LANDTEC
A DIVISION OF CES

GA-90

LANDFILL GAS ANALYZER

OPERATION MANUAL

Table of Contents

Chapter 1-Getting Started

GA-90 Options

While the external appearance of the GA-90 is the same for all configurations, the user will see the N/A symbol for all options not purchased. The following features are optional:

- Oxygen Sensor
- Barometer/Probe Pressure
- Logging Function
- RS-232 Gas Analyzer Communications Package
- Carbon Dioxide Sensor

This manual is written for a fully configured GA-90. Those sections that cover optional features are marked **OPTIONAL FEATURE**. If your GA-90 is not fully configured and user selects an unavailable option, the following screen will appear (Figure 1.1). User can return to previous menu by pressing any key.

Figure 1.1

The basic GA-90 configuration can be upgraded with any combination of the optional features. This upgrade can be completed in as little as five days with our Expedited Upgrade Program. Contact your LANDTEC Sales Engineer for details.

Unpacking the GA-90

The GA-90 unit is normally shipped in a special protective Styrofoam shipping unit. An optional protective hard case with a foam interior offers additional protection, transportation convenience and component hardware storage. When properly sealed, the hard case is watertight. The hard case is equipped with a pressure relief valve (by the handle on the case) that is normally kept closed. If there is a change in elevation, the hard case may not open until the pressure is equalized by turning the pressure relief valve. When shipping a GA-90 back to LANDTEC for calibration or service, always ship it in the original packaging to protect unit from damage.

Carefully unpack the contents of the GA-90, inspect and inventory them. The following items should be contained in your package:

- Hard carrying case (**OPTIONAL FEATURE**) When opening the hard case, it may be necessary to open the pressure relief vent.
- The GA-90 unit
- GA-90 Operation Manual
- Warranty/Registration Card and other instructional information
- Soft carrying case with replaceable protective window and carrying strap
- External sampling hose assembly (5 ft.) with external filter/water trap assembly

- Spare internal filter element
- Polypropylene male connector (hose barb) connects to tubing
- Spare external filter element
- 110-volt Nickel-Cadmium battery charger
- GA-90 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 GA-90 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 (310) 908-7651. Complete the Registration/Warranty Card and return it to LANDTEC. The model and serial numbers are located on the back of the GA-90 unit.

Attaching the Hose Assembly

The GA-90 hose assembly comes fully assembled but it needs to be connected to the GA-90. To sample, connect the hose with the external filter/water trap assembly to the sampling port on the top left corner of the GA-90.

To read pressure, connect the tubing to the pressure port on the GA-90 (See Figure 1.2). This port is located on the bottom left corner of the GA-90. DO NOT block the exhaust port (See Figure 1.2).

Quick Connect Fittings

The quick connect fittings will simplify reading wellfield probe. 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.

Must Do's Before Using the GA-90

Read Chapter 2 of this manual.

Proper operation of the GA-90 requires the following functions to be completed before proceeding.

- Charge the unit with the battery charger
- Check the Time/Date
- Perform a Zero Pressure **(OPTIONAL FEATURE)**
- Field Calibrate the unit

Calibration Gases

Calibration gases are required to field calibrate the GA-90 (See Chapter 2-Field Calibration). Portable Calibration Gas Kits and 12-unit cylinder cases are available from LANDTEC or can be obtained from a specialty gas company. See LANDTEC Calibration Gas Kits literature at end of this manual.

Special Keying Functions

Entering an ID code with Letters and Numbers

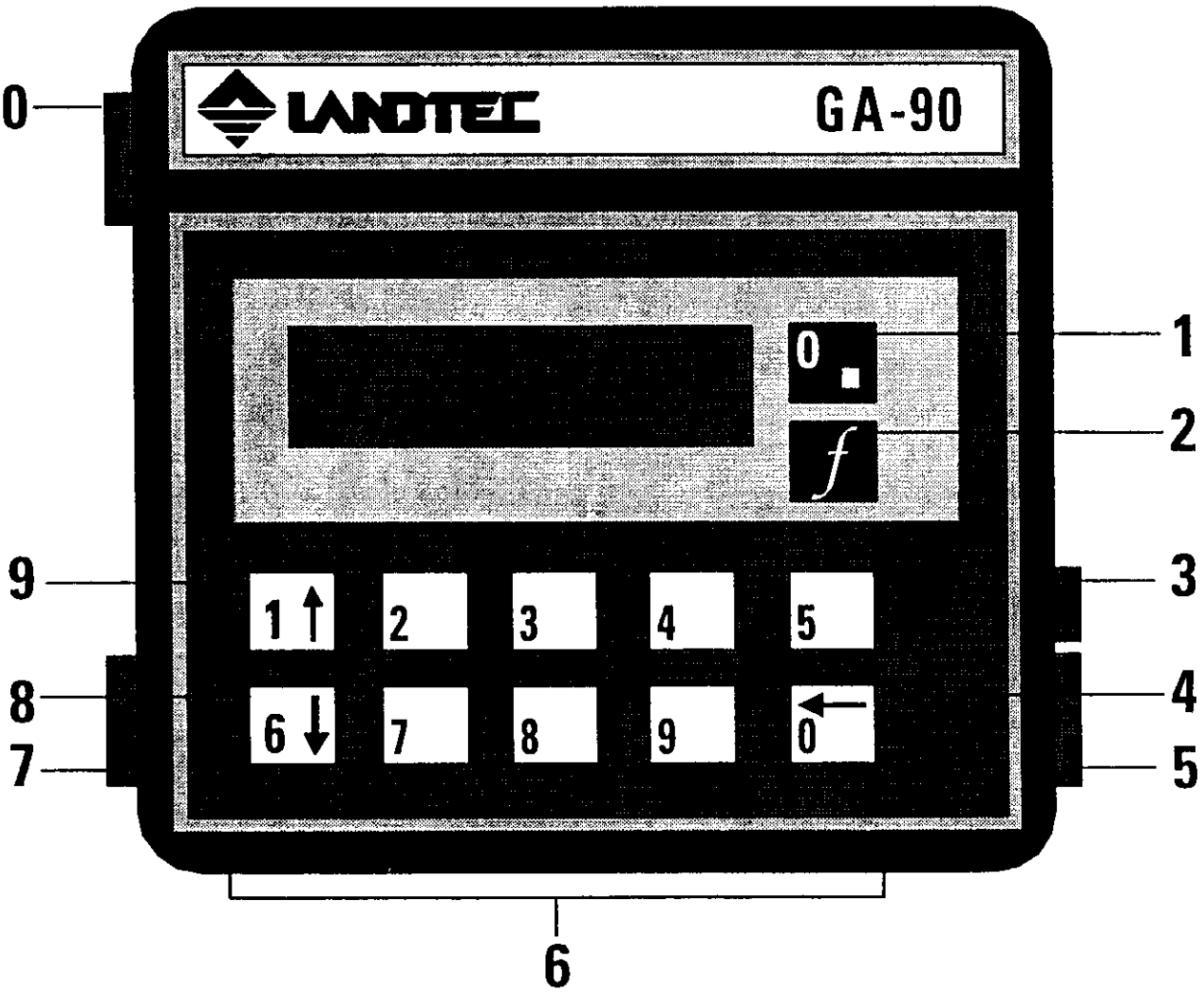
Use blue toggle key to shift back and forth between number mode and letter mode. When in number mode, use number KEYS to enter numbers. When in letter mode, use arrow **KEY 1-UP ARROW** or **KEY 6-DOWN ARROW** to scroll to desired letter, then press **KEY 0** to enter the letter on the display. Repeat 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.

GA-90 Keyboard and Port Description

Figure 1.2



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. Receptacle Port—Used for battery recharging, temperature readings and optional RS-232 communications.
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. Pressure Port—Measures pressure when connected to wellhead or probe.
8. Cursor-Down Key—Enters numeral 6, and scans lines of information or screens.
9. Cursor-Up Key—Enters numeral 1, and scans lines of information or screens by moving up or toward the beginning of a list or alphabet.
10. Sampling Port—Used as as inlet/suction port.

Chapter 2-Using Menu Screens

Starting Up the GA

This procedure is the same each time the GA-90 is turned on by pressing the **RED KEY ON/OFF**. The following steps will allow you to proceed to the Main Menu Screen of the GA.

Note: If the GA 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 GA-90 is not to be used in confined areas such as vaults, excavations or indoors. An explosion could result causing serious injury or death.

Figure 2.1

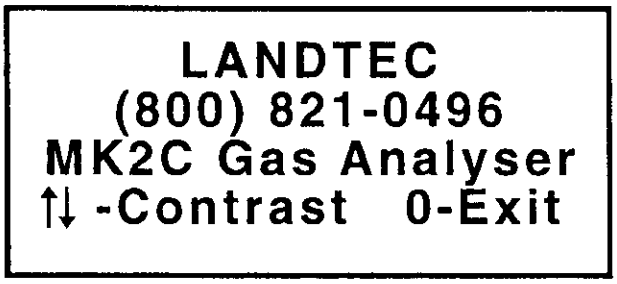
3. If a service contract has been purchased, the Service Contract Screen (Figure 2.2) may appear for five seconds. Otherwise Figure 2.3 will appear. The GA-90 is a portable scientific field instrument that does require factory maintenance and calibration at recommended six month intervals under normal landfill usage.

Figure 2.2

Figure 2.3

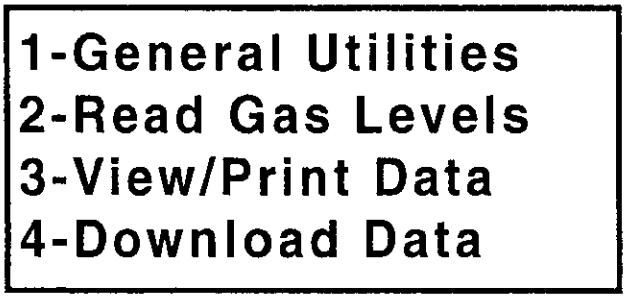
The LANDTEC/Contrast Screen follows and allows the user to adjust the contrast of the characters on the liquid crystal display screen. Press and hold **KEY 1-Cursor-Up Arrow** to increase contrast. Press and hold the **KEY 6-Cursor-Down Arrow** to decrease the contrast. Adjust the contrast as necessary. Press the **KEY 0** to exit to the next screen.

Figure 2.4



4. Following is the Main Menu Screen. All GA-90 functions are accessed from the Main Menu Screen. All future instructions about GA-90 functions will start with from this screen.

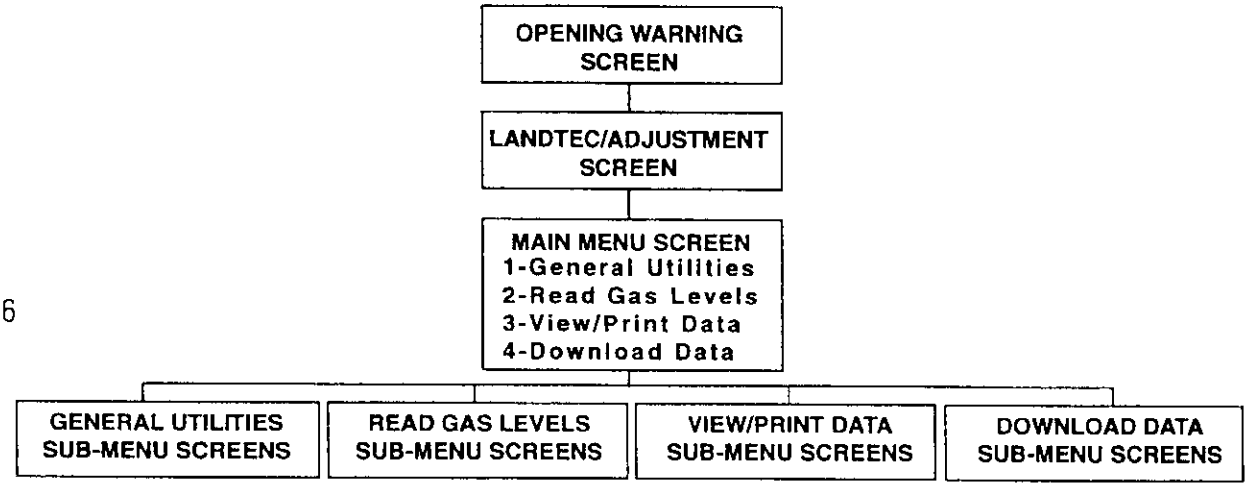
Figure 2.5



GA-90 Menu Screens Tree

The overall menu screens structure is displayed below:

Figure 2.6



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 housekeeping and other maintenance including:

KEY 1-Check Time/Date: Used to check or set time and date.

KEY 2-USA/Metric Units: Select either USA standard or metric measurement units.

KEY 3-Gas Alarm: Sets gas alarm levels.

KEY 4-Memory: Checks memory available and clears all data and ID information.

KEY 5-Calibration: Allows field calibration for increased accuracy (Discussed in Section 2).

KEY 6-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 and pressure 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 GA display screen, individually displayed or printed via the optional RS-232 cable to a serial printer.

Download Data (OPTIONAL FEATURE)

The Download Data function allows stored data to be downloaded via the optional communications software and RS-232 cable to a personal computer or serial printer 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.

Chapter 3-Field Calibration

Field Calibration is menu-guided and can be completed in about ten minutes. The pump does not have to be running to pass calibration gas through instrument. Using the pump will consume more gas than necessary. The GA-90 contains a calibration map which is accessed by its microprocessor for baseline reference data. This reference data was programmed into the GA-90 during the factory calibration using various gas mixtures in an environmental chamber. At any time, the GA-90 can be reset by returning to the "factory settings." This clears the GA-90 of any user calibration settings and restores the GA-90 to its original factory calibration.

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 GA-90 on-site after the instrument has stabilized at working temperature. For this reason, a GA-90 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 GA-90 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 GA-90 field-calibrated using 50% CH4 and 35% CO2 will give improved readings for the higher methane concentrations, but may provide less accurate readings at very low methane concentrations (which are not common in LFG). Recommended gas mixture is 15/15 (15% methane, 15% carbon dioxide, 4.5% oxygen and balance nitrogen.**

Calibration Gas/Span Gases

Field calibration requires two calibration gas mixtures. Various calibration gas mixtures are available from LANDTEC. The second calibration gas is used to calibrate the levels of oxygen. Any oxygen mixture of less than 5% oxygen can be used to calibrate low levels of oxygen. A 4/96 mixture of oxygen and nitrogen (4% O2 and 96% N2) is acceptable under normal conditions. 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 GA-90 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. This is done by providing the GA-90 a sample that is known to have zero methane—often air is used. This establishes a zero point. This significantly improves the GA-90's CH4 accuracy over the entire range. **It is essential that the gas analyzer is clear of any CH4 at the time of zeroing.** Care must be taken if the GA-90 is to be zeroed on a landfill site. There are situations where methane, which is odorless and colorless, could be in the atmosphere.

After the Zero methane function is performed, the GA-90 recalculates 16 methane calibration points on its methane gas curve and stores the revised data in its memory. The GA-90 does not need to 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.

> **Note: The Zero Methane should be set before setting the Methane Span.**

Span Carbon Dioxide (OPTIONAL FEATURE)

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.

Zero Oxygen (OPTIONAL FEATURE)

This function is essential where low concentrations of oxygen are expected (below 6%). Normally there is very little oxygen in LFG. This establishes the zero point of an oxygen curve that is stored in the GA-90's permanent memory.

Span Oxygen (OPTIONAL FEATURE)

The oxygen calibration map contains two span curves, one for oxygen below 5% and one for oxygen above 5%. The proper curve is automatically selected. If a calibration gas with less than 5% oxygen is used, the lower span curve is adjusted. If the calibration gas has more than 5% oxygen, the higher calibration curve is adjusted. Due to the resolution of the GA-90 processor at higher concentrations, the GA-90 may not display the exact concentration entered. 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 Zero Oxygen should be set before setting the Oxygen Span.

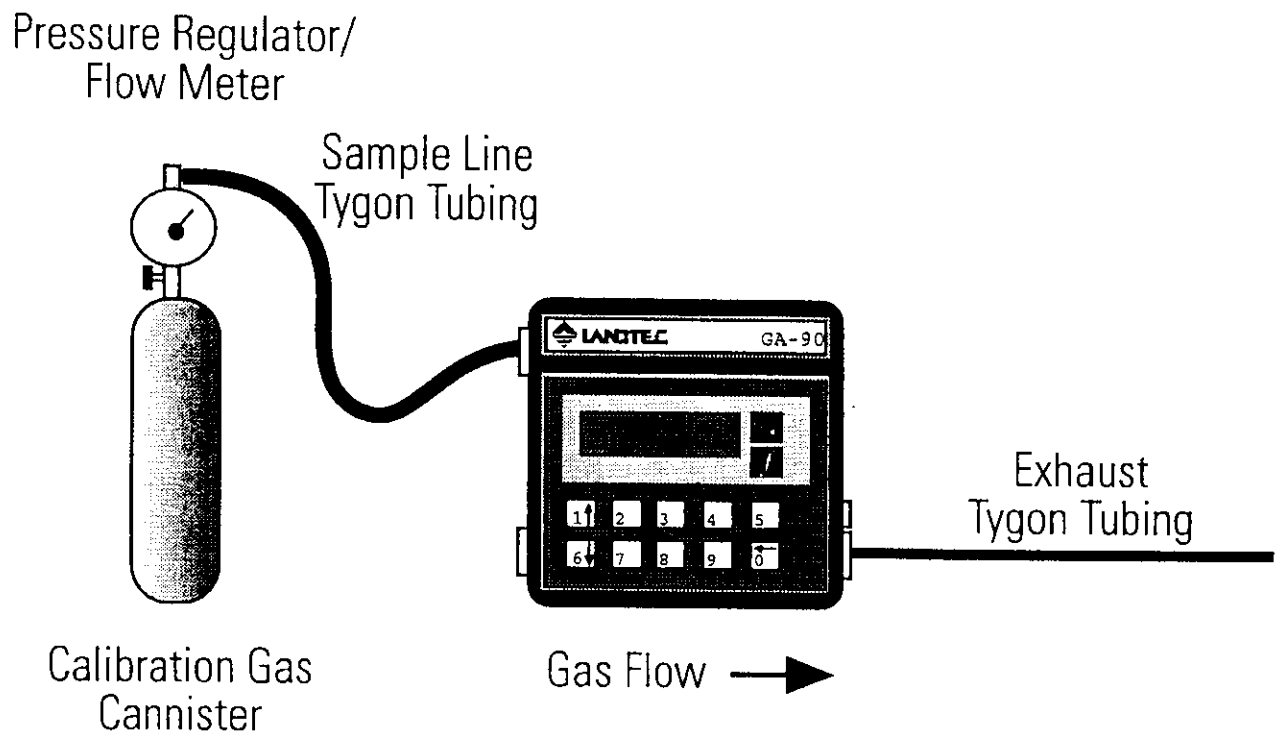
Equipment

To perform a field calibration, the following items are required.

1. Cylinder of methane and carbon dioxide span gas
2. Cylinder of 4/96 (4% O2 and 96% N2) 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 100 - 600 cc per minute maximum with fittings suitable for 1/4" Tygon tubing or LANDTEC regulator which is set to deliver the required flow.
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 3.1.

