Green is life tmg

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www.tmgtestequipment.com.au

Test & Measurement

- sales
- rentals
- calibration
- repair
- disposal

Complimentary Reference Material

This PDF has been made available as a complimentary service for you to assist in evaluating this model for your testing requirements.

TMG offers a wide range of test equipment solutions, from renting short to long term, buying refurbished and purchasing new. Financing options, such as Financial Rental, and Leasing are also available on application.

TMG will assist if you are unsure whether this model will suit your requirements.

Call TMG if you need to organise repair and/or calibrate your unit.

If you click on the "Click-to-Call" logo below, you can all us for FREE!

TMG Corporate Website **TMG Products Website**

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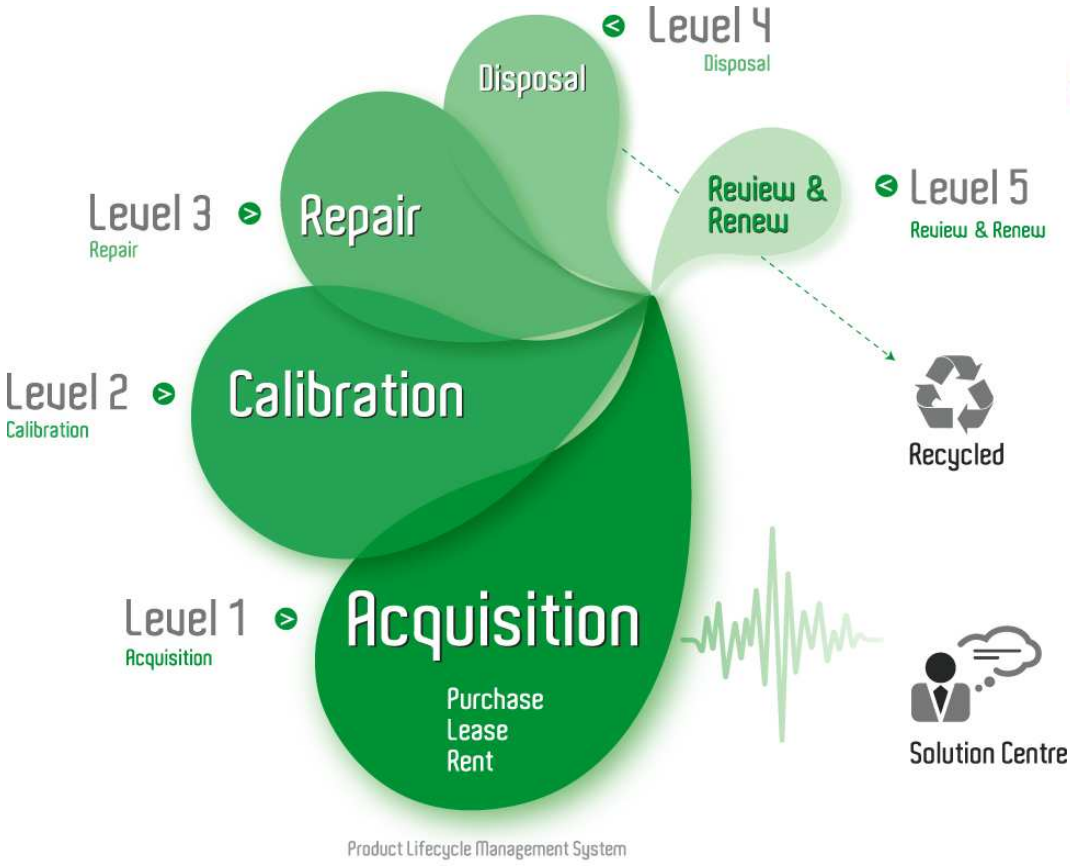

GEM2000
GEM2000 Plus

GAS ANALYZER & EXTRACTION MONITOR

OPERATION MANUAL
For
Serial Numbers 10000 and up

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1 Introduction

LANDTEC is the premier manufacturer of products, instruments and software for landfill gas extraction and for regulatory monitoring compliance. LANDTEC has provided the landfill industry with a technologically innovative family of products for more than a decade. These products are the result of field-proven experience in design, operation and maintenance of landfills for environmental compliance.

The GEM2000 and GEM2000 Plus, designed by LANDTEC, are specifically for use on landfills to monitor landfill gas (LFG) extraction systems, flares and migration control systems. Both instruments sample and analyze the Methane, Carbon Dioxide and Oxygen content of LFG. The GEM2000 Plus also samples and analyzes Carbon Monoxide and Hydrogen Sulfide. The readings are displayed and can be stored in the instrument and downloaded to a personal computer for reporting, analyzing and archiving.

The GEM2000 / GEM2000 Plus instrument is shipped in a protective hard case with a foam interior that 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 (located under 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 relief valve is opened to equalize internal pressure. When shipping a GEM2000 / GEM2000 Plus back to LANDTEC for calibration or service, always ship it in the hard case to protect unit from damage.

Carefully unpack the contents of the GEM2000 / GEM2000 Plus, inspect and inventory them. The following items should be contained in your package:

- The GEM2000 / GEM2000 Plus instrument
- GEM2000 / GEM2000 Plus Operation Manual
- Registration/Warranty Card
- Soft carrying case with replaceable protective window and carrying strap
- Clear ¼" vinyl sampling hose assembly (5 ft.) with external water trap filter assembly
- Blue ¼" vinyl pressure sampling hose (5 ft.)
- Spare internal particulate filter element
- Polypropylene male connector (hose barb) connects to blue vinyl tubing
- Spare external water trap filter element
- 100-240 volt battery charger
- Software on CD-ROM
- RS-232 serial cable for computer/instrument communications
- Temperature probe (optional)
- Hard carrying case

Complete the Registration/Warranty Card and return it to LANDTEC. The model and serial numbers are located on the back of the GEM2000 / GEM2000 Plus instrument.

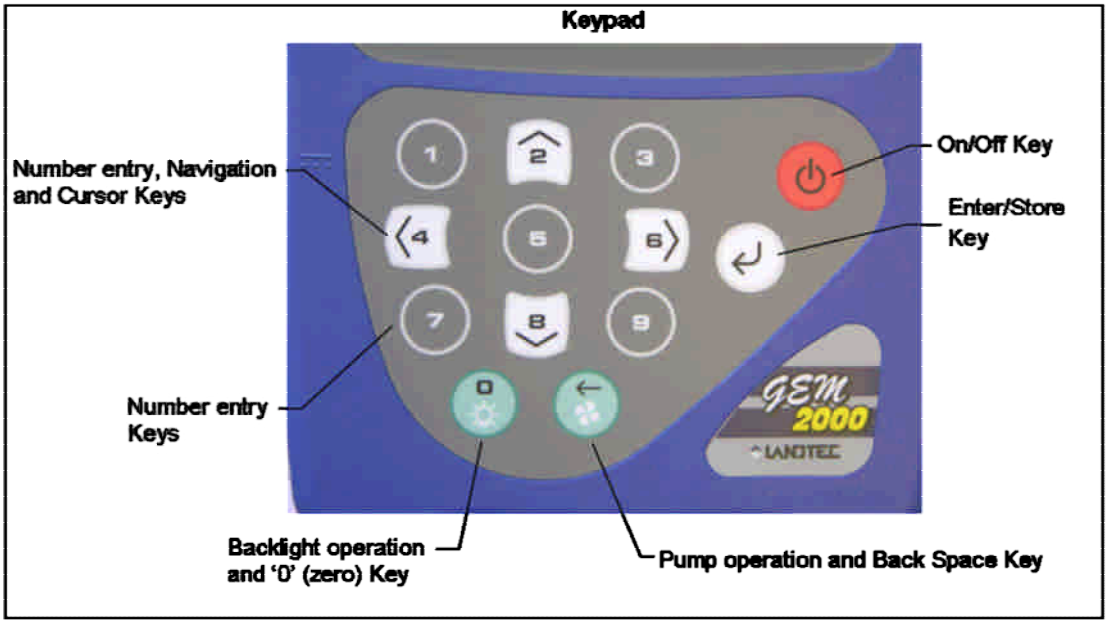
Immediately notify shipping company if the GEM2000 / GEM2000 Plus unit or accessories are damaged due to shipping. Contact LANDTEC immediately if any items are missing.

For questions regarding instrument operation and procedures, please contact LANDTEC at:

Customer Service or Technical Support	(800) 821-0496 Extension 6131
Factory Service	(800) 821-0496 Extension 6141

2 General Operational Features

2.1 Physical Characteristics of the GEM2000 / GEM2000 Plus



2.2 Storage

Do not keep the instrument in the trunk of a car or shed because it may be exposed to temperature extremes.

When not in use, instruments should be kept in a clean, dry and warm environment such as an office.

The instrument batteries should be discharged and fully charged at least once every four weeks regardless of indicated charge state. The discharge function may be carried out with the use of the Data Logging Function in GA mode of operation.

2.3 Battery/Charging

The Battery Charger IS NOT covered by the unit UL certification. Therefore, when connected to the Battery Charger, the instrument IS NOT intrinsically safe and should not be used in confined spaces.

The battery used in the GEM2000 / GEM2000 Plus is a Nickel Metal Hydride manufactured as an encapsulated pack from six individual cells. This type of battery is not so susceptible to “memory effects” as Nickel Cadmium batteries, although it is not recommended that the unit be given short-term charges. When the flashing LED indicates “Trickle Charge” the charging is completed and the unit can be disconnected from the charger.

The battery charger indicates when the unit is charging, charged or if there is a fault. A full charge should take approximately 2 hours.

2.4 Instrument Certification

The GEM2000 / GEM2000 Plus is UL/Sira certified for use in hazardous locations. Specifically certified as to intrinsic safety for use in hazardous locations Class I, Zone 1, AEx ib d IIA T1 (Ta=32°F to +104°F).

For the certification to remain intact it is vital the instructions in this manual are followed closely and repairs of this equipment be carried out in accordance with the applicable code of practice by an approved repair facility. See section 9.2 for a list of authorized repair locations.

It is the responsibility of the operator to determine the protection concept and classification required for a particular application.

2.5 Safety Information

The GEM2000 / GEM2000 Plus is normally used for measuring gases from landfill sites. Inhaling these gases, or gases from other sites may be harmful to health and in some cases may be fatal. It is the responsibility of the user to ensure that he/she is adequately trained in the safety aspects of the gases being used and that appropriate procedures be followed. In particular, where hazardous gases are being used the gas exhausted from the analyzer must be piped to an area where it is safe to discharge the gas. Hazardous gas can also be expelled from the instrument when purging with clean air.

