	10,000	10,000	25,000	10,000	25,000
Hexane, n-	10,000	50,000	75,000	50,000	75,000
Xylene, m-	10,000	100,000	150,000	100,000	150,000
Benzene	5,000	1,000	2,500	500	2,500
Styrene	10,000	20,000	40,000	20,000	40,000
Toluene	10,000	50,000	100,000	50,000	100,000
Vinyl Chloride	10,000	5,000	10,000	5,000	10,000
Custom	5,000	2,000	5,000	2,000	5,000

2.7 Integrated Sampling Pump

The ppbRAE PPB VOC monitor includes an integrated sampling pump. This is a diaphragm type pump that provides 450-550 cc/minute flow rate.

The pump turns on when a measurement is started, and turns off when the sample is manually stopped in the Survey mode or when the unit is turned off from the Hygiene mode.

If liquid or other objects are pulled into the inlet port filter, causing the pump to stall, the monitor will detect the obstruction and shut down the pump immediately. The alarm will be activated and a flashing error message "Pump" will be also displayed on the LCD display.

The user needs to acknowledge the pump shut off condition by clearing the obstruction and pressing the **[Y/+]** key to re-start the pump.

The pump stall threshold is set in the special Diagnostic Mode (Section 8).

2.8 Back Light

The LCD display is equipped with an LED back light to assist in reading the display under poor lighting conditions. Pressing and holding the **[N/-]** key for one second in normal operation can turn the back light on. Pressing **[N/-]** a second time can turn off the backlight. If the **[N/-]** key is not pressed, the back light will be turned off automatically after a pre-programmed time-out period to save power. In addition, the ambient light is sensed and the back light will be turned on automatically if the ambient light is below a threshold level. The back light is turned off automatically when the ambient light exceeds the threshold level.

See Section 8 for instructions on how to set the light threshold level.

Note: The LED backlight consumes about 20-30% of the total average current, when the instrument is idle or not taking a measurement.

2.9 Datalogging

During datalogging, the ppbRAE Portable VOC monitor flashes a superscript "L," on the display to indicate that datalogging is enabled. The monitor stores the time stamp, sample number, and measured gas concentration at the end of every sample period (when data logging is enabled). In addition, the following information is stored: users ID, site ID, serial number, last calibration date, and alarm limits. All data is retained (even after the unit is turned off) in non-volatile memory so that it can be down loaded at a later time to a PC.

Datalogging event

When datalogging is enabled, measurement readings are being saved. This data is stored in "groups" or "events." A new event is created and stored each time the monitor is turned on, or a configuration parameter is changed, or datalogging is interrupted (e.g. communication with the PC during the Hygiene mode). Information, such as the start time, user ID, site ID, gas name, serial number, last calibration date, and the alarm limits will be recorded.

Datalogging sample

After an event is recorded, the unit records a shorter form of the data. This data contains the sample number, time (hour/minute), and gas concentration.

3. OPERATION OFACCESSORIES

The accessories for the ppbRAE include:

- An AC Adapter (Battery Charger)
- Alkaline Battery Holder
- Water Trap Filter

Optional Accessories:

- Dilution Fitting
- Calibration Adapter
- Calibration Regulator and Flow Controller
- Organic Vapor Zeroing Kit

3.1 Standard Kit and Accessories

1. AC Adapter (Battery Charger)

WARNING:

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

Ne charger les batteries que dans emplacements designes non-dangere.

A battery charging circuit is built into the ppbRAE monitor. It only needs a regular AC to 12 V DC adapter (wall mount transformer) to charge the monitor.

To charge the battery inside the ppbRAE monitor:

1. Power off the monitor.
2. Connect the AC adapter (or the optional automotive charging adapter) to the DC jack on ppbRAE monitor. If the unit was off, it will automatically turn on.
3. The first message displayed will be "Deep discharge?" The unit will ask this question three times. If the user wants to discharge the battery pack, affirm this query with the **[Y/+]** key, otherwise the unit will move on to the charge mode directly.
4. While charging, the display message will alternate between "Charging" and "Bat=x.xV" (x.x is the present battery voltage). The LED should be red in color when charging.
5. When the battery is fully charged, the LED will change from red to green and the message "Fully charged" will appear on the display. After the battery is fully charged, the unit will enter the "trickle charge" mode. In this mode, the red LED

will turn on for several seconds each minute to maintain the full charge.

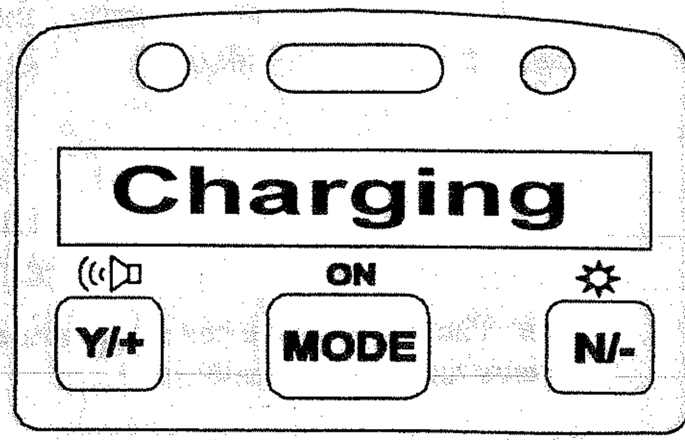


Figure 3-1. Charging the unit.

A completely discharged ppbRAE monitor will be charged to full capacity within 10 hours. The battery will be drained slowly even if the monitor is turned off. If the monitor has not been charged for 7-10 days, the battery voltage will be low.

The factory-supplied battery is designed to last for 10 hours of normal operation (no alarm, no back light condition), for a new battery under the best condition. As the battery becomes older or is subject to adverse conditions (such as cold ambient temperature), the battery capacity will be reduced significantly.

2. Alkaline Battery Holder

An alkaline battery holder is supplied with each ppbRAE. It accepts four AA size alkaline batteries and can be used in place of the Ni-MH or Ni-Cd battery pack to provide approximately 12-14 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the Ni-Cd or Ni-MH battery pack.

To install the adapter, remove the cover of the battery compartment. Remove the Ni-Cd or Ni-MH battery pack from the battery compartment and replace with the alkaline battery adapter. Replace the battery compartment cover.

The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the monitor.

Note: The AA Alkaline battery adapter supplied by RAE Systems Inc. is intrinsically safe!

3. Water Trap Filter

The water trap filter is made of PTFE (Teflon®) membrane with a 10-micron pore size to prevent water from being sucked into the sensor manifold, which would cause extensive damage to the monitor. It will also remove any dust and other particles from entering the monitor and prolong the operating life of the sensor.

To install the water trap, simply insert it to the front of the inlet tube of the ppbRAE monitor.

3.2 Optional Accessories

1. Dilution Fitting

The user may wish to install a dilution fitting on the inlet to dilute the gas samples. One application for a dilution fitting is to measure organic gas when the concentration exceeds the upper limit of the sensor range.

Make sure to set the dilution ratio in the programming mode (see Section 4.7.9) so that the correct gas reading will be displayed when the dilution fitting is used.

WARNING: To use a dilution fitting, the user must have the monitor located in a clean atmosphere outside of confined spaces and use a remote access probe or Tygon tubing to measure the gas concentration inside confined spaces.

2. Calibration Adapter

The calibration adapter for the ppbRAE 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 ppbRAE and the tubing to the gas regulator on the gas bottle.

3. Calibration Regulator and Flow Controller

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

4. Organic Vapor Zeroing Kit (Charcoal Filter)

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

4. PROGRAMMING OF ppbRAE

The ppbRAE Monitor is built with a microcomputer to provide programming flexibility. Authorized users can re-calibrate the monitor, change the alarm limits, change the site ID, user ID, lamp type, and real time clock, etc.

Programming is menu-driven to provide intuitive end-user operation. The display shows the menu options and the keypad used for menu selection and data entry.

4.1 Programming Mode

The programming mode allows users to change the setups in the monitor, calibrate the monitor, modify the sensor configuration and enter user information, etc. The programming mode has four menu items. Each menu item includes several sub-menus to perform additional programming functions. Appendix A shows a more detailed menu tree structure.

Table 4-1.
Programming Menu

Calibrate/Select Gas?
Change Alarm Limits?
View or Change Datalog?
Change Monitor Setup?

Once inside the programming mode, the LCD will display the first menu. Each subsequent menu item can be viewed by pressing the **[N/-]** repeatedly until the desired menu is displayed. To enter the sub-menu of a particular menu, press **[Y/+]** key, the sub-menu will be displayed.

Return to Operation mode: To exit the programming mode and return to operation, press the **[MODE]** key once at any of the programming menu displays.

4.2 Keys for Programming Mode

The three keys perform a different set of functions during the programming mode as summarized below.

Table 4-2. Keys for Programming Mode

Key	Function in Programming Mode
[MODE]:	Exit menu when pressed shortly or exit data entry mode when pressed and held for 1 second.
[Y/+]:	Increase alphanumerical value for data entry or confirm (yes) for a question.
[N/-]:	Decrease alphanumerical value for data entry or deny (no) for a question.

4.3 Entering into Programming Mode

1. Turn on the ppbRAE monitor and wait for the **"Ready.."** message or the instantaneous reading display **"xxx ppb"** message displayed.

2. Press and hold down both the **[N/-]** and **[MODE]** keys for three seconds to enter into the programming mode. This delay is to prevent the user from entering into the programming mode accidentally.

3. The first menu item "Calibrate/select Gas?" will be displayed.

4. Release both the **[MODE]** and **[N/-]** keys simultaneously to start the programming mode.

5. Press the **[N/-]** key to scroll to the next menu item of the programming menu. Press the **[Y/+]** key to select the displayed menu item.

The following Sections 4.4 - 4.7 describe the details of each menu option.

4.4 Calibrate and Select Gas

> **WARNING:**
>
> **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 used or put into service.**
>
> **For maximum safety, the accuracy of the ppbRAE should be checked by exposing the sensor(s) to known concentration calibration gas before each day's use.**

In the first menu of the programming mode, the user can perform functions such as calibration of the ppbRAE Monitor, select default cal memories, and modify cal memories (see Table 4-3).

Table 4-3. Calibrate/Select Gas Sub-Menu

Zero Cal?
Span Cal?
Select Cal Memory?
Change Span Value?
Modify Cal Memory?
Change Correction Factor?

Calibrating the ppbRAE monitor is a two-point process using "fresh air" and the standard reference gas (also known as span gas). A "fresh air" or zero calibration, which contains no detectable VOC (less than 200 ppb) or bottled air, is used to set the zero point for the sensor. Then a standard reference gas that contains a known concentration of a given gas is used to set the second point of reference.

Note: The span value must be set prior to calibrating for fresh air or span.

In addition to calibrations, the first menu allows the user to store calibrations for up to eight different measurement gases.

The default gas selections are as follows:

Cal Memory #0......Isobutylene
Cal Memory #1......Hexane
Cal Memory #2......Xylene
Cal Memory #3......Benzene
Cal Memory #4......Styrene
Cal Memory #5......Toluene
Cal Memory #6......Vinyl Chloride
Cal Memory #7......Custom

All cal memories may be modified to one of 102 preprogrammed chemicals or to a user-defined custom gas. In the gas library, only the gases that can be detected by the installed UV lamp will actually be displayed. If Isobutylene in memory #0 is calibrated and the selected gas in memory #1 to #7 is not calibrated, the correction factor from the library will be used automatically, so the reading for the selected gas will be correct even without calibration. If the selected gas has been calibrated, no correction factor is applied.

To change a default gas to a library or custom gas, first go to Select Cal Memory (Section 4.4.3) and then proceed to Modify Cal Memory (Section 4.4.5) to enter the desired gas.

4.4.1 Zero Calibration

This procedure determines the zero point of the sensor calibration curve. To perform a zero air calibration, connect a charcoal filter from the ppbRAE inlet to a clean ambient air without any detectable contaminants, or connect to a cylinder of zero grade air. Caution: most commercial zero air is not specified as to its impurities at ppb levels.

Note: The charcoal filter has a check box so that user can mark off a box each time the filter has been used. The charcoal filter should be replaced after four calibrations.

4.4.2 Span Calibration

This procedure determines the second point of the sensor calibration curve for the sensor. A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is needed to perform this procedure. Choose the 500 cc/min. regulator only because the flow rate matches the flow rate of the pump inside. Alternatively, the span gas can first be filled into a Tedlar Bag. Connect the calibration adapter to the inlet port of the ppbRAE Monitor, and connect the tube to the regulator or Tedlar bag.

Before executing a span calibration, make sure the span value has been set correctly (see next sub-menu).

1. Make sure the monitor is connected to one of the span gas sources described above.
2. Press the **[Y/+]** key at the "Span Cal?" to start the calibration. The display shows the gas name and the span value of the corresponding gas.
3. The display shows: "Apply gas now!" Turn on the valve of the span gas supply.
4. Display shows "wait.... 30" with a count down timer showing the number of remaining seconds while the monitor performs the calibration.
5. To abort the calibration, press any key during the count down. The display shows "Aborted!" and return to "Span Cal?" sub-menu.
6. When the count down timer reaches 0, the display shows the calibrated value.

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

7. During calibration, the monitor waits for an increased signal before starting the countdown timer. If a minimal response is not obtained after 35 seconds, the monitor displays "No Gas!" Check that the span gas valve is on and for lamp or sensor failure before trying again.

8. The calibration can be started manually by pressing any key while the "Apply gas now!" screen is displayed.

9. After the span calibration is completed, the display will show the message "Span Cal Done! Turn Off Gas."

10. Turn off the flow of gas. Disconnect the calibration adapter or Tedlar bag from the ppbRAE Monitor.

11. Press any key to return back to "Span Gas Cal?"

4.4.3 Selecting Cal Memory

This function allows the user to select one of eight different memories for gas measurement. The gas concentration reading will be automatically calculated using the correction factor inside the monitor and the calibration data in cal memory #0 if the gas is not calibrated. The user may calibrate the selected gas for that memory if no automatic conversion is wanted. The default gas selections are listed in Section 4.4.

1. "Select Cal Memory?" is the third sub-menu item in the Calibration sub-menu. Pressing the **[Y/+]** key, the display will show "Gas =" gas name followed by "Mem # x?"

2. Press **[N/-]** to scroll through all the memory numbers and the gas selections respectively. Press **[Y/+]** to accept the displayed Cal Memory number.

3. After the **[Y/+]** key is pressed, the display shows "Save?" Press the **[Y/+]** key to save and proceed. Press **[N/-]** to discard the entry and advance to the next sub-menu.

4. If the gas in a newly selected Cal Memory number is not calibrated, the display shows "CF= x.xx". A correction factor with the value "x.xx" will be applied.

5. If the gas of a newly selected cal memory number has been calibrated previously, the display shows "Last calibrated xx/xx/xx".

4.4.4 Changing the Span Value

This function allows the user to change the span values of the calibration gases.

1. "Change Span Value?" is the fourth sub-menu item in the Calibration sub-menu.

2. Press **[Y/+]**, display shows the gas name and the span value. A cursor will blink at the first digit of the Span value. To modify the span gas value, go to Step 3. Otherwise, press and hold the **[MODE]** key for one second to accept the previously stored span gas value and move to the next sub-menu.

3. Starting from the left-most digit of the span gas value, use the **[Y/+]** or **[N/-]** keys to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. Repeat this process until all digits are entered. Press and hold the **[MODE]** for one second to exit.