Figure 3.1



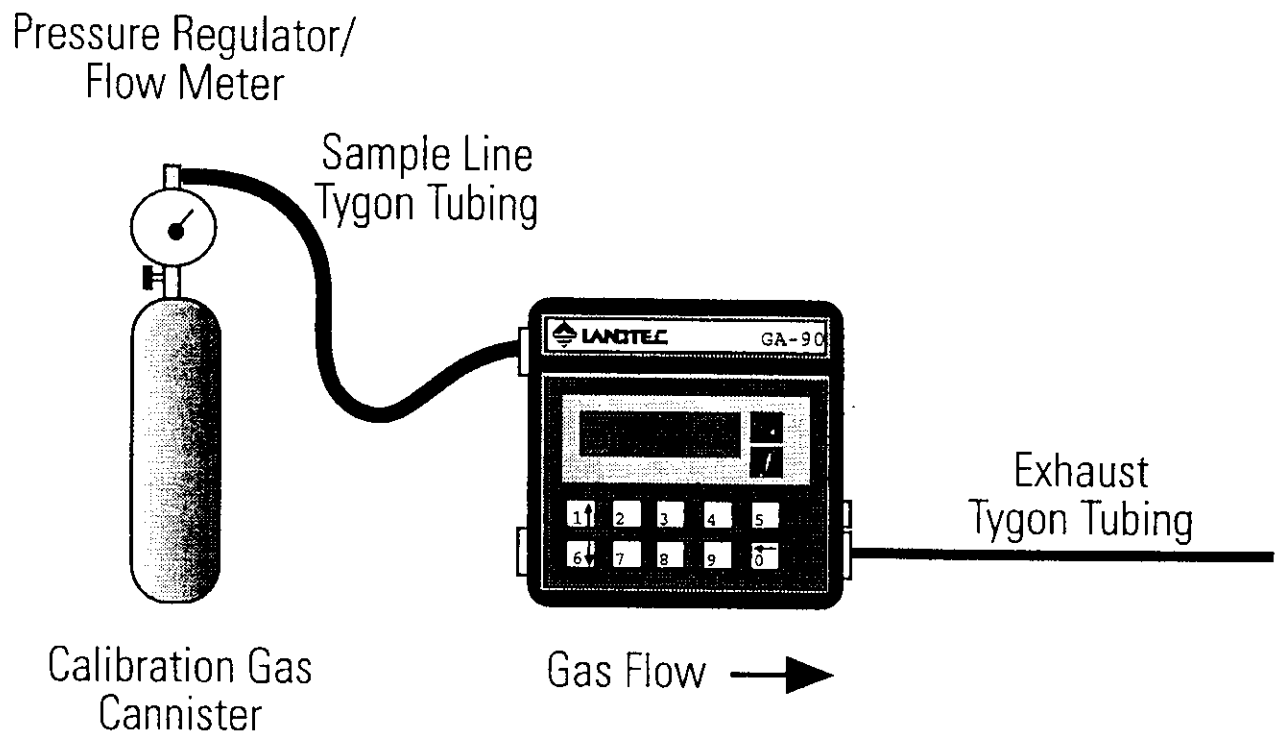
Setting Up the Equipment

As described and shown in the Equipment Section, begin assembly of the GA-90:

1. Connect calibration gas cylinder to the pressure regulator.
2. Connect sample input line.
3. Connect second 24" of 1/4" Tygon tubing to the exhaust nozzle of the GA-90. Direct exhaust away from you and out of the immediate area.
4. Turn the calibration gas cylinder valve two turns.
5. If using a LANDTEC regulator, no flow meter is required. Turn off cylinder valve.
6. If **not** using the LANDTEC regulator, adjust the regulator discharge pressure to 2 psig and the flow meter to 300 cc per minute. Pinch the gas supply hose that will attach to the GA-90. The regulator discharge pressure should not climb to over 5 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.

Figure 3.1



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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.

Recommended Calibration Gases

Zero Methane in non-methane environment: air
Zero Methane in a methane environment: 4.5% oxygen and balance nitrogen
Methane Span: 15% methane, 15% carbon dioxide, balance nitrogen
Oxygen Span: 4.5% oxygen, balance nitrogen

Recommended Calibration Method Overview

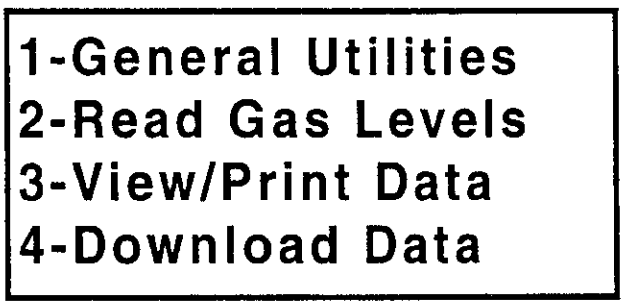
1. Zero methane
2. Connect methane/carbon dioxide mixture
3. Span methane
4. Zero oxygen
5. Disconnect methane/carbon dioxide mixture
6. Connect oxygen mixture
7. Span oxygen
8. Disconnect oxygen mixture

General Utilities 5 - Gas Calibration

The GA-90 is factory calibrated. To improve accuracy, all standard landfill gas instruments are field calibrated, zeroed or in other ways adjusted prior to every use . This function is done from the General Utilities Menu of the GA-90 which is explained in Chapter 2. Because of the importance of Gas Calibration, this function has been made a separate section. To get to the General Utilities Screen on the GA-90, see Chapter 2, Using the Menu Screens.

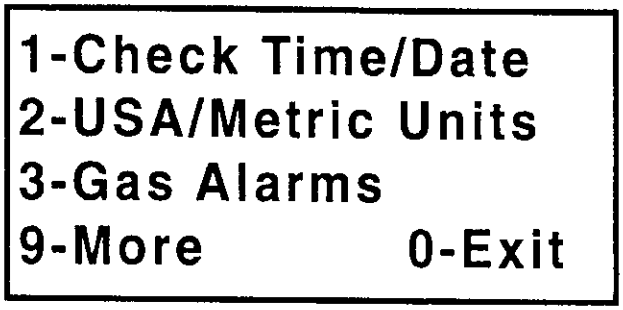
1. Press **KEY 1-General Utilities** at the Main Menu Screen (See Figure 3.2.).

Figure 3.2



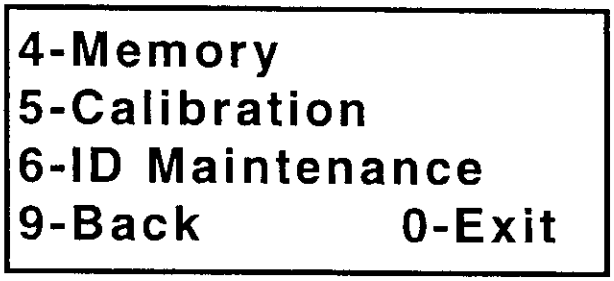
2. The General Utilities Screen appears as shown in Figure 3.3.

Figure 3.3



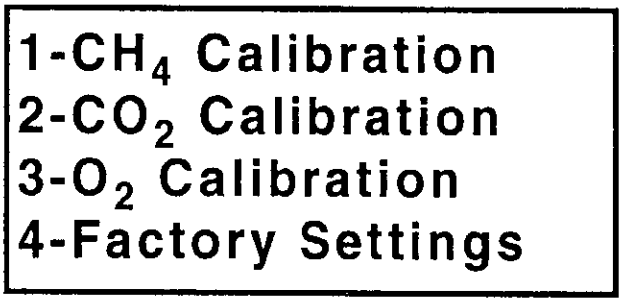
3. The gas calibration function is not on the first General Utilities Screen. To reach this screen, press **KEY 9-More** and **KEY 5-Gas Calibration** (Figure 3.4). You could also select **KEY 5** while at the General Utilities Screen and proceed directly to the gas calibration screen.

Figure 3.4



4. After selecting **KEY 5-Gas Calibration** on the General Utilities Sub-Menu Screen, the first Gas Calibration Screen appears as shown in Figure 3.5.

Figure 3.5



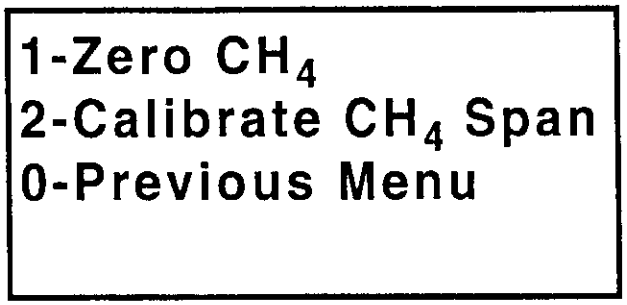
5. There are four possible choices. The first allows a field calibration to be performed on the GA-90 for methane. The second choice calibrates carbon dioxide. The third choice calibrates oxygen. The fourth choice returns the GA-90 from a field calibration established by the user to the original factory settings.

6. Each of these calibration options will now be reviewed in order.

Methane (CH4) Calibration - Zero CH4

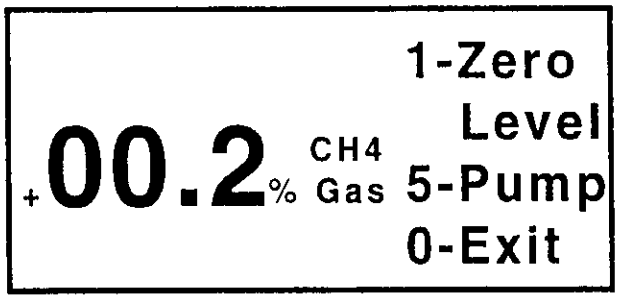
1. Pressing **KEY 1-CH4 Calibration** on the Calibration Screen brings up the Methane Calibration Screen (Figure 3.6).

Figure 3.6



2. Pressing **KEY 1-Zero CH4** brings up the Zero Methane Screen (Figure 3.7). 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.

Figure 3.7

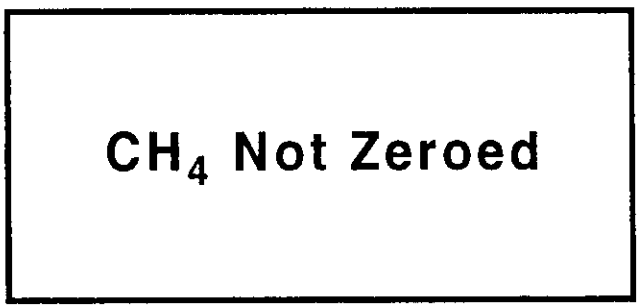


Note: Do not perform this procedure in the presence of methane.

3. Pressing **KEY 5-Pump** turns on the GA-90 sample pump. There should be no calibration gas hoses attached to the GA-90 during this procedure. The GA-90 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 GA-90 has already reached operating temperature by having been used and is at operating temperature, the pump can be operated for two minutes or until gas reading stabilizes. When in doubt, let it run for the full five minutes.)

4. Press **KEY 1 - Zero level** and one of the following screens (Figure 3.8 or Figure 3.9) will be displayed for three seconds before returning to the Zero Methane Screen shown in Figure 3.7.

Figure 3.8



3. Connect the 1/4" Tygon tubing from the calibration gas regulator/flow meter to the GA-90 gas sample port (Figure 1.1). Attach, if not already attached, the Tygon tubing to the exhaust port of the GA-90. Direct the exhaust away from you and out of the immediate area.

4. Turn on the calibration gas mixture of methane and carbon dioxide. Pump does not have to be on.

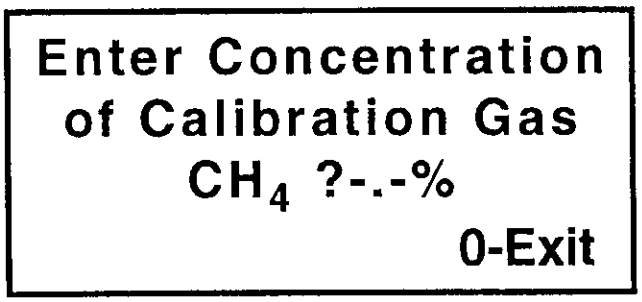
5. If not using LANDTEC supplied regulator, check the calibration gas flow at 300cc and pressure no greater than 2 psig.

6. Allow the calibration gas to flow into the GA-90 for two minutes or until instrument gas reading stabilizes.

7. 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 at the 15% gas level, 1% at the higher gas level.

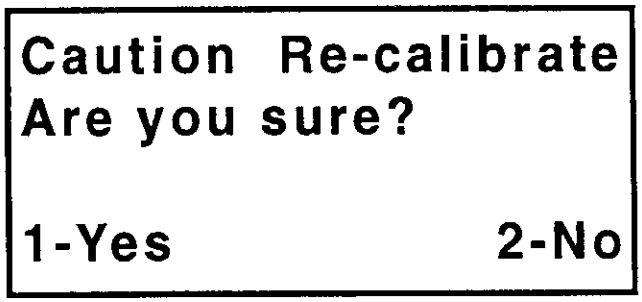
8. Press **KEY 1-Enter Gas Con** and input the methane concentration of the calibration gas from the keyboard of the GA-90 (Figure 3.12). Enter the percentage as three digits XX.X%. 15% methane would be input as 150. The GA-90 will automatically place a decimal point in the proper position. After the percentage is entered, press KEY 0-Exit.

Figure 3.12



9. The next screen is the Caution Re-Calibrate Screen (Figure 3.13).

Figure 3.13



10. Press **KEY 1-Yes** and one of two messages will appear (Figure 3.14 or Figure 3.15).

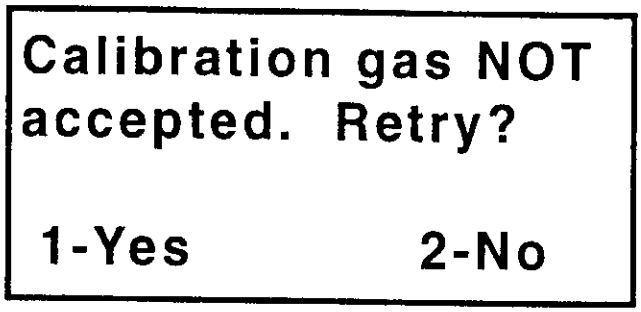


Figure 3.14

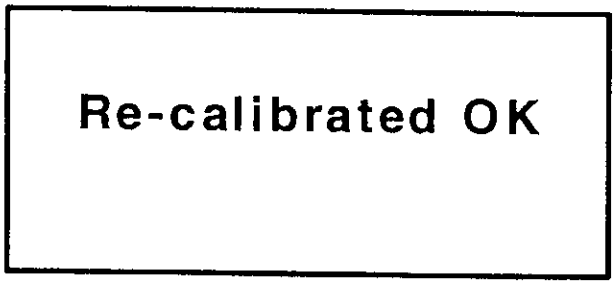


Figure 3.15

11. If the Calibration OK Screen flashed (Figure 3.15), proceed to step 13.

12. If the Calibration Gas Not Accepted Screen appears (Figure 3.14) press **Key 1-Yes** and re-enter methane percentage. If Calibration Gas Not Accepted Screen still appears, press **KEY 0-No** and start procedure again from zero methane. If problem persists, proceed to Factory Settings later in this chapter.

13. If no further calibration is required go to step 15.

14. If CO2 is to be calibrated, press **KEY 0** twice. The Gas Calibration Screen (Figure 3.16) should appear. Follow CO2 calibration instructions on next page.

15. Turn off calibration gas cylinder. Remove gas hose attached to gas sample port. Leave exhaust port hose connnected. Turn on pump and purge instrument with air for 60 seconds (CH4 concentration should read 00.0%). You have successfully completed a CH4 field calibration. Press Key 0 to return to Main Menu Screen. If instrument has CO2 option, press **KEY 0** twice to return to Gas Calibration screen.

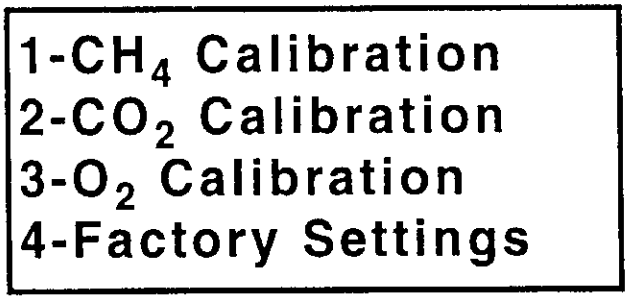
Carbon Dioxide (CO2) Calibration (OPTIONAL FEATURE)

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 GA-90 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 GA-90, 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.

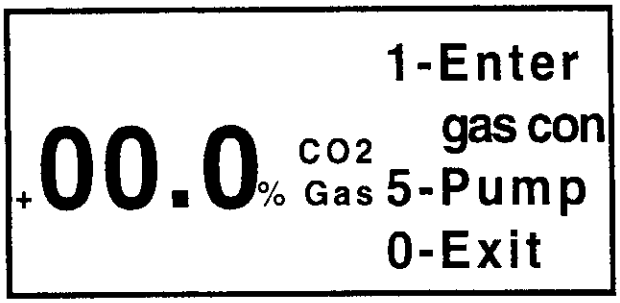
2. Press **Key 2 - CO2 Calibration** on the Gas Calibration Screen (Figure 3.16).

Figure 3.16



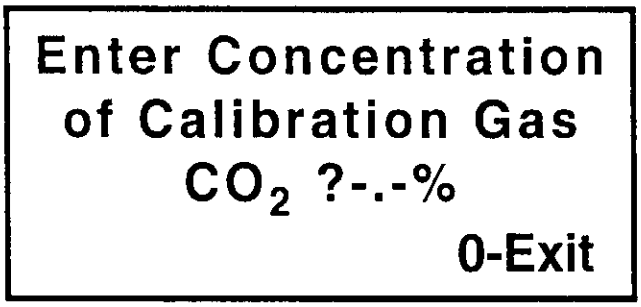
3. There is no Zero CO2 function as there is in the methane or oxygen calibration procedures. The following CO2 Span Screen will appear (Figure 3.17).

Figure 3.17



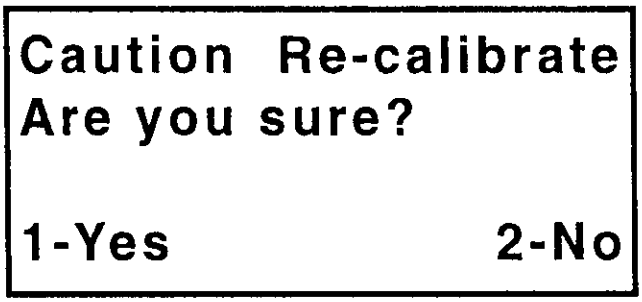
4. Press **KEY 1-Enter Gas Con** and the Enter Concentration Screen shown in Figure 3.18 appears. Input the carbon dioxide concentration of the calibration gas from the keyboard of the GA-90 (Figure 3.18). Enter the percentage as three digits XX.X%. 15% carbon dioxide would be input as 150. The GA-90 will automatically place a decimal point in the proper position. After the percentage is entered, press **KEY 0 - Exit.**

Figure 3.18



5. The next screen, Figure 3.19, is the Caution Re-Calibrate Screen.

Figure 3.19



6. Press **KEY 1-Yes** and one of two messages will appear (Figure 3.20 or Figure 3.21).

Figure 3.20

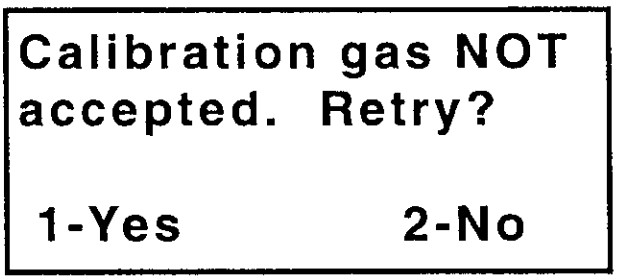
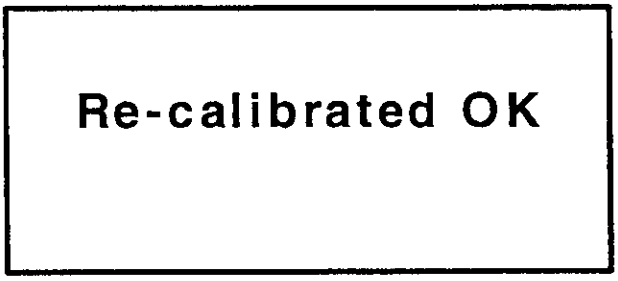


Figure 3.21



7. If the Calibration OK Screen (Figure 3.21) flashed, proceed to step 9.

8. If the Calibration Gas Not Accepted Screen appears (Figure 3.20) press **Key 1-Yes** and re-enter methane percentage. If Calibration Gas Not Accepted Screen still appears, press **KEY 0-No** and start procedure again. If problem persists, proceed to Factory Settings later in this chapter.

9. If no further calibration is required go to step 11.

10. If oxygen **(OPTIONAL)** is to be calibrated, press **KEY 0.** The Gas Calibration Screen (Figure 3.16) should appear. Perform following O2 calibration instructions.

11. Turn off calibration gas cylinder. Remove gas hose attached to gas sample port. Leave exhaust port hose connnected. Turn on pump and purge instrument with air for 60 seconds (CO2 concentration should read 0.00%). You have successfully completed a CO2 field calibration. Press **KEY 0** twice to return to Main Menu Screen.

Oxygen (02) Calibration - Zero 02 (OPTIONAL FEATURE)

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 nitrogen 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 GA-90 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 GA-90, 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 3.22).

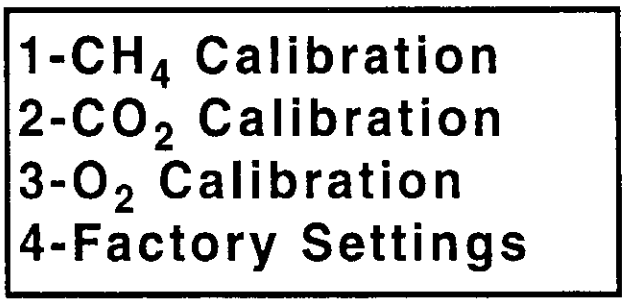
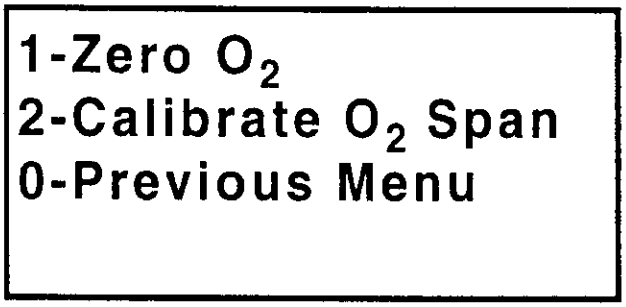


Figure 3.22

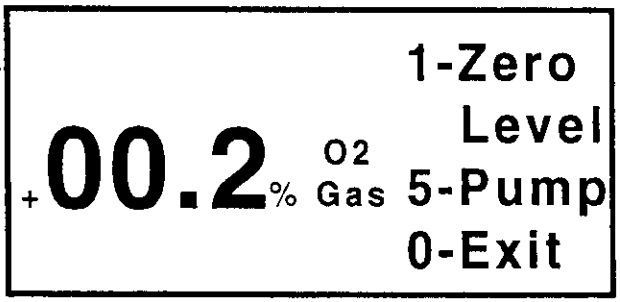
3. The Oxygen Calibration Screen will appear (Figure 3.23).