2.6 Turning the Instrument On/Off

When switching the instrument on, a long beep will sound, followed by the LANDTEC logo being displayed and the self-test will commence. Whenever a key is pressed the unit will emit a short ‘beep’ as an acknowledgement. This function cannot be turned off.
When switching the instrument off, the On/Off button must be held down for approximately 2-3 seconds, at

which point a clean air purge will be carried out. If for any reason the instrument 'locks-up' and will not switch off, press and hold the On/Off button for 15 seconds. This will force the instrument to switch off.

2.7 Warm-up Self Test

When switched on, the instrument will perform a predetermined self-test sequence taking approximately 30 seconds, during this time many of the instrument's functions are tested, including:

- General operation
- Pump function
- Gas flow measurement
- Calibration
- Backlight function
- Solenoid function

During the self-test, the following information is also displayed:

- Software version
- Serial Number. Calibration due date.
- Date format.
- Operating language.
- Communication Baud rate.

2.8 Warning and Error Display

During the self-test, if any operational parameters are out of specification or the pre-programmed recommended calibration/service date has passed errors or warnings may be displayed. Only three errors/warnings can be displayed at any time. To ascertain if more errors occurred, use the '∧' and '∨' key to scroll up/down the list, to exit from this screen press the "Enter/Store" key '↵'.

2.8.1 WARNING Displayed

All warnings displayed will be prefixed by the word "**WARNING**' followed by a relevant description. Two types of warnings may be displayed.

1. General warnings that may not have an effect on the instrument's function and those where the self-test has detected a function that is outside the usual programmed operating criteria (e.g. Battery charge low, memory nearly full, etc.).
2. Specific warnings of operational parameters that can affect the performance of the instrument (e.g. O_2 Cell out of calibration, CH_4 out of calibration, CO_2 out of calibration, etc.).

The most likely reason for the errors is either an incorrect user calibration, or sensor failure. If an incorrect user calibration has caused the warning, it should be correctable by way of returning the instrument to factory settings, zeroing or carrying out a user calibration as necessary for the relevant function.

2.8.2 ERROR Displayed

All errors displayed will be prefixed by the word '**ERROR**' followed by a number and description. The errors detected by the self-test are usually caused by a user calibration being out of specification or possibly memory corruption. This will have an effect on the functionality of the instrument and should be corrected before use (e.g. 01 - User cal data, CH_4 reading or channel out of specification, 02 - User cal data, CO_2 reading out of specification).

If any other Warnings or Errors are displayed, contact a LANDTEC Authorized Service Facility for further information.

2.9 Service Information Screen

Upon self-test completion, the GEM2000 / GEM2000 Plus will display service information including when the next manufacturers service is due, what type of service agreement the instrument is under (if applicable), and when the last factory gas check was performed. To exit from this screen press the "Enter/Store" key '↵'.

2.10 Technician ID Screen

The Technician ID screen is displayed after the Service Information screen. While it is not necessary to input a Technician ID it is possible to select a technician from a predetermined list (created in LSGAMS) or input up to four characters to identify the technician performing the readings. This ID will be appended to all readings that are taken until the instrument is turned off. To change the Technician ID simply turn the instrument off and back on again. The Technician ID can be input through a virtual key board shown on the instruments display. Letters or numbers can be selected by using the '∧' and '∨' key to scroll up/down and the '<' and '>' to scroll left and right. Pressing the "Enter/Store" key '↵' will select the highlighted character. Once the Technician ID is selected, or to bypass selecting any characters press the '①' button.

2.11 Gas Reading Screen

After inputting or bypassing the Technician ID, the instrument will go into the Gas Reading screen, also considered the normal operation screen. All operations are carried out from this starting point. The following information is displayed in various boxed sections at this time:

- Current programmed time and date
- Current selected ID code
- Pump status
- Pump run time
- Three main constituent gases – CH_4, CO_2, O_2 (in %)
- Two minor gases – CO & H_2S and indication of H2 (GEM2000 Plus only)
- Balance gas
- Last read time/date (if previous data is in memory)
- Technician ID
- External devices (displays pod type or temperature probe readings when attached)
- % LEL CH_4 (if selected through LSGAM)
- Barometric pressure reading.
- Current relative pressure reading (GA mode only)
- Gas Pod or Temperature Probe reading (if connected)
- Battery Charge graph (5 segment, flashes at 20% remaining)
- Memory Usage graph (5 segment, flashes at 5% remaining)

Other options:

① Menu	Allows access to all instrument user functions.
③ Next ID	Allows the next ID to be selected (if IDs are available).
⑤Measure Flow	For GEM mode only.
⑦Previous Reading	Allows the previous reading of the selected ID to be viewed (if data is available).
↵ Store Reading	Stores the current displayed reading. (GA mode only)

2.11.1 Keypad Lock

After the instrument enters into the Gas Reading Screen, and from this point forward, the keypad can be locked by pressing and holding the backlight key for approximately 2 seconds. A message will display at the bottom of the display instructing you that to release the lock you will need to press and hold the backlight button.

2.12 Optional Gas Pods

Optional Gas Pods are available for use with the GEM2000 / GEM2000 Plus. These pods are available in seven different gases with eight different PPM ranges. Connection to the instrument is made via the data port and exhaust port. The detected PPM level is displayed in the upper right area of the gas read screen and is saved in the same manner as the other gas readings. The Gas Pods are not classified as intrinsically safe they should not be attached or detached from the instrument in hazardous areas.

Gas Type	Range (PPM)	Resolution (PPM)
H_2S	0-50	0.1
	0-200	1.0
	0-5000	35
CO	0-1000	1.0
SO_2	0-20	0.1
	0-100	1.0
H_2	0-1000	1.0
HCN	0-100	1.0

Gas Pods are intended for use as an inexpensive detection means and not for regulatory reporting purposes. If the GEM2000, fitted with a Gas Pod, indicates the presence of the selected gas, further testing should be performed with regulatory approved instrumentation. LANDTEC recommends that field calibration be performed using the relevant gas and concentration, prior to sampling with a Gas Pod. If calibrated properly the accuracy of these Gas Pods are typically 5-10% Full Scale.

2.13 Memory

The instrument's memory is volatile. It is maintained by a battery back-up system, which will maintain the memory while the battery is being changed.

The memory is not to be used as a permanent storage medium and any data should be transferred to a more permanent storage medium as soon as possible. An Instrument should never be stored for prolonged periods with valuable data in its memory.

Although unlikely, sudden shocks, high levels of electromagnetic interference or static discharge may cause memory corruption or loss. If this occurs, the instrument should be Cold Started and the calibration reset to factory settings before further use. **Cold starting will erase all data in the instrument including resetting the time and date to the default value**.

2.13.1 Cold Start

THIS FUNCTION SHOULD BE USED ONLY AS A LAST RESORT.
(For Gas Calibration Error Messages, confirm that Factory Settings and User Calibration are done).

A Cold Start should only be carried out to correct an instrument if no other course of action has proved successful. This function **WILL ERASE** the instrument memory entirely. After a cold start is performed the user will need to reset the instrument to factory settings, perform a field calibration and reset the internal time/date to the default settings. Please note that the time/date may only be updated through the communication software. It cannot be updated manually.

To carry out a cold start, turn the instrument on, before the instrument enters into the self-test screen press and continue to hold the '↵' key until a pass code entry screen is displayed. At this point the '↵' key may be released. Enter the passcode **12345** and press '↵' to confirm.

After the pass-code entry has been accepted, the instrument serial number will be displayed along with the hours in use, pump run time and service dates. There are four options from this screen;

1 - Cold Start
2 - Recover readings
3 - Print readings
0 - Exit

ONLY select option '**1'** if a Cold Start is to be carried out. Press key '**1**' to confirm this operation or press key '**0**' to continue with normal operation. If you select '**1**' to confirm the cold start a message will be displayed confirming the cold start operation and all memory will be cleared. The instrument will continue to the technician ID screen.

2.13.2 Recover Readings

THIS FUNCTION SHOULD BE USED ONLY AS A LAST RESORT.

Recover readings is a low level memory function that should only be used as a last resort if all your readings were inadvertently deleted and you know how many readings you had. This function moves the memory buffer and can cause instrument corruption. Contact LANDTEC before attempting to recover readings.

2.13.3 Print Readings

This function is best performed using an appropriate RS232 cable (included with new instruments, also available from LANDTEC) and the LSGAM software. See section 3.12 Downloading Readings for more detail.

2.14 RF Interference

The gas sensors, especially the Methane sensor, are sensitive to RF interference.

Any device that transmits radio waves can cause your gas readings to fluctuate. Cell phones are the most common cause of the problem. You should never use your cell phone while you are taking gas readings.

3 The LANDTEC System Gas Analyzer Manager Software

3.1 Configuration Options

The GEM2000 and LANDTEC System Gas Analyzer Manager (LSGAM) software can be utilized in a number of ways:

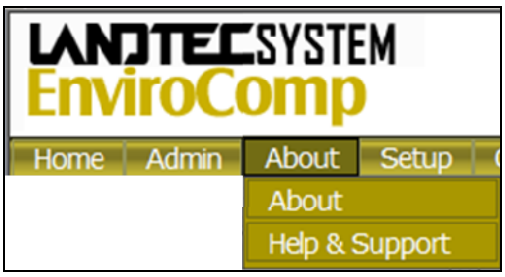
- Configured for operation with the LANDTEC System online service;
- Used offline as a local application storing information on the desktop/laptop computer;
- Used out of the box without software; (this does not allow the user to generate flow rate values or select comments with the instrument and also prevents downloading of readings to the computer. It also does not allow the user to correct the time and date or to clear the memory, unless cold started.)

3.2 Online Users

The procedures included in the section are intended for those connected to the LANDTEC System online service. The LANDTEC System is an online collaboration tool to Collect, Validate, Analyze, and Communicate information based on field data obtained using LANDTEC instrumentation.

If you currently are a registered user on the LANDTEC System, please log in at https://www.landtecsystem.com/. If you are not currently using the LANDTEC System, you may register by contacting LANDTEC in the US: 800-821-0496 or International: +1-909-783-3636.

Online reference for using LANDTEC System Gas Analyzer Manager (LSGAM) with the LANDTEC System can be found under the About → Help & Support menu within the LANDTEC System.



If you do not have login information please contact Technical Support at +1-909-783-3636 extension 6131.

3.3 Offline Users

The procedures included in the section describe use of the LANDTEC System Gas Analyzer Manager (LSGAM) Software while **NOT** connected to the LANDTEC System online service.

3.3.1 Installation with the CD

System Requirements:
Windows 98/NT/2000XP/Vista
Pentium III 500 MH or equal
64 (MB) RAM
120 (MB) Hard Drive Space Available
CDROM Drive

NOTE: The computer may need some administrative privileges to install the program.