4. The display shows "Save?" To accept the new value, press the **[Y/+]** key. Press the **[N/-]** key or the **[MODE]** key to discard the change and move to the next sub-menu.

4.4.5 Modifying the Cal Memory

If the current cal memory number selected is not memory 0, users will be prompted whether to modify the settings of the selected cal memory. Press **[Y/+]** to modify the cal memory and **[N/-]** to go to the next sub-menu.

Once **[Y/+]** is pressed the LCD display will show the current memory number, current gas selected and prompt the user for acceptance of the current gas selected. If the current cal memory is #0, the display will show a message "Cannot modify Mem #0!!"

1. Press **[N/-]** to modify the gas selection if desired. Or press the **[Y/+]** key to skip the change of gas selection, and proceed to the next sub-menu.
2. After pressing **[N/-]**, the display shows "Copy gas from library?" Press **[Y/+]** to accept or **[N/-]** for the next sub-menu, "Enter custom gas?"
3. In the "Copy gas from library" sub-menu, use the **[Y/+]** and **[N/-]** keys to scroll through the selections in the library. Press the **[MODE]** key momentarily to select the gas. The display shows "Save?" Press **[Y/+]** to save or **[N/-]** to discard the changes and proceed to the next sub-menu.
4. In the Custom gas sub-menu, the user can enter the gas name. Press the **[Y/+]** or **[N/-]** keys to cycle through all 26 letters and 10 numerals. Press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all digits (up to 8 digits) of the custom gas name is entered.
5. Press and hold the **[MODE]** key for one second to exit the name entry mode. The display will show "Save?" Press **[Y/+]** to save the entry, or **[N/-]** to discard the changes.

4.4.6 Changing the Correction Factor

This function allows the user to change the Correction Factor of the standard calibration gas (except for Cal Memory #0).

1. "Change Correction Factor?" is the sixth sub-menu in the Calibration sub-menu.
2. Press the **[Y/+]** key. The display shows the gas name, then the correction factor.
3. A cursor blinks at the left-most digit of the correction factor. If the user wants to modify the correction factor, go to step 3. Otherwise, press and hold the **[MODE]** key for one second to accept the previously stored correction factor value and return to the first sub-menu of the calibrate/select gas menu.
4. Starting from the left-most digit of the correction factor, use the **[Y/+]** or **[N/-]** keys to change the digit value and press the **[MODE]** key momentarily to advance to the next digit, the cursor will move to the next digit to the right. Repeat this process until all digits are entered. Press and hold the **[MODE]** key for one second to exit.
5. The display shows "Save?" To confirm the new value, press the **[Y/+]** key to accept the change. Press the **[N/-]** key or the **[MODE]** key to discard the change and return to the first sub-menu of the Calibrate and Select Gas menu.

4.5 Changing Alarm Limits

In this menu, the user can change the high and low alarm limits, the STEL limit and the TWA limit. See Table 4-4 below. Press the **[Y/+]** key and the display shows the current gas selected followed by the first sub-menu item below.

Table 4-4. Alarm Limit Sub-Menu

Change High Alarm limit?
Change Low Alarm limit?
Change STEL limit?
Change TWA limit?

1. Scroll through the Alarm Limit sub-menu using the **[N/-]** key until the display shows the desired limit to be changed, e.g., "High limit?", "STEL limit?",etc.
2. Press the **[Y/+]** key to select the desired limit. The display shows a flashing cursor on the left-most digit of the previously stored alarm limit.
3. To modify this limit value, use the **[Y/+]** or **[N/-]** keys to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to the next digit to its right. Repeat this process until the new limit values are entered. Press and hold the **[MODE]** key for one second to exit data entry mode.
4. If there is any change to the existing value, the display shows "Save?" Press the **[Y/+]** key to accept the new value and move to the next sub-menu. Press the **[N/-]** key to discard the changes and move to the next sub-menu.

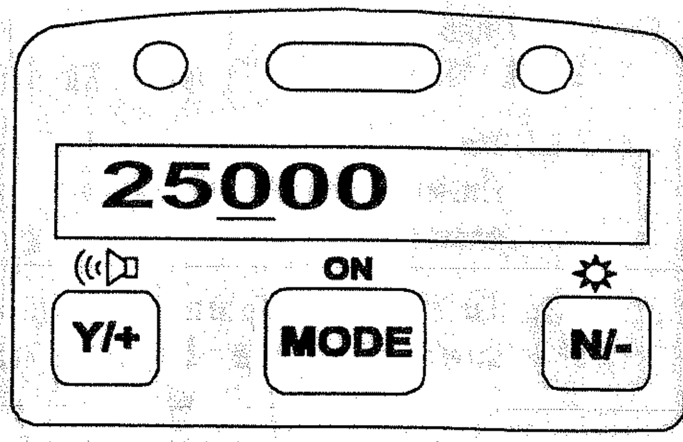


Figure 4-1. Set Alarm Limit display

4.5.1 Changing the Low Alarm Limit

The second sub-menu item in the Alarm Limit sub-menu allows the user to change the Low Alarm limit. The LCD displays "Low limit?" To change the Low Alarm limit, press the **[Y/+]** key, or press the **[N/-]** key to advance to the next sub-menu in Table 4-5.

1. Press **[Y/+]** and the display will show a flashing cursor on the left-most digit of the previously stored Low alarm limit.

2. To modify this limit value, use the **[Y/+]** or **[N/-]** keys to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new limit values are entered. Press and hold the **[MODE]** key for one second to exit the data entry mode.

3. If there are any changes to the existing value, the display shows "Save?" Press the **[Y/+]** key to accept the new value and move to the next sub-menu. Press the **[N/-]** key to discard the changes and move to the next sub-menu.

4.5.2 Changing the STEL Limit

This sub-menu item allows the user to change the STEL limit. The display shows "STEL limit?"

1. Press the **[Y/+]** key and the display will show a flashing cursor on the left-most digit of the previously stored STEL limit.
2. To modify this limit value, use the **[Y/+]** or **[N/-]** keys to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to the next digit to its right. Repeat this process until the new limit values are entered. Press and hold the **[MODE]** key for one second to exit the data entry mode.
3. If there are any changes to the existing value, the display shows "Save?" Press the **[Y/+]** key to accept the new value and move to the next sub-menu. Press the **[N/-]** key to discard the changes and move to the next sub-menu.

4.5.3 Changing the TWA Limit

This sub-menu item allows the user to change the TWA limit. The LCD displays "TWA limit?"

1. Press **[Y/+]** and the display will show a flashing cursor on the left-most digit of the previously stored TWA limit.
2. To modify this limit value, use the **[Y/+]** or **[N/-]** keys to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to the next digit to its right. Repeat this process until the new limit values are entered. Press and hold the **[MODE]** key for one second to exit data entry mode.

3. If there are any changes to the existing value, the display shows "Save?" Press the **[Y/+]** key to accept the new value and move to the next sub-menu. Press the **[N/-]** key to discard the changes and move to the next sub-menu.

4.6 Viewing or Changing the Datalog

The ppbRAE monitor calculates and stores the concentration and ID of each sample taken. In the datalog sub-menu, a user can perform the tasks and functions shown in Table 4-5.

Datalog Sub-Menu

Table 4-5. Datalog Sub-Menu.

View Data?
Clear Data?
Change Data Period?
Change Average Type?

4.6.1 Viewing Data (Datalogging)

This function allows the user to review all the data that is stored in the non-volatile datalog memory.

Data is stored in groups or "events." Each event consists of the event time (hour : minute : second), and measurement values.

For example:

Event/Log #1

Data #1 (10/01/97, 14:35:05, Avg., 0.2 PPM, Max 4.0)
Data #2 (14:35:10, Avg. 0.4, Max 11.0)
Data #3 (14:35:15, Avg. 0.4, Max 11.0)

Event/Log #2

Data #1 (10/03/98, 07:20:30, Avg. 3.4, Max 20.0)
Data #2 (07:20:40, Avg. 0.7, Max 20.0)

1. "View Data?" is the second sub-menu item in the Datalog sub-menu.
2. Press the **[Y/+]** key and the display shows "Event.." and "Log #1?" (see figure below). Press the **[Y/+]** key to view the data of the displayed event. Or press the **[N/-]** key to scroll to next event. If there are no more events, the message "No more events! Start from event #1?" will appear. Press the **[Y/+]** key, the monitor will jump back to the first event. Press the **[N/-]** key, the monitor will remain in the last event.
3. Press the **[Y/+]** key to review the first data of the selected event. The display shows the stored data including the time stamp in hours and minutes, and measurement values.

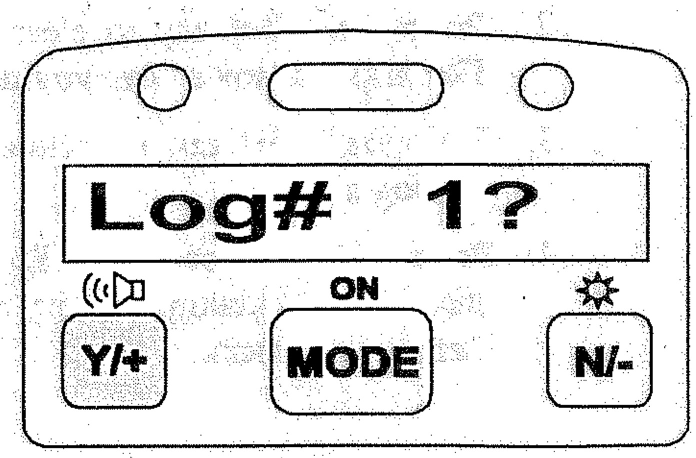


Figure 4-2. Viewing logged data.

Action	Display
	Event, Log# 1?
[Y/+]	08/01/99, 14:20:07, Avg. 150, Max 210
[Y/+]	14:20:08, Avg. 150, Max 200

Press the **[Y/+]** or **[N/-]** keys to move forward or backward to view other data from this event. When the beginning or the end of the event is reached, the message "1st data" or "End data" will appear. Press the **[MODE]** key to exit the current event.

4.6.2 Clearing Data

This function will erase all data stored in the non-volatile datalog memory.

> **Note:** This function does not change STEL, TWA, Peak, Minimum and run time values which are stored in the regular data memory.

1. "Clear Data?" is the third sub-menu item in the Datalog sub-menu.
2. Press the **[Y/+]** key to clear the datalog memory. The display shows "Are you sure?"
3. Press the **[Y/+]** key again to confirm erasure of the datalog memory.
4. Press the **[N/-]** or **[MODE]** keys to exit without clearing the datalog memory and move to the next Datalog sub-menu.

4.6.3 Changing the Datalog Period

The datalog period can be programmed from 1 to 3,600 seconds (1 hour).

1. "Change Data Period?" is the fifth sub-menu item in the Datalog sub-menu.
2. Press the **[Y/+]** key and the display shows "Datalog Period = XXXX" with the left-most digit flashing, where "XXXX" is the previously stored datalog period.

3. To modify this period, starting from the left-most digit, use the **[Y/+]** or **[N/-]** keys to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all four digits of the new period are entered. Press and hold the **[MODE]** key for one second to exit data entry mode.

4. If there is any change to the existing value, the display will show "Save?" Press the **[Y/+]** key to accept the new value. Press the **[N/-]** key to discard the changes then move to the next sub-menu.

4.6.4 Changing the Average Type

The user can select either an 8-hour Time Weighted Average (TWA) or a running Average. The running average is simply the average of all instantaneous (1-second) readings since the measurement was started. This average may increase or decrease with time depending on the readings. The TWA is a cumulative value used to estimate the fraction of the 8-hour limit to which the user has been exposed since the start of the measurement. This value can only increase or remain constant, never decrease. Refer to Technical Note 119 for more information on how the TWA is calculated.

1. "Change Average Type?" is the sixth sub-menu in the Datalog sub-menu.

2. Press the **[Y/+]** key to enter the function.

3. The display will show "Running Average?" or "Time Weighted Average?" depending on the current average type.

4. Press the **[N/-]** key to toggle between the average types. Press the **[Y/+]** key to select the displayed average type.

5. If there is any change to the existing setting, the display shows "Save?" Press the **[Y/+]** key to save the change. Press the **[N/-]** or **[MODE]** keys to discard the change and return to the first sub-menu.

4.7 Changing the Monitor Setup

Several monitor specific variables can be changed in this menu. The following is a list of configuration data that can be modified by the user.

Table 4-6. Monitor Setup Sub-Menu

Change Operation Mode?
Change Site ID?
Change User ID?
Change Alarm Mode?
Change User Mode?
Change Date?
Change Time?
Change Lamp?
Change Unit?
Change Pump Speed?
Change Dilution Ratio?
Change External Output?
Change DAC Range?

4.7.1 Changing Operation Mode

The ppbRAE supports two operational modes: Survey and Hygiene mode.

Survey mode: Manual start/stop of measurements and display of certain exposure values.

Hygiene mode: Automatic measurements, running and datalogging continuously and calculates additional exposure values.

1. "Change Op Mode?" is the first sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the **[Y/+]** key and the display shows the current user mode: "Op Mode = *current mode*?"
3. Press the **[Y/+]** key to accept the currently displayed operation (Op) mode. Press **[N/-]** to toggle to the other operation modes. Press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.
4. When changing Op mode from the Hygiene to the Survey, the display shows the additional message "Exit from Hygiene?" to prevent accidentally exiting from the Hygiene mode.
5. If there is any change to the existing setting, the display will show "Save?" Press the **[Y/+]** key to accept or the **[N/-]** key to discard and move to the next sub-menu.

Note: If a new Op mode change is saved, display shows "Op Mode changed!!" when exiting out of programming mode.

4.7.2 Changing the Site ID

The user can enter an 8-digit alphanumeric site ID in the programming mode. This site ID will be included in the datalog report.

1. "Change Site ID?" is the second sub-menu item in the Monitor Setup menu (Table 4-6).
2. Press the **[Y/+]** key and the display shows the current site ID: "Site ID = xxxxxxx" with the left most digit flashing.
3. Press the **[Y/+]** or **[N/-]** keys to cycle through all 26 letters and 10 numerals. Press **[MODE]** momentarily to advance to the next digit. The cursor will move to the next digit to the right.

Repeat this process until all eight digits of the new site ID are entered. Press and hold the **[MODE]** key for one second to exit the data entry mode.

4. If there are any changes to the existing site ID, the display shows "Save?" Press the **[Y/+]** key to accept the new site ID. Press the **[N/-]** key to discard the change and move to the next sub-menu.

4.7.3 Changing the User ID

The user can enter an 8-digit alphanumeric user ID in the programming mode. This user ID will be included in the datalog report.

1. "Change User ID?" is the third sub-menus item the Monitor Setup menu.
2. Press the **[Y/+]** key and the display shows the current user ID: "User ID = xxxxxxxx" with the left most digit flashing.
3. Press the **[Y/+]** or **[N/-]** keys to cycle through all 26 letters and 10 numerals. Press **[MODE]** momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all eight digits of the new user ID are entered.
4. Press and hold the **[MODE]** key for one second to exit the data entry mode. If there are any changes to the existing user ID, the display shows "Save?" Press the **[Y/+]** key to accept the new user ID. Or press the **[N/-]** key to discard the changes and move to the next sub-menu.

4.7.4 Changing the Alarm Mode

There are two different alarm modes: **Latched** and **Automatic Reset** (Auto Reset) in the ppbRAE that can be selected from the programming menu.