Figure 3.23



4. Pressing **KEY 1-Zero O2** will bring up the Zero Oxygen Screen (Figure 3.24).

Figure 3.24



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 3.25 or Figure 3.26) 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 3.25

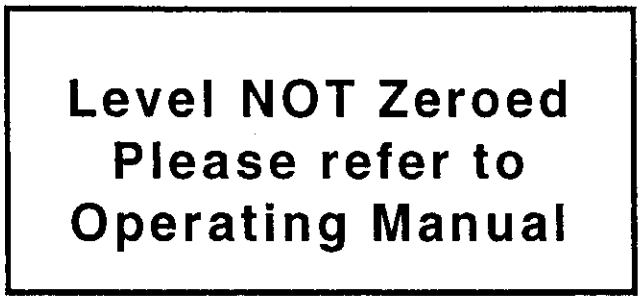
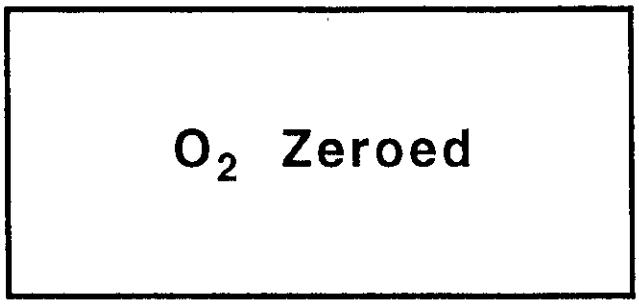


Figure 3.26



7. If the Oxygen NOT Zeroed Screen was displayed, return to the Oxygen Calibration Screen. Recheck hose for air leaks and that the calibration gas contains no oxygen. The gas used must be oxygen free. Connect the correct gas (if necessary) 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 flashed, turn off the calibration gas.

9. Remove the hose to the GA-90 from the flow regulator.

10. Press **KEY 0-Exit** to return to the Oxygen Calibration Screen Shown in Figure 3.27 and proceed to the next section.

O2 Calibration - O2 Span (OPTIONAL FEATURE)

1. From the O2 Calibration Screen (Figure 3.27), press **KEY 2-Calibrate O2 Span** and the Oxygen Calibration Screen (Figure 3.28) will appear.

Figure 3.27

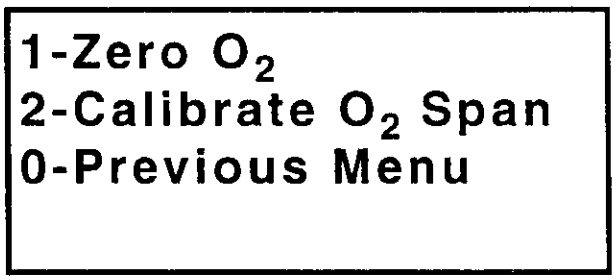
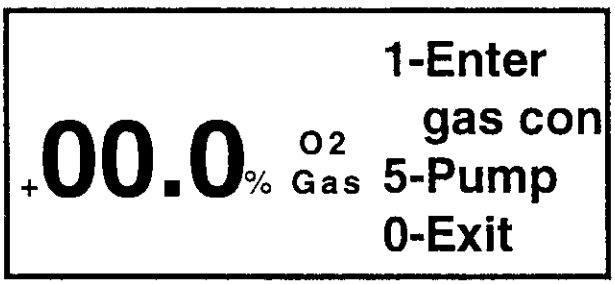


Figure 3.28



Note: The calibration gas used in this procedure is a mixture of oxygen and balance gas. The oxygen concentration by volume can be 2-5% with the remainder Nitrogen. The instructions assume a 4% oxygen/96% nitrogen mixture will be used.

2. 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 if not using the LANDTEC regulator/flow meter. Turn off the gas.

3. Connect the 1/4" Tygon tubing from the calibration gas regulator/flowmeter to the GA-90 gas sample port (Figure 1.1). Attach, if not already attached, the Tygon tubing to the exhaust port of the GA-90. Direct the exhaust away from you and out of the immediate area.

4. Turn on the calibration gas mixture of oxygen and nitrogen.

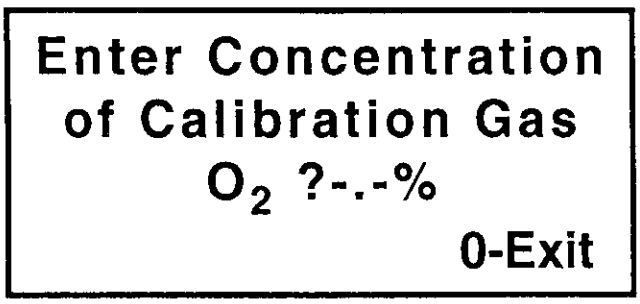
5. Check the calibration gas flow (300 cc) and pressure (2 psig) if not using the LANDTEC regulator.

6. Allow the calibration gas to flow into the GA-90 for two minutes or until O2 reading stablizes.

7. 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.

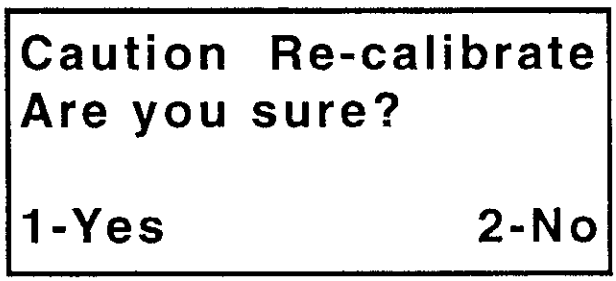
8. Press **KEY 1-Enter Gas Con** and input the oxygen concentration of the CALIBRATION GAS from the keyboard of the GA-90 (Figure 3.29). Enter the percentage as three digits XX.X%. 4% oxygen would be input as 040. The GA-90 will automatically place a decimal point in the proper position. After the percentage is entered, press KEY 0-Exit.

Figure 3.29



9. The next screen to appear, Figure 3.30, is the Caution Re-Calibrate Screen.

Figure 3.30



10. Press **KEY 1-Yes** and one of two screens will appear (Figure 3.31 or Figure 3.32). If the Calibration OK Screen flashed, proceed to step 14.

Figure 3.31

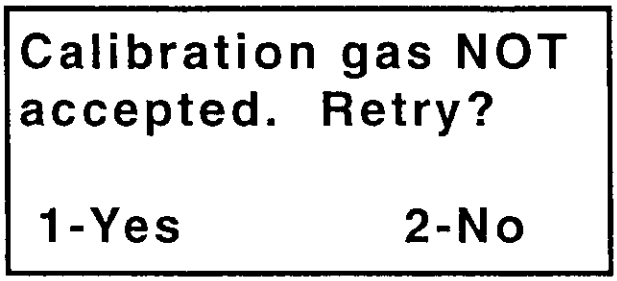
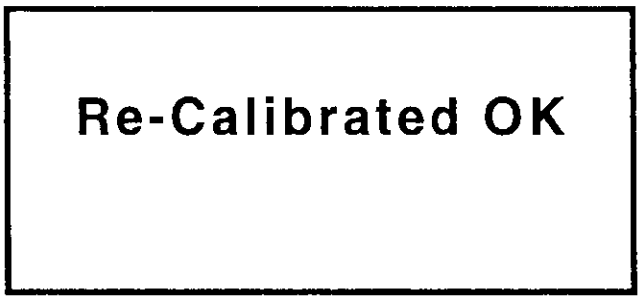


Figure 3.32



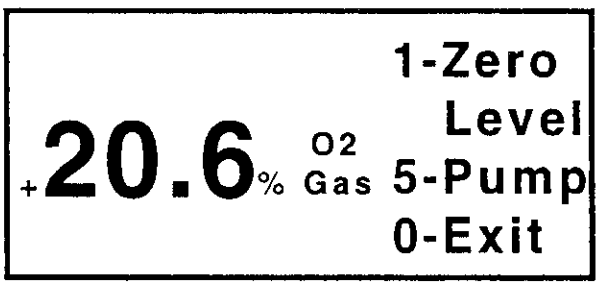
11. If the Calibration gas NOT Accepted Screen appears, several things could have happened. Press **KEY 1-Yes** and enter the percentage of oxygen in the Calibration Gas. It is possible the wrong percentage was input. If on a second attempt this has not worked, press **KEY 0-No** and return to the oxygen 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.

12. Press **KEY 0-Exit** and return to the Oxygen Calibration Screen shown on the following page.

13. Turn off the Calibration Gas. Remove the Calibration Gas hose attached to the gas sample port. Leave the exhaust port hose connected. Press **KEY 5-Pump** to purge instrument with air for 60 seconds.

14. Optional Step Upper O2 Scale Calibration- The GA-90 was just calibrated on 0-5% oxygen scale. The 5-21% scale can be calibrated using normal air. While on the Oxygen Calibration Screen press **KEY 5-Pump** and enter an O2 concentration of 21.0% even though the screen will seldom reach more than 20.6%. You have just calibrated the upper oxygen scale.

Figure 3.33



15. To exit, press **KEY 0** until the main menu appears. You have successfully completed an oxygen Field Calibration.

Factory Settings Calibration

As previously mentioned, the GA-90 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 GA-90 back to factory settings before trying to field calibrate the unit.

1. From the Gas Calibration Screen, Figure 3.34, press **KEY 4-Factory Settings.**

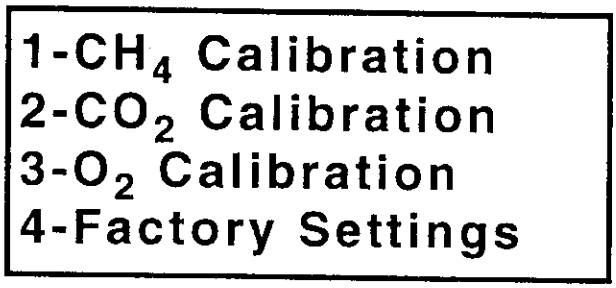


Figure 3.34

2. The Caution Screen, Figure 3.35, shown below will be displayed. If **KEY 0 - No** is pressed, screen represented in Figure 3.36 will appear for two seconds and the Gas Calibration Screen will return.

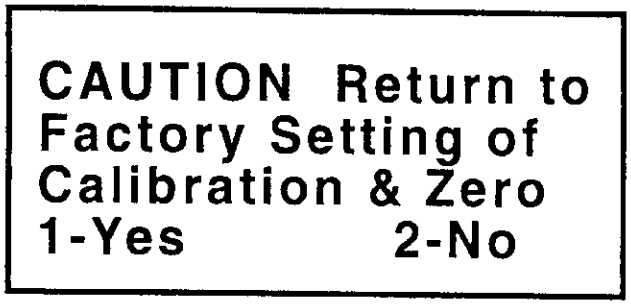


Figure 3.35

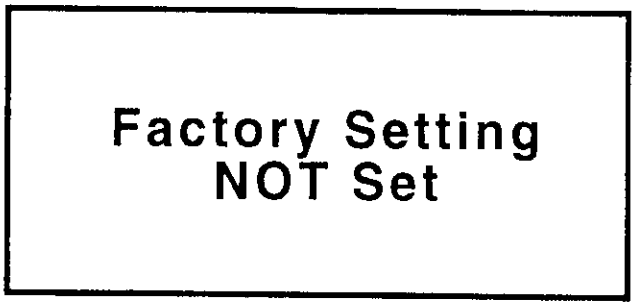


Figure 3.36

3. Press **KEY 1-Yes** and the screen shown in Figure 3.37 is displayed for three seconds before returning to the Gas Calibration Screen shown in step 1.

Figure 3.37

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 GA-90 is field calibrated. These functions are available from the General Utilities Menu and include:

KEY 1-Check Time/Date—to make sure the data collected is properly date stamped.

KEY 4-Check Memory—to see if there is enough space in the GA-90 for the reading you plan to do. Otherwise the memory will have to be cleared.

KEY 3-Set Gas Alarms—if you wish to have the GA-90 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.

Chapter 4-General Utilities

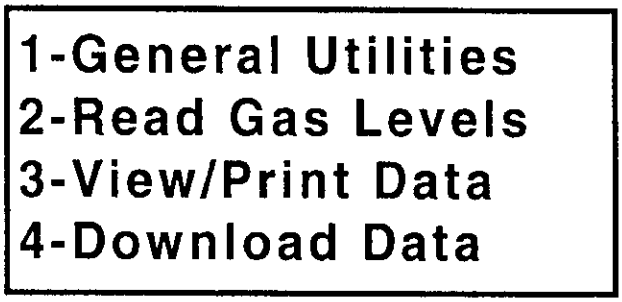
Read Chapter 2 on how to get to the Main Menu Screen. Also see the GA-90 Menu Screen Tree diagram located in Chapter 2.

Press **KEY 1-General Utilities** on the Main Menu Screen. There are six 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).

General Utilities Functions

1. CHECK TIME/DATE: Used to check or set time and date.
2. USA/METRIC UNITS: Select either USA standard (Imperial) or metric (SI) measurement units.
3. GAS ALARM: Sets gas alarm levels.
4. MEMORY: Check memory available and allows clearing of all data and ID information.
5. CALIBRATION: Allows methane, carbon dioxide and oxygen to be field calibrated by the user with a special gas mixture for increased accuracy.
6. ID MAINTENANCE: Used to view, edit or delete existing ID information and to enter new ID information.

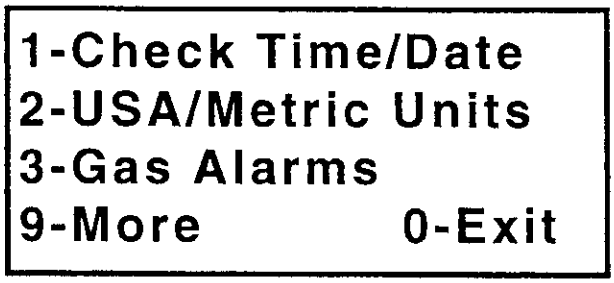
Figure 4.1



General Utilities Menu

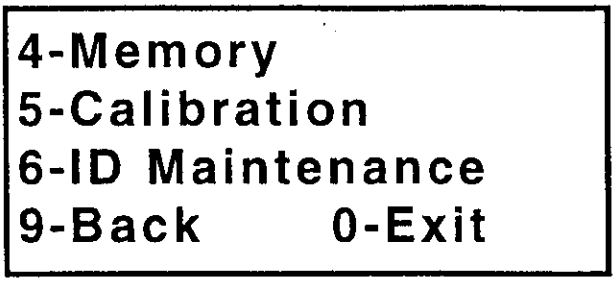
By pressing **KEY 1** on the Main Menu Screen, the General Utilities Menu Screen (Figure 4.2) will appear.

Figure 4.2



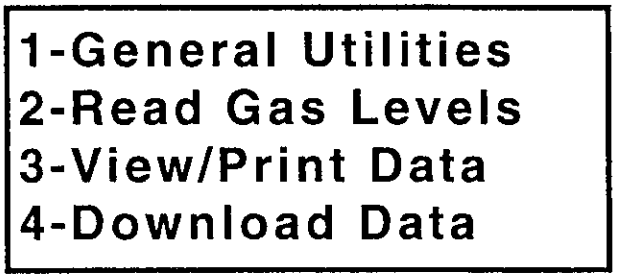
As shown, three General Utilities functions are shown on each General Utilities Menu Screen. By pressing **KEY 9**, the next screen of utility functions is displayed (Figure 4.3).

Figure 4.3



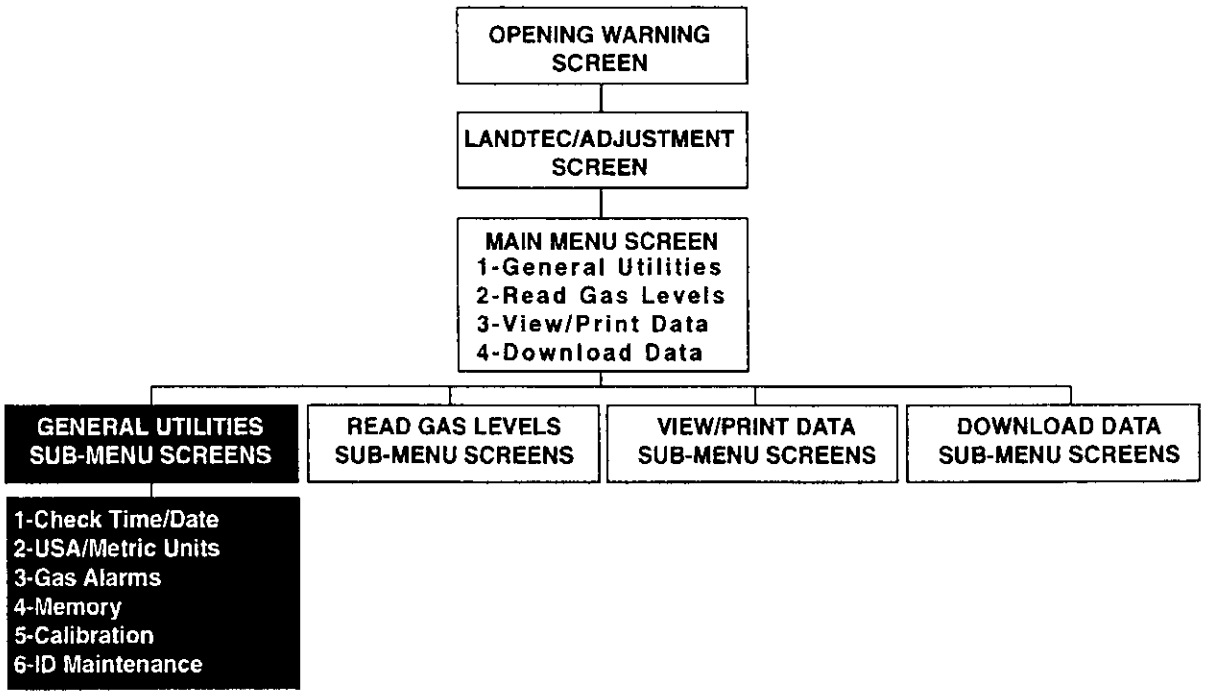
As previously mentioned, any function number can be pressed while any screen is displayed. Pressing the **KEY 0** returns you to the Main Menu Screen (Figure 4.4).

Figure 4.4



General Utilities Tree

Figure 4.5



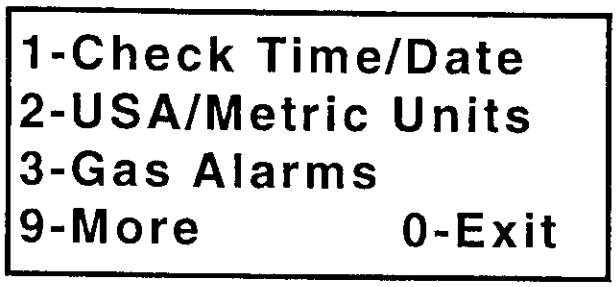
General Utilities 1 - Check Time/Date

There is an internal clock and calendar in the GA-90 unit which is powered by a secondary battery. This maintains the clock function even when the GA-90 is off. The battery can only be changed by an authorized factory service representative.

As each reading is stored in the GA-90, 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.

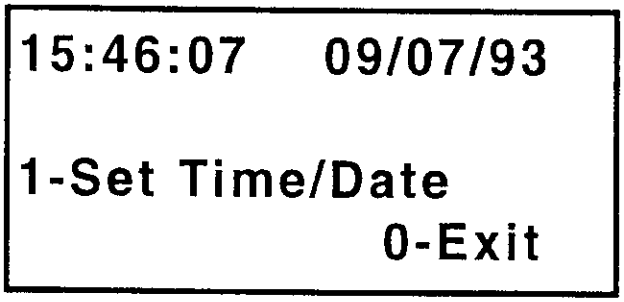
1. Press **KEY 1** on the Main Menu Screen for the General Utilities Sub-Menu Screen. This takes you to the General Utilities Sub-Menu Screen (Figure 4.6). Press **KEY 1** on the General Utilities Sub-Menu Screen as shown below for the Check Time/Date function.