Insert the CD into your CD ROM drive and wait for the setup to auto start. Click on the Launch Setup button and follow the onscreen instructions. Once the software is installed you will have a shortcut icon on your desktop which you will use to start the LSGAM instrument program.

The Java programming is an import part of this software and will be loaded with the CD install. The java icon, shown below, will be in the task tray at the bottom of your computer screen where your time is shown. There will also be a GAM log icon, shown below, that will be created on your desk top during installation.

.

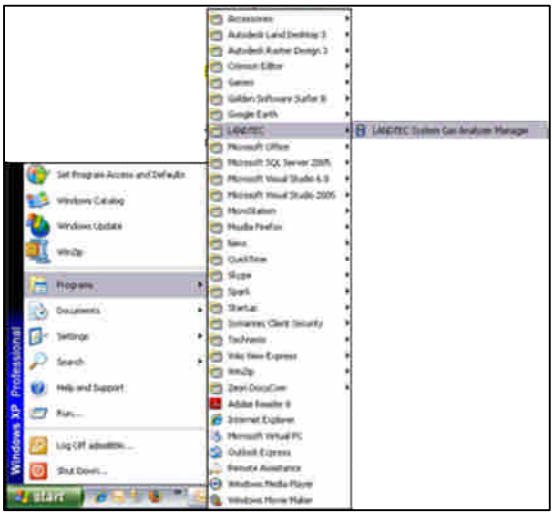
3.3.2 Start Up

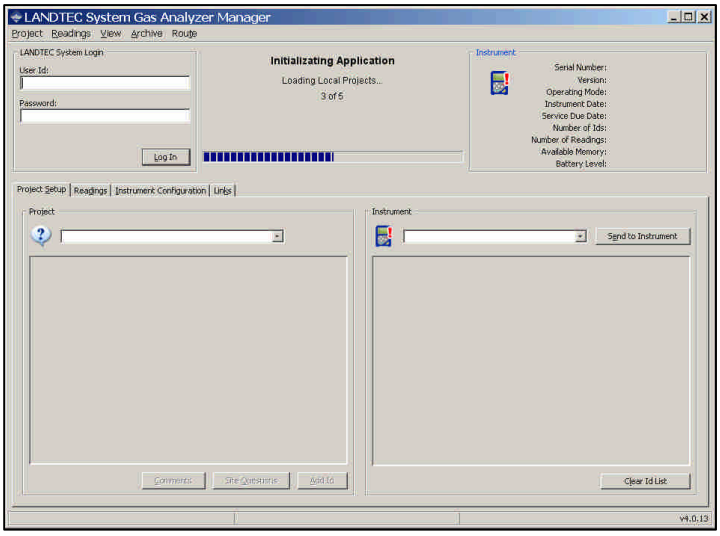
Starting LSGAM can be easily done by doing one of the following:

Double-Click on the Desktop icon.

OR - go to;

Start → All Programs → LANDTEC → LANDTEC System Gas Analyzer Manager



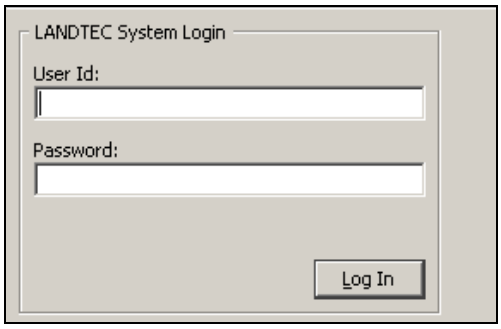


3.3.3 Navigation

The LANDTEC System Gas Analyzer Manager User Interface allows for easy access and navigation to various utilities to use the LANDTEC portable instrument on a day to day basis. The following is a general description of the user interface.

LANDTEC System Login

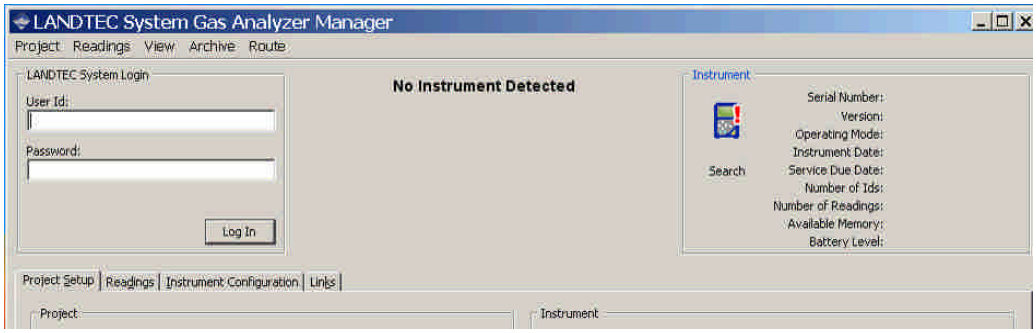
When LSGAM is used with the LANDTEC System online service, the username and password will be entered in the screen below, if you are using LSGSM as a desktop application the User Id and Password fields do not need to be filled in.



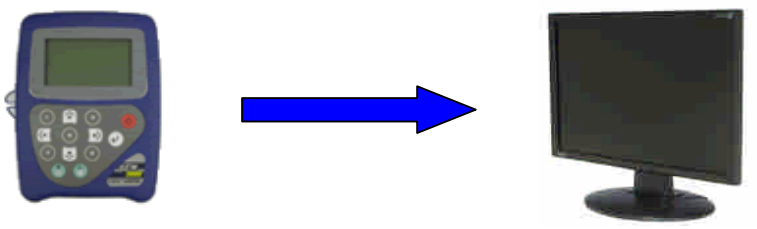
The Progress section indicates the status of the current process. For example, when starting up LSGAM, this will show you the activity of the software.

The Instrument section displays whether or not an instrument is connected. This also downloads the IDs, readings, and comments. If an instrument is found the following is shown:

Instrument Type:
Serial Number:
Version:
Operating Mode:
Instrument Date:
Service Due Date:
Number of IDs:
Number of Readings:
Available Memory:
Battery Level:



3.4 Connecting to the Instrument



1. **Connect the GEM2000 with the RS-232 Download Cable to your Computer**
2. **Instrument must be powered ON and in the Gas Reading screen**
3. **Launch the LSGAM software by clicking on the icon on your desktop**

This is the first screen you will see when starting the program.

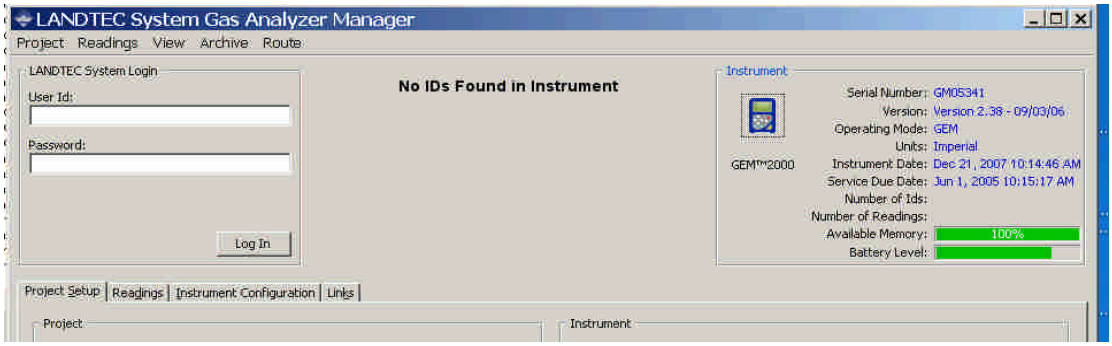
Once the software is installed on your computer with an internet connection this instrument communications program has Auto application updates. This enables you to always have the most current version of the instrument communications LSGAM.

If an update to LSGAM is available, <u>you will see this notice when connected to the internet</u>.

Click on OK this will return you to the desktop and you will then need to click on the  LSGAM shortcut again.

The GEM must be connected to computer and turned ON. It must also be in the Gas Reading screen. The LSGAM software will automatically download any information in the instrument including readings, comments and IDs.

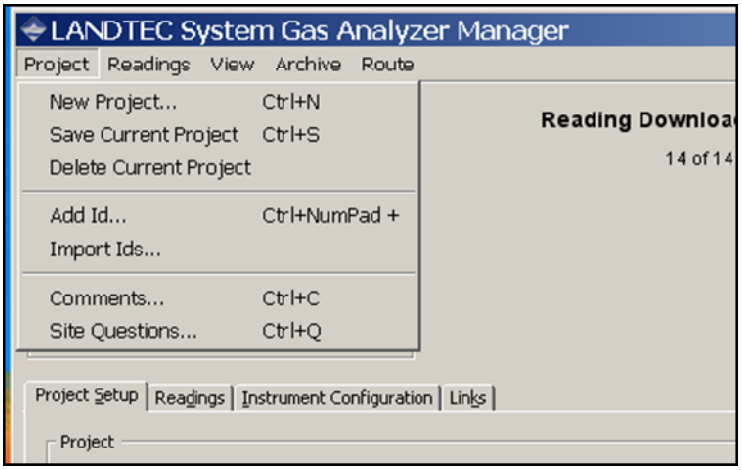
A new instrument containing no information will display only the instrument information: Serial Number, Version, Operating Mode, Instrument Date, Service Due Date, Number of IDs, Number of Readings, Available Memory, and Battery Level.



3.5 Create a Project / Select a Project

Projects are a collection of Device IDs and their associated reading history. A project can be created using LSGAM to contain a group of sequenced IDs and chronological history of instrument readings.

To create a Project, click on the Project menu and select New Project.



Upon selecting **New Project…** you will be prompted to enter a Project Name and select from one of three options.

Create a New Empty Project
This option creates an blank project where you configure all IDs and Comments.

Create a New Project with comments and site questions from a Current Project
Selecting this option allows the user to create a new project that will have the same Comments and Site Questions as an existing project.

Create a New Project from the data in a GEM2000
This option will create a New Project and automatically associate the IDs, Comments, and Site Questions that exist in the connected portable instrument.