1. "Change Alarm Mode?" is the fourth sub-menu item in the Monitor Setup menu (Table 4-6).
2. Press the **[Y/+]** key; the display shows the current alarm mode.
3. Press the **[Y/+]** key to accept the currently displayed alarm mode. Press **[N/-]** to toggle to the other alarm mode. Press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there are any changes to the existing setting, the display will show "Save?" Press the **[Y/+]** key to save the new change. Or press the **[N/-]** key to discard the change and move to the next sub-menu.

4.7.5 Changing the User Mode

There are two different user modes: **Display** and **Program** that can be selected from the programming menu.

1. "Change User Mode?" is the fifth sub-menu item in the Monitor Setup menu (Table 4-6).
2. Press the **[Y/+]** key; the display shows the current user mode selected.
3. Press the **[Y/+]** key to accept the currently displayed user mode. Press **[N/-]** key to toggle to the alternate user modes. Press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there are any changes to the existing selection, the display shows messages "Program change" and "Are you sure?" Press the **[Y/+]** key to confirm the

change or press the **[N/-]** key to discard the changes and move to the next sub-menu.

CAUTION: If the user mode is changed to the **Display** mode, the user can no longer enter the programming mode. Therefore, the user cannot change the user mode back to the **Program** mode in the normal mode.

To restore the user mode back to the **Program** mode, turn the unit off and back on in Diagnostic mode. Next enter the Program mode by holding the **[MODE]** and **[N/-]** keys for three seconds. Enter the password at the prompt (the default is 0000). Once program mode is entered, go to the "Change Monitor Setup"/"Change User Mode" and change the mode back to **Program.**

An alternative way to change Display mode back to Program mode is through the PC, utilizing the ProRAE-Suite software (see Section 5.3).

4.7.6 Changing the Date

The ppbRAE monitor is equipped with a real time clock (RTC). The user can enter the correct date and time (see Section 4.7.7) for the real time clock.

1. "Change Date?" is the sixth sub-menu item in the Monitor Setup menu.
2. Press **[Y/+]** and the display shows the current date "mm/dd/yy" with the left most digit of the date flashing.
3. To modify this value, use the **[Y/+]** or **[N/-]** keys to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to the next digit to its right. Repeat this process until the new date and time values are entered. Press and hold the **[MODE]** key for one second to exit data entry mode.

4. If there are any changes to the existing value, the display shows "Save?" Press the **[Y/+]** key to accept the new value or press the **[N/-]** key to discard the changes and move to next sub-menu.

4.7.7 Changing the Time

To change the time in the RTC of the ppbRAE:

1. "Change Time?" is the seventh sub-menu item in the Monitor Setup menu.
2. Press **[Y/+]** and the display shows the current time in the 24-hour format "hh mm" with the left most digit of the time flashing.
3. To modify this value, use the **[Y/+]** or **[N/-]** keys to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to the next digit to its right. Repeat this process until the new date and time values are entered. Press and hold the **[MODE]** key for one second to exit data entry mode.
4. If there are any changes to the existing value, the display shows "Save?" Press the **[Y/+]** key to accept the new value. Press the **[N/-]** key to discard the change and move to the next sub-menu.

4.7.8 Changing the Lamp

There are two UV lamps with different photon energies available for the ppbRAE: **9.8** and **10.6 eV**. The user can select any one of the lamps from the programming mode. An **11.7 eV** option is also given although currently this lamp is not recommended.

1. "Change Lamp Type?" is the eighth sub-menu item in the Monitor Setup menu (Table 4-6).
2. Press the **[Y/+]** key; the display shows the current PID lamp selection.
3. Press the **[Y/+]** key to accept the currently displayed lamp. Press the **[N/-]** key to scroll through the sub-menu for other lamp selections. Press **[MODE]** to exit this sub-menu and return to the next sub-menu in Table 4-6.
4. If there is any change to the existing selection, the display will show "Save?" Press the **[Y/+]** to save the new selection or press the **[N/-]** to discard the change and return to the next sub-menu in Table 4-6.

4.7.9 Changing the Units

Table 4-7. Units Sub-Menu

Display Unit = ppb?
Display Unit = ug?
Display Unit = ppm?
Display Unit = mg?

The user can change the display and datalog units from parts per billion (ppb), micrograms per cubic meter (ug), parts per million (ppm), and milligrams per cubic meter (mg).

1. "Change Unit?" is the ninth sub-menu item in the Monitor Setup sub-menu.
2. Press the [Y/+] key, the display should show the current unit "Display Unit = xxx?"
3. Press [Y/+] key to accept the currently displayed unit. Press [N/-] key to toggle to the other units. Press the **[MODE]** key to exit this sub-menu.

4. If there are any changes to the existing selection, press the [Y/+] key to save the change or press [N/-] key to discard the change.

CAUTION:

1. **The correction factor in the gas library is calculated based on "ppb" and "ppm" units. If either "ug" or "mg" units are selected, the built-in correction factor library is not valid.**
2. **The Automatic range is between "ppb" and "ppm" or between "ug" and "mg." There are no other automatic conversions.**
3. **When the unit name is changed from "ppb" or "ppm" to "ug" or "mg," calibration by using a standard "mg" gas is required. The same rule applies when the unit is changed back.**

4.7.10 Changing the Output

There are two different external output options: DAC (Analog output) and Alarm in the ppbRAE that can be selected from the programming menu. The alarm output can be used to connect to the optional vibration alarm (vibrator) only. The analog output that represents the gas concentration can be connected to a charter.

1. "Change Output?" is the tenth sub-menu item in the Monitor Setup menu.
2. Press the **[Y/+]** key and the display shows the current output option selection: "Output = DAC?"
3. Press the **[Y/+]** key to accept the currently displayed output option. Press **[N/-]** to change to the other external option: "Output = Alarm?" Press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there are any changes to the existing selection, pressing the **[Y/+]** key the display will show

"Save?" Then, press the **[Y/+]** key to save the change or press **[N/-]** to go back to Step 2.

4.7.11 Changing the Pump Speed

There are two pump speeds of approximately 600 cc/min and 400 cc/min designated as "high" and "low," respectively.

1. "Change Pump Speed?" is the eleventh sub-menu item in the Monitor Setup menu.
2. Press the **[Y/+]** key and the display shows the current pump speed: "Pump = Low?"
3. Press the **[Y/+]** key to accept the currently displayed output option. Press **[N/-]** to change to the other external option: "Pump = High?" Press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there are any changes to the existing selection, pressing the **[Y/+]** key the display will show "Save?" Then, press the **[Y/+]** key to save the change or press **[N/-]** to go back to Step 2.

4.7.12 Changing the DAC Range

There are three different DAC (Digital-to-Analog Conversion) range values available in the **ppbRAE: 2, 20,** and **200 ppm**. The maximum 2.5V DC analog signal output from the unit will represent the range value chosen (see for analog signal output connection).

1. "Change DAC Range?" is the twelfth sub-menu item in the Monitor Setup menu.
2. Press the **[Y/+]** key, the display shows the current DAC Range value: "DAC Range = 2000 ppb?"

3. Press the **[Y/+]** key to accept the currently displayed value. Press **[N/-]** to scroll through the sub-menu for other range values. Press **[MODE]** to exit this sub-menu and return to the first sub-menu in Table 4-6.

4. If there is any change to the existing selection, pressing the **[Y/+]** key the display will show "Save?" Press the **[Y/+]** key to save the change or press the **[N/-]** key to discard and return to the first sub-menu in Table 4-6.

4.8 Exit Programming Mode

1. To exit programming mode from the first tier menu level, press the **[MODE]** key once.

2. To exit programming mode from 2nd tier sub-menu, press the **[MODE]** key twice.

3. To return to programming mode, press and hold down both the [MODE] and [N/-] keys for 3 seconds.

5. COMPUTER INTERFACE

Each ppbRAE is shipped with a software package, called ProRAE-Suite, and a serial computer interface cable.

This software package runs on any IBM compatible Personal Computer (PC) under Windows 95®, Windows 98®, Windows NT® 4.0 and later environments. It allows the user to configure the ppbRAE through a user-friendly interface and send the configuration information from the PC to the ppbRAE monitor. Collected data can also be extracted from the ppbRAE to the PC in order to perform data analysis, report generation or record keeping. Installation and operation of this software package is described in the following sections.

5.1 Install ProRAE-Suite Software

The ProRAE-Suite software package is available on 3.5" setup diskettes. To install the ProRAE-Suite software, insert the first setup diskette into the "A" or "B" floppy disk drive. Click the **Start** button on the taskbar to display the start menu, then click **Run** from the start menu to display the **Run** dialog box. If the setup diskette is in disk drive A, type A:\Setup.exe in the **Open** field, as shown in Figure 5-1.

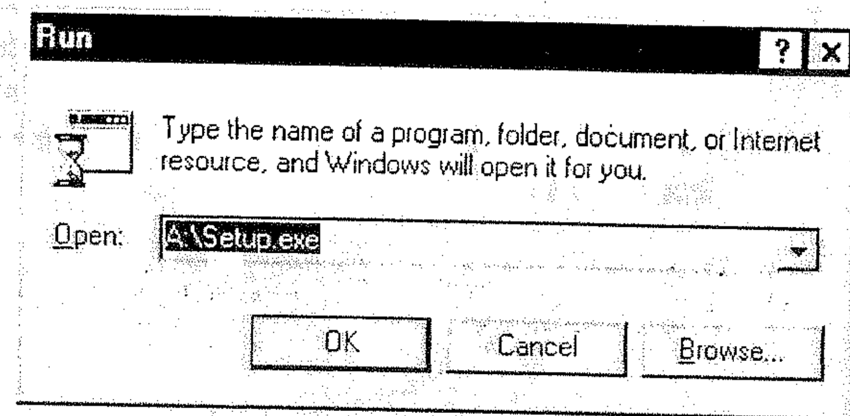


Figure 5-1. Run Dialog Box

Press the **Enter** key on the keyboard or click the **OK** button on the **Run** dialog box to start the setup process. If the user chooses the default settings in every step of the process, the ProRAE-Suite software will be installed under the default directory: **C:\Program Files\RAE Systems Inc\ProRAE-Suite**. After the software is installed successfully, a new menu item **(ProRAE-Suite)** is added to the **Programs** menu. To start the **ProRAE-Suite** software, click the **Start** button on the taskbar to display the **Start** menu, click the **Programs** menu item to display the **Programs** submenu, then click the **ProRAE-Suite** menu item to display the **ProRAE-Suite** submenu. There are two submenu items under the **ProRAE-Suite** sub-menu: **ProRAE-Suite** and **Readme**, as shown in Figure 5-2. Click the **ProRAE-Suite** sub-menu item to start the **ProRAE-Suite** software.

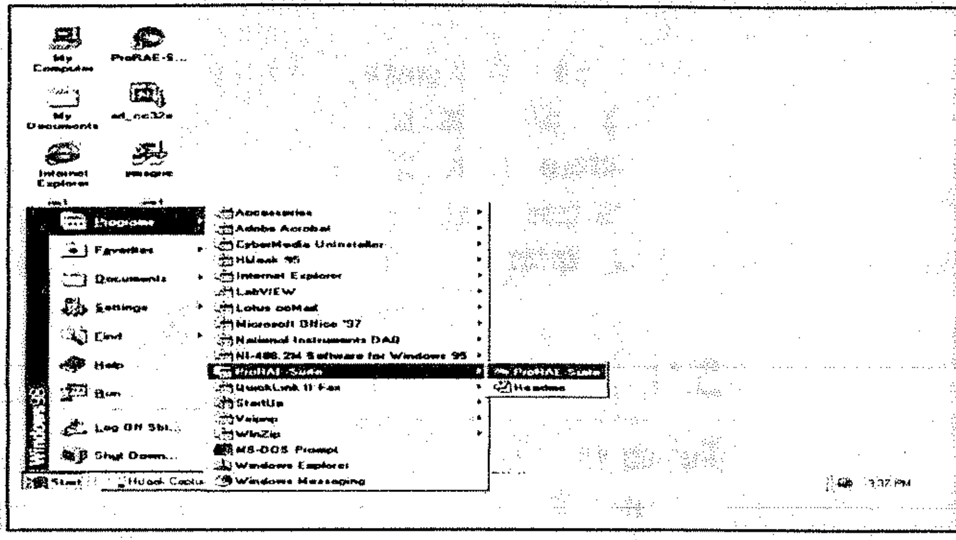


Figure 5-2. Start Menu

5.2 Connecting ppbRAE to the PC

The basic kit of the ppbRAE is supplied with a serial interface cable. Connect the DB-9 connector side of the cable to the serial port of the PC, and connect another side of the cable to the ppbRAE monitor.

Turn on the power to the ppbRAE monitor. Press the **[MODE]** key several times until the LCD shows "PC comm?" Press the **[Y/+]** key and the display shows "Pause monitor, OK?" Press [Y/+] key to confirm and the display shows "Comm...." to indicate that the ppbRAE monitor is ready and waiting for communication with the PC. During the communication session, the PC will directly control the ppbRAE monitor through the serial link. There is no need for users to press any keys on the ppbRAE monitor during the communication session.

If no data transfer has occurred within two minutes, the ppbRAE monitor will return to the instantaneous reading display.

> **Note:** Do not mistakenly connect to the parallel port of the PC. The parallel port is usually a 25 pin

female D connector on the back of the PC, the serial port is usually a 25 or 9 pin **male D connector**. If the serial port on the PC is a 25-pin connector, the user needs to use a 25 pin to 9-pin adapter in order to accept the serial cable.

5.3 Starting ProRAE-Suite Software

To start the ProRAE-Suite software, click the **Start** button on the taskbar to display the **Start** menu, click **Programs→ProRAE-Suite→ProRAE-Suite** sub-menu item to start the ProRAE-Suite software. Figure 5-3 shows the main window of the ProRAE-Suite software.

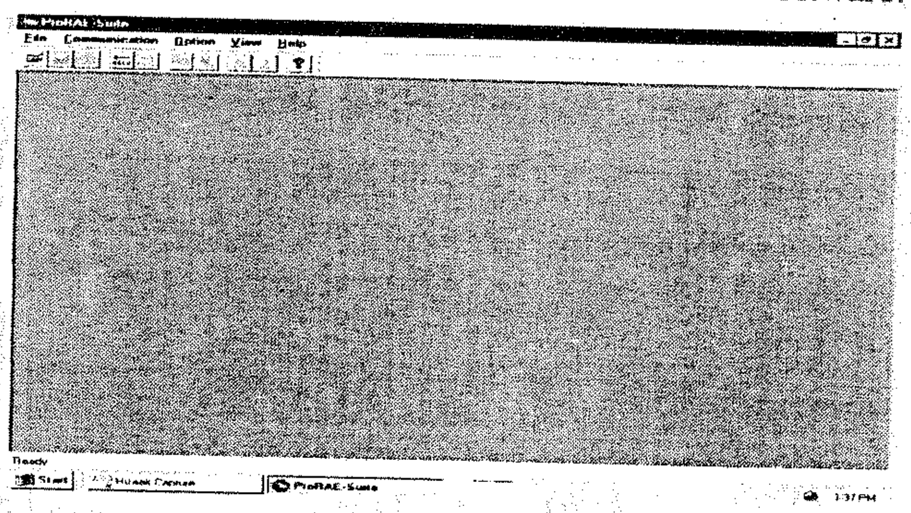


Figure 5-3. ProRAE-Suite Main Window

The functions of ProRAE-Suite software can be divided into three categories:

1. Configuration of data: The ProRAE-Suite software package has the ability to send and receive the configuration data from the ppbRAE monitor as well as edit the configuration data file.
2. Logging of data: Data logged from the ppbRAE monitor is received, displayed in multiple formats, exported to a tab delimited file to be read and worked with in conjunction with Microsoft Excel, etc.