Figure 4.6



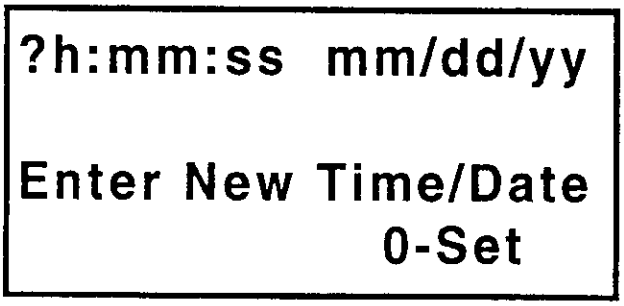
2. The following Set Time/Date Screen is displayed (Figure 4.7). Press **KEY 1** to proceed.

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).
4. If CHECK TIME/DATE is correct, 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 GA-90 keyboard. Press the **KEY 0-Set** when done.

Figure 4.8



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

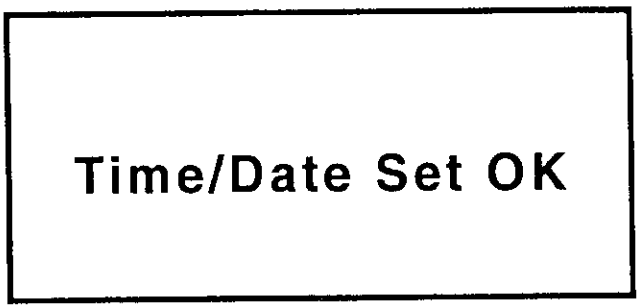
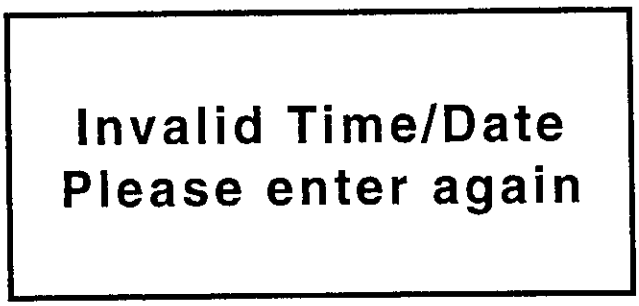


Figure 4.10

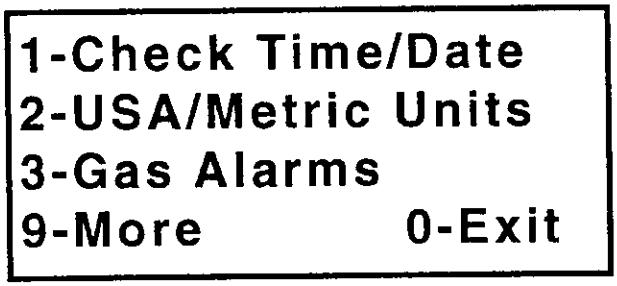


General Utilities 2 - USA/Metric Units

The GA-90 can display and story data in Metric (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.

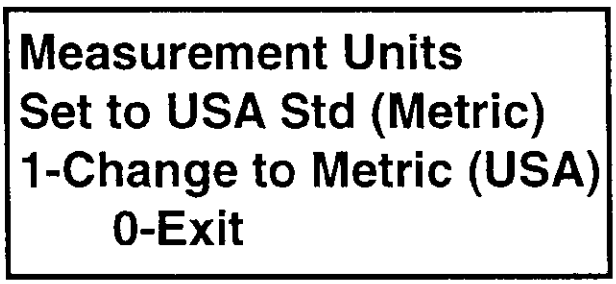
1. Press **KEY 1-General Utilities** at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Press the **KEY 2-USA/Metric Units** on the General Utilities Sub-Menu Screen as shown in Figure 4.11.

Figure 4.11



3. The Measurement Units Screen appears as shown in Figure 4.12. Press the **KEY 1** to change from one unit to the other. (It acts a toggle switching from one to the other.) If the GA-90 is currently displaying USA measurement units (Imperial — Btu's, Standard Cubic Feet, Fahrenheit temperatures, etc.) it switches to Metric. See the specifications and units measured by the GA-90 elsewhere in this manual. When done, press **KEY 0-Exit** to return to the General Utilities Sub-Menu Screen.

Figure 4.12

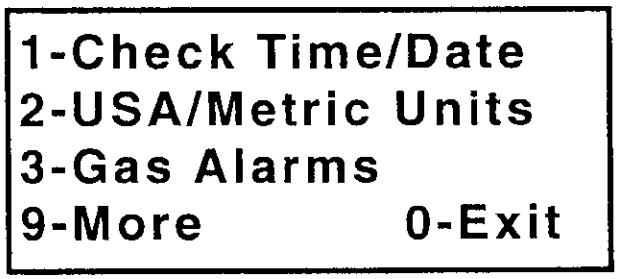


General Utilities 3 - Gas Alarm

The GA-90 has three alarm options that can warn the operator if a gas sample contains concentrations of methane or carbon dioxide are below established levels or oxygen is 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.

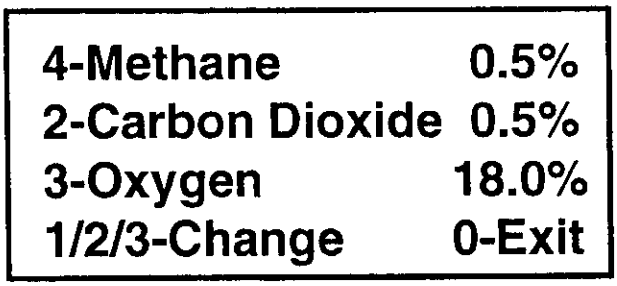
1. Press **KEY 1** at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Press the **KEY 3-Gas Alarms** on the General Utilities Sub-Menu Screen as shown in Figure 4.13.

Figure 4.13



3. The following screen is displayed (Figure 4.14). Choose **KEY 1**, **KEY 2** or **KEY 3** to change the methane, carbon dioxide or oxygen alarm level. If no change in gas levels is required press the **KEY 0-Exit** to return to the General Utilities Sub-Menu Screen.

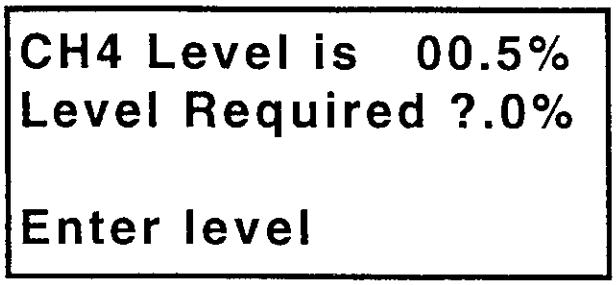
Figure 4.14



Alarm Settings:	**CH4**	**CO2**	**O2**
Alarm On	Above Setpoint	Above Setpoint	Below Setpoint
Alarm Off	Below Setpoint	Below Setpoint	Above Setpoint

4. If **KEY 1-Change Methane** is pressed the following screen will appear (Figure 4.15). Using the numbered keys on the GA keyboard input the new 3 digit level for methane (CH4). All three digits must be entered (XX.X%), the decimal point is automatically inserted. Press **KEY 0-Exit.**

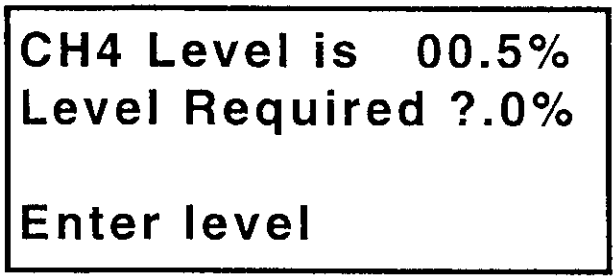
Figure 4.15



Note: Screens shown in steps 4, 5 and 6 display current alarm levels of methane (CH4), carbon dioxide (CO2) and oxygen (O2). During the Read Gas Levels procedure, if the GA receives CH4, CO2 at or above these levels, or O2 gas at or below these levels, then an visual/audible warning sound will occur to alert operator.

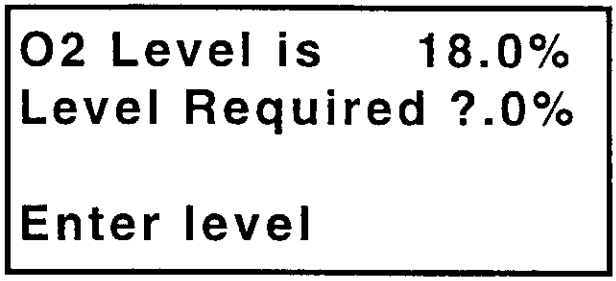
5. If **KEY 2-Change Carbon Dioxide** is pressed Figure 4.16 will appear. Using the numbered keys on the GA keyboard input the new three digit level for carbon dioxide (CO2). All three digits must be entered and the decimal point is automatically inserted. Press **KEY 0-Exit.**

Figure 4.16



6. If **KEY 3-Change Oxygen** is pressed Figure 4.17 will appear. Using the numbered keys on the GA keyboard input the new three digit level for oxygen (O2). All three digits must be entered and the decimal point is automatically inserted. Press **KEY 0-Exit.**

Figure 4.17



Note: In steps 4, 5 or 6, if necessary to correct an entry error, 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.

7. 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 4 - Memory

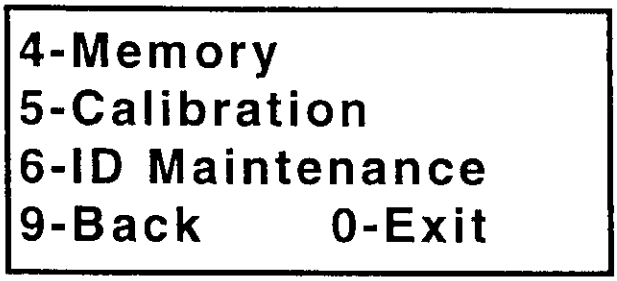
Caution: This function can erase all stored data.

Each GA-90 ID point and all readings taken at that ID point are stored in the GA-90'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 GA-90 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.

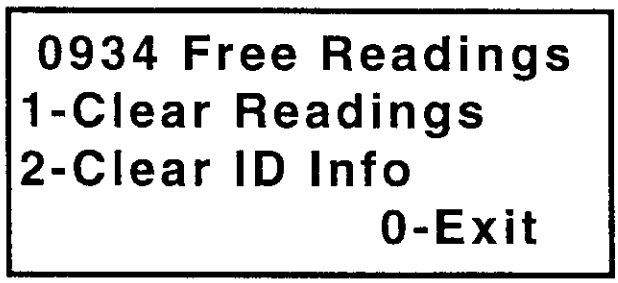
1. Press **KEY 1** at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Then press the **KEY 4** for Memory on the General Utilities Sub-Menu Screen (Figure 4.18).

Figure 4.18



3. The following screen—Number of Free Readings Screen, allows for three choices: Press the **KEY 0 - Exit** to escape from the procedure and return to the General Utilities Sub-Menu Screen; press **KEY 1 - Clear Readings** to erase all gas/data readings; or press **KEY 2 - Clear ID Info** to erase All ID Code Numbers that have accumulated in the GA-90 from ID MAINTENANCE and READ GAS functions.

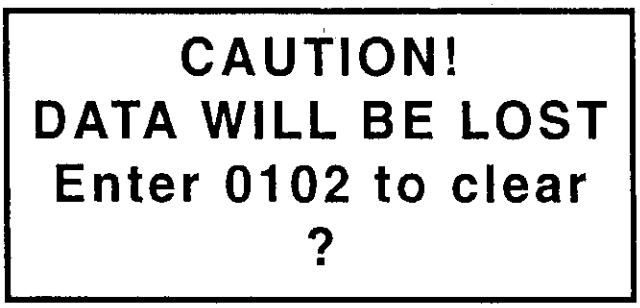
Figure 4.19



Caution: This step erases stored data. You may want to print the memory out or download the data first so it is not lost.

4. After making your choice from the screen above, the following screen appears (Figure 4.20). As a final safety check, you must input the numeric value **0102** from the GA-90 keyboard to clear the memory. IF YOU DECIDE NOT TO CLEAR THE MEMORY AT THIS POINT—TURN THE GA-90 OFF BY PRESSING THE RED ON/OFF KEY or enter an incorrect number then **KEY 0-Exit** to return to memory screen. Do Not Input 0102 unless you want to proceed.

Figure 4.20



5. Enter 0102 from the keyboard and press the **KEY 0 - Exit.** The Clearing Memory Screen appears for three seconds if the memory was erased.

Figure 4.21

After displaying the above, the Number of Free Readings Screen shown in Step 4 above is re-displayed. Press **Key 0** to Exit to the General Utilities Menu Screen.

General Utilities 5 - Calibration

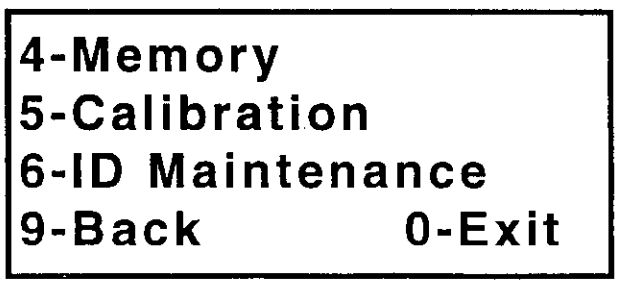
Please refer to Chapter 3-Field Calibration for all information and instructions relating to the Gas Calibration function.

General Utilities 6 - 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 indicate is a pressure reading is required at that ID location (Step 5).

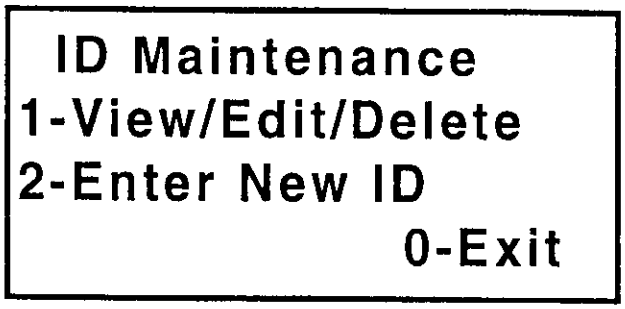
1. Press **KEY 1** at the Main Menu Screen for the General Utilities Sub-Menu Screen.
2. Then press the **KEY 9 - More.** Press the **KEY 6-ID Maintenance** on the General Utilities Sub-Menu Screen as shown in Figure 4.22.

Figure 4.22



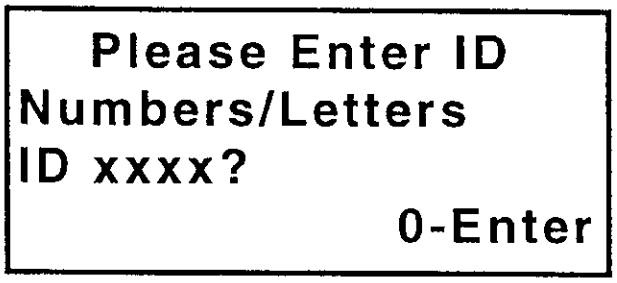
3. The screen represented by Figure 4.23 is displayed. Press **KEY 2-Enter New ID** and go to Step 4 or press **KEY 1-View/Edit/Delete** to see, change or delete ID information. Go directly to Step 10 .

Figure 4.23



4. After pressing **KEY 2- Enter New ID** screen (Figure 4.24) appears. Insert the letters or numbers in the ID code.

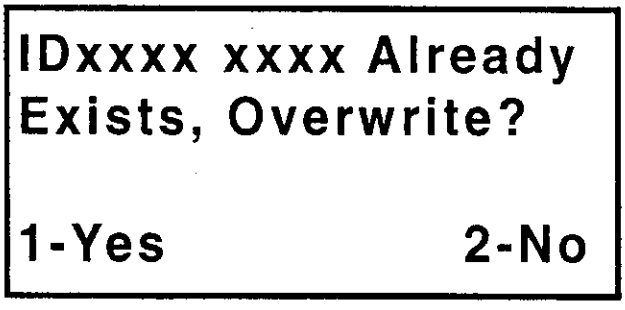
Figure 4.24



5. Enter the new ID code as shown on the above screen using number or letters. Use the **BLUE KEY** to switch between letters and numbers. (See Keyboard Information in the Getting Started Section at the beginning of this Manual.)
   For numbers press **Number KEYS.**
   For letters, press arrow **KEY 1** or **KEY 6** and enter each letter by pressing **KEY 0.**

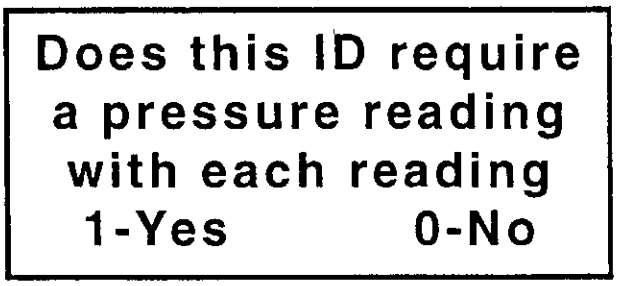
   After the final digit is inserted **KEY 0-Continue** is displayed. Press if ready to enter, otherwise press and hold the **KEY 0** and use it as a Backspace Key.
6. WHEN AN EXISTING ID CODE IS ENTERED, A SCREEN AS SHOWN IN FIGURE 4.25 WILL APPEAR. Press the **KEY 1-Yes** to proceed. If **KEY 2-No** is selected, the GA returns to screen shown in step 3 above.

Figure 4.25



7. The screen displayed as Figure 4.26 allows an **(optional)** pressure reading to be included with the stored data.

Figure 4.26

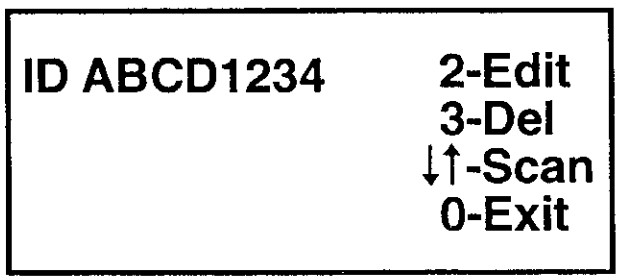


8. The ID Stored OK Screen is displayed for three seconds (Figure 4.27). The GA then returns to the screen displayed in step 3 for additional ID input.

Figure 4.27

10. To view ID information, press **KEY 1** to scroll through stored ID codes and data.

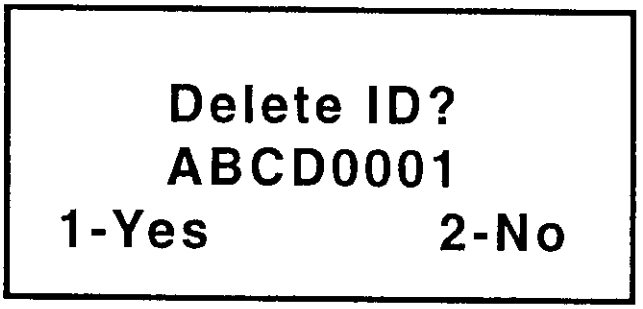
Figure 4.28



11. Press the arrows **KEY 1** and **KEY 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.

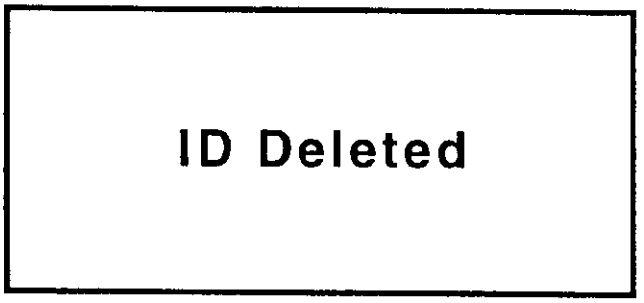
12. If **KEY 3-Del** was selected to erase the data, Figure 4.29 will ask for confirmation. Press the **KEY 1-Yes** to delete and **KEY 2-No** to abort.

Figure 4.29



13. If the **KEY 1-Yes** was pressed, the screen shown below will appear for three seconds before returning to step 10.

Figure 4.30



Chapter 5-Read Gas Levels

This section instructs the operator in how to use the GA-90 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 GA.

The operator should be familiar with the following:

- Check the TIME/DATE (See General Utilities Menu)
- Charge the unit's nickel cadmium batteries (See Chapter 8 - Maintenance)
- Perform a Field Calibration on the unit (See Chapter 3 - Field Calibration)

If the distance to the site where it will be used is great, put the GA-90 in its protective hard case and secure it well. If the site is nearby, the soft case will offer enough protection. The GA-90 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.

Warnings

Review the warnings given in the beginning of this manual. The GA-90 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.

GA-90 Hose and Wellhead Connection

The proper hoses must be connected from the GA-90 to a wellhead (Figures 5.2 or 5.3 are typical wellheads) 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 sampling port (Figure 5.1).