3.6 Setup IDs

An ID represents a physical sampling point in the field. An ID can be allocated to field components such as extraction wellheads, gas transmission lines, or passive monitoring probes. LSGAM allows users to configure an ID for each sampling point in order to obtain accurate readings with LANDTEC portable

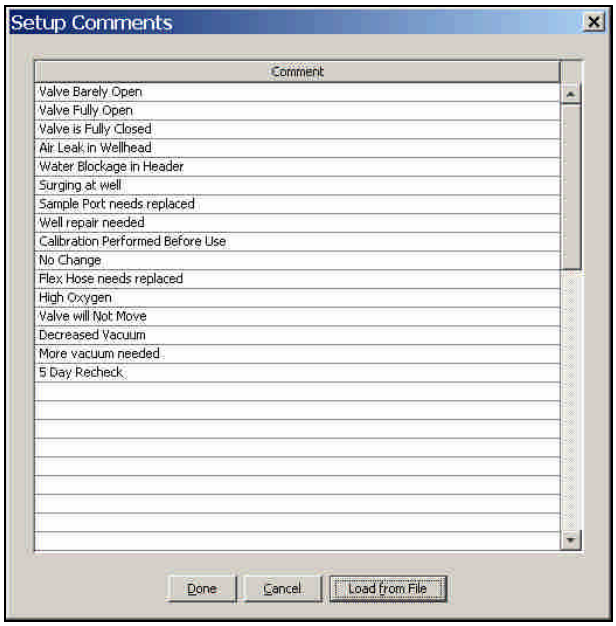
instrumentation

IDs are created, modified, and removed from the Project Setup tab in the software.

3.6.1 Creating Comments

Comments should be setup prior to creating new IDs. The user can define Comments that can be associated with a reading in the portable instrument.

If you selected Create a New Project when creating your project, you will need to click on the Create Comments button. Comments can be entered in this setup screen or loaded from a file and will be displayed in the user interface.



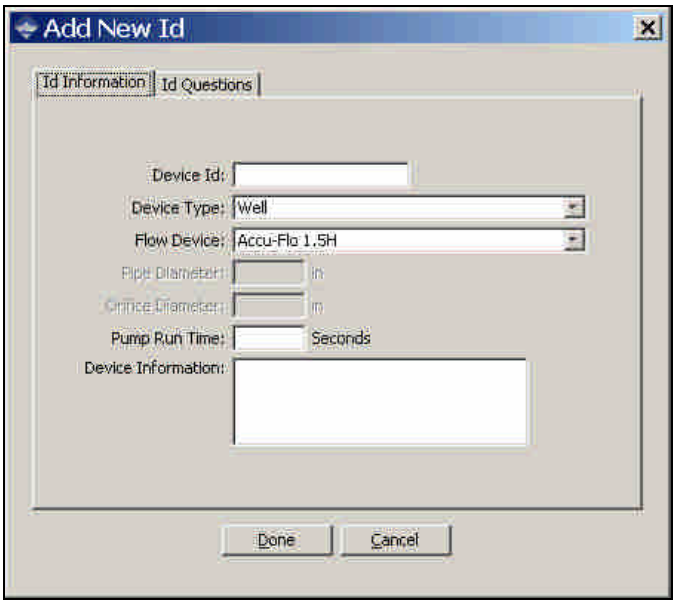
3.6.2 Creating IDs

There are several ways to input IDs to the Project. The following describes each process:

Creating new IDs with LSGAM

To create a new ID using the LANDTEC System Gas Analyzer Manager, Right Click on the left ID pane beneath your active project and select the Add New ID option.

The Add New ID form will be displayed. From the ID Information tab of this form, entry of the following is available:



Device ID: Must be eight (8) alphanumeric character spaces. (For example, LSGW0001)

Device Type:

- Well: An active gas extraction well which may require a flow rate reading.
- Sample Port: A sample point along a gas transmission line that may require a flow rate.
- Probe: A passive gas migration monitoring probe that does not require a flow rate.

The GEM2000 calculates flow rate values specific to each device type (listed above). The available flow devices programmed in GEM mode are listed below.

Flow Device:
Accu-Flo 1.5V
Accu-Flo 1.5H
Accu-Flo 2V
Accu-Flo 2H
Accu-Flo 3V
Accu-Flo 3H
Orifice Plate

- Pitot Tube
- User Input

Orifice Plate WellSide
Accuflo-1.5V-Include System Pressure
Accuflo-1.5H-Include System Pressure
Accuflo-2V-Include System Pressure
Accuflo-2H-Include System Pressure
Accuflo-3V-Include System Pressure
Accuflo-3H-Include System Pressure
Orifice Plate-System Side-Include System Pressure
Pitot Tube-Include System Pressure
User Input-Include System Pressure
Orifice Plate WellSide-Include System Pressure

Pipe Diameter: The pipe inside diameter (ID) is required.

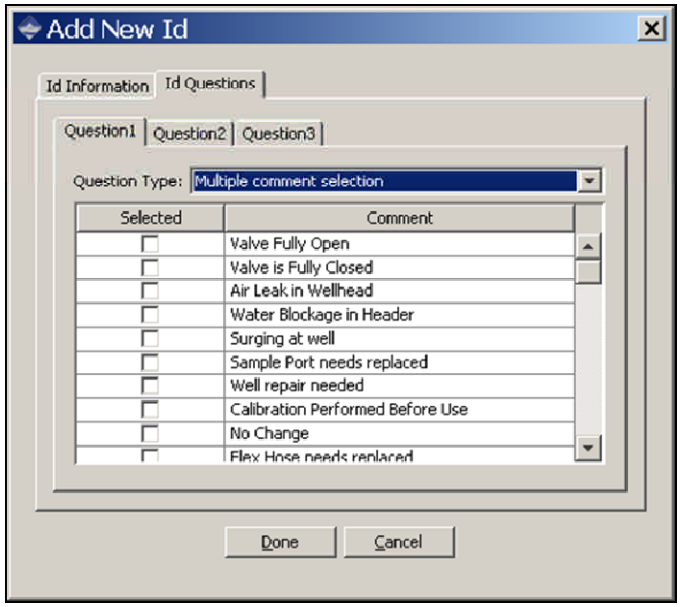
Orifice Diameter: The field for orifice bore diameter is available for all Orifice Plate flow devices.

Pump Run Time: Indicates the duration the GEM2000 pump will run while sampling for the selected ID. Allows the user to enter general information for the device. This can also displayed the GEM2000 instrument.

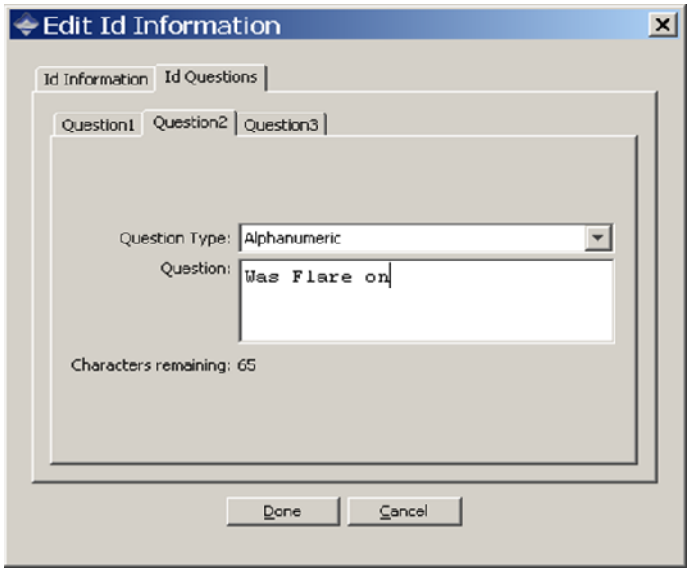
Device Information: Allows the user to enter general information for the device. This will display on the screen of the GEM 2000 instrument.

There are _ Question Types that can be selected:

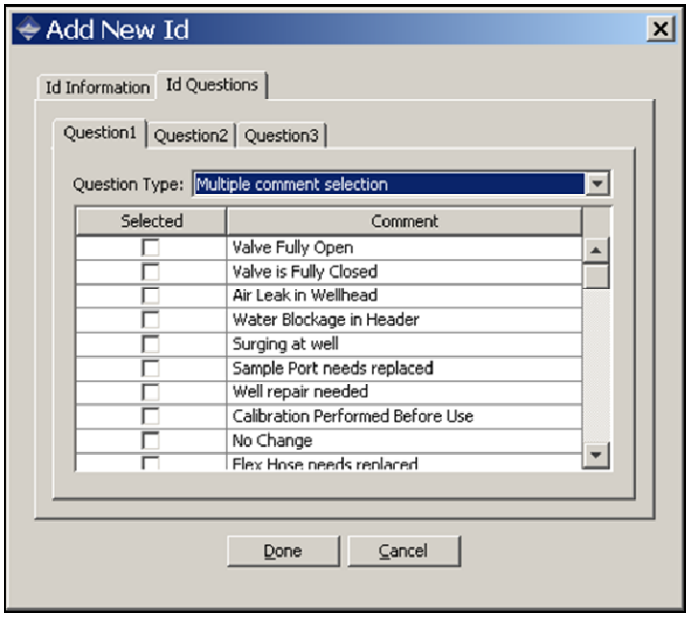
None
Alphanumeric
Numeric
Multiple comment selection
Single comment selection



Users may select up to 8 comments that will be available to the technician to select from when storing a reading with the GEM2000.

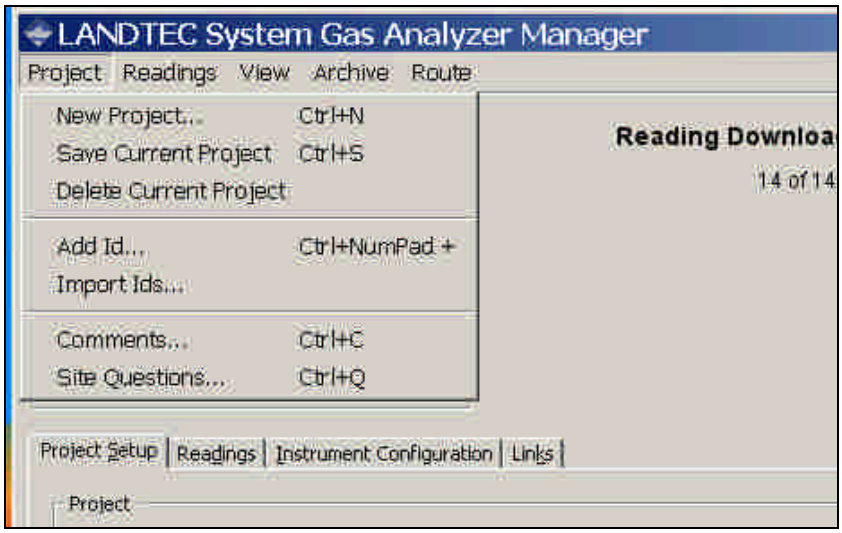


Alphanumeric questions prompt the user to enter a comment on the instrument consisting of letters and numbers.