3. Upgrading: Pro-RAE Suite also includes the ability to upgrade the datalog feature and firmware of the ppbRAE monitor and upgrade the firmware.

There is a tool bar beneath the menu bar. The frequently used functions are represented in this tool bar in the form of small icons. For example, the **Receive data** function in the **Communication** sub-menu is represented as a small arrow with the letters "RECV." When the mouse cursor (a small arrow) is positioned near each icon in the tool bar, a short text will also appear at the bottom of the Window to describe the function of this icon.

This tool bar allows users to invoke a function conveniently by clicking on the icon without going through the sub-menus.

5.4 Setup Communication Port

It is necessary to setup the communication port on the ProRAE-Suite software so that the ppbRAE monitor can communicate with the PC correctly. Figure 5-4 shows the **Setup Port** dialog box. Choose the appropriate port according to the PC's serial port setup.

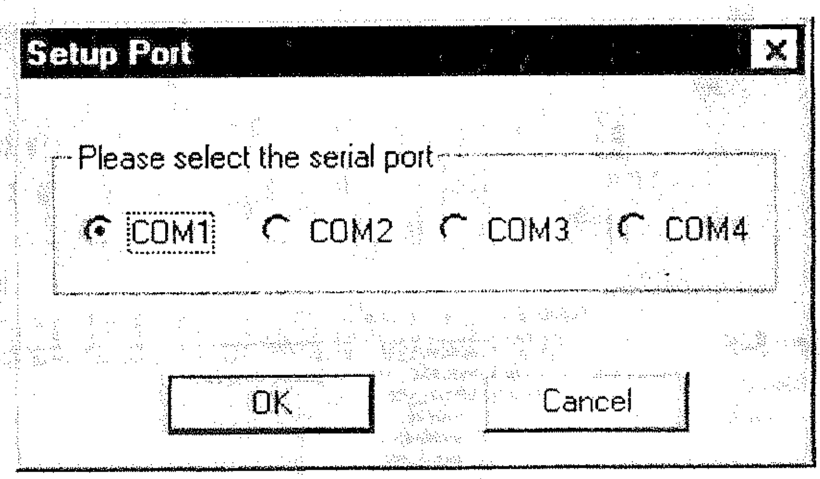


Figure 5-1. Setup Port Dialog Box

Note: In most PC's, there are two serial ports. Make sure that the serial port selected in the **Setup Port** dialog box matches the actual serial port connected to the ppbRAE monitor. The default serial port for ProRAE-Suite is COM1. If the incorrect serial port is selected, an error message of "error occurred during serial port initialization" will appear when a user tries to communicate between the PC and the ppbRAE monitor.

5.5 Processing the Configuration Data

The ProRAE-Suite software allows the user to send configuration data to, receive configuration data from, and edit the configuration data from the ppbRAE monitor. The following sub-sections describe the details of each operation.

5.5.1 Editing the Configuration Data

There are two possible sources of configuration files: either saved on a computer or downloaded from the unit.

- *Load and review the monitor configuration.* From the main menu of the ProRAE-Suite software, select the **Receive Configuration...** menu item from the **Communication** dropdown menu, then click **OK** if the unit is connected to the communication port and ready.
- *Load a saved configuration file.* From the main menu, select **Open** from the **File...** dropdown menu, a dialog box appears. Select the "Files of type:" to Config Files[*.cfg], as shown in Figure 5-5.

Figure 5-5
Open Dialog Box

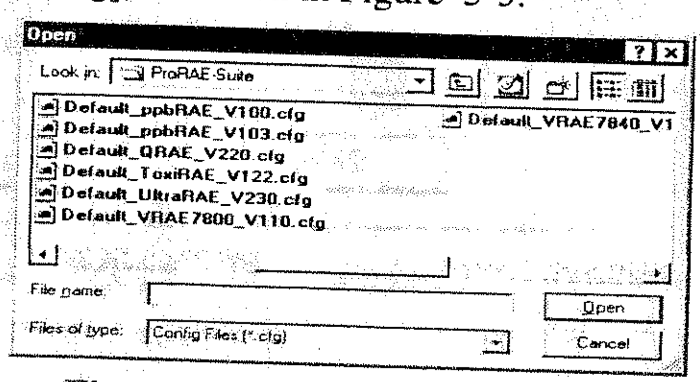


Figure 5-5. Open File Dialog Box

There should be one or more configuration files in the file list. Each configuration file has a file extension of ".CFG". There is one generic ppbRAE configuration file supplied with the ProRAE-Suite software: **Default_ppbRAE_V###.CFG**, where ### is the version number of the default configuration file. For example, Default_ppbRAE_V100.cfg means this file is for **ppbRAE** monitor and its version is V1.00. Choose a configuration file by highlighting the file name and press the **Enter** key or click the **Open** button on the dialog box. Once the configuration file is open, the configuration data is displayed in the newly opened client window, as shown in Figure 5-6.

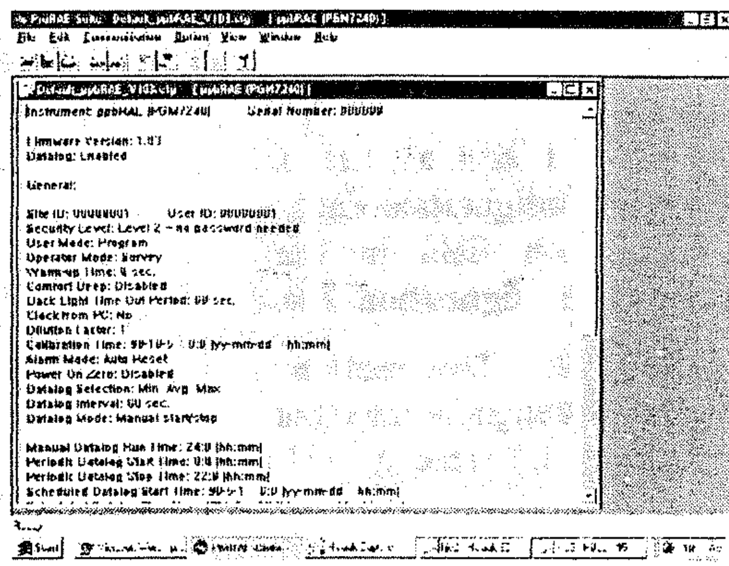


Figure 5-6. Displayed configuration data

To edit the opened configuration data file, click the **Edit→Configuration** menu item or the **Configuration** toolbar button to open the **Edit Configuration File** dialog box, as shown in Figure 5-7. After completing the editing of the configuration settings, click the **OK** button to close the **Edit Configuration File** dialog box. The new values of the configuration settings will be reflected in the client window.

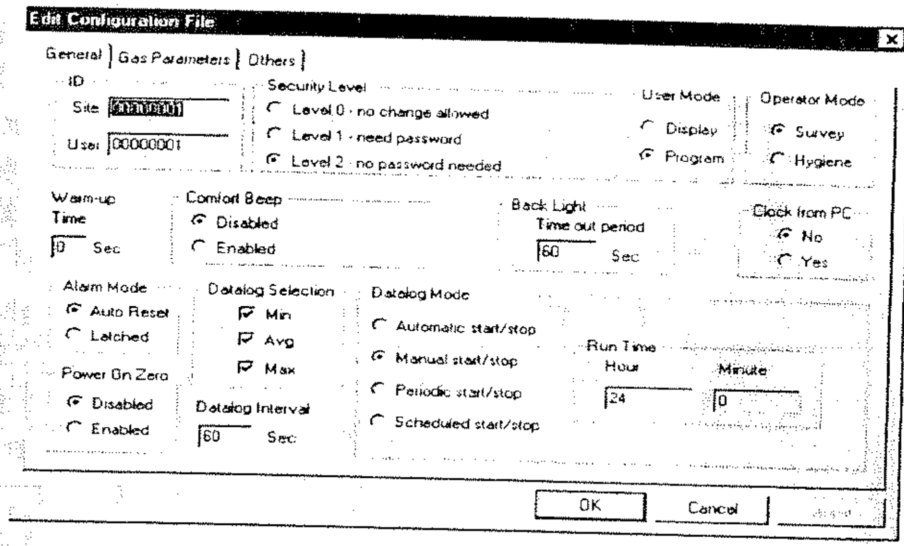


Figure 5-7. Edit Configuration File Dialog Box

General Tab Page

The **General** tab page, which is shown in Figure 5-7, allows the user to change the general settings of the configuration data. The following is the description of each field in the **General** tab page of the **Edit Configuration File** dialog:

ID: This section sets the identification that is used throughout the datalog process. Both editing fields, **Site** and **User,** can hold up to eight alphanumeric letters.

Security Level: There are three levels of security. Use security level to provide protection against unauthorized changes to the monitor settings in the programming mode.

> **Level 0** allows the user to enter the programming menu without password checking, but does not allow changes to alarm limits, real time clock, correction factor, or user and site information, etc. The user can still perform calibrations.
>
> If **Level 1** is selected, a four-digit password is required to enter the programming menu.

If **Level 2** is selected, the programming menu may be entered without restriction. Any changes made in the programming menu can be saved.

Password: Entry to the programming menu requires the four-digit password to be entered if Level 1 is selected as the security level.

User mode: In the **Display** mode, the user can view several readings in the normal operation, but cannot enter the programming menu. In the **Program** mode, the user can enter the programming mode to calibrate the monitor or change various setups in the monitor.

Operator Mode: There are two operator modes the user can set: Hygiene and Survey. The Hygiene mode is a continuous measurement mode. The Survey mode is a manual start and stop measurement mode. See Chapter 2 for more details on the Hygiene and Survey modes.

Warm-up Time: This option allows the user to choose the warm-up time of the instrument, in seconds.

Comfort Beep: This option allows the user to specify a time interval in which the buzzer will beep once to remind the user that the monitor is on. If zero is entered for the time interval, then the comfort beep feature is disabled.

Back Light: This option allows the user to enter a time out period so that the back light will be turned off automatically after the time out period.

Clock from PC: This option allows the PC clock to be downloaded to the ppbRAE monitor so that the user does not need to manually set the clock in the ppbRAE monitor.

Alarm mode: This option allows the alarm to be either **latched** or **auto-reset**. Selecting **auto-reset** turns the alarms off automatically when the alarm situation no longer exists. The **latched** option keeps the alarms on even after the alarm situation clears; the alarm must be turned off manually by pressing the [Y/+] key to acknowledge the alarm situation.

Power On Zero: This option allows the monitor to perform a fresh air calibration automatically when the monitor is turned on. Care must be taken, when using this mode, to ensure that the monitor is in a fresh air environment and the unit has been warmed up when turned on.

Datalog Interval: The datalog interval is the rate at which datalog samples are recorded while the datalog is running. The units of the datalog interval are seconds. The datalog interval determines how often a new sample is calculated and stored to the datalog.

Datalog Selection: The user can choose one or more values for datalogging purposes. User can also choose to datalog the minimum, average, and maximum values, or any combination of the three values.

Datalog Mode: This may be set to either of four choices:

- With **Automatic start/stop**, the datalogging begins when the monitor is turned on and ends when it is turned off.
- With **Manual start/stop**, the datalog can begin by a series of key presses in the menu of normal operation. The maximum run time determines an automatic end to the datalog or it can be stopped manually.
- If **Periodic start/stop** (or daily) mode is chosen, the user must specify the start and stop hour and minute. The interval between start and stop is the period of time the monitor will datalog (at the "data logging period" rate).
- With **Scheduled start/stop,** all the entry boxes for year, month, day, hour and minute for both start and

stop time must be entered to specify when the datalog is to occur.

Run Time: If the **manual start/stop** mode for datalogging is chosen, the user needs to specify a maximum run time. After the monitor has been on for the specified run time, datalogging will be turned off automatically.

Start Time and Stop Time: If **scheduled start/stop** mode is chosen for datalogging, all entry boxes must be completed for start and stop year, month, day, hour and minute. The monitor must already be turned on. Then once the start date/time is reached, the monitor will start datalogging. When the stop date/time is reached, the datalogging will stop automatically. With **periodic start/stop** mode, the hours and minutes are used for the datalog period to be run each day.

OK/Cancel: When the configuration changes are completed, click on the **OK** button to save the configuration and return to the client window, or click on the **Cancel** button to abort the configuration changes.

Gas Parameters Tab Page

In the **Gas Parameters** tab, located behind the general tab page, the user can change measurement units, current gas selections, cal memory selections, and the parameters of the current gas. The following is the description of each field in the **Gas Parameters** tab page of the **Edit Configuration File** dialog, see Figure 5-8.

Measurement Unit: This section allows the user to choose between parts per million (ppm), milligrams per cubic meter (mg/m3), parts per billion (ppb), and micrograms per cubic meter (ug/m3) as the standard unit of measurement.

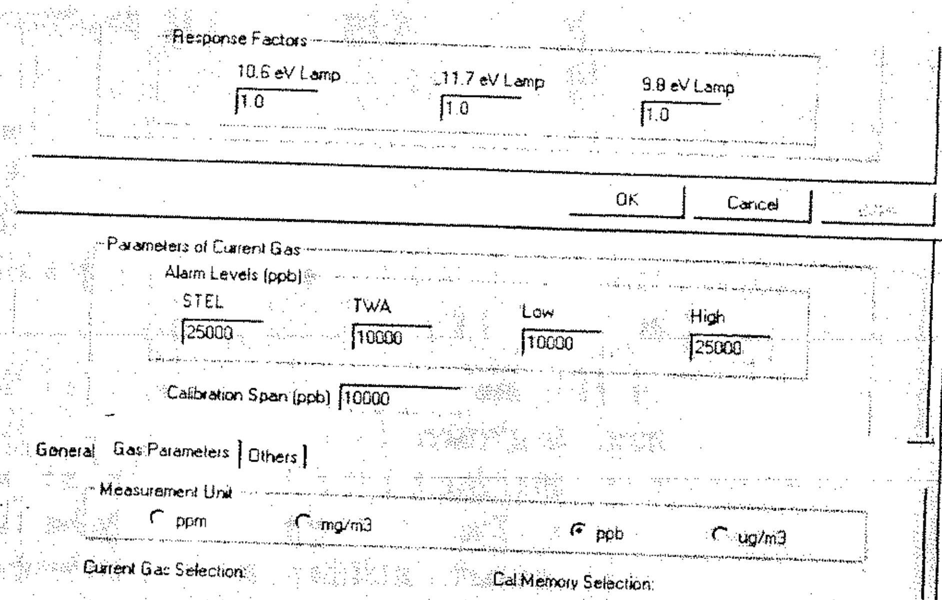


Figure 5-8. Gas Parameters Tab Page

Caution: The error message: "You just changed the measure unit from 'ppm/ppb' to 'mg/m3 or ug/m3', please update the Alarm Levels fields and the Calibration Span field!" will appear when converting between non-scalable units. The conversion is not done automatically.

Current Gas Selection: This option allows the user to choose the specific gas monitored. Click on the arrow at the right of the dialog box to scroll through the selection of gases offered.

Cal Memory Selection: There are eight memory possibilities, numbered "Memory 0" through "Memory 7," that will store previous calibration settings.