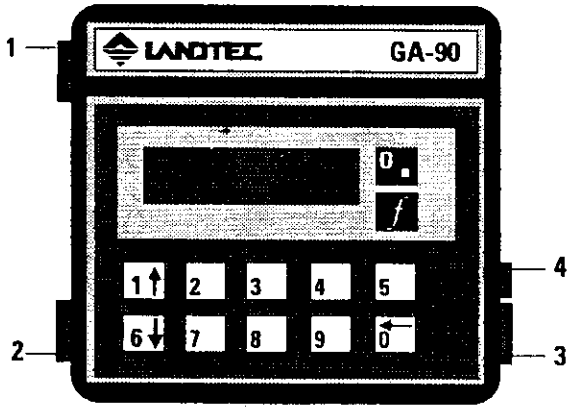
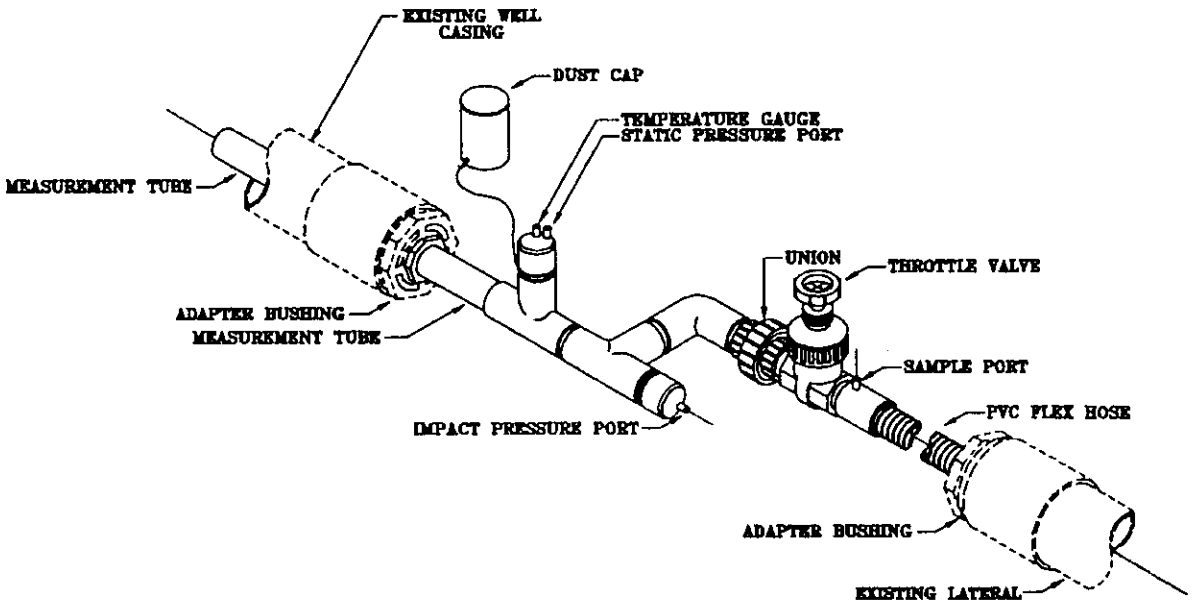


Figure 5.1

1. Sampling Port—Measures pressure when connected to wellhead static pressure port by tubing.
2. 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. Receptacle Port—Used for battery recharging, data downloading and temperature readings.

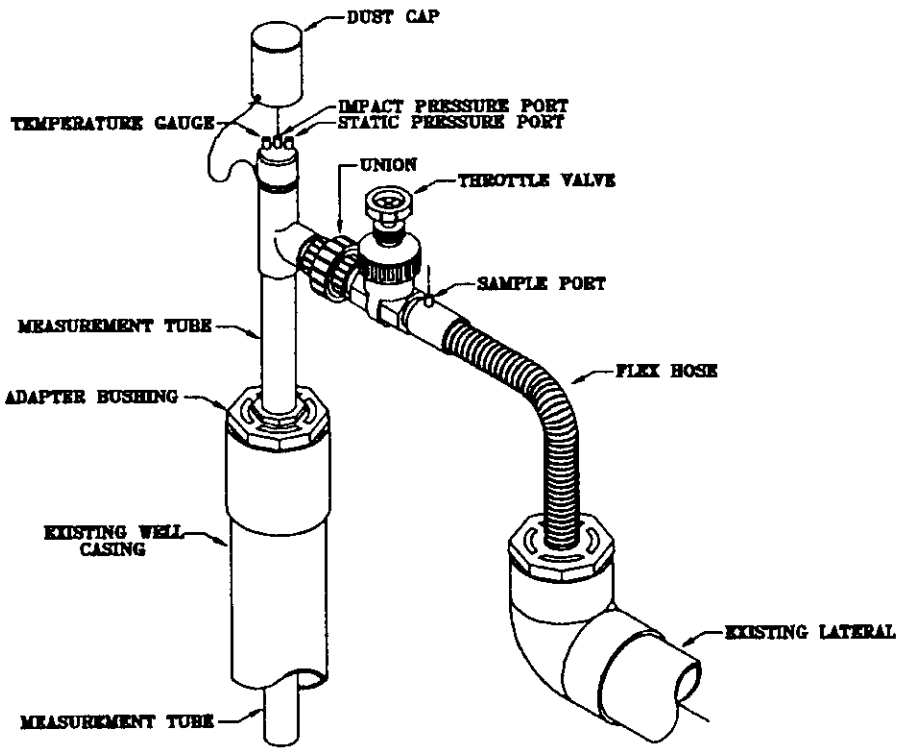
LANDTEC Horizontal Accu-Flo Wellhead

Figure 5.2



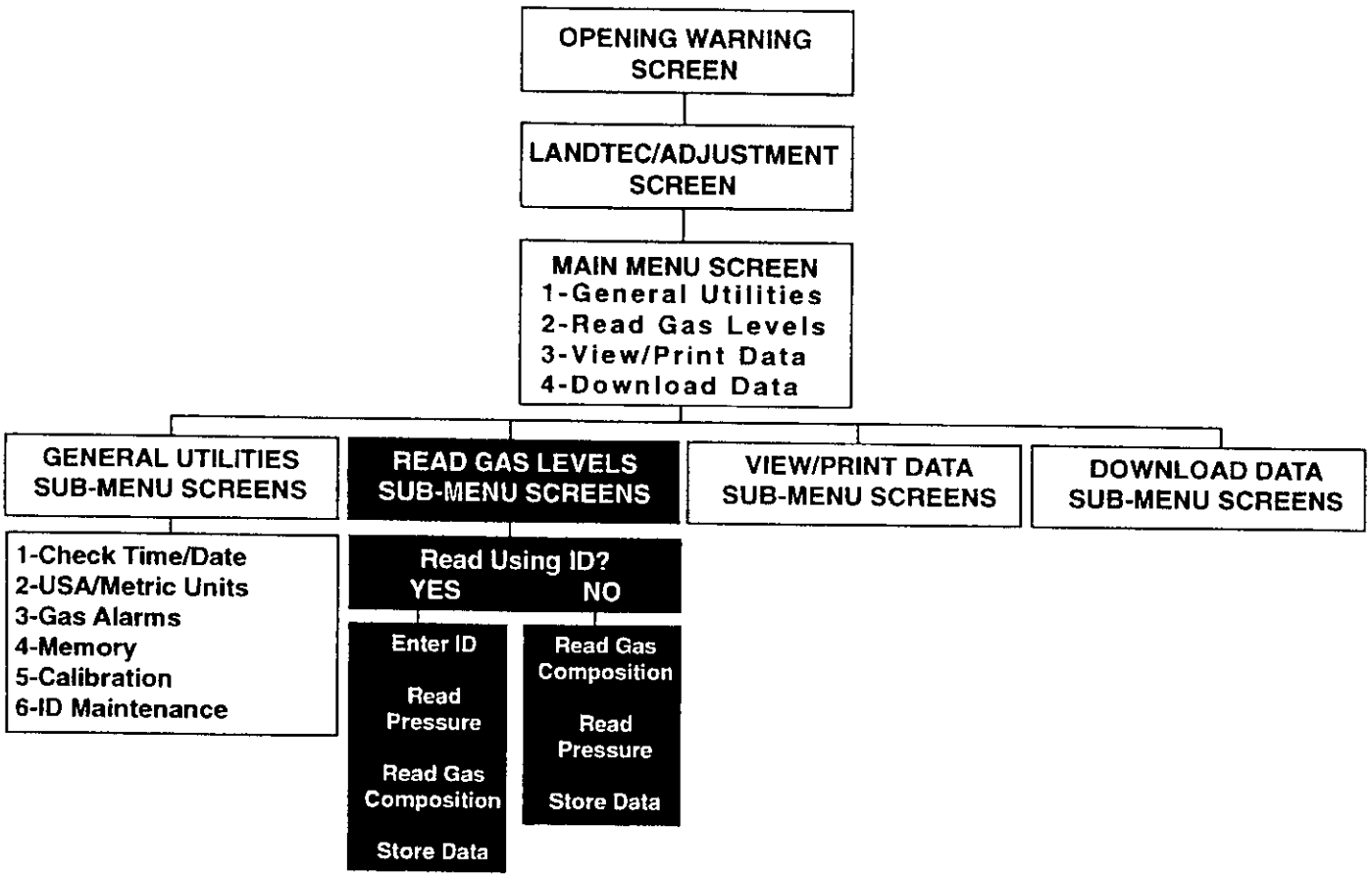
LANDTEC Vertical Accu-Flo Wellhead

Figure 5.3



Read Gas Levels Screen Tree Diagram

Figure 5.4

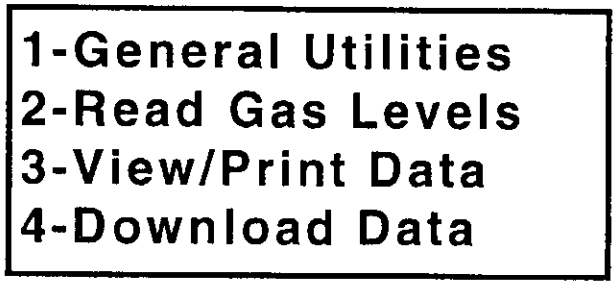


As shown in the screen tree diagram (Figure 5.4), there are two paths depending on whether or not an ID has been defined and stored in the GA-90. IDs can be added during this procedure at several other points.

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



2. The Read Gas Levels Screen is displayed as shown in Figure 5.6.

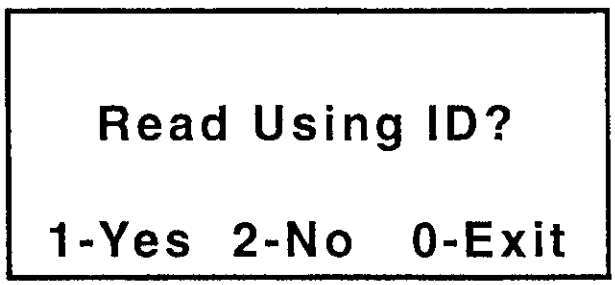


Figure 5.6

3. The normal response to this screen is **KEY 1-Yes.** 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.

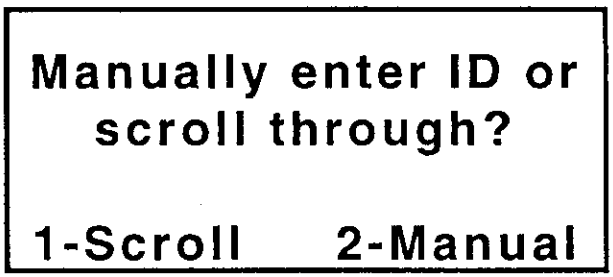


Figure 5.7

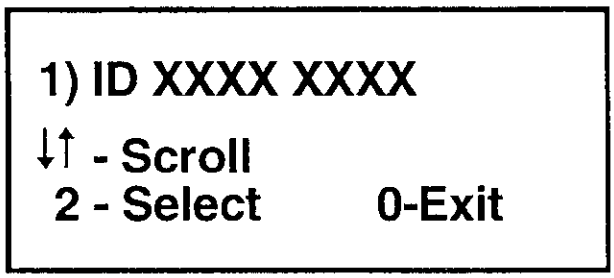
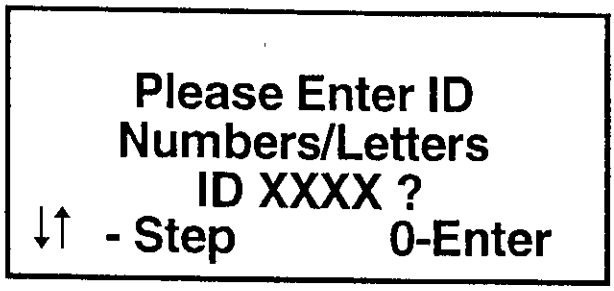


Figure 5.8

Figure 5.9



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 (Use **Blue KEY** to switch between numbers and letters.):
   For numbers, press Number KEYS
   For letters, press **KEY 1-Cursor-Up** and or **KEY 6-Cursor-Down** and enter each letter by pressing **KEY 0-Enter.**

   (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 GA-90'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.

Figure 5.10

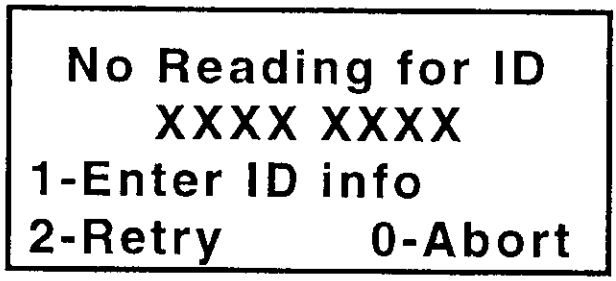
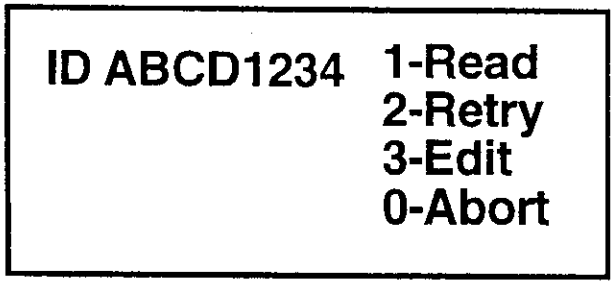
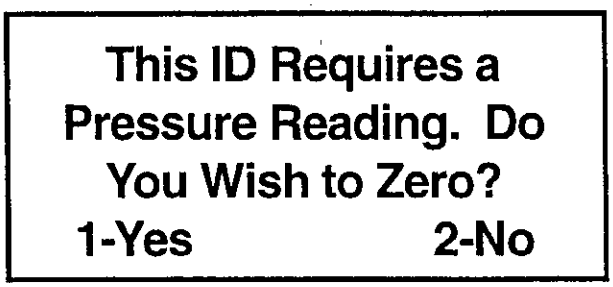


Figure 5.11



7. Press the **KEY 1- Read Gas Levels** and Figure 5.12 will appear. If the ID requires a pressure measurement (**OPTIONAL FEATURE**), the following screen (Figure 5.12) will appear. If not, skip to step 15.

Figure 5.12



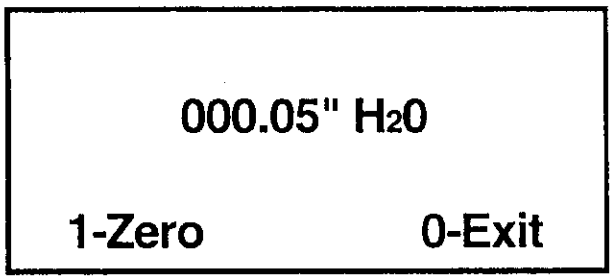
Note: While taking gas readings, the GA-90 unit may sound an alarm (beeping). This means that gas levels set in KEY 6-GAS ALARMS on the General Utilities Screen have been reached or exceeded. The data screen readings of alarmed gases will also blink.

8. If it is desired to zero pressure, press **KEY 1.** Otherwise, press **KEY 0.** After selecting KEY 1, the following screen is shown (Figure 5.13)

Figure 5.13

9. Remove hoses and press any key. The next screen (Figure 5.14) will appear.

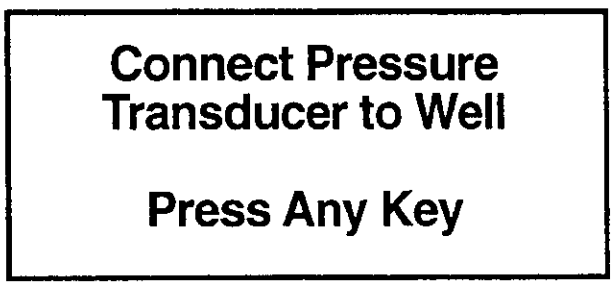
Figure 5.14



10. The Transducer Zeroed Screen will appear for three seconds before going back to the screen in step 9. Ensure that the pressure indicated is 000.00 in H2O. If not, repeat Step 9. If pressure is zeroed, press **KEY 0-Exit.**

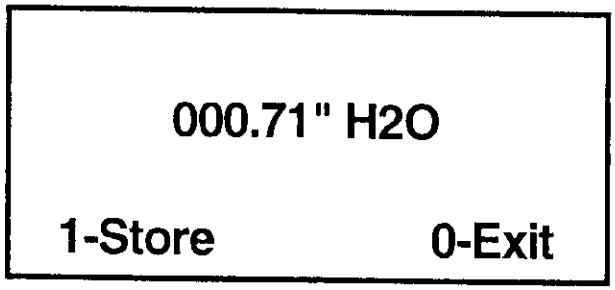
11. After exiting the Transducer Zeroed Screen, connect the hose to the pressure port (Figure 5.15). Press any key to continued.

Figure 5.15



12. The well or probe pressure will be shown (Figure 5.16)

Figure 5.16



13. Press **KEY 1** to store this reading. The Reading Stored Screen will be displayed for three seconds before returning to the screen shown as Figure 5.16. An updated pressure may be stored by repeating this step.

14. To continue to gas measurement, press **KEY 0.** The screen in Figure 5.17 will appear. After reconnecting the hose to the sample port, press any key.

Figure 5.17

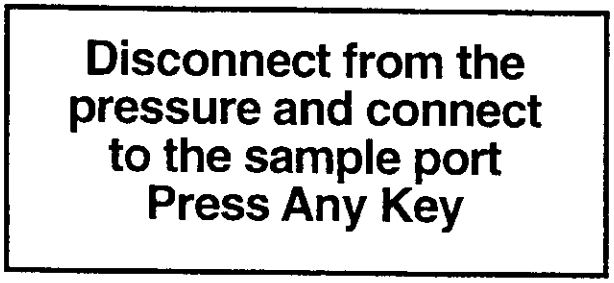
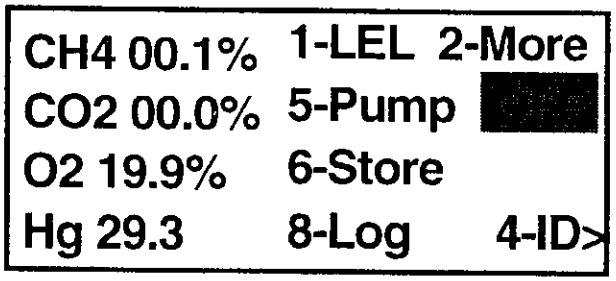


Figure 5.18



15. Press **KEY 5-Pump** to turn pump on and draw a gas sample into the GA-90. Allow readings on left side of screen to become stable (typically about 60 seconds) before pressing KEY 6-Store. Press the **KEY 5-Pump** to turn pump off. Press **KEY 1-LEL** to display the Lower Explosive Limit Screen. Press **KEY 0-Exit** when finished.

Note: 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.

16. Go to Step 17 if gas sample temperature and probe depth are required. If not required, press **KEY 4- ID>** to advance to the next pre-programmed ID and go to Step 18.

17. To record gas sample temperature and probe depth, press **KEY 2-More** and Figure 5.19 will appear. Leading zeros must be inserted for both temperature and depth. 78° would be entered as 078 and 5' 6" would be entered as 00506. Press **KEY 6-Store** and **KEY-4 ID>** to advance to next programmed ID.

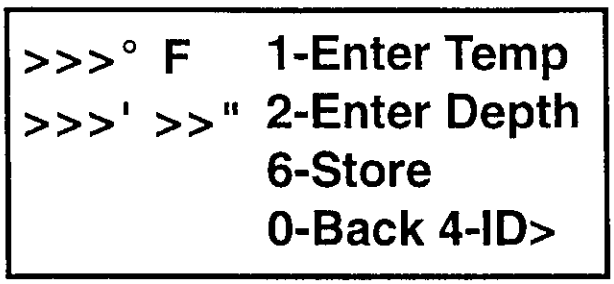


Figure 5.19

18. After pressing **KEY 4-ID>,** pump will automatically shut off if still on. The Purge Prompt Screen (Figure 5,20) will appear. Press **KEY 5-Purge** and follow screen instructions to perform purge or press **KEY 1-Next ID.** The next pre-programmed ID will appear (Figure 5.21) If ID has pressure requirement, applicable screens will guide you through the process until Figure 5.21 appears. If an alternate ID needs to be located, select **KEY 2-Retry** and select the alternate ID.