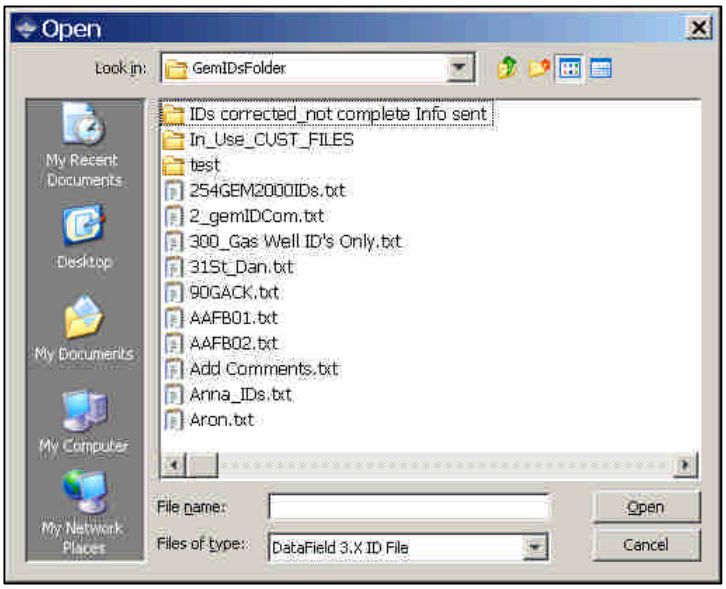


Numeric questions will prompt the user to enter a numeric answer on the instrument with a specified format.

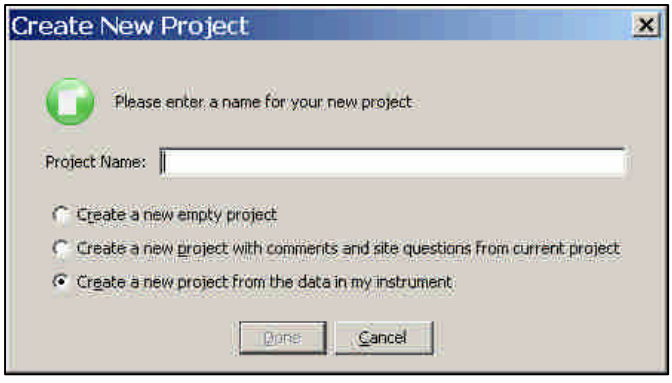
If you have existing ID files from DataField CS v3.2.x, these files can be imported by LSGAM. To begin this operation select the ***Import IDs…*** option from the ***Project*** menu.



Select an ID file generated by DataField CS v3.2.x.



3.6.1 IDS ALREADY IN THE INSTRUMENT:

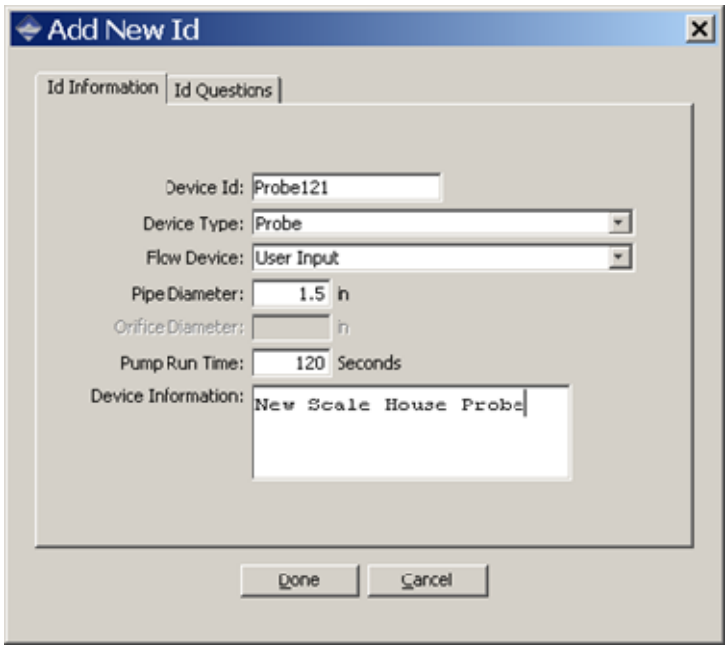


To create a Project based on the information in the GEM2000, select ***Create a new project from the data in my instrument***.

Creating a Device ID that does not measure flow Example- Probe or Sample Port

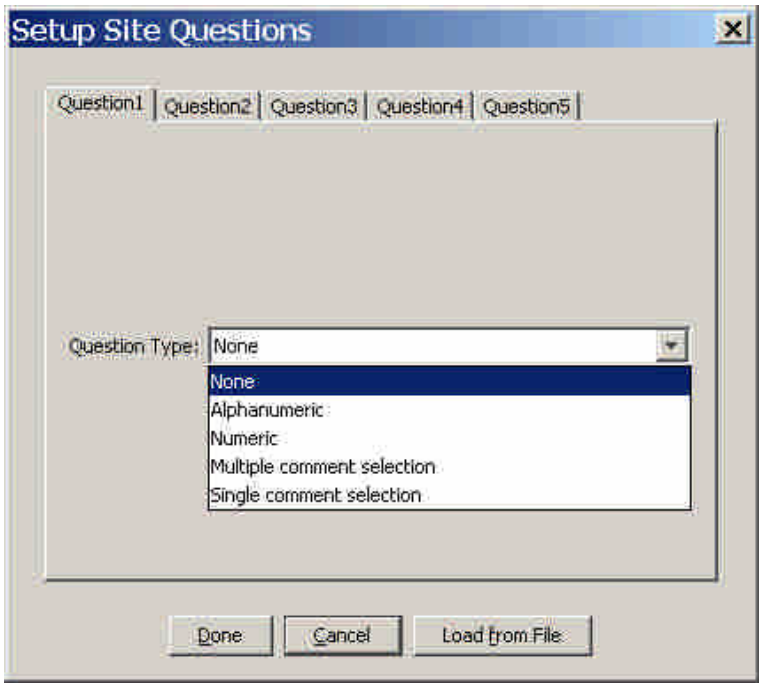
If there is no flow device you will choose User Input. When choosing the User Input option you will need to enter the appropriate pipe inside diameter and pump run time.

This ID is then generally sent to the GA mode [Landfill Gas Analyzer] of the instrument. Because this mode of the instrument does not read flow will not show the pressure readings screens that are in the GEM mode for vacuum and impact pressures.

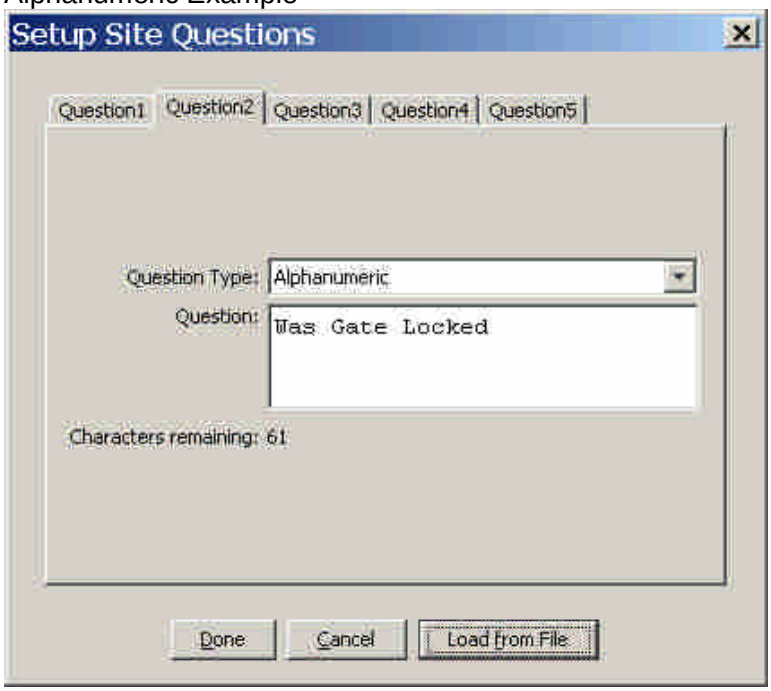


3.7 Creating your site questions

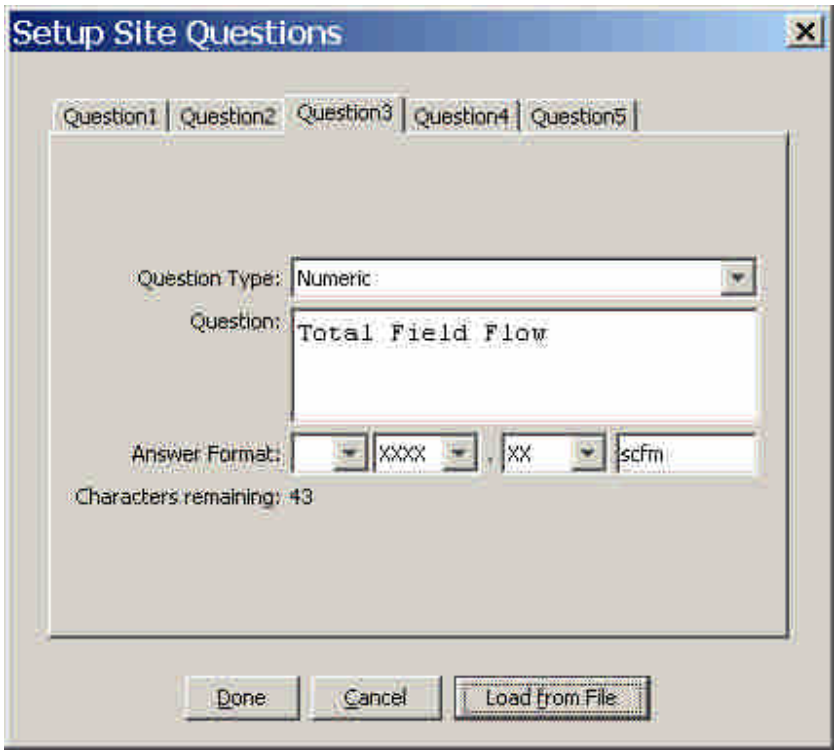
After sending site questions to your instrument they must be updated each time you use the GEM. This is done by going to the menu selection in the GEM and choosing [Update Site Data]
The options for questions are Alphanumeric – Numeric – Multiple or Single comment selection.