Current Parameters Gas: The current STEL, TWA, Low, and High alarm levels are displayed in ppb units, as well as the calibration span. The correction factors of the three avaliable lamps (10.6 eV, 11.7 eV or 9.8 eV) are also displayed.

Note: 11.7 eV lamps are not recommended for use with the ppbRAE even though the correction factor is available.

Others Tab Page

In the **Others** tab, the user can put in a power-on-customized name. The name will be displayed when the unit is powered on.

5.5.2 Sending the Configuration Data to the ppbRAE

After the ProRAE-Suit software opens the configuration data file, the user can send the configuration settings to the ppbRAE monitor. To send the configuration settings to the instrument, click **Communication → Send Config** menu item or click the **Send** toolbar icon (right arrow with "Send" letters), a message box will appear to remind the user to connect the instrument to the PC through the serial port. After making sure that the instrument is connected to the PC and ready for communication, click the **OK** button to start the data transfer.

After the configuration information is sent successfully, a message box will appear to indicate that the configuration sending process is completed. Click the **OK** button to close the message box.

If the communication is not successful, an error message indicating that there is no response from the instrument will appear. Check the cable to make sure that the connectors on both ends of the cable are securely seated in the sockets and the unit is set to be communication ready, then try to send the configuration again. If the error message still appears after repeated attempts, call an authorized service center for help.

5.5.3 Saving Configuration Data

In order to save the configuration information for future use click **File→Save** or the **File→Save As** menu item to save the opened configuration data to a file. Once the configuration file is saved on disk, it can be opened at a later time for further modification or can be sent to the ppbRAE monitor.

5.5.4 Configuring All Settings

The user can use this function to update all the configuration settings (except the instrument ID, serial number and the datalog option) in the ppbRAE monitor. To configure all the settings in the instrument, click the **Option→Config All** menu item, and a message box will appear to remind the user to connect the instrument to the PC through the serial port. After making sure that the instrument is connected to the PC, click the **OK** button. Another message box will appear to warn the user that this operation will erase all the current configuration settings in the monitor. If the user does not want this to happen, click the **Cancel** button, otherwise click the **OK** button to start the data transfer.

After the information is sent successfully, a message box will appear to indicate that the sending configuration process is completed. Click the **OK** button to close the message box.

Warning: The **Config All** option is mainly used to restore the ppbRAE monitor's default operational settings when the configuration of the unit is non-recoverable and the unit is malfunctioning. Because the default parameters are not normally fit to a specific unit, a user will need to re-calibrate, re-setup the lamp, pump, and LCD contrast threshold, etc. Use this function only if necessary.

5.6 Processing the Logged Data

ProRAE-Suite allows the user to retrieve the logged data from the ppbRAE monitor and display the data in many different formats. The user can also export the displayed text to a tab delimited text file so that Microsoft Excel can read it directly.

5.6.1 Receiving Data

To receive logged data from the ppbRAE monitor, click the **Communication→Receive Data** menu item or click the **Receive Data** toolbar button (left arrow with "Recv" letters). A message box will appear to remind user to connect the instrument to the PC through the serial port. After making sure the instrument is connected to the PC, click the **OK** button to start the data transfer. After the data transfer is finished, a new client window is opened with the newly received logged data displayed. In order to save the logged data for future use, user can click **File→Save** or the **File→Save As** menu item to save the newly received logged data to a file.

5.6.2 View Logged Data in Text Mode

Once the user opens a data file or receives the logged data from the instrument, a data window appears, as shown in Figure 5-9.

Figure 5-9
Displayed
Logged Data

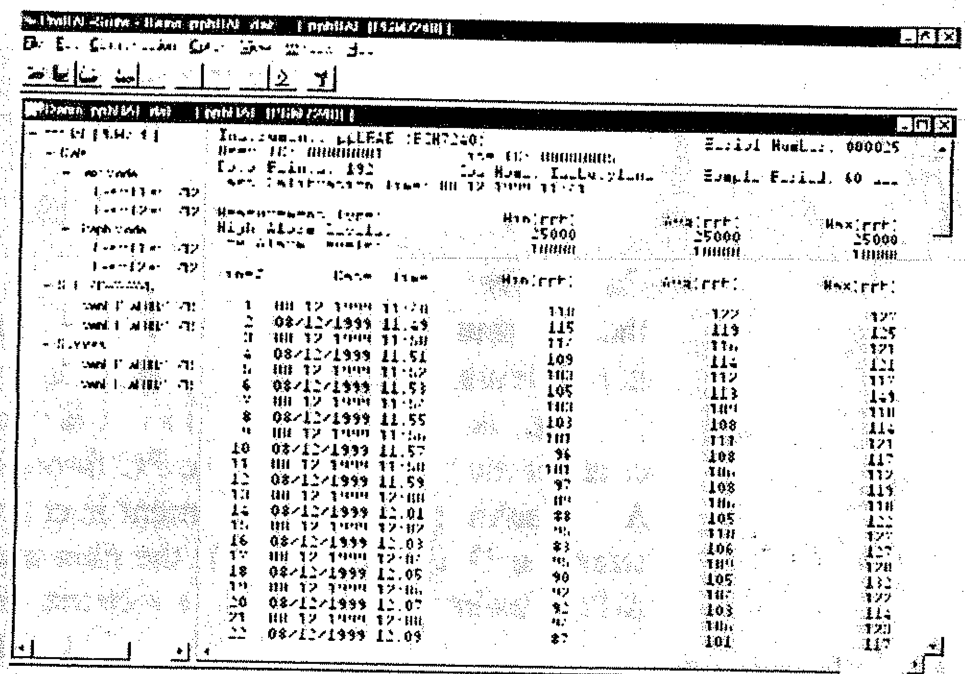


Figure 5-9. Displayed Logged Data

The data window is a two-pane client window. The left pane contains a tree view that lists all the display formats of each event, and the right pane displays the information according to the display format and the event the user selects in the left pane. To select any display format of any event, simply click the format item on the left pane. To view the next event or the previous event, click the **Next Event** (double right arrow) or the **Previous Event** (double left arrow) toolbar buttons. The user can also drag the splitter bar between the left pane and the right pane to the left or to the right to resize the pane as desired.

To view the data points of a specific event, click the item representing that event under the item **Text Mode**. For example, click the item **Event #2** on the left pane, and the right pane displays the data points of event #2, as shown in Figure 5-9.

5.6.3 View STEL/TWA/AVG Value

To view the STEL, TWA or AVG value of any event, click the event number item under the tree item **STEL/TWA/AVG** in the left pane. The right pane displays the STEL, TWA, and AVG value of each data point of that event, as shown in Figure 5-10.

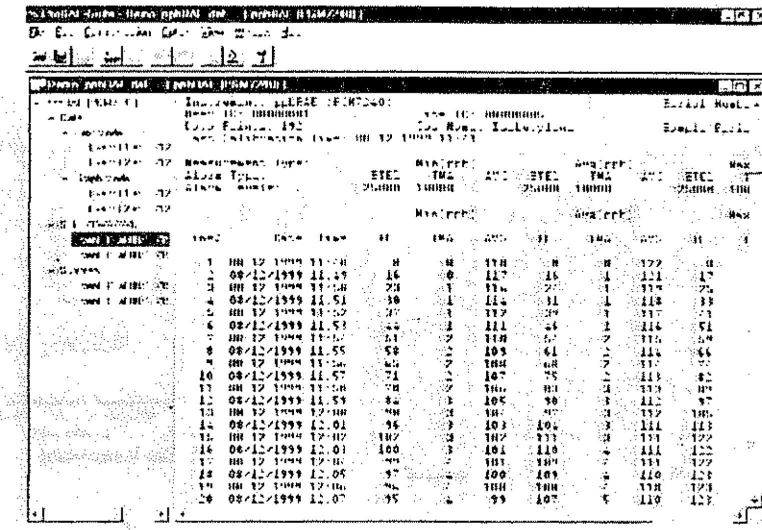


Figure 5-10. STEL, TWA, and AVG of Logged Data

5.6.4 View the Summary Information

To view the summary information of any event, such as the peak and minimum values, click the event number item under the left tree item **Summary** (Figure 5-11)

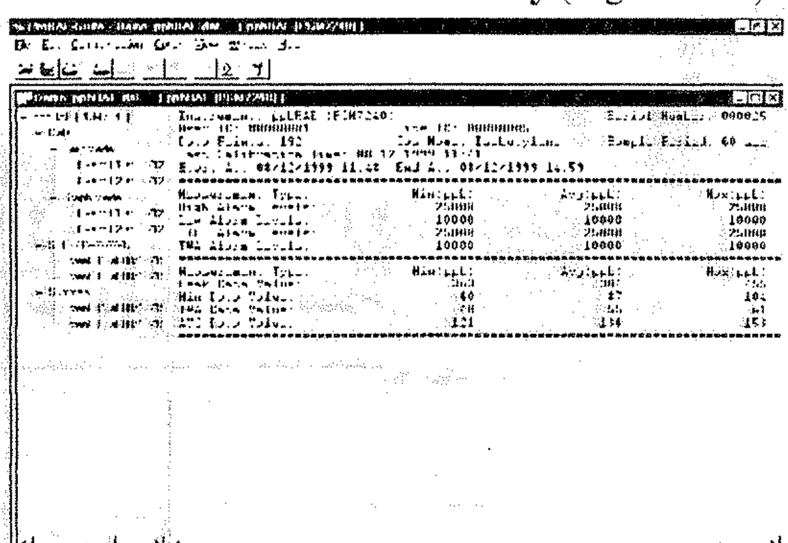


Figure 5-11. Logged Data Summary Information

5.6.5 View Logged Data in Graph Mode

To view the logged data of a specific event in graph mode, click the event item under the tree item **Graph Mode** in the left pane, and the right pane displays the graph of that event, as shown in Figure 5-12.

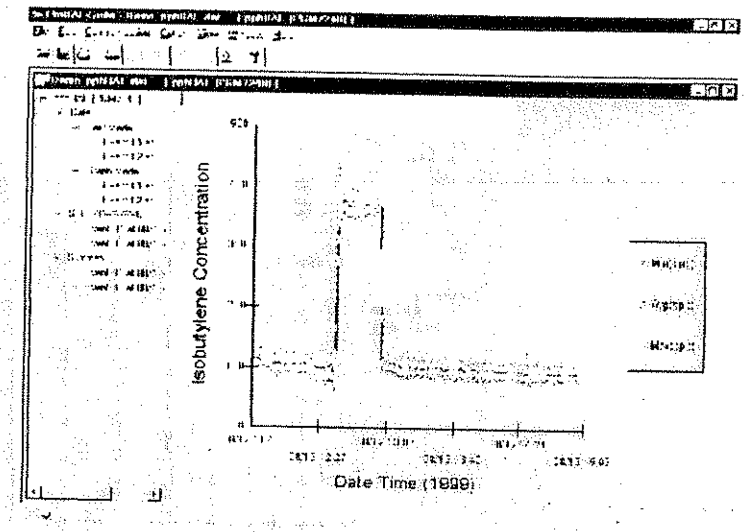


Figure 5-12. Graph of Logged Data

Select graph type: Choose the type of data in the **Graph Type** tab page of the **Graph Settings** dialog box. To display the **Graph Settings** dialog box, click anywhere within the right hand-side pane, then click the **Option→Graph Settings** menu item to display the **Graph Settings** dialog box. Figure 5-13 shows the **Graph Type** tab page of the **Graph Settings** dialog box.

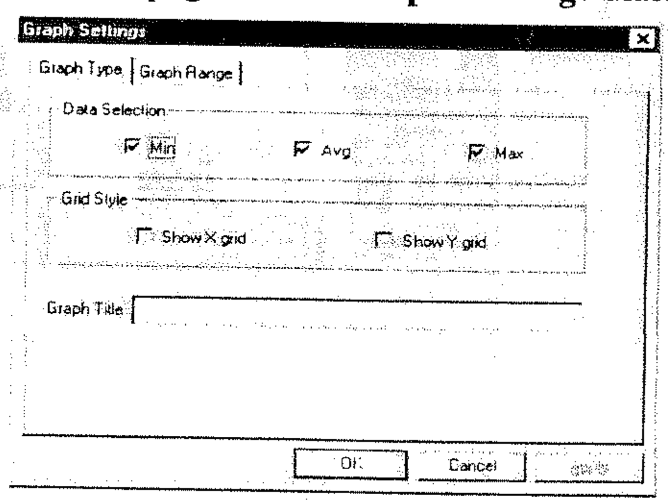


Figure 5-13. Graph Type Tab Page

Select graph range: Choose the value range on the x-axis and y-axis in the **Graph Range** tab page of the **Graph Settings** dialog box. To display the **Graph Settings** dialog box, click anywhere within the right-hand pane, then click **Option→Graph Settings** menu item to display the **Graph Settings** dialog box. To bring up the **Graph Range** tab page, simply click the page header of the **Graph Range** tab page. Figure 5-14 shows the **Graph Range** tab page of the **Graph Settings** dialog box. Here, the user can choose the graph range on the x and y-axes.

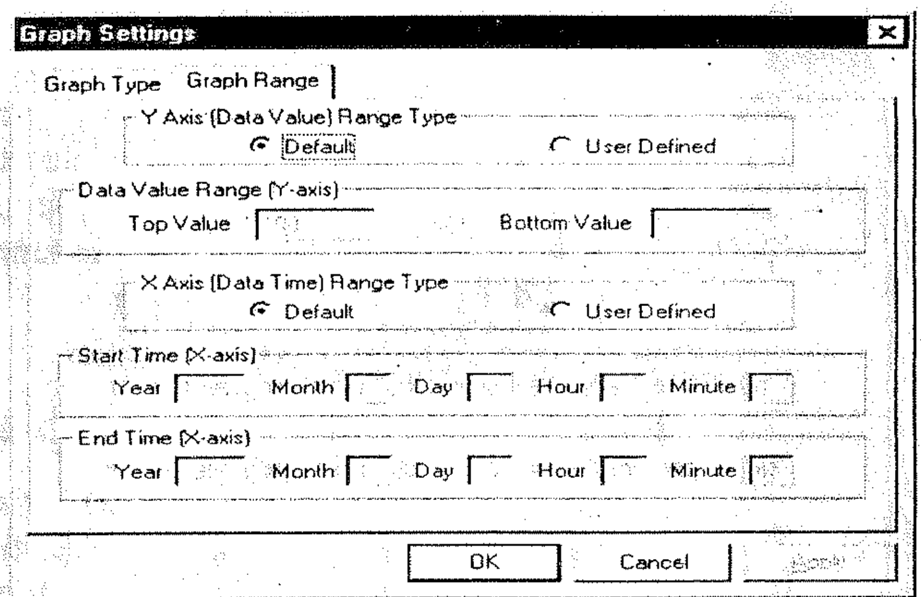


Figure 5-14. Graph Range Tab Page

To choose the range of the y-axis, first click the **User Defined** radio button in the **y-axis (Data Value) Range type** group box, then the user can specify the top value and the bottom value in the **Data Value Range (y-axis)** group box.

If the user selects the **Default** radio button in **the y-axis (Data Value) Range type** group box, the ProRAE-Suite software will scale the range of y-axis automatically to cover the maximum data value inputted on the y-axis.