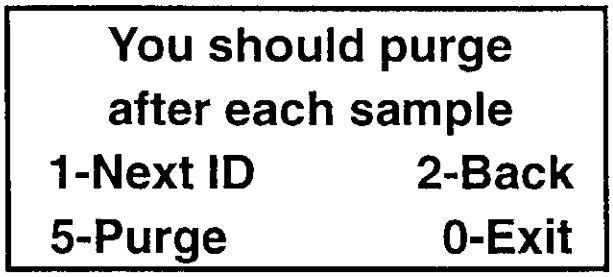


Figure 5.20

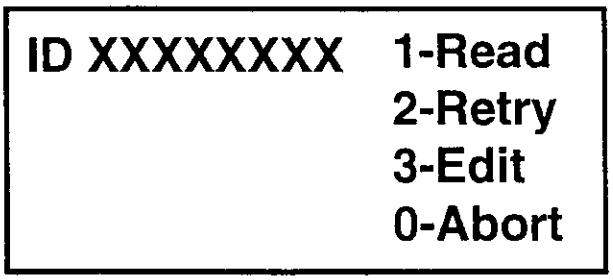


Figure 5.21

Read Gas-Logging Function (OPTIONAL FEATURE)

Six hours of automatic gas data logging is possible with a GA-90 as long as the batteries are fully charged. The logging function requires that the well being logged have an ID stored in the GA-90. The logging time interval is from five to 60 minutes.

1. The well to be logged must have an ID already stored in the GA-90. See the General Utilities instructions for ID maintenance function. IDs 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 GA-90 must be connected.

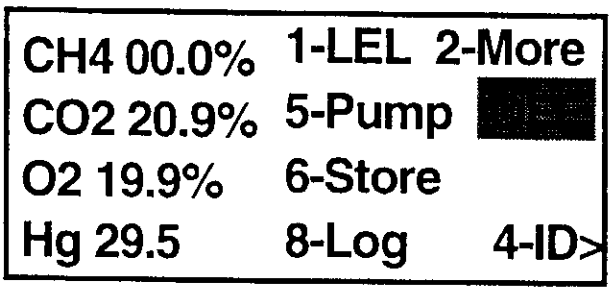


Figure 5.22

3. From the screen shown in Figure 5.22, press **KEY 8** to start the logging function. The Logging Interval Screen appears as shown in Figure 5.19. Input a sampling time interval of five to 60 minutes and press **KEY 0** to exit. If an unacceptable time is input (i.e. less than five minutes or more than 60 minutes), an "Invalid Duration - Please Enter Again" screen will flash for three seconds before returning to Figure 5.23.

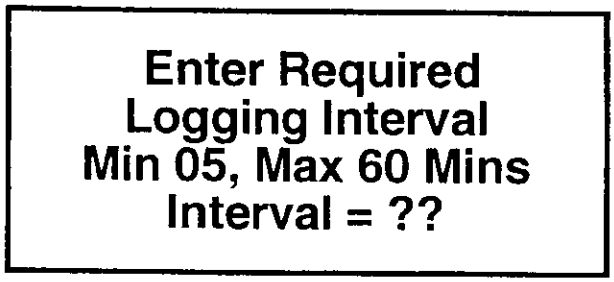


Figure 5.23

4. The next screen (Figure 5.24) allows user o select the running time of the GA-90's pump. There are five choices ranging from 15 to 90 seconds. If an invalid time is input, an "Invalid Pump Time - Please enter again" message will be displayed for three seconds before returning to the screen below. Input time and press **KEY 0-Exit**.

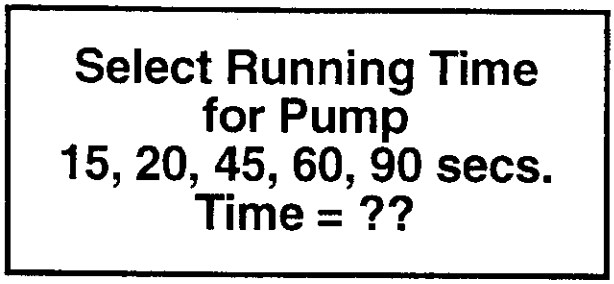


Figure 5.24

5. The Logging Screen is then displayed (Figure 5.25). Logging will continue as long as the battery power in the GA-90 can power the unit. To end logging, press **KEY 0-Stop Logging.** When the logging function is ended, it returns to the Gas Composition Screen (Figure 5.22).

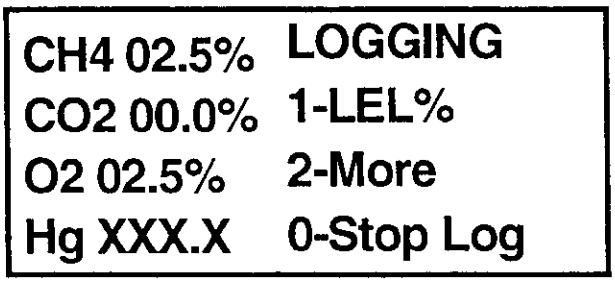


Figure 5.25

6. Press **KEY 0-Exit** again to return to the Main Menu.

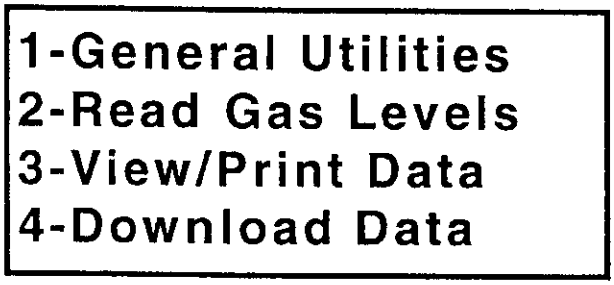
Chapter 6-View/Print Data

The GA-90 can be connected to a standard 80-column serial printer and produce a hard copy of the data stored in the memory. A printer cable is supplied with optional communications package. The data can also be viewed on the GA-90's screen. Normally the Print function is done daily or before the GA-90's memory is cleared in the General Utilities **KEY 3 - Memory.**

View Data

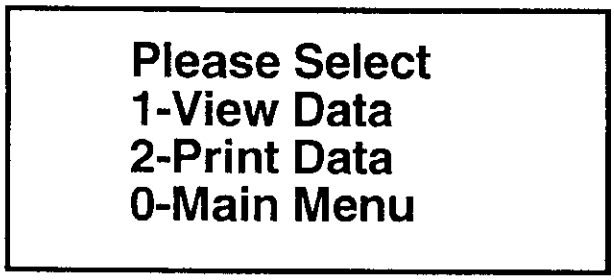
1. From the Main Menu, select **KEY 3-View/Print Data** from the Main Menu Screen as shown in Figure 6.1.

Figure 6.1



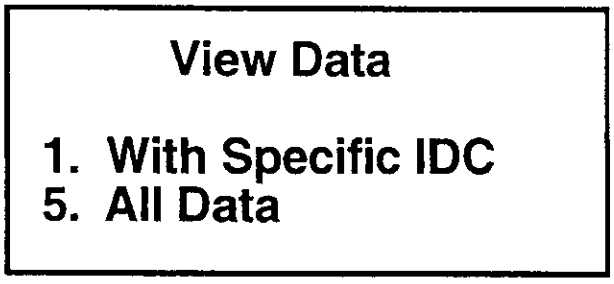
2. The Select Screen appears as shown in Figure 6.2. From this screen you can choose **KEY 1-View Data, KEY 2-Print Data** or return to the Main Menu Screen by pressing **KEY 0.**

Figure 6.2



3. Press **KEY 1-View Data** and the View Data Screen (Figure 6.3) appears. Press **KEY 1-IDC** to view only one data point. Data selection screens will lead you through selection process as shown in Chapter 5. **KEY 5** can be used to scroll through all data. Continue to Step 4.

Figure 6.3



4. After an ID (or IDs) is selected, the following screen (Figure 6.4 is displayed. Use **KEY 1** and **KEY 6** to move up or down the data displayed. Press any key to continue viewing or press **KEY 0** to exit.

Figure 6.4

```
Use: ↓↑  -Scan  0-Exit
2-Go First  7-Go Last
5-Change data screen
Any key to continue
```

8. Use **KEY 5** to toggle between gas concentrations (Figure 6.5) and gas sample temperature and probe depth (Figure 6.6).

Figure 6.5

```
CH4 00.0%  ID XXXXXXXX
CO2 00.0%  AT 22:03:33
O2  00.0%  ON 08/09/93
"Hg 02.7   R±000.00" H2O
```

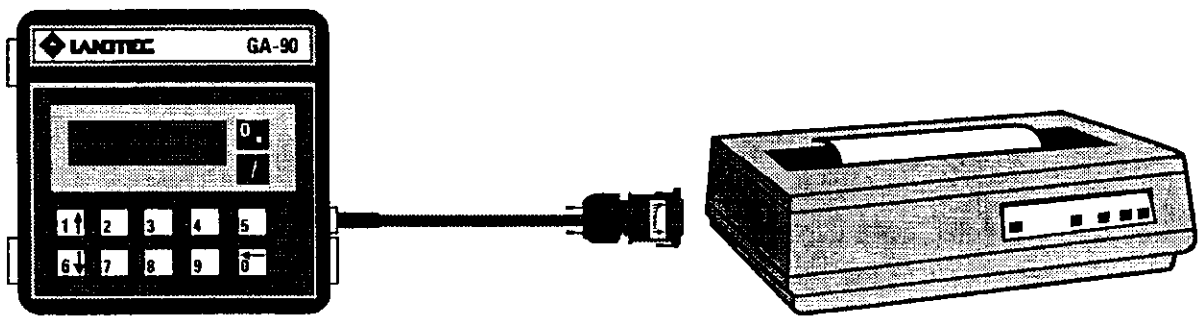
Figure 6.6

```
082°F      ID XXXXXXXX
>>>' >>"   AT 22:03:33
           ON 08/09/93
           R±000.00" H2O
```

Print Data (OPTIONAL FEATURE)

1. If data is to be printed, connect RS-232 cable (provided) from the GA-90 RS-232 port to the printer adapter. The adapter should be connected so the arrows point towards the printer as indicated on adapter label. Connect the converter to the 25-pin input port of 80 column printer (Figure 6.7). 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 GA-90 on.

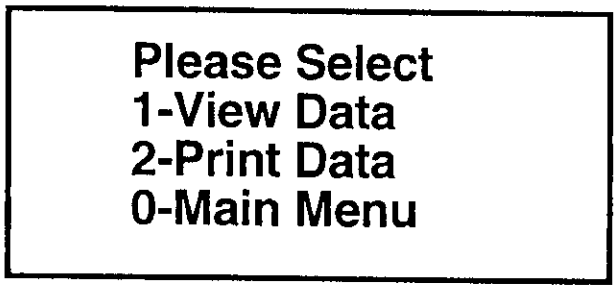
Figure 6.7



2. From the Main Menu Screen, select **KEY 3-View/Print Data** from the Main Menu Screen.

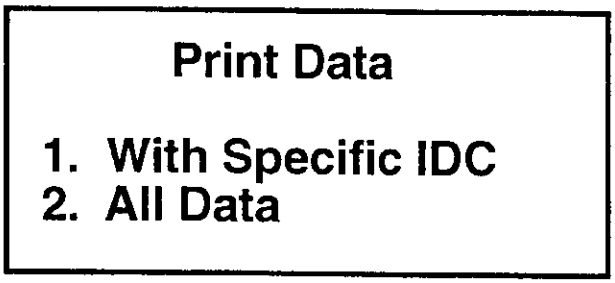
3. The Select Screen appears as shown below (Figure 6.8). Choose **KEY 2-Print Data.**

Figure 6.8



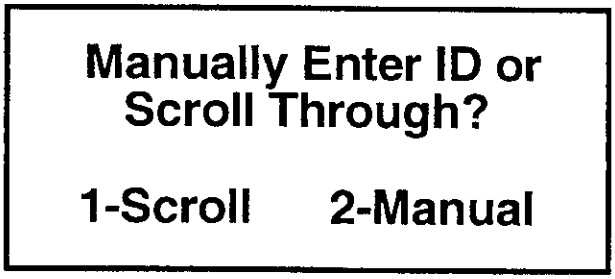
4. Press **KEY 1-With Specific ID** to print only one data point. Press KEY 5 to print all the data.

Figure 6.9



5. Figure 6.10 shows the results if **KEY 1** is pressed. To scroll through the ID list press **KEY 1** or press **KEY 2** to manually enter the ID (Figure 6.11).

Figure 6.10



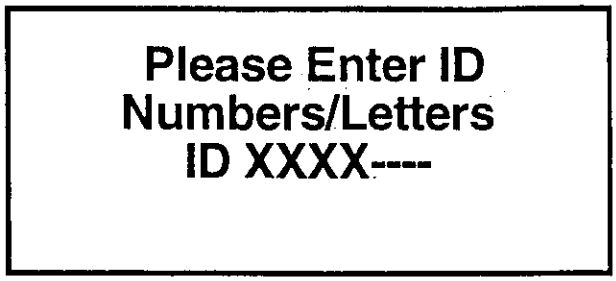


Figure 6.11

7. Printing will begin after ID (IDs) have been specified. Figure 6.12 or 6.13 will appear.

Figure 6.12

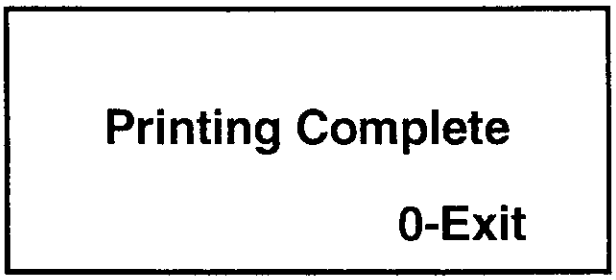


Figure 6.13

Output - Print Report Format (OPTIONAL FEATURE)

The report format is shown below. The stored data is sorted by time, date, and ID

Time	Date	IDC	CH4 %	CO2 %	O2 %	Atmos "Hg	Relative "H2O

Chapter 7-GA-90 Communications (OPTIONAL FEATURE)

This chapter reviews:

- Connecting the GA unit to IBM PC compatible host computer via an RS-232 cable
- Installation of the GA software program (contained on GA_COMM floppy disk) into a file on the compatible host computer
- Loading the program on the host computer screen, and
- Downloading and manipulating data from GA unit into host computer. GA readings are normally downloaded daily. The stored data is also downloaded before the GA's memory is cleared because it is full (see General Utilities-4 Memory).

The optional RS-232 cable attaches to the GA with a special manufactured 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 goes into the computer as a standard serial connector.

Installing Gas Analyzer Communications Program on Computer

LANDTEC's Gas Analyzer Communications program software converts the binary data from the GA-90 to an ASCII format. Data in ASCII format can be imported into LOTUS 1 2 3™, Excel™ 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 GA 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 GA download floppy disk into host computer floppy drive.
3. Install the GA software into a sub-directory of your choice, using the drive of your choice, by typing the following instructions (assuming drive A contains source diskette and C is the destination drive).

   C:\>MD GA <ENTER>
   C:\>CD GA <ENTER>
   C:\>GA> COPY A:*.* <ENTER>
   A:\GA_COMM.EXE
   1 file copied
   C:\GA

4. GA software program is now installed on the computer.
5. Remove the diskette in drive A. Store it in a safe place. You may make one backup copy of the program.

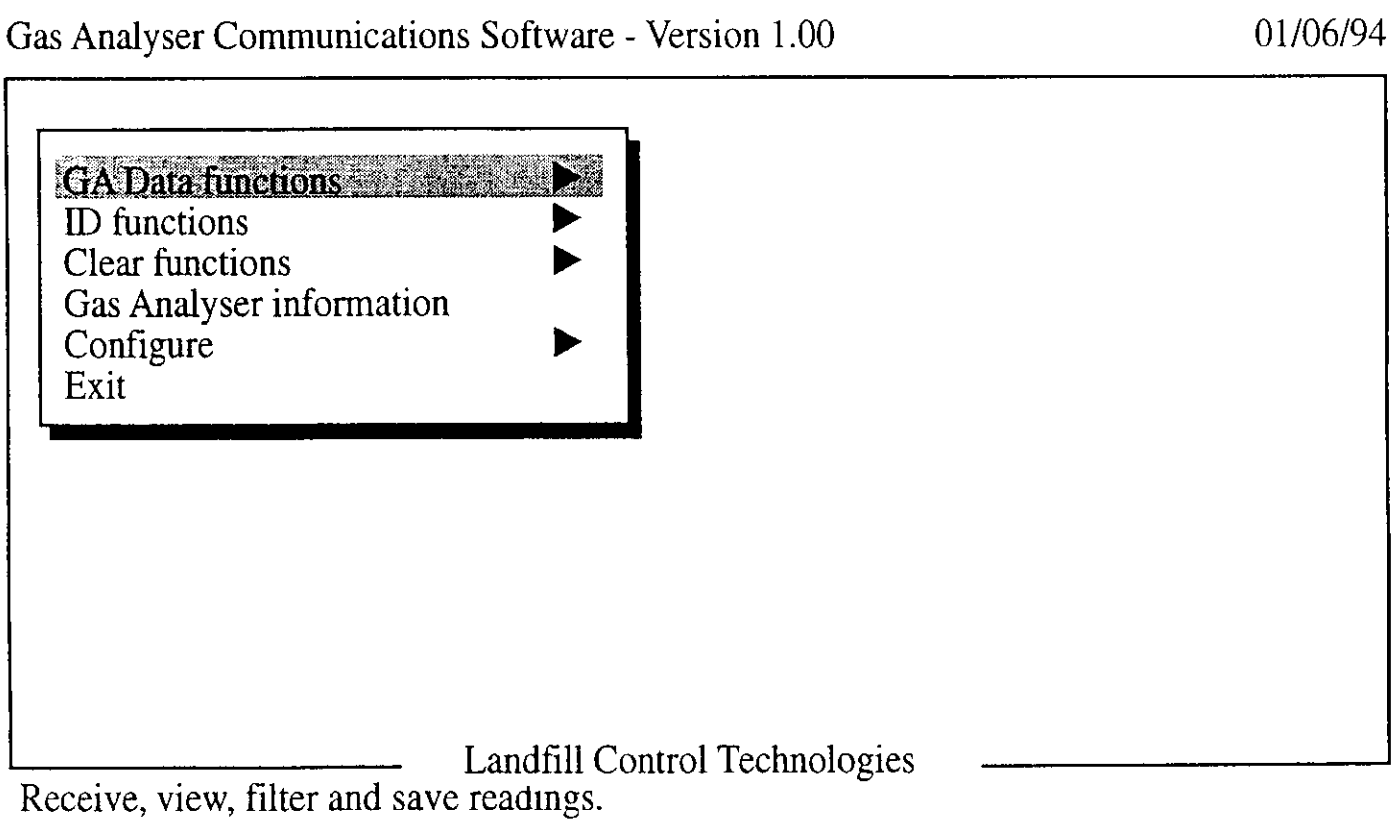
Starting Gas Analyzer Communications Program on Computer

1. Turn off the computer and attach the DB-25 connector to COM Port 1 or 2 of the computer. Plug the RS-232 cable into the GA. Turn on the computer.
2. At the C:> prompt on the computer, change to the GA sub-directory by typing:

   C:\> CD GA <Enter>
   C:\> GA_COMM<Enter> (Figure 7.1 will appear)

   Note: While using Gas Analyzer Communications Software - Version 1.00, brief function descriptions and instructions will appear in the lower left-hand side of screen. Use the ESC key to exit or abort subdirectory functions.