Alphanumeric Example

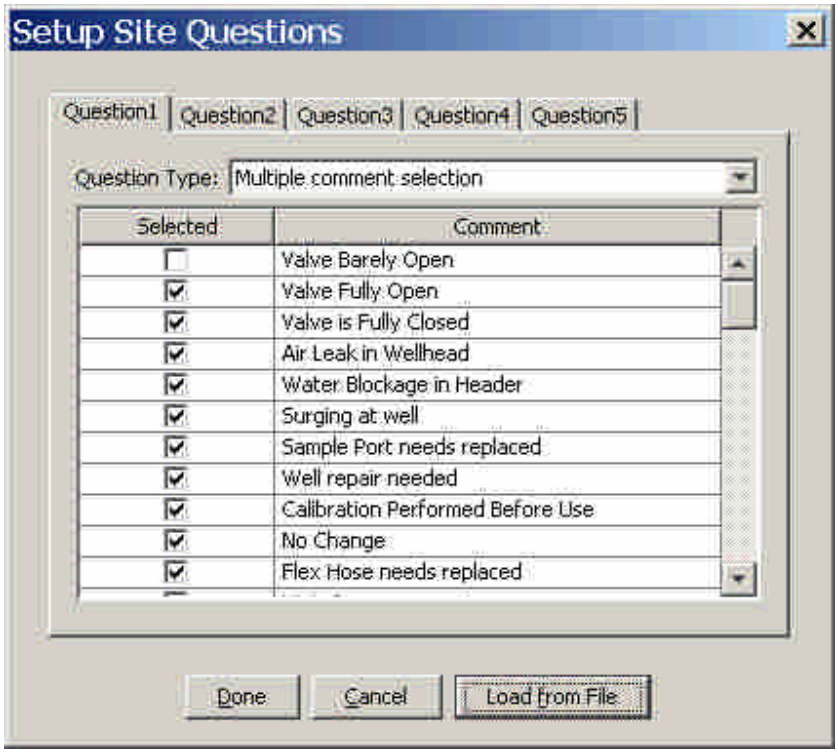


Example of Numeric Question

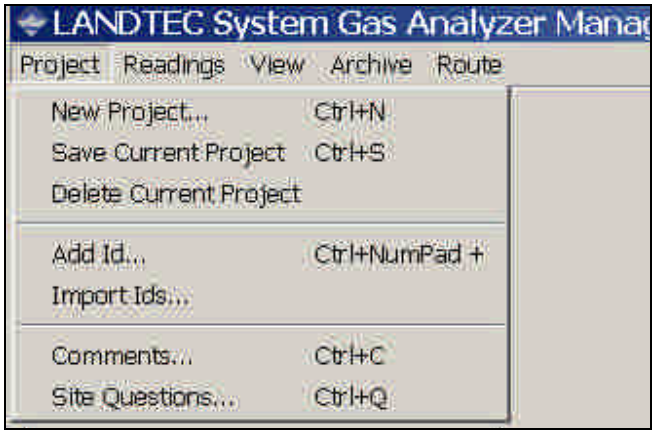


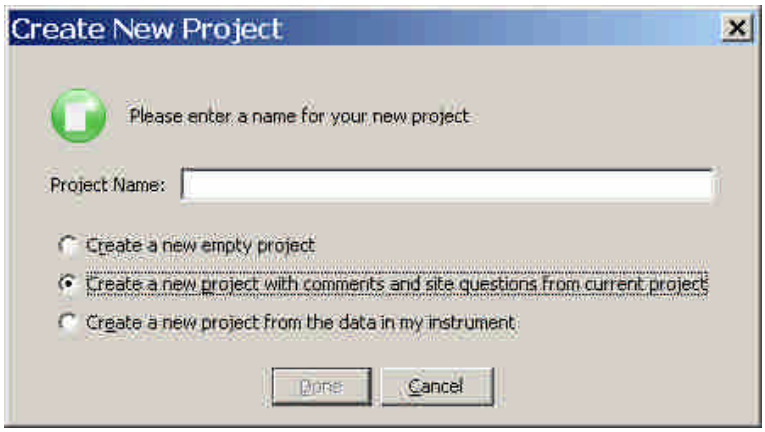
You may use Multiple or Single Comment selections

Using the Comments that were created for this project

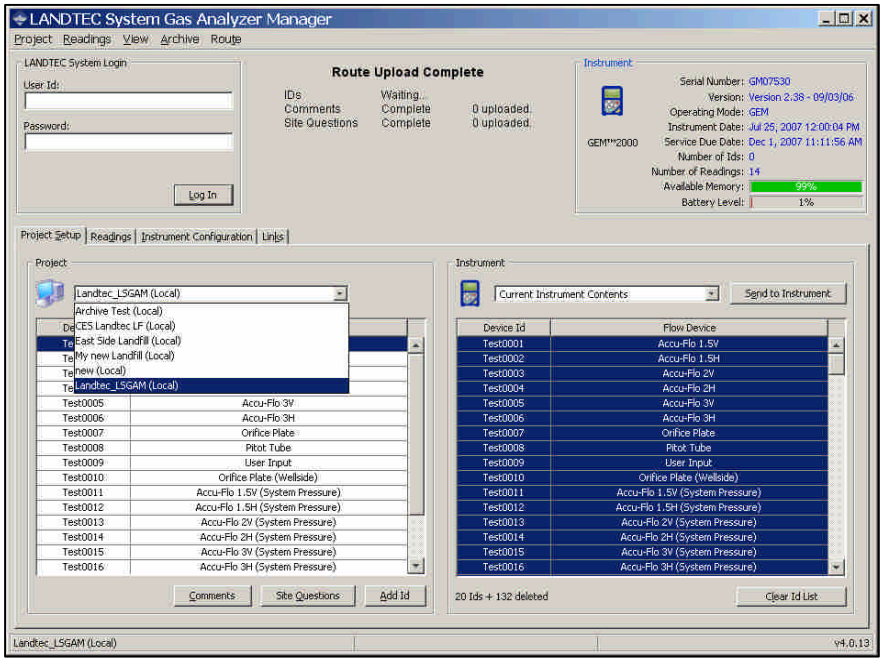


These Site Questions may be used again with another project by selecting the Create New Project and create new project with comments and **site questions** from current project.

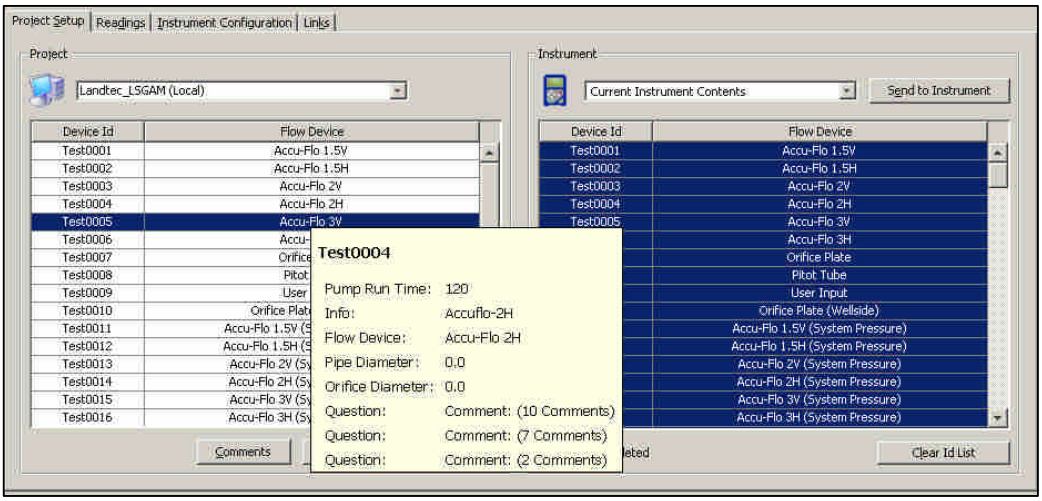




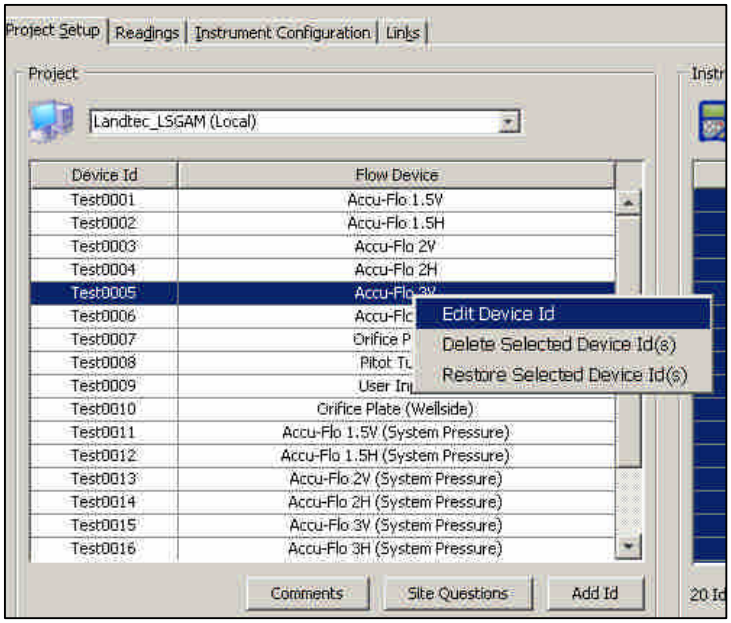
The project will be created and the IDs, Comments, and Site Questions that exist in the instrument will be applied to the new project.



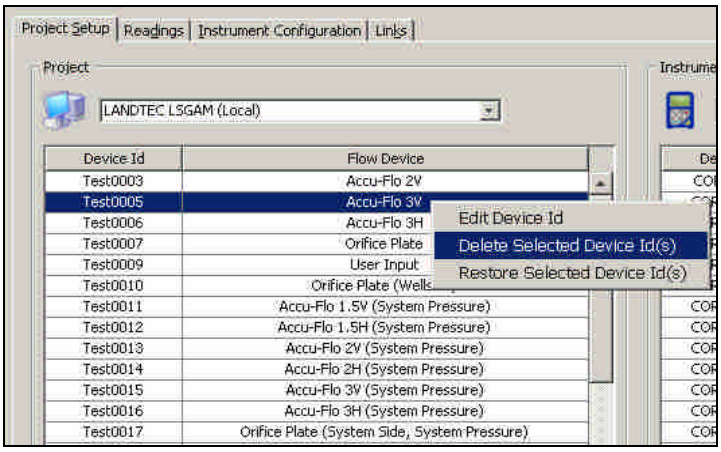
Placing the mouse cursor over a specific device ID will show detailed information about that ID.