To choose the x-axis range, first click the **User Defined** radio button in the **x-axis (Data Time) Range type** group box, then specify the start time fields in the **Start Time (x-axis)** group box and the end time fields in the **End Time (x-axis)** group box. If the **Default** radio button is selected in the **x-axis (Data Time) Range** group box, ProRAE-Suite will scale the range of x-axis automatically to cover every data point on the x-axis.

5.6.6 Exporting the Displayed Data to a Text File

The ProRAE-Suite software allows the user to export the displayed text to a tab delimited text file so that Microsoft Excel® can read it directly. To export the text displayed in the right pane to a tab delimited text file, click the **Option→Export Text** menu item, a **Save As** dialog box is displayed. Specify the file name in the **File name** field, then click the **Save** button.

5.6.7 Exporting Graphics to a File

The ProRAE-Suite software allows the user to export the displayed graph to a windows bitmap (.bmp) file or a windows metafile (.wmf) file. To export the displayed graph click clicking anywhere within the right-hand pane, then click the **Option→Export Graph** menu item to display a **Save As** dialog box. Select the export graph file type (.bmp or .wmf) in the **Save as type** field, then specify the export file name in the **File name** field. Click the **Save** button to close the **Save As** dialog box. The newly created graph file contains the graph displayed in the right pane.

5.6.8 Printing the Logged Data

After viewing the data results, the user may print the data to obtain a hard copy of the text or graphics. First, click anywhere within the right hand-side pane, then select the

File→Print menu item, or click the **Print** toolbar button (a printer) to print the graphic or text data.

A printer setup dialog box will appear before the printing starts so that the paper size, orientation, printer type, etc. can be configured correctly.

5.6.9 Upgrade to Datalog Capability

To upgrade to datalogging capability, open the ProRAE-Suite software. Do not open any configuration file or data file, so the ProRAE-Suite software has no client window open, as shown in Figure 5-15.

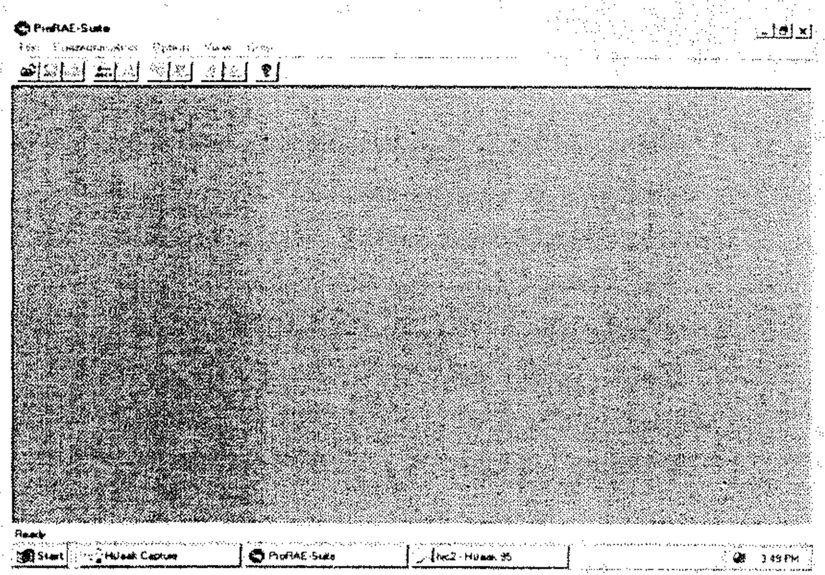


Figure 5-15. Main Window of Pro-RAE-Suite

Click the **Option→Enable Datalog** menu item, and a message box will appear to remind the user to connect the instrument to the PC through the serial port. After making sure that the ppbRAE monitor is connected to the PC, click the **OK** button to start. After the ProRAE-Suite software has made successful contact to the instrument connected to the PC, a dialog box is displayed, as shown in Figure 5-16.

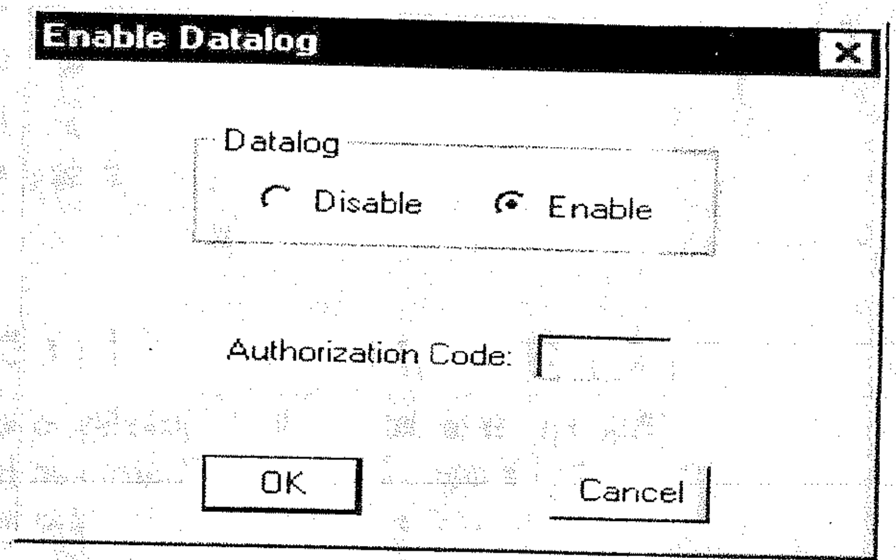


Figure 5-16. Enable Datalog Dialog Box

Figure 5-16 shows that the instrument's datalog feature is currently disabled. If the user wants to enable the datalog option, click the **Enable** radio button, and type the three digit authorization code in the **Authorization Code** field, then click the **OK** button to close the dialog box. After the datalog option is changed, a message box will appear on the screen to let the user know that the datalog option has successfully changed.

5.6 Upgrading the Firmware

To upgrade the firmware in the ppbRAE monitor, open the ProRAE-Suite software. Do not open any configuration file or data file, so the ProRAE-Suite software has no client window open, as shown in Figure 5-15. Click the **Option→Load Firmware** menu item; a message box will appear to remind the user to connect the instrument to the PC through the serial port. After making sure that the instrument is connected to the PC, click the **OK** button. An **Open** dialog box is displayed, as shown in Figure 5-17. Select the firmware file (.a07) to be loaded into the instrument, and click the **Open** button to start the loading process. After the firmware loading is finished, a message box will appear on the screen to let the user know that the firmware has been successfully loaded into the instrument.

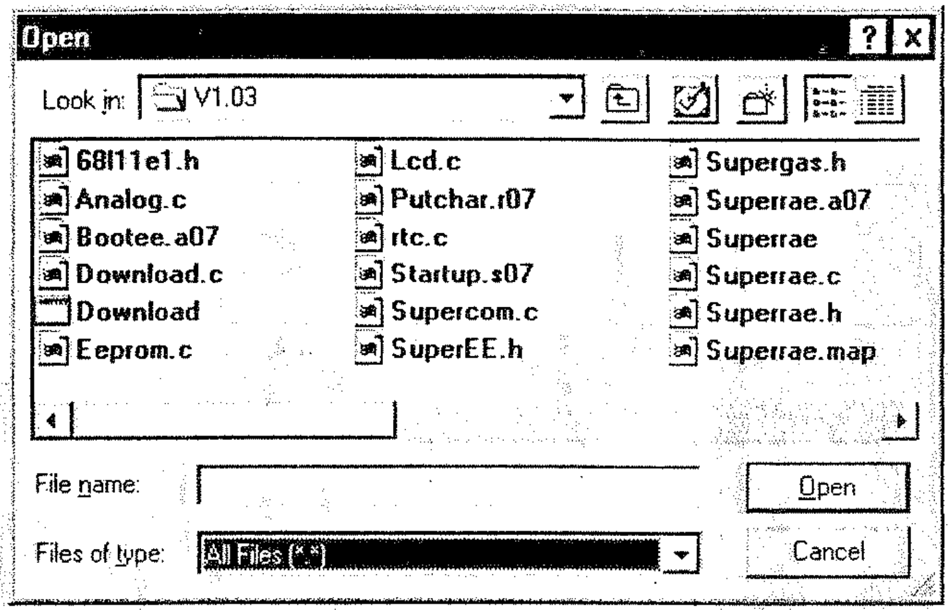


Figure 5-17. Open Firmware File Dialog Box

6. THEORY OF OPERATION

6.1 Overview

The ppbRAE monitor consists of a newly developed dual channel photo-ionization detector (PID) and an electrodeless discharge UV lamp as the high-energy photon source. Both channels of the detector are located in the ionization chamber. As organic vapors pass by the lamp, they are photo-ionized and the ejected electrons are detected as a current. The first channel current primarily results from the ionized gases. The second channel current measures the ionized gases plus photoelectric emission of electrons from the metal surface, which is a function of the UV light intensity. The dual channel currents can thus be used to compensate the variation of the light intensity due to lamp contamination and degradation.

The dual channel structure allows the ppbRAE to determine the ionizable gas concentration accurately to a ppb (parts per billion) level without frequent calibrations. The PID sensor detects a broad range of organic vapors. The standard lamp for the ppbRAE is a 10.6 eV lamp, which yields the best resolution and sensitivity, and also has the longest lifetime. A lamp with high photon energies (e.g. 11.7 eV) measures a greater number of compounds, whereas low photon energies (e.g. 9.8 eV) are selective for easily ionizable compounds such as aromatics. However, at the current time, 11.7 eV lamps do not offer enough power to be used in the ppbRAE.

The PID sensor for the ppbRAE monitor is constructed as a small cavity in front of the UV lamp. A diaphragm pump inside the monitor continuously draws air through the sensor and then discharges it through a gas outlet port on the side of the monitor.

A single chip microcomputer is used to control the operation of the alarm buzzer, LED, pump and light sensor. It measures the sensor readings and calculates the gas concentrations based on calibration to known standard gases. The data are stored in non-volatile memory so that it can be sent to a PC for record keeping purposes. RS-232 transceivers provide a serial interface between the monitor and the serial port of a PC. An LCD display consisting of a single row of eight alpha/numeric characters is used to display the readings. The user interacts with the monitor through three keys on the front panel keypad.

A rechargeable NiMH, NiCd battery, or an alkaline battery pack powers the monitor.

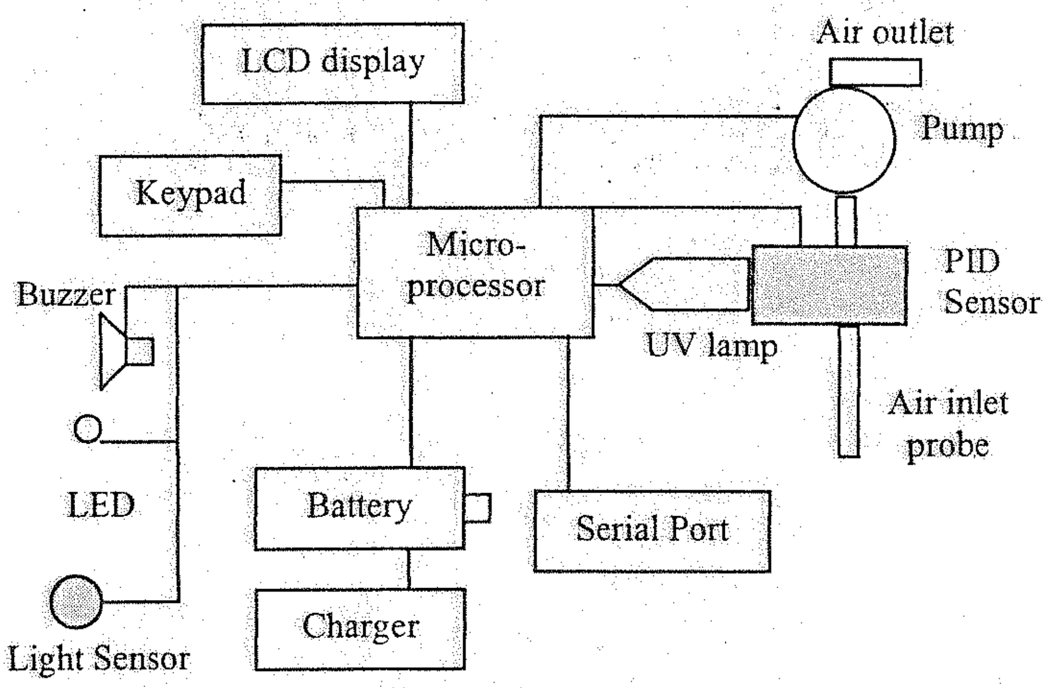


Figure 6-1. ppbRAE Schematic Diagram

Note: The printed circuit board of the monitor is connected to the battery pack even if the power is turned off. Therefore, it is very important to disconnect the battery pack before servicing or replacing any components inside the monitor. Severe damage to the printed circuit board or battery may occur if the battery pack is not disconnected before servicing the unit.

7. MAINTENANCE

The major maintenance items of the ppbRAE are:

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

Note: Maintenance should be performed by qualified personnel only.

7.1 Battery Charging and Replacement

When the display shows a flashing message "Bat," the battery requires recharging (see Section 3.1 for Battery charging). It is recommended to recharge the ppbRAE monitor upon returning from fieldwork. A fully charged battery runs the monitor for 10 hours continuously. The charging time is less than 10 hours for a fully discharged battery. A built-in micro-controller prevents over-charging. The battery may be replaced in the field (in an area known to be non-hazardous) if required.

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

Replacing the Battery Pack

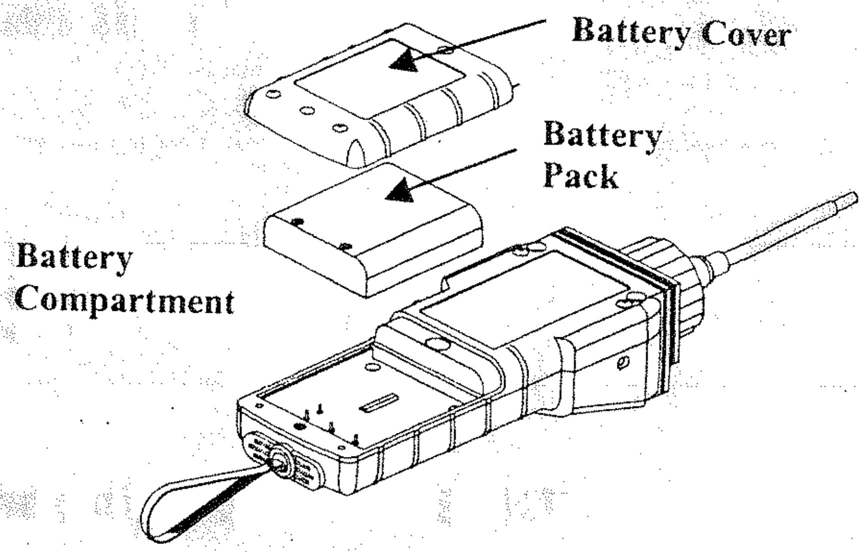


Figure 7-1. Battery Replacement

1. Turn off the power to the ppbRAE.
2. Unscrew the two battery compartment screws, located on the bottom of the monitor, and remove the cover.
3. Remove the battery pack from the battery compartment.
4. Place a fully charged spare battery pack inside the battery compartment. Make sure the battery pack is oriented properly inside the compartment.

Close the battery cover and tighten the two screws.

Replacing the Alkaline Battery Adapter

1. Insert four fresh AA size alkaline batteries into the alkaline battery holder. Make sure that the polarity of the batteries is correct. Follow the above procedures to replace the battery holder.