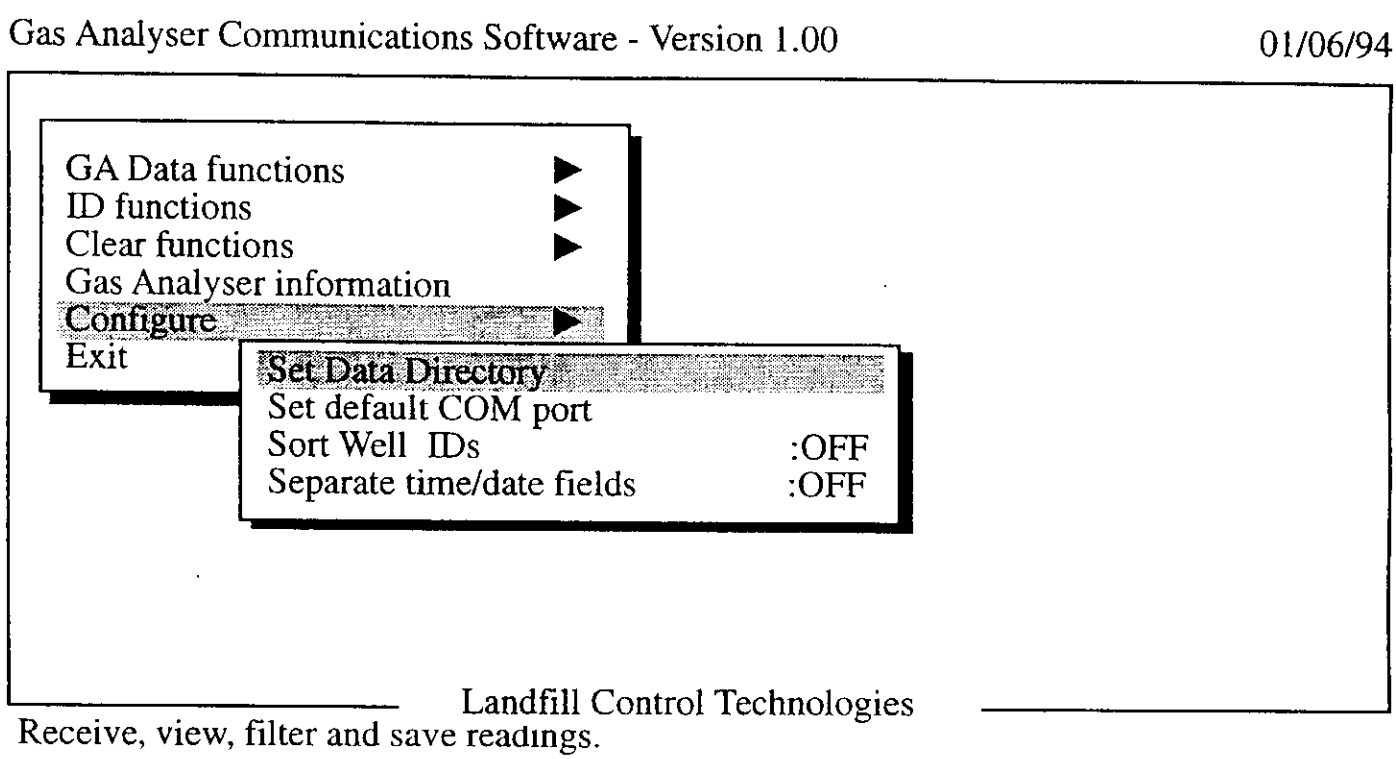
Figure 7.1



CONFIGURE (Set communications port, data directory and ID sorting options)

1. Using the up and down directional arrows of your computer keypad, highlight **Configure** from the main menu screen (Figure 7.2) and press enter key.

Figure 7.2



2. **Set Data Directory** (locations of ID storage) by pressing enter and following screen instructions.

3. **IMPORTANT—Set Default COM Port** by highlighting the option and pressing enter. Your port options are COM1 or COM2. Press 1 or 2 on the computer keypad and press escape to change the port. To verify com port setting, press enter.

4. **Sort Well ID** function has default of OFF. This function sorts ID in an alphanumeric order after receipt from GA or disk. IDs remain in same order as downloaded with this option in OFF mode. If desired, use the enter key to select ON.

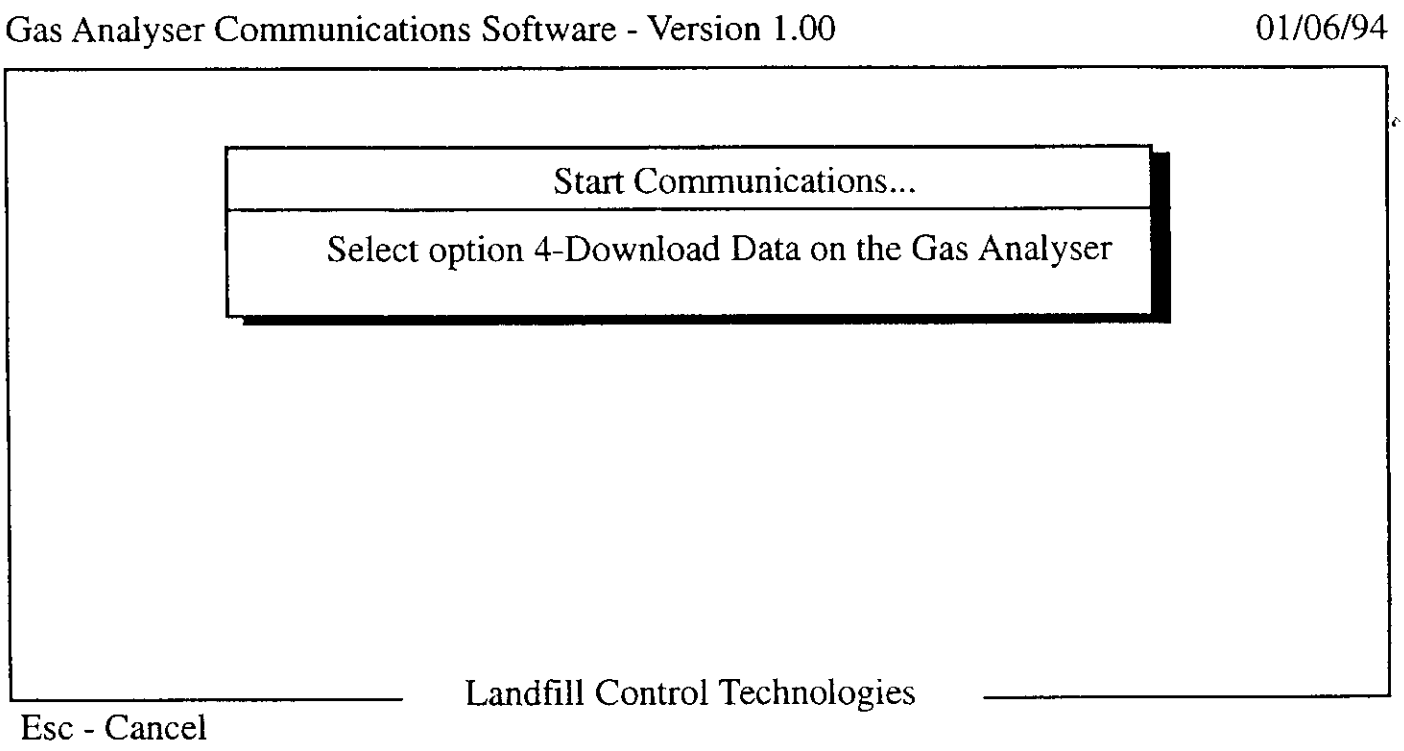
5. The **Separate time/date fields** function has default of OFF. This function sets format to have different fields for time and date. If desired, use the enter key to select ON.

6. Press the escape key to return to the main menu.

Gas Analyzer Information (Displays gas analyzer information and memory status)

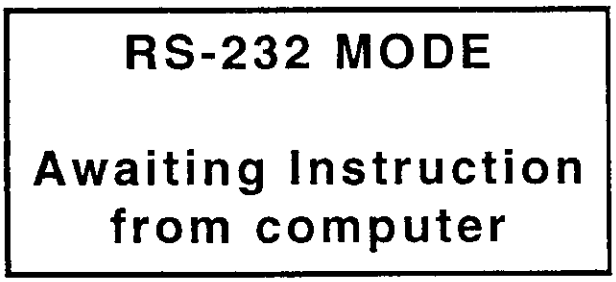
1. From the main menu, highlight **Gas Analyzer Information** and press enter. Figure 7.3 will appear.

Figure 7.3



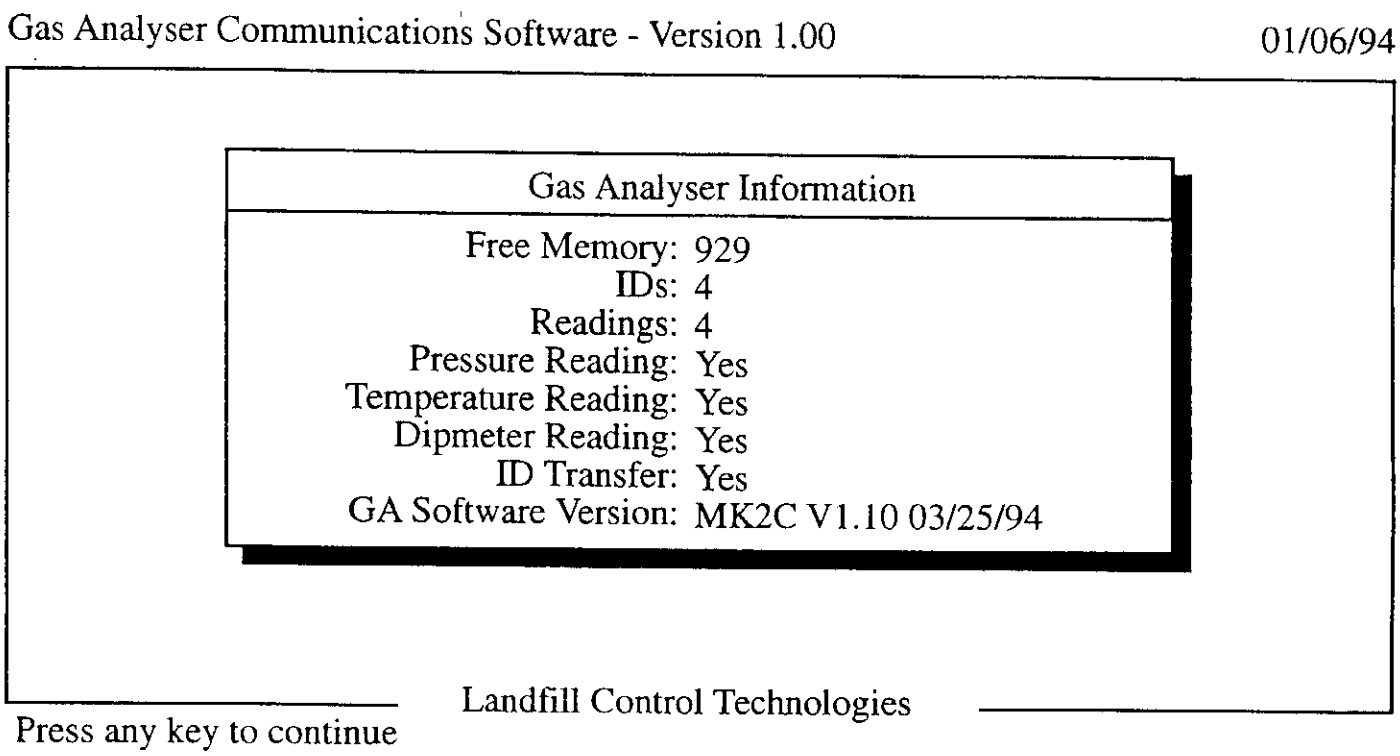
2. Turn the GA-90 on and select **KEY 0** for the main menu and then press **KEY 4-Download Data.** The **RS-232 Mode** screen will appear on the GA-90. (Figure 7.4)

Figure 7.4



3. The **Gas Analyzer Information** screen, Figure 7.5, should appear on the computer. If this screen does not appear, confirm configuration settings are correct. The **Gas Analyzer Information** screen details remaining memory and IDs, quantity of stored readings and GA-90 software version. Optionally available on this screen are Pressure Reading, Temperature Reading, Dipmeter Reading and ID Transfer. If you have not purchased these options, contact your LANDTEC Sales Engineer at (800) 821-0496.

Figure 7.5


Gas Analyser Communications Software - Version 1.00
01/06/94
Gas Analyser Information
Free Memory: 929
IDs: 4
Readings: 4
Pressure Reading: Yes
Temperature Reading: Yes
Dipmeter Reading: Yes
ID Transfer: Yes
GA Software Version: MK2C V1.10 03/25/94
Landfill Control Technologies
Press any key to continue

GA DATA FUNCTIONS (Receive, view, filter and save readings)

1. Press any key to return to main menu screen. Highlight **GA Data functions** and press enter. Highlight **Receive readings from GA** and press enter (Figure 7.6).

   NOTE: There must be readings stored in unit to proceed with the following steps. Refer to Reading Gas Levels and Storing Data Chapters for further information.

   Readings will now display on the computer screen (Figure 7.7). Use the up and down directional arrows to view readings. Use the End and Home keys to view last and first data.

Figure 7.6

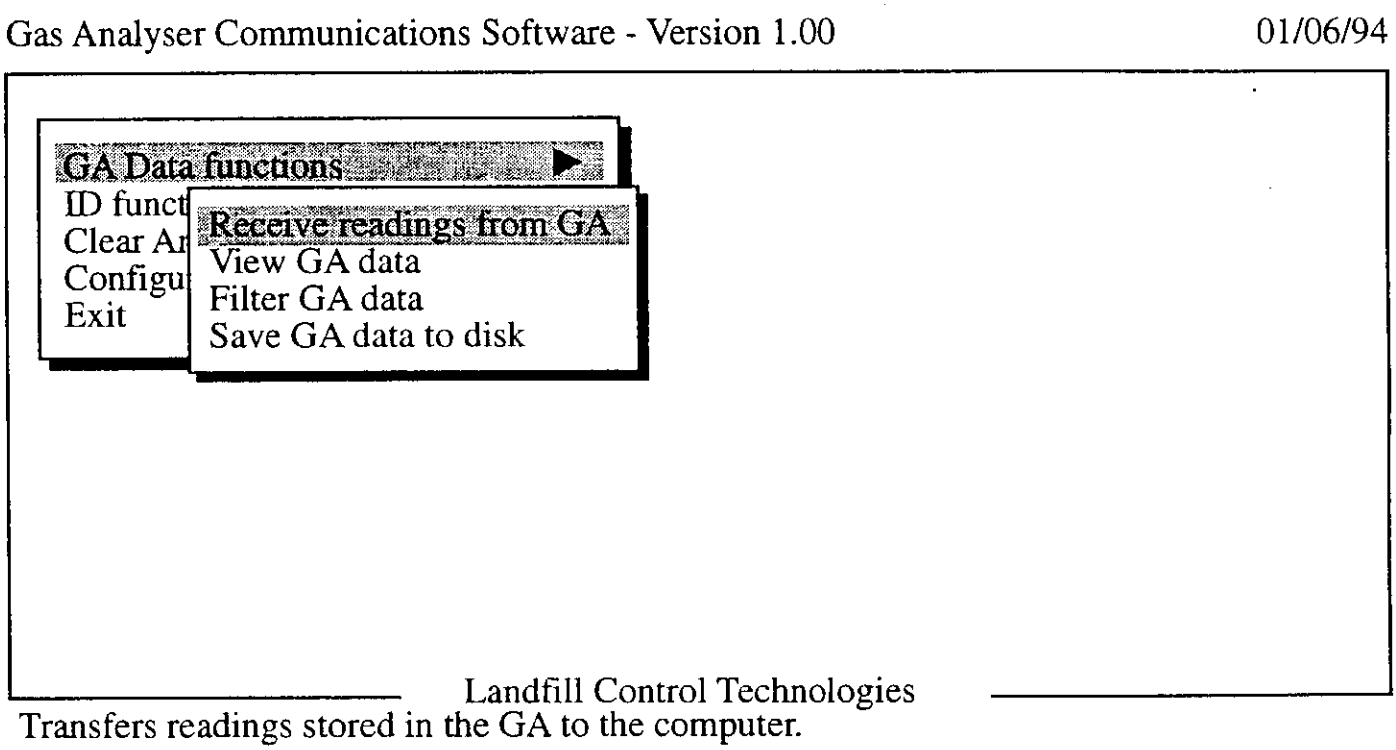
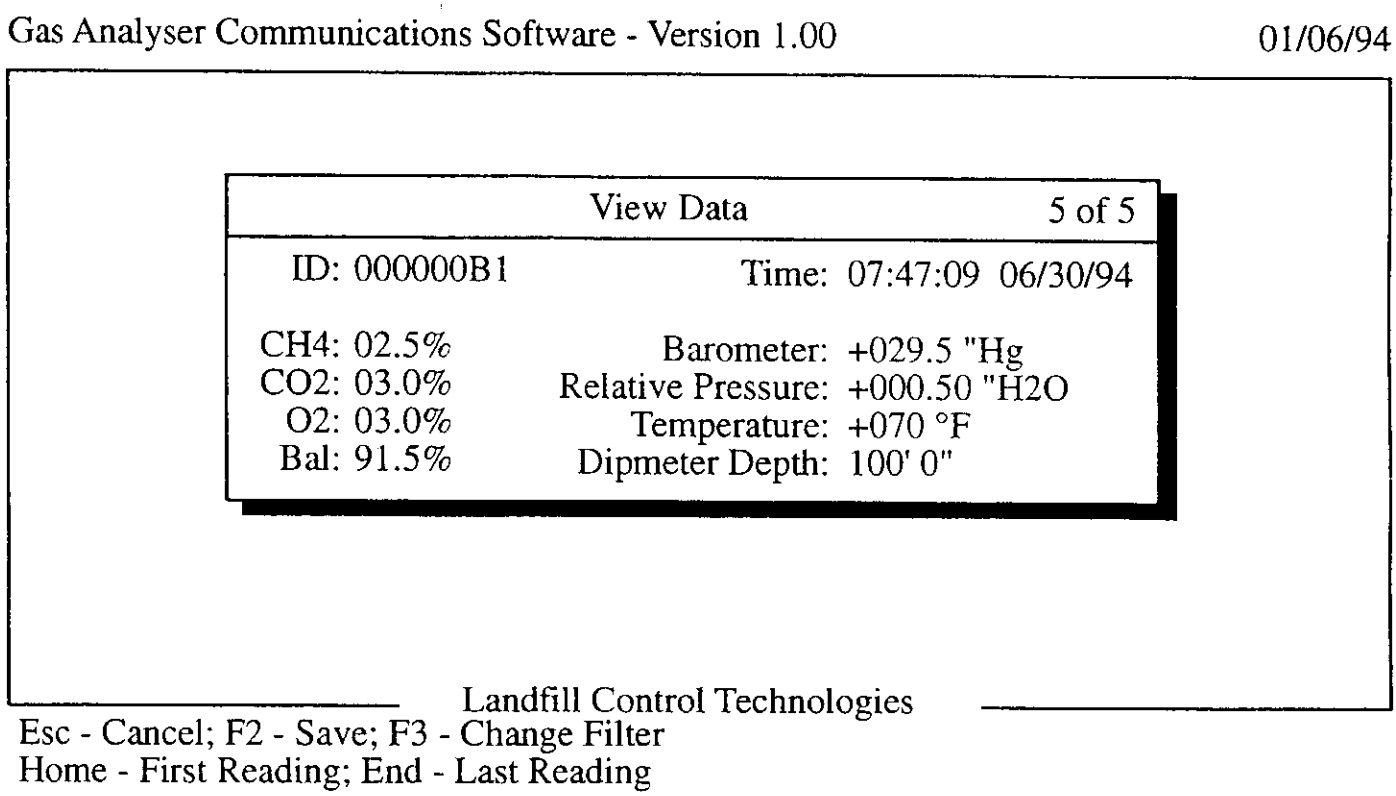