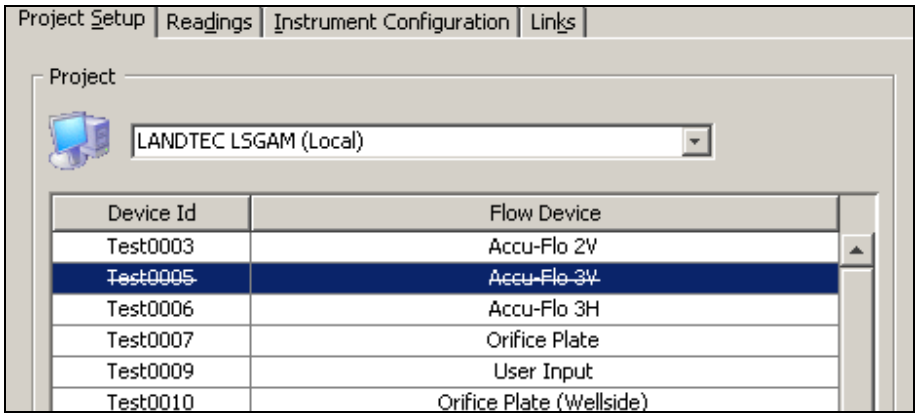


To edit a Device ID, right click on the desired device and select ***Edit Device ID***.



To delete an existing ID, right click on the desired device and select ***Delete Selected Device ID(s)***.





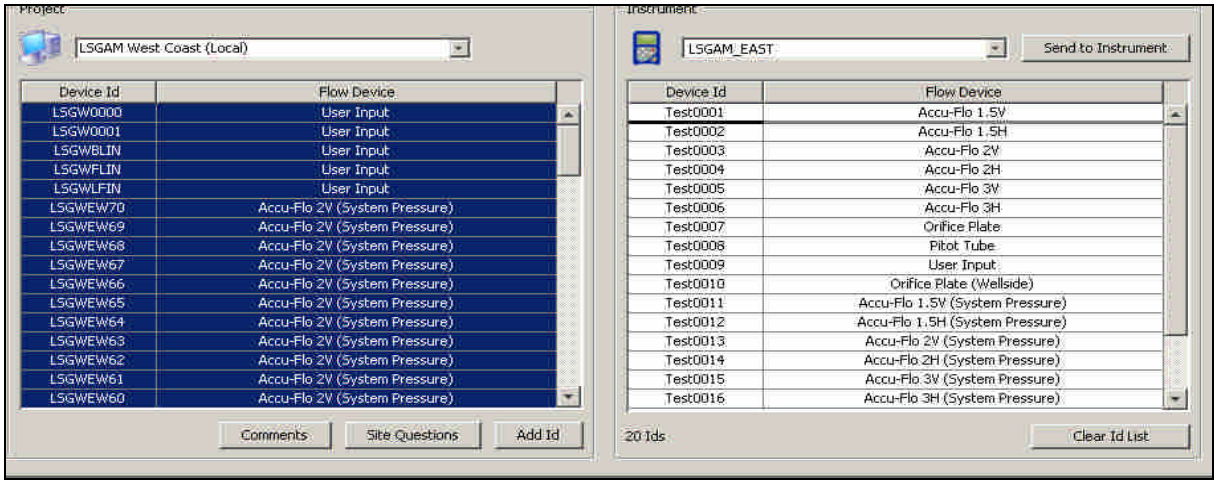
Deleted IDs are displayed with a line through the information on the screen. To restore a deleted ID, right click on the ID and click ***Restore Selected Device ID(s).***

3.8 Sending IDs to the instrument

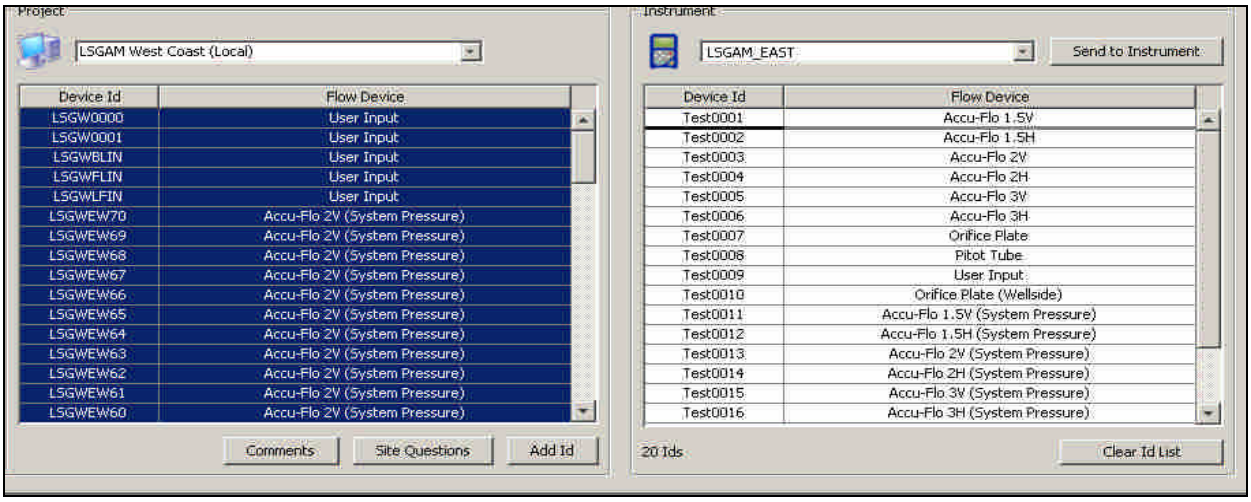
Once IDs have been created in the project, they must be uploaded to the instrument. To perform this operation, select the desired IDs from the left table under the Project name, left click and drag the IDs to the right table.

Place the mouse arrow at the edge of the first cell and hold down the left key. The arrow will change to .

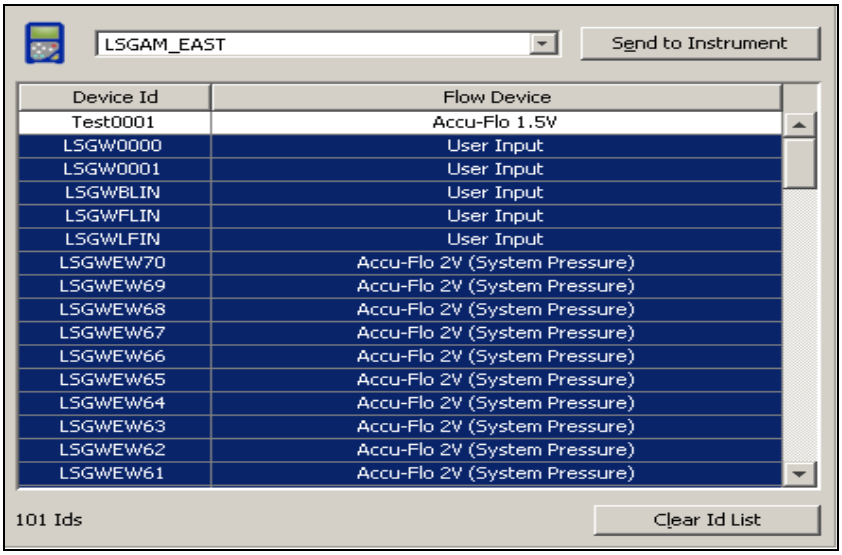
To highlight all, select control, then A on your key board. You can now drag the list to the Instrument side of the screen.



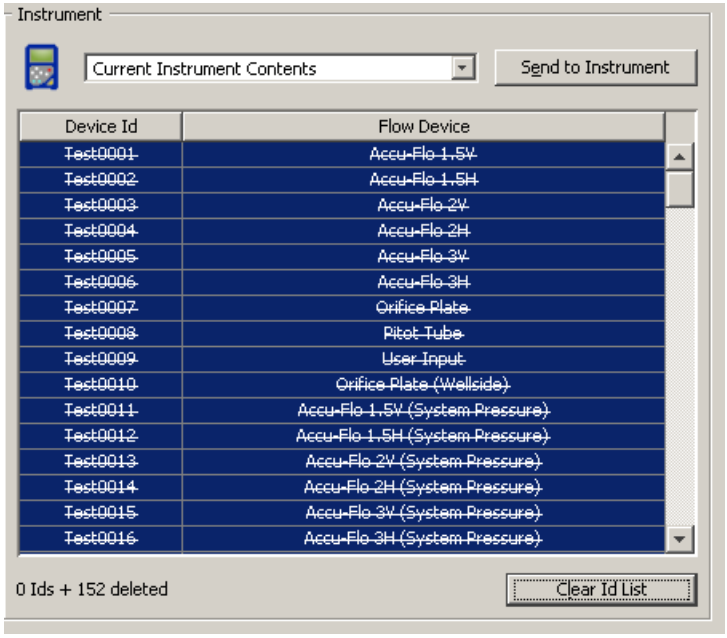
Once you have dragged the list or any selection of IDs to the instrument side, the line will change where you have the arrow and the circle will become a box.



Upon releasing the mouse key your IDs will be in the instrument list. Now select ***Send to Instrument*** button.