Note: The internal charging circuit is designed to prevent charging to alkaline batteries.

7.2 PID Sensor & Lamp Cleaning / Replacement

The sensor module is made of several components and is attached to the lamp-housing unit as shown in Figure 7-2.

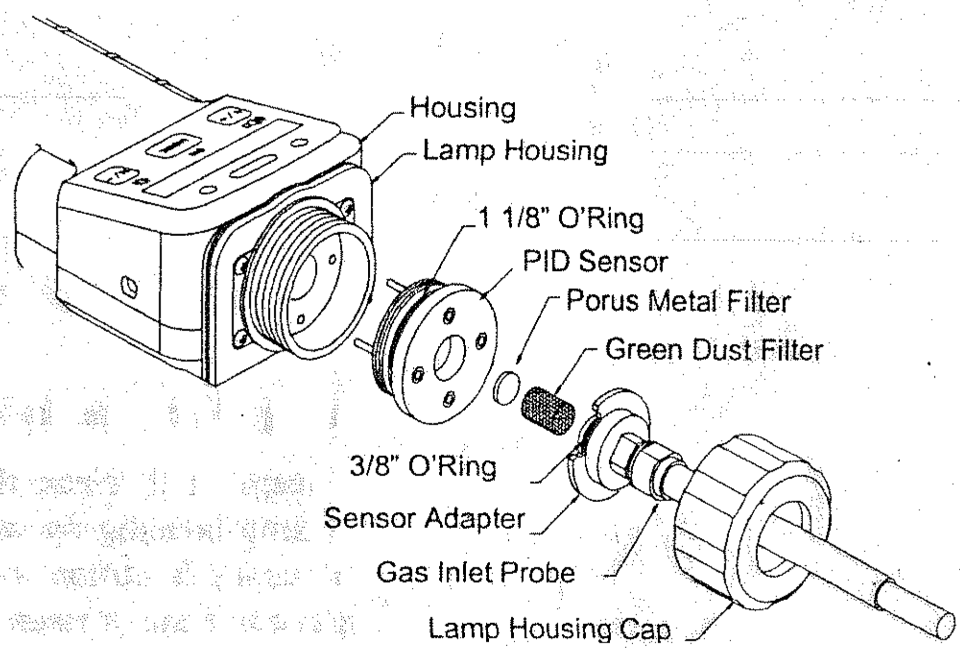


Figure 7-2. Probe and Sensor Components

Note: The cleaning procedure is not normally necessary. Clean the PID sensor module, the lamp and the lamp housing only when one of the following happens:

1. The reading is inaccurate even after calibration.
2. The reading is very sensitive to the moisture in the air.
3. A chemical liquid has been sucked into the unit and caused damage.

Use of the water trap filter will help to prevent contamination and accidents.

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 altogether. Then hold the PID sensor and pull straight out gently. A slight rocking motion helps ease out the sensor

If the lamp does not turn on, the monitor will display an error message (Lamp) to indicate replacement of the lamp may be required.

To clean the PID sensor:

Place the entire PID sensor module into GC grade methanol. It is highly recommended that an ultrasound bath be used to clean the sensor for at least 15 minutes. Then dry the sensor thoroughly. Never touch the electrodes of the sensor.

To clean lamp housing or change the lamp:

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. Rub in a circular motion at moderate pressure. After cleaning, hold the lamp up to 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 fingers or anything that may leave a film. Never use acetone or aqueous solutions, especially on 11.7 eV lamps.

2. If the lamp does not turn on, remove the UV lamp from the lamp housing. Insert a new lamp, avoiding contact with the flat window surface.

3. Reinstall the PID sensor module.

4. Tighten the Lamp Housing Cap.

5. If the lamp type has been changed, adjust the lamp type setting in the programming mode (Section 4.7.8).

7.3 Sampling Pump

When approaching the end of the specified lifetime of the pump, it will consume higher amounts 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 400 cc/min when there is no air leakage.

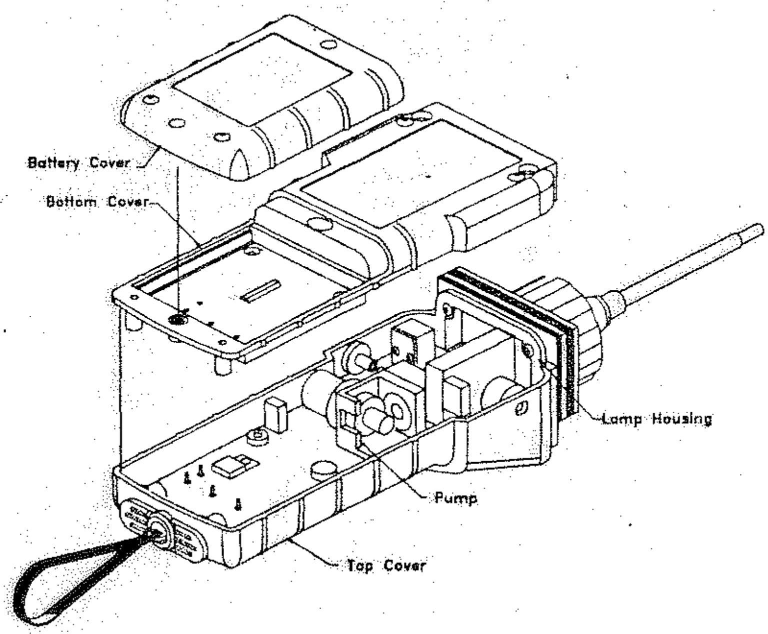


Figure 7-2. Sampling Pump Location

Pump Replacement

1. Turn off the ppbRAE power.
2. Open the battery cover, remove the battery pack, and carefully unscrew the six screws to open the bottom cover.
3. Unplug the pump from the PCB. Unscrew the two screws that hold the pump assembly to the PCB. Disconnect the Tygon tubing that connects the pump

to the gas inlet port and gas outlet port.

4. Insert a new pump assembly. Connect the Tygon tubing to the gas inlet port. Plug the pump connector back into the PCB and screw down the pump assembly to the board.

5. Replace the bottom cover and tighten the six screws. Re-connect the battery pack. Replace the battery pack and its cover.

7.4 Turning on the UV Lamp

The UV lamp is made of a glass envelope and a UV window on one end of the envelope. The inside of the lamp is filled with low-pressure gases. To turn on the lamp, a high voltage electric field is applied from the outside of the glass envelope. The molecules inside the lamp are ionized and produce a glow discharge effect to generate the UV light. Because this UV lamp does not have an electrode inside the glass envelope, it requires a small amount of ions inside the lamp to initiate the glow discharge process.

If the UV lamp has not been used for a long period of time (>1 month), it may become slightly harder to turn on. If such a condition occurs, an error message "Lamp" will appear in the monitor display during the power on sequence. This phenomenon is more significant in 0.25" UV lamps used in ToxiRAE and MultiRAE Plus products, because of the relatively small lamp size.

To solve this problem, simply turn the monitor on and off a few times and the lamp should turn on. Gently shaking the monitor may also help to initiate the glow discharge process. After the UV lamp is turned on for the first time, it should be easier to turn on the UV lamp the next time.

The ppbRAE has a built-in sensing mechanism to monitor the status of the UV lamp. If the UV lamp is not on, the error message "Lamp" will be displayed. If the lamp error message persist, then it is necessary to further diagnose the problem.

It is possible that the UV lamp is actually on when the lamp error message appears. This is because with old UV lamps the internal threshold level to detect lamp failure may have been shifted enough to cause a false alarm. To eliminate such a possibility, simply check to see that the UV lamp is actually on. This can be done easily by removing the sensor cap and observe the glow of the UV lamp in a dark area. The customer can also feed the monitor with calibration gas and observe if the sensor reading changes. If the reading changes significantly with the gas, the UV lamp is actually on. If the UV lamp is on while the error message persist, then it is necessary to adjust the lamp threshold. Please refer to **"2) Adjust Lamp Failure Threshold"** in Chapter 8 on adjusting the threshold level for the UV lamp.

One of the most common failure mechanisms for the UV lamp is the development of a leak along the seal of the glass envelope. When such a condition occurs, the lamp will become very hard or impossible to turn on. Therefore, after going through the above diagnostic procedures, if the UV lamp still cannot be turned on, it is most likely that the UV lamp must be replaced.

8. TROUBLESHOOTING

To aid the user in diagnosing the monitor, the monitor has a special diagnostic mode that can display critical, low level parameters. Section 8.1 describes the operation of the diagnostic mode. Section 8.2 summarizes the frequently encountered problems and suggested solutions. By turning on the ppbRAE monitor in diagnostic mode and using the troubleshooting table in Section 8.2, the user can usually correct the problem without having to return the monitor for repair.

> **WARNING:** This function should be used by qualified personnel only! The diagnostic mode allows the user to set several low-level parameters that are very critical to the operation of the monitor. Extra care should be taken when setting these low-level parameters. If the user is not familiar with these parameters and sets them incorrectly, it may cause the monitor to shut down or malfunction.

8.1 Special Diagnostic Mode

To turn on the monitor to the special diagnostic mode, push and hold the **[Y/+]** key, and then push and hold the **[MODE]** key for at least two seconds when the monitor is off. After the required delay, release both keys, the monitor will go through the start-up sequence and display a "Diagnostic mode" message. At the end of the special mode start-up, the display will show the raw counts of sensor channel 1A. These numbers are raw sensor readings without calibration.

In Diagnostic Mode the pump and lamp are normally on, and the user may enter Programming Mode and calibrate the instrument as usual by holding the **[MODE]** and **[N/-]** keys down simultaneously for 3 seconds. Once the monitor is started up in Diagnostic Mode, the user can switch between Diagnostic Mode and normal operating mode by pressing and holding down the **[MODE]** and **[Y/+]** keys simultaneously for 2 seconds.

Critical parameters of the monitor available in Diagnostic Mode are shown below. They can be reached by pressing the **[MODE]** key repeatedly until the desired parameters are displayed.

Table 8-1. Diagnostic Mode Menu

Key Action	Parameter	Display
	Raw Reading	1A (+ = 1X) 1B (+ = 1X)
[MODE]	Raw Reading	10A (+ = 10X) 10B (+ = 10X)
[Y/+]	Raw Reading	100A (+ = 100X) 100B (+ = 100X)
[MODE]	Lamp Current	Lamp = 103
[MODE]	Lamp Fail Level	Fail = 75 (+/-)
[MODE]	Lamp Drive*	Ldrv = 200 (+/-)# *
[MODE]	Battery Type	Ni-Cd/MH /Alkaline
[MODE]	LCD Contrast	Contrast (+/-) □□□□ - - -
[MODE]	Battery Duration	Battery Duration: XX:XX
[MODE]	Pump Current	Pump 7/ 7
[MODE]	Pump Stall Level	Stall 10 (+/-)
[MODE]	Pump Motor drive	Mdrv = 200 (+/-)*
[MODE]	DAC Output Count	DAC = 2048 (+/-)
[MODE]	Alarm Test	Alarm (on/off)?
[MODE]	Ambient Light Level	Lite = 237
[MODE]	Backlight Trip Level	Trip = 100 (+/-)
[MODE]	PC Comm	PC Comm?

* Normally this setting should not be changed.

The lamp drive is 200 for 10.6 eV lamp and 220 for others.

Below is a brief description of the diagnostic displays:

1) Raw Sensor Readings

The raw sensor readings provide a quick diagnosis on the response and the sensitivity of the sensor. When zero gas (fresh clean air) is applied to the monitor, the raw sensor readings typically should be between 100 and 200 for 1A and 1B, 100 and 400 for 10A and 10B, and 300 and 3000 for 100A and 100B. If the raw reading is outside this range when zero gas is applied, the sensor or the lamp housing may be dirty or the electronics may be defective.

When a specific gas is applied to the monitor, the raw reading should increase. If the reading does not change when the gas is applied, then the sensor or lamp may be defective.

2) Adjusting the Lamp Failure Threshold

This display can be used to calibrate the PID lamp failure threshold. If the lamp appears to be good but in normal operation, a lamp failure message (i.e. "Lamp") is displayed, the lamp failure level may be set too high. This level can be adjusted by using the following steps:

1. Turn the monitor off. Remove the UV lamp from the PID sensor (see Section 7.2).
2. Turn the monitor on in the special diagnostic mode (**[Y/+] & [MODE]**).
3. Press the **[MODE]** key until "Lamp xxx" is displayed, write down this number. The reading "xxx" is the lamp's current reading.
4. Press the **[MODE]** key one more time, "Fail yyy" is now displayed. The value "yyy" is the threshold level that determines lamp failure. Anything below this level is considered a failure.
5. Push the **[Y/+]** or **[N/-]** key to increase or decrease the threshold value "yyy" until it is about 10-15 counts above the "xxx" value. This will optimally set the lamp failure threshold. Press the **[MODE]** key to exit this display. If the threshold value has changed, a message "Save?" will appear. Press **[Y/+]** to confirm the change, **[N/-]** or **[MODE]** key to abandon the changes.

6. Turn the monitor off and replace the lamp.
7. To verify the above adjustment, turn the monitor back on in Diagnostic Mode and press the **[MODE]** key until "Lamp xxx" is displayed. Press the **[MODE]** key once more so that "Fail yyy +/-" is displayed. The lamp's current reading "xxx" should be higher than the threshold value "yyy" by at least 10-15 counts. If not, the lamp may be defective or very weak.

In most cases lamp failure threshold adjust is not required, in which case the user should press the **[MODE]** key to exit this display.

3) Lamp Drive

For the 10.6eV lamp, use 200. For the 9.8eV and 11.7eV lamps, use 220 as the lamp drive value. Note that the 11.7 eV lamp is not recommended and both 9.8 and 11.7 will not meet the same sensitivity specifications as the 10.6 eV lamp.

4) Battery Type

The ppbRAE can be powered by either a rechargeable nominal 4.8V NiMH/NiCd battery pack or an alkaline battery holder. This display shows the type of battery currently installed in the monitor. The charger cable must be unplugged for a correct battery type display.

5) Adjusting the LCD Contrast

This display allows the user to adjust the LCD contrast. Press **[Y/+]** to increase the contrast and **[N/-]** key to decrease the contrast. The bar graph shows the current LCD contrast setting. If the display appears blank or very faint, press the **[Y/+]** key several times to increase the contrast or darken the display.

6) Battery Duration

This display shows the run time of the last time the unit powered itself off due to a low battery or was turned off by the user. It is useful for battery life testing.

7) Adjusting the Pump Stall Threshold

This display can be used to calibrate 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.

1. In diagnostic mode, press the **[MODE]** key until "Pump xxx/yyy" is displayed. This is the maximum and average pump current under normal conditions.
2. Block the gas inlet and watch the pump current reading increase. Write down the blocked reading. If the pump current reading does not increase significantly (i.e. more than ten counts), then there may be a leak in the gas inlet or the pump is weak or defective. Press **[MODE]** one more time, and the display should show the message "Stall yyy"
3. Use the **[Y/+]** or **[N/-]** key to increase or decrease the stall value until it is the average of the maximum block count and the maximum idle count. Press the **[MODE]** key to exit this display. If the threshold value is changed, a message "Save?" will appear. Press **[Y/+]** to confirm the change, **[N/-]** or **[MODE]** key to abandon the changes.