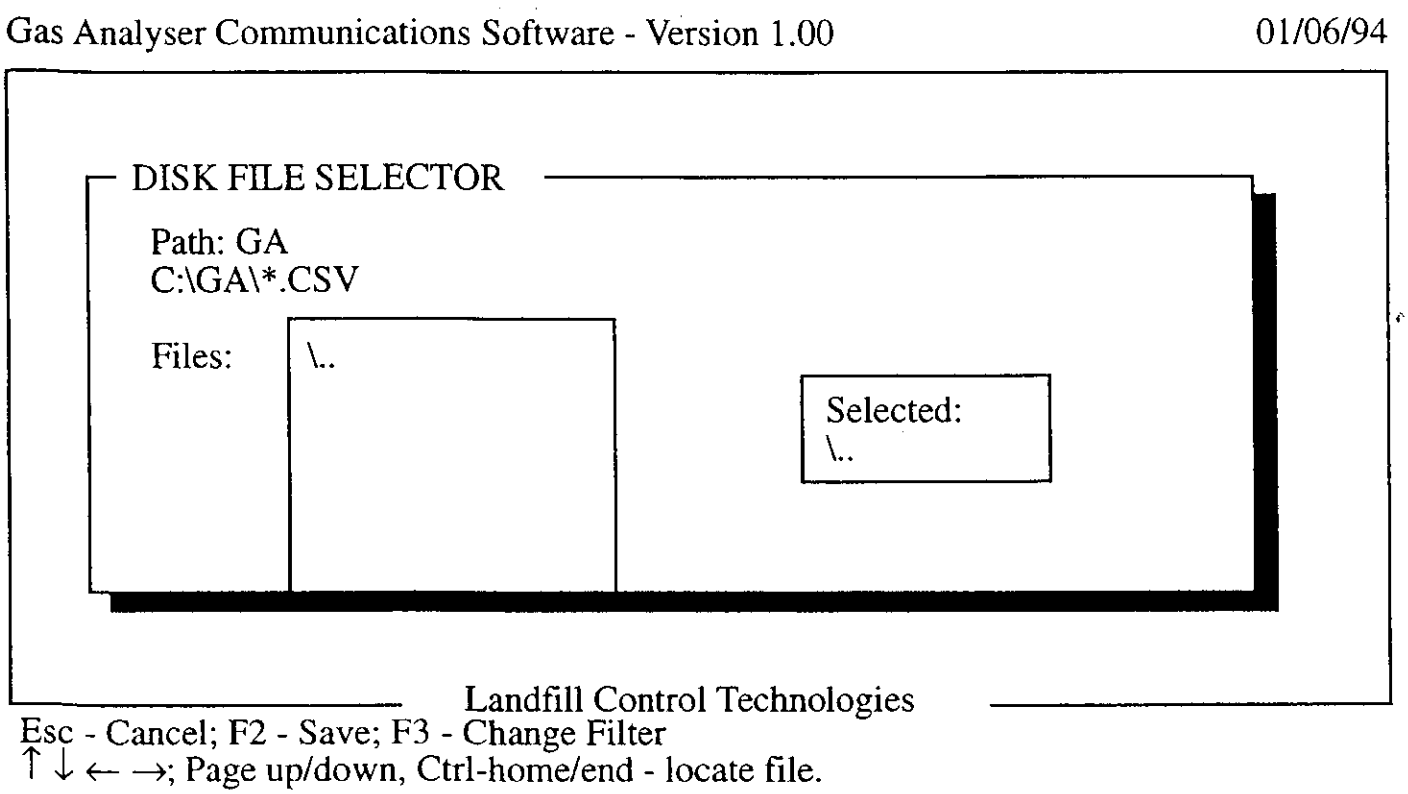
Figure 7.7



2. Your next options are to **Esc - Cancel** out of viewing, **F2 - Save** data or **F3 - Change Filter.**

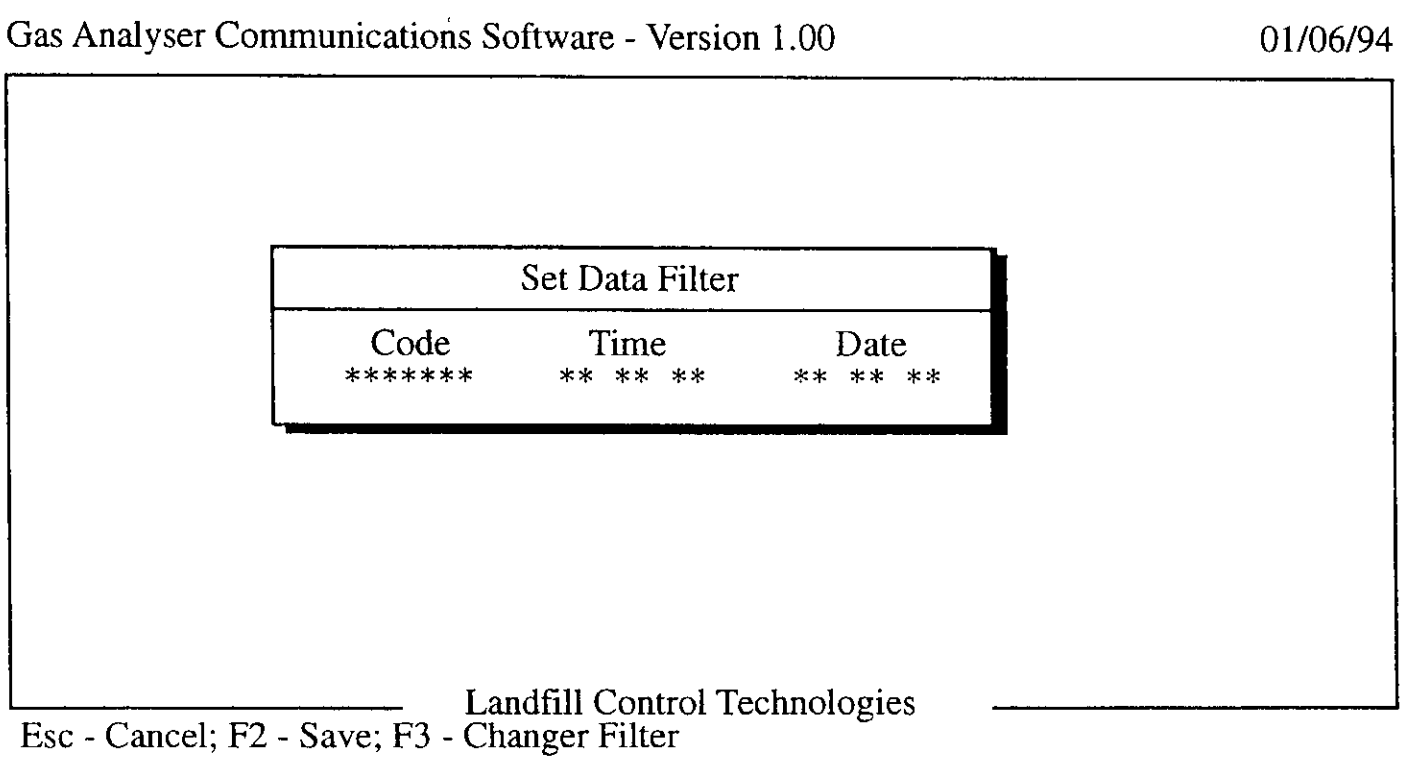
3. To save data from this screen, press F2. If desired, the path may be changed by pressing enter, selecting path and typing name of file with .CSV extension (or extension of your choice). See Figure 7.8 for Disk File Selector screen.

Figure 7.8



4. If you want to change filter, press F3 and note the three available filtering options: **ID, Date and Time,** contain asterisks (Figure 7.9). By entering ID date or time details in these catagories you can filter out unspecified readings. For example, if you wanted to see all readings for ID 11112234, enter that number in ID portion of the screen. Only the readings for ID 11112234 will be viewable. After data filters are set, press enter. Highlight **View GA Data** to view your filtered readings. The **View Data** screen will show all readings specified in filter, however, it will indicate the same quantity of total records. To view all readings, select filter and press return with default asterisks.

   Note: To view the filtered readings, use up and down directional arrows ONLY. The Home key and End key will still show first and last readings respectively although they are not included in the filter. When save the filtered readings the first and last readings will NOT be saved unless they are a part of the specified filter.


Gas Analyser Communications Software - Version 1.00
01/06/94
Set Data Filter
Code
****
Time
** ** **
Date
** ** **
Landfill Control Technologies
Esc - Cancel; F2 - Save; F3 - Changer Filter

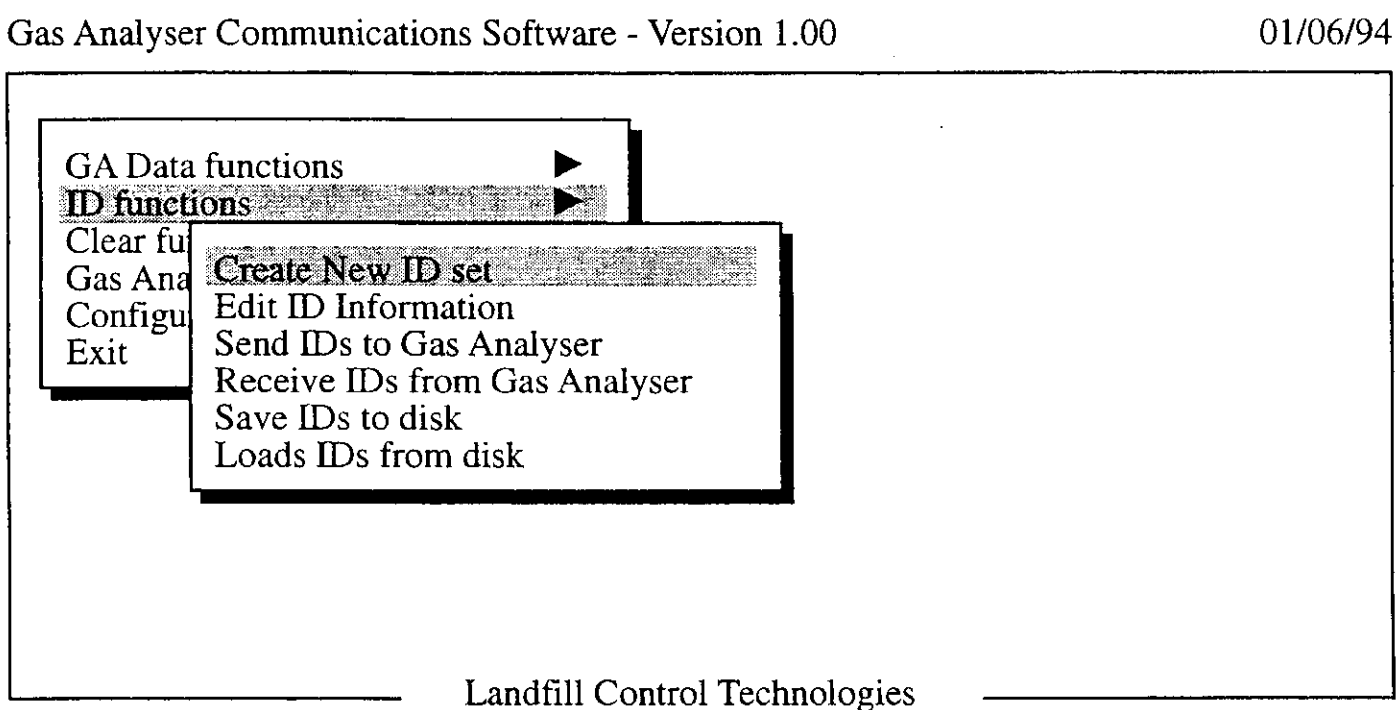
ID Functions

Using the ID Functions of the Gas Analyzer Communications program, ID information can be sent to and from the GA-90. New ID information can be entered on a computer, stored to disk and transferred to the GA-90. Existing ID information in the GA-90 can be transferred to the computer, edited, stored to disk and sent back to the GA-90.

Loading ID Functions

1. As detailed previously, connect the RS-232 cable to your computer and your GA. Load the Gas Analyzer Communications program on the computer and go to main menu screen, highlight **ID Function** and press enter. Select **KEY 4-Download** from the main menu of the GA-90 (Figure 7.10).

Figure 7.10



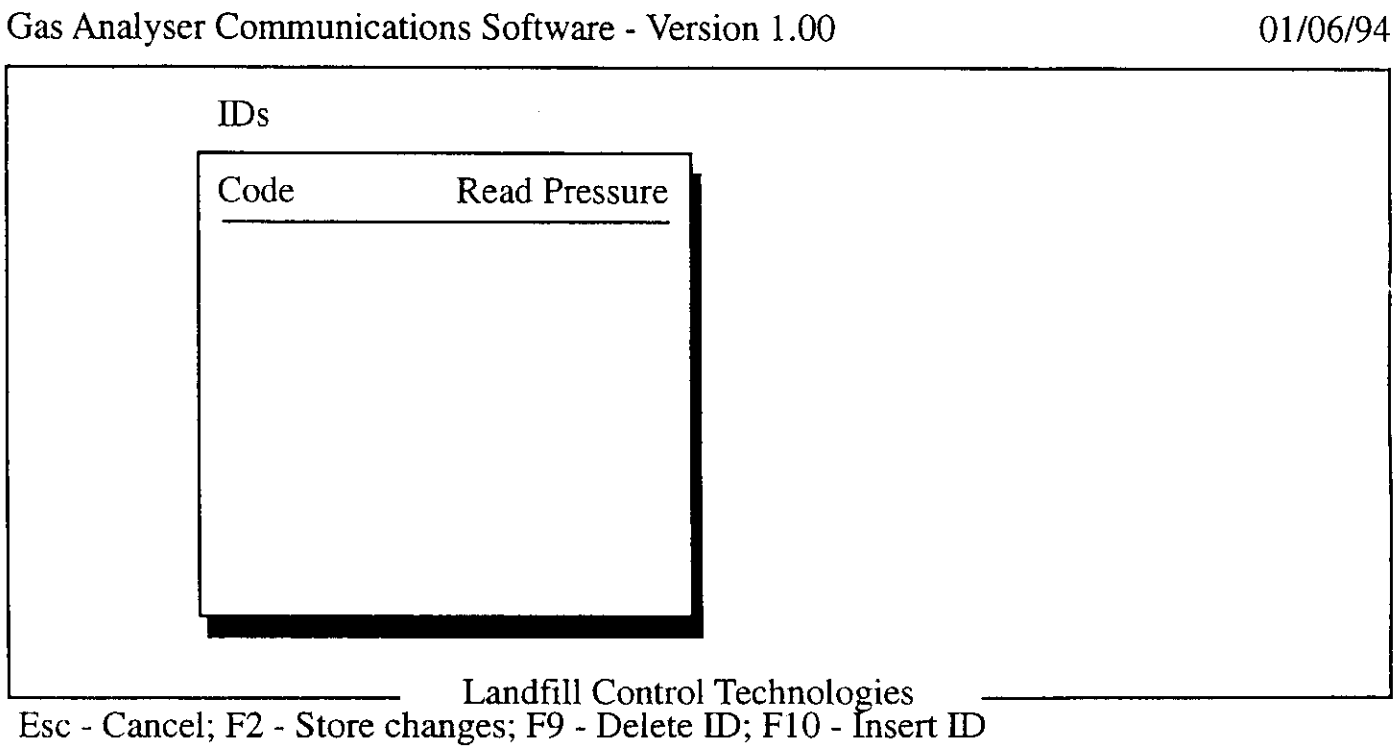
Note: The Create New ID set function, Receive IDs from Gas Analyzer function and Loads IDs from disk function are only available functions at this stage. Once one of these three functions are performed, the remaining functions will be available. Descriptions of all functions follow.

Create New ID set (Erase current ID set from memory, and prepare for new set.)

1. From the **ID Function screen** (Figure 7.10), highlight **Create New ID set** and press enter.

2. The **Create New ID set** screen will appear (Figure 7.11)

Figure 7.11



3. Enter an eight character ID of any combination of letters and numbers. Cursor will move to the **Read Pressure** column—enter Y for Yes and N for No.

4. Press enter and use the up and down directional keys to move to next line if more IDs are desired.

5. Use **F9-Delete ID** or **F10-Insert ID** if required. Press enter when complete.

6. Save your new IDs by pressing **F2-Store changes**. See **Send IDs to Gas Analyzer** for further instructions.

Edit ID Information

1. From the **ID function** screen (Figure 7.9) highlight **Edit ID information** and press enter. The currently loaded ID set will appear.

2. 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.

3. To change a pressure measurement for an ID, type N or Y in the **Read Pressure** column. Press enter to store the selection.

4. Press **F2-Store Changes** to store the changes to the ID information into the computer or GA-90 memory. You will now need to either select **Save IDs to disk** or **Send IDs to GA-90** option.

Send IDs to GA-90

1. To send IDs to GA-90, highlight **Send IDs to Gas Analyzer** from the **ID Functions** screen (Figure 7.9) and press enter. The currently loaded or newly created ID sets will be transferred to the GA-90.

2. The user may be prompted to select **KEY 4-Download** on the GA-90 or save changes on the computer if not already done.

3. The ID codes will be displayed as they are transferred.

   Note: If an ID that already exists is sent to the GA-90, the one in the memory of the GA-90 will be overwritten. If the ID does not already exist it will be appended to the list in the GA. Transfer will be aborted if there is insufficient memory in the GA-90 to store all ID codes and an error message will be displayed on the PC.

Receive IDs from GA-90

1. From the ID function screen, highlight Receive IDs from GA-90 and press enter.

2. The user may be prompted to select **KEY 4-Download** on the GA-90 or save changes on the computer if not already done.

3. The ID codes will be displayed as they are transferred. Once all of the IDs have been read they will be shown in the edit screen. IDs can be edited and stored from this screen.

Save IDs to Disk

1. To save a current ID set to disk, highlight this option from the ID function screen and press enter.

2. The disk File Selector screen will be displayed. Enter file name and press enter.

4. The files will be stored to disk ASCII format. The file can be edited using any ASCII text editor, i.e. one that does not introduce control characters into the file.

Load IDs from Disk

1. To load stored IDs, select Load IDs from Disk from the ID Functions screen and press enter.

2. Disk File Selector screen will appear showing all files with the file name extension of .G2A.

3. Once file is loaded, IDs can be edited and saved to GA or to disk.

Clear Functions

Clear IDs in GA-90 (Erase all of the ID information currently stored in the Gas Analyzer)

1. To delete ID information in the GA-90, select the function and press enter.

2. User will be prompted to press F1 to delete the ID information.

Clear readings in GA-90 (Erase all readings currently stored in the Gas Analyzer.)

1. To delete readings in the GA-90, select the option and press enter.

2. User will be prompted to press F1 to delete the all readings.

Chapter 8-Maintenance

Servicing

The unit has been electronically and functionally tested before leaving the factory. It is recommended that with normal usage, the GA-90 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 GA-90 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 GA-90 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 GA-90. It is in-line in the sample hose. The filter is easily accessed by unscrewing the filter holder. A second filter is inside the GA-90 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. DO NOT OVERTIGHTEN O-RINTS. Periodically inspect the o-rings to check their condition. Replace the o-rings if they become nicked, cut, swelled or otherwise damaged. The GA-90 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 or 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 GA-90 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 GA-90 The GA-90 is a delicate instrument. When charging the battery overnight, the GA-90 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 GA-90 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 charge cycles.

2. Discharge batteries by setting logging function for a five minute interval and pump running to 90 seconds. Unit will run until batteries are discharged. LANDTEC batteries are recommended, however, if you purchase your own batteries, we recommend at least 2000mAhr capacity. LANDTEC does not guaranty operating time if non-LANDTEC batteries are used.

3. When charging batteries, let them charge for at least 14 hours. LANDTEC chargers will not over charge batteries.

4. Never try to operate the GA-90 while the batteries are re-charging.

5. Only charge a GA-90 with a LANDTEC Battery Charger (provided with the unit).

Battery Shut-Off

A circuit within the GA-90 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

When the battery voltage drops below 60% capacity, a Battery Symbol will appear on the top right corner of the GA-90's display screen. Approximately two hours of full pump power remain in the GA-90 when the symbol is displayed. If batteries were not fully charged or batteries are worn out, the Battery Symbol will appear earlier and GA-90 will shut off sooner.

Automatic Power-Off

The GA-90 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 GA-90 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 GA-90 . Insert the alkaline battery "C" cells.

WARNING: DO NOT USE THE BATTERY CHARGER IN CONJUNCTION WITH STANDARD ALKALINE BATTERIES—THEY CAN EXPLODE IF RE-CHARGED.

Chapter 9-Troubleshooting

The GA-90 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 may be so low they will not display any screens

This is done to protect the GA-90's memory. Recharge the unit for 14 hours.

The GA-90 displays ****** or >>>> in some fields

The GA-90 substitutes the "*" symbols because the instrument is warming up or there is no valid information to display. If data is overrange, the ">" symbols are substituted.

The screen says "FLOW FAIL" along with a continuous audible warning

One or more of the GA-90'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 GA-90 in its soft case. Do not place a heat source (including placing the GA-90 on very hot soil) on the back of the GA-90 below the battery compartment. If it persists after the above problems have been corrected, perform a Field Calibration.

The Readings taken by the GA-90 are not what is expected

Use Calibration Gas to test your GA-90 . With its known composition, you will immediately know the if the GA-90 is in calibration. Field Calibration may be necessary. Once you have extablished the accuracy of the GA-90 on calibration gas, you should accept the results it is providing.

Chapter 10-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)
Barometric Pressure	"Hg	"w.c. (Hg)	mb (millibar)
Probe Pressure	"H_2O	"w.c. (H_2O)	mb (millibar)

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-Probe	.0-100 "w.c.	0.01
Pressure-Barometric	36 "Hg	0.1

Accuracy

Concentration	% Methane LEL	% Carbon Dioxide by Volume	% Oxygen by Volume
5%	0.5%	0.5%	.25%
15%	1.0%	1.0%	1.0%
100%	3.0%	3.0%	n/a

Chapter 11-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.

Controlling by Gas Composition

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 GA-90 or magnehelic)
- Velocity head (P or PT) (from GA-90 or pitot tube and magnehelic)

- Wellhead gas flow (from GA-90, 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 GA-90 or magnehelic)
- Velocity head (P or Pt) (from GA-90 or pitot tube and magnehelic)
- Wellhead gas flow (from GA-90, 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.)

- LFG and methane flow from the wellhead
- 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.

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.

Chapter 12-Quick Start Screen Tree

Figure 12.1