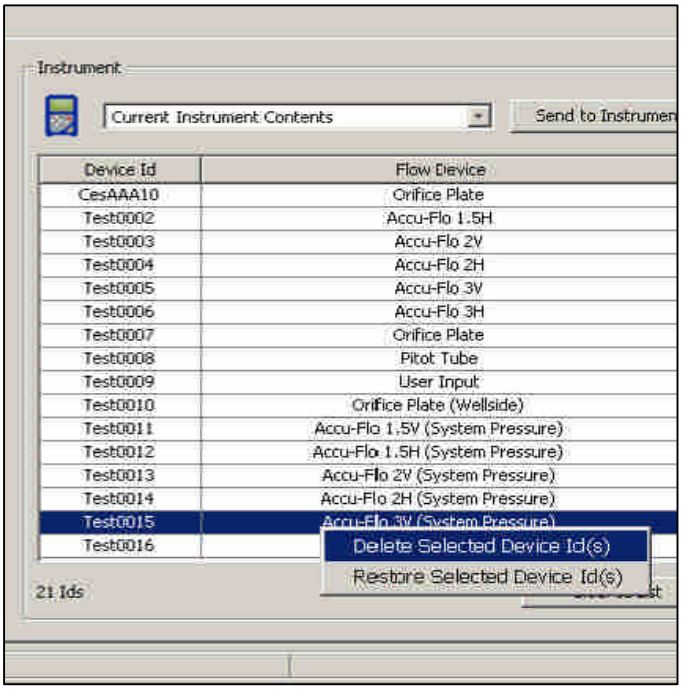


3.8.1 Clearing ID s from your instrument or Deleting a Project



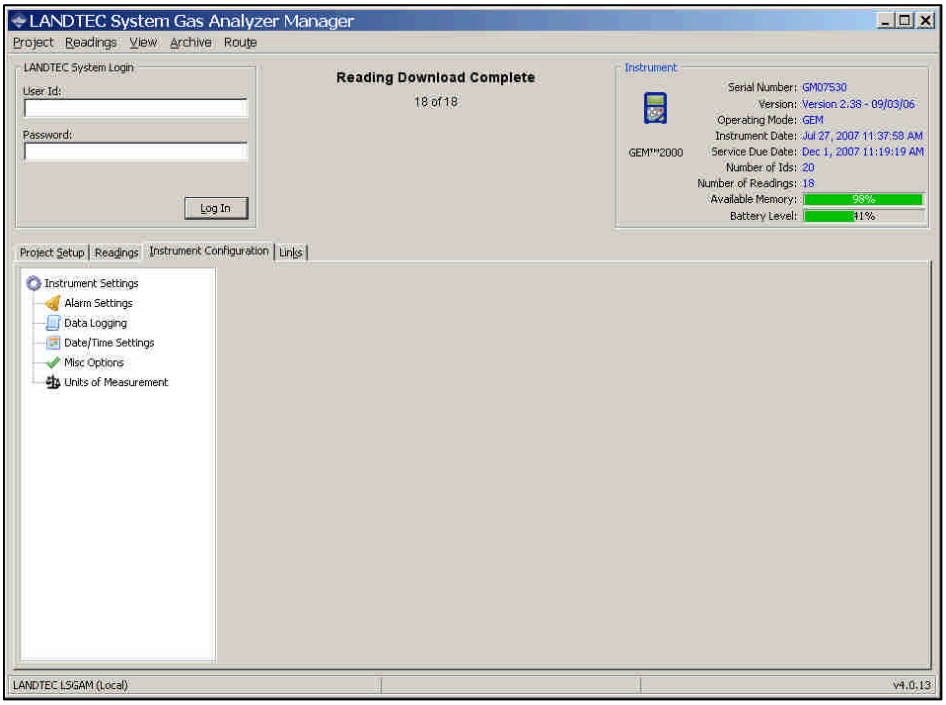
In current instrument contents when selecting the Clear ID List option it will draw lines through the IDS. You then need to select ***Send to Instrument***. This will clear all IDs from the GEM in both the GEM and GA mode.

You may also delete one ID from a list by highlighting the ID RIGHT CLICK with your mouse and select the Delete Selected Device option. If you have selected the wrong ID and deleted then you may select the Restore option to return the ID to the list.



3.9 Instrument Settings

The LANDTEC System Gas Analyzer Manager software allows users to change many of the operational settings of the instrument. To view and change the available settings click on the ***Instrument Configuration*** tab.

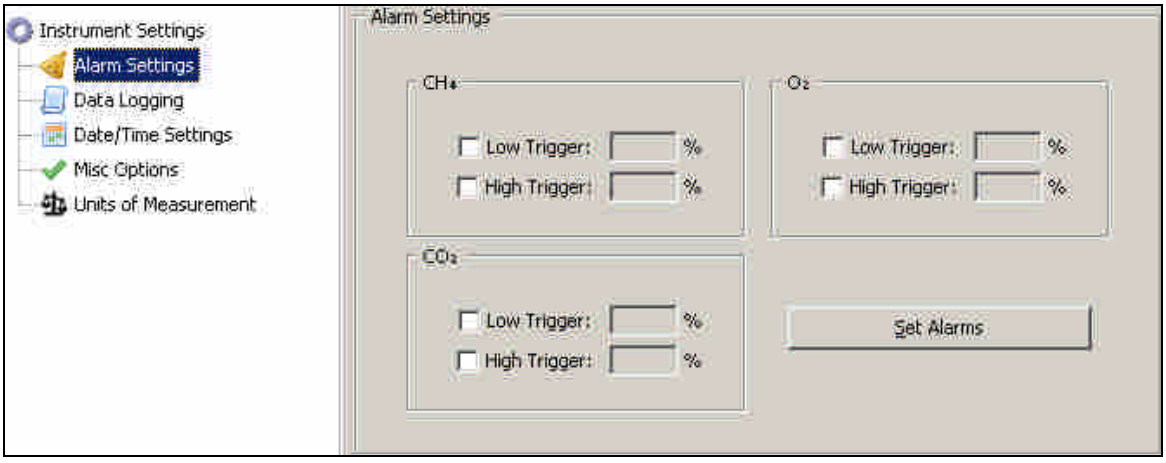


In the Instrument Configuration user interface, there is an Instrument Settings option tree. The Instrument Settings tree allows for easy navigation to the following categories:

Alarm Settings
Data Logging
Date/Time Settings
Misc Options
Units of Measurement

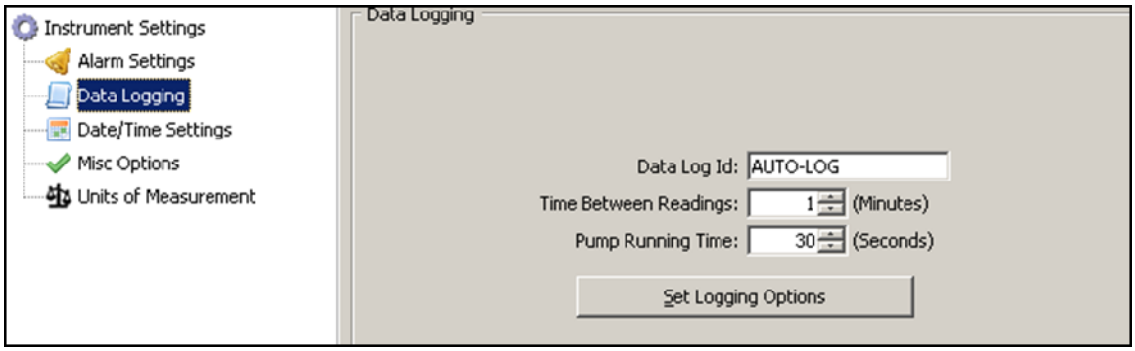
The following sections describe each option category.

3.9.1 Alarm Settings



The Alarm Settings options control the activation and deactivation of the audible alarms in the GEM2000 instrument. Audible alarms can be configured for CH_4, CO_2, or O_2 parameters. Each parameter can be configured with a Low Trigger and/or High Trigger for the alarm. To activate any specific alarm, click and place a checkmark in the desired box. This will activate the entry field to place the value. The values must be 0 – 100.

3.9.2 Data Logging

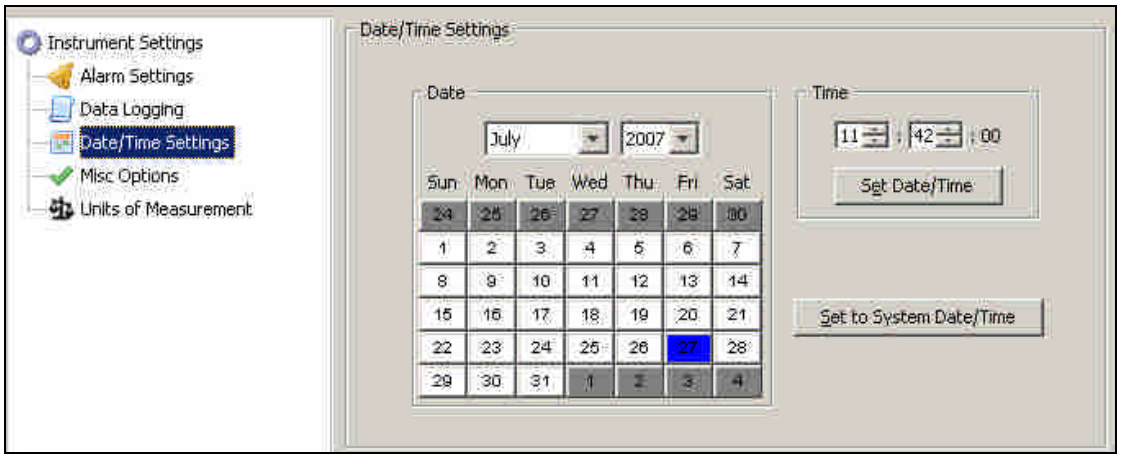


Data Log ID
The Data Logging option allows the user to specify an ID to be associated to readings taken with the Auto-logging feature of the instrument.

Time Between Readings
This value indicates the time from when the pump stops running until the pump begins sampling.

Pump Running Time
This value indicates the duration the pump will be run for sampling.

Date/Time Settings



The **Date/Time Settings** screen allows the user to set the date and time of the instrument.

Setting the Computer's Date and Time
To set the instrument's date and time to that of the computer, click on the Set to System Date/Time button. This will set the calendar and time fields to the current date and time of the computer. Then click the Set Date/Time button to apply to the instrument

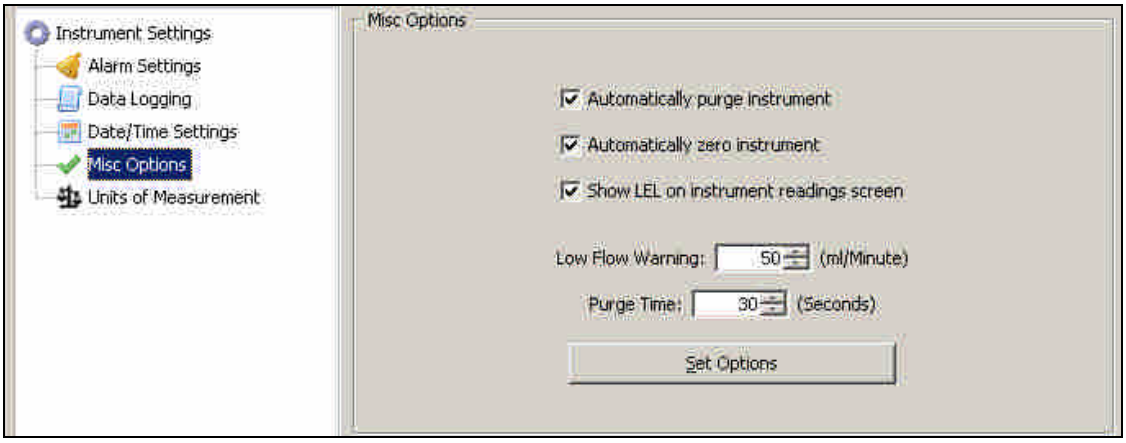
Date
Use the calendar options to select the desired date.

Time
Use the up and down controls to select the desired hour and minutes.

3.9.1 Set Date/Time in the instrument

Click the Set Date/Time button to apply the settings to the instrument

3.10 Misc Options



Under the miscellaneous options interface the user can change the following instrument settings:

Automatically purge instrument
Activates and deactivates the automatic purge feature in the instrument