8) Motor Drive

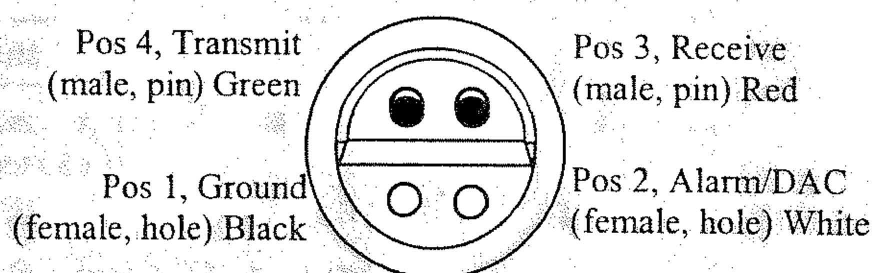
This display allows the user to adjust the pump drive. Normally, the user should not adjust this parameter.

9) DAC Output Counts

The menu allows the user to check the DAC analog output using the **[Y/+]** and **[N/-]** keys. The remote alarm output signal on the serial interface cable is deselected and the analog output signal is selected in its place. This signal has a range of 0 to 2.5V in 4096 steps. The initial default output is 2048, or 1.25V. See Figure 8-1 for signal pin-out. The user can attach a voltmeter to check the analog voltage output.

10) Alarm Test

This menu is used to test the monitor's alarm generators, including four bright LED's, the loud buzzer, and the vibrator output signal (remote alarm). The message "Alarm" is first displayed followed by "On?" If the **[Y/+]** key is pressed at this point, the alarms will turn on and the message "Off?" will appear. Press the **[Y/+]** key again to turn the alarms off. Check external alarm signal at connector.



(front view of connector on monitor)

Figure 8-1. Communication/Alarm Connector

11) Adjusting the Back Light Threshold

This display can be used to calibrate the LCD back light on/off threshold. Use the following steps to adjust the back light threshold.

1. The "Lite = xxx" message displays the present ambient light level incident on the face of the

monitor. In a brightly-lit room, the light reading should be above 130.

2. The user can shade the light sensor, which is located at the upper left corner of the monitor, with their hand and watch the light sensor reading. The light reading should drop to less than 100. Press the **[MODE]** key one more time, the display should show the message "Trip = 100".

3. Use the **[Y/+]** or **[N/-]** key to increase or decrease the trip value until it is 100. Press **[MODE]** to exit this display. If the threshold value is changed, a message "Save?" will appear. Press **[Y/+]** to confirm the change, **[N/-]** or **[MODE]** to abandon the changes.

8.2 Troubleshooting Table

Table 8-2. Troubleshooting Guide

Problem	Possible Reasons & Solutions	
Cannot turn on after charging the battery	**Reasons:**	Discharged battery, defective battery, or microcomputer hang-up.
	Solutions:	Charge or replace the battery. Disconnect, then connect the battery to reset the computer.
No LED or LCD back light	**Reasons:**	Trigger level too low, in manual, defective LED or LCD back light.
	Solutions:	Adjust the trigger level. Verify that the back light can be turned on in user mode. Call an authorized service center.

Lost password	**Solutions:**	Use the default configuration to reset the password from computer.
	Warning:	If the default configuration is loaded, all the parameters needed for setup. Including: pump, lamp and LCD contrast threshold. Enter the serial number and re-calibrate.
Reading abnormally high	**Reasons:**	Dirty sensor module. Dirty water trap filter. Excessive moisture and water condensation.
	Solutions:	Clean the sensor module and lamp housing. Replace water trap filter. Blow dry the sensor module.
Buzzer inoperative	**Reasons:**	Bad buzzer
	Solutions:	Call an 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 connections, Teflon tube compression fitting. Replace pump or diaphragm.

Problem	Possible Reasons & Solutions
"Lamp" message during operation	**Reasons:** Lamp drive circuit. Lamp threshold set too high. Weak or defective PID lamp. **Solutions:** Check and reset lamp threshold. Replace the UV lamp.
Full scale measurement in humid environment	**Reasons:** Dirty or wet sensor **Solutions:** Clean and dry the sensor and lamp housing. Use water trap filter.
Reading abnormally low	**Reasons:** Incorrect calibration. Low sensitivity to the specific gas. Weak or dirty lamp. Air leakage. **Solutions:** Calibrate the monitor. Replace the sensor. Clean the lamp. Check for air leakage.
Reading an abnormal background value	**Reasons:** There is actually a small background gas level sensor zero drift. **Solutions:** Do a zero air calibration (see Section 4.4.1).
Reading jumping around randomly	**Reasons:** Incorrect calibration gas value. Low sensitivity to cal gas. Weak or dirty lamp. Air leakage. **Solutions:** Calibrate the sensor. Use different a cal gas. Clean or replace the lamp. Check for air leakage.

Problem	Possible Reasons & Solutions
Cannot turn off the monitor or there are corrupted characters in the LCD display	**Reasons:** Microprocessor hang-up. **Solutions:** Disconnect and re-connect the battery to reset computer. Call an authorized service center.
"Bat" message induring operation	**Reasons:** Discharged battery. **Solutions:** Recharge battery.
Excessive pump noise or no inlet air suction	**Reasons:** Blocked inlet path. Defective pump. **Solutions:** Check inlet connection. Check pump.
Calibration error message	**Reasons:** No standard gas input. W, weak PID lamp. U, unit zeroed with gas present. **Solutions:** Make sure standard gas flows into monitor. Zero sensor & recalibrate, replace lamp.

APPENDIX A
QUICK REFERENCE GUIDE

PROGRAMMING MODE

Calibrate/select Gas?

- Fresh air cal?
- Span cal?
- Select cal memory?
- Change span value?
- Modify cal memory?
- Change correction factor?

Change alarm limits?

- High limit?
- Low limit?
- STEL limit?
- TWA limit?

View/change datalog?

- View Data?
- Clear Data?
- Change Data Period?
- Change Average Type?

Change monitor setup?

- Change Op mode?
- Change Site ID?
- Change User ID?
- Change Alarm Mode?
- Change User Mode?
- Change Date?
- Change Time?
- Change Lamp?
- Change Unit?
- Change Pump Speed?
- Change Output?
- Change DAC Range?

APPENDIX B

EXPENDABLE AND REPLACEMENT PART LIST

The replacement part number of the standard expendables and common repair parts are listed in the table below:

Table B-1

Part Number	Part Description
000-5001-000	ProRAE-Suite software
002-3008-000	Organic vapor zero kit
002-3011-000	Regulator with adapter
008-3003-000	Computer interface cable
011-2011-000	Lamp housing shield
011-2027-000	Lamp housing cap
011-3006-000	Filter and O-ring
012-3009-000	Air outlet adapter
012-3051-000	NiMH battery pack
012-3052-000	Battery adapter
017-3012-000	Inlet probe
025-3009-000	Hard transport case
025-3042-000	Rubber boot
025-4001	ppbRAE manual
050-0000-001	½", 10.6 eV electrodeless UV lamp
050-0001-000	½", 11.7 eV electrodeless UV lamp
050-0020-000	½", 9.8 eV electrodeless UV lamp
081-0004-000	Charcoal filter, 6 pk
081-0008-000	Tool kit
300-0012-170	Pump
411-0018-037	Tygon tubing, 1/8" diameter inside
430-0014-001	O-ring, ½" diameter inside
430-0025-001	O-ring, 3/8" diameter inside
500-0036-000	Batter charger, 110VAC, 12VDC
600-0069-000	10 ppm isobutylene

APPENDIX C

RAE SYSTEMS TECHNICAL NOTES

- ❒ TN-102 Facts About PID Measurement
- ❒ TN-103 External Datalogger Interface to MiniRAE PID
- ❒ TN-104 Partial List of Ionization Potentials
- ❒ TN-105 MiniRAE PID Battery Characteristics
- ❒ TN-106 Correction Factors, Ionization Potentials, and Calibration Characteristics
- ❒ TN-108 MiniRAE PLUS PGM-76 and 76IS ProRAE 76 Software Upgrade for PGM-75
- ❒ TN-109 MiniRAE Professional PID Zero Drift
- ❒ TN-112 MiniRAE PLUS Datalogger Data Conversion to Microsoft Excel version 5.0
- ❒ TN-113 Calibration Procedures for ModuRAE PDM-10A
- ❒ TN-114 ToxiRAE Sensor Specifications
- ❒ TN-115 ToxiRAE Toxic Gas Monitor (PGM-35) at a Glance
- ❒ TN-116 ToxiRAE Oxygen Monitor (PGM-36) at a Glance
- ❒ TN-117 ToxiRAE Combustible Gas Monitor (PGM-37) at a Glance
- ❒ TN-118 Use of RAE PIDs for Soil Headspace Measurements
- ❒ TN-119 Calculation of STEL, TWA, Min., Max., and Average Values for ToxiRAE PID.
- ❒ TN-120 Measuring Correction Factors for Volatile Compounds with MiniRAE 7 and ToxiRAE PIDs
- ❒ TN-121 CO Sensor Cross-Sensitivity and Removal with Charcoal Filter
- ❒ TN-122 MiniRAE Compliance with EPA Method 21
- ❒ TN-123 Diagnostic Modes for RAE Instruments
- ❒ TN 124 PID Lamp Characteristics
- ❒ TN 125 Creating Custom Correction Factors and Gas Names for the ToxiRAE PID
- ❒ TN-126 Interchangeability of Sensors in PGM-35 and PGM-50
- ❒ TN-127 Benzene-Specific Measurements in Petroleum Hydrocarbons using the UltraRAE
- ❒ TN-128 ToxiRAE PID Communications Problems
- ❒ TN-130 Setting Alarm Limits for Mixtures
- ❒ TN-131 Verifying and Fixing Gas Alarm Limits

See Appendix E on how to obtain Technical Notes

APPENDIX D

RAE SYSTEMS APPLICATION NOTES

- ❒ AP-200 PIDs and Aircraft Wing-tank Entry
- ❒ AP-201 Measuring Ammonia (NH_3) with PIDs
- ❒ AP-202 ABCs of Gases in Industry
- ❒ AP-203 PID as a Hazmat Response Tool
- ❒ AP-204 Pulp & Paper: Measuring Turpentine & ClO_2
- ❒ AP-205 Measuring Heat Transfer Fluids with a PID
- ❒ AP-206 Guide to Atmospheric Testing in a Confined Space
- ❒ AP-207 PIDs as an Arson Investigation Tool
- ❒ AP-208 HAZMAT User List
- ❒ AP-209 UltraRAE User List
- ❒ AP-210 North American RAE User List
- ❒ AP-211 PIDs for Continuous Monitoring of VOCs
- ❒ AP-212 PIDs for Indoor Air Quality
- ❒ AP-213 ModuRAE PID Configuration and Applications
- ❒ AP-214 Environmental Applications for PIDs
- ❒ AP-215 Gas Detection in the Marine Industry
- ❒ AP-216 Weapons of Mass Destruction
- ❒ AP-217 Confined Spaces in the Construction Industry
- ❒ AP-218 Lengthening the Interval Between Calibration Checks
- ❒ AP-219 Using PIDs for 10% of LEL Decisions
- ❒ AP-220 Using PIDs in Clan Lab Investigations
- ❒ AP-221 PIDs for Exposure Risk in Unknown Environments
- ❒ AP-222 CO & Natural Gas Detection for Fire Department Engine Companies
- ❒ AP-223 ppbRAE User List
- ❒ AP-224 Understanding the CDRAE and its Applications

See Appendix E on how to obtain Application Notes.

RAE Systems Inc.
1339 Moffett Park Drive
Sunnyvale, California 94089
USA

Main Contact Numbers

Telephone: 408-752-0[illegible]

Fax: 408-752-0724

Toll Free Numbers

Instrument Sales: 877-RAE-CUSTomer (723-2878)

Technical Service: 888-RAE-4800 (723-4800)

Tube Sales: 888-RAE-Tube (723-8823)

Appendix D

O&M Forms

Adelaide Avenue School - System O&M Form

Date of O&M: ____________________ Performed by: ____________________________

PID/Methane Calibration? ____________________ (yes/no)

Date of last Methane Sensor Filter Replacement: ____________________ Replaced this O&M Visit? __________________ (yes/no)

General Status of SSD System: ____

General Status of Methane Monitoring System: ____

Eng. Cap/Fence Inspection Performed/Notes: ____ (take photographs of any deficiencies noted)

			VOC Monitoring	Methane Monitoring			Air/Vapor Sample Collection						
Monitoring/ Sampling Location	Sub-slab or gauge vacuum	Air Velocity (fpm)	PID (ppm)	Indoor Sensor (ppm)	(% Gas)	(% LEL)*	Summa Can ID	Controller ID	Start Time	Start Vac (inches Hg)	End Time	End Vac (inches Hg)	Comments/Notes (Ambient weather conditions, status of HVAC, possible monitoring/sampling interferences, etc .... continue on separate sheet if needed)
Gymnasium	NA	NA											
Cafeteria	NA	NA											
Kitchen Storage Room	NA	NA											
Elevator Hallway	NA	NA											
Room 145	NA	NA											
Room 152	NA	NA											
Room 118	NA	NA											
Room 110	NA	NA											
MP-1		NA		NA									
MP-2		NA		NA									
MP-3		NA		NA									
MP-4		NA		NA									
MP-5		NA		NA									
MP-6		NA		NA									
MP-7		NA		NA									
MP-8		NA		NA									
IMP-1		NA		NA									
IMP-2		NA		NA									
IMP-3		NA		NA									
Roof-Top Fan 1				NA									
Roof-Top Fan 2				NA									
Roof-Top Fan 3				NA									
Ambient Outdoor Air	NA	NA		NA									

NA: not applicable.
NM: not monitored on this date.
NS : not sampled on this date.
* RIDEM Action Level for methane %LEL beneath the building is 10% and within the building is 1%. If these methane levels are exceeded, immediately notify EA Project Manager to initiate response protocol.

EA Engineering, Science, and Technology, Inc.

METHANE ALARM REPORT/UNINTENTIONAL SYSTEM SHUT-DOWN FORM

Date: ____________ **Time:** ____________

Personnel: ______________________________

Location of Elevated Methane/Reason for Shut-Down: ____

Description of Actions

____

____

____

____

____

____

____

____

____

____

Signature: ____

Appendix E

Technical Assistance Contacts

APPENDIX E: TECHNICAL ASSISTANCE CONTACTS

Technical Subject	Name	Telephone No.
SSD and Methane Monitoring System O&M	City of Providence Environmental Consultant - EA Engineering, Science, and Technology, Inc. – Peter Grivers	401-736-3440, Ext. 216 or 401-935-5080
	City of Providence General Contractor – H.V. Collins – Patrick Collins	401-421-4080
	Electrical Subcontractor – Aladdin Electric – Henry Kanzerski	401-272-8450
	Mechanical Subcontractor – Aero Mechanical – John Cronin	401-751-8880
	Methane Monitoring System Supplier and Technical Assistance – DOD Technologies, Inc. – Frank Gambino	815-788-5200
	City of Providence – Facility Services Contractor – Aramark Education – Richard Ormsby	401-278-2855
	Monitoring Equipment Rental Supplier, U.S. Environmental Rental	888-550-8100
RIDEM Regulatory Compliance	City of Providence Environmental Consultant - EA Engineering, Science, and Technology, Inc. – Peter Grivers	401-736-3440, Ext. 216 or 401-935-5080
	RIDEM Contact – Joseph Martella II RIDEM – Office of Waste Management 235 Promenade Street Providence, RI 02908-5767	401-222-2797, ext. 7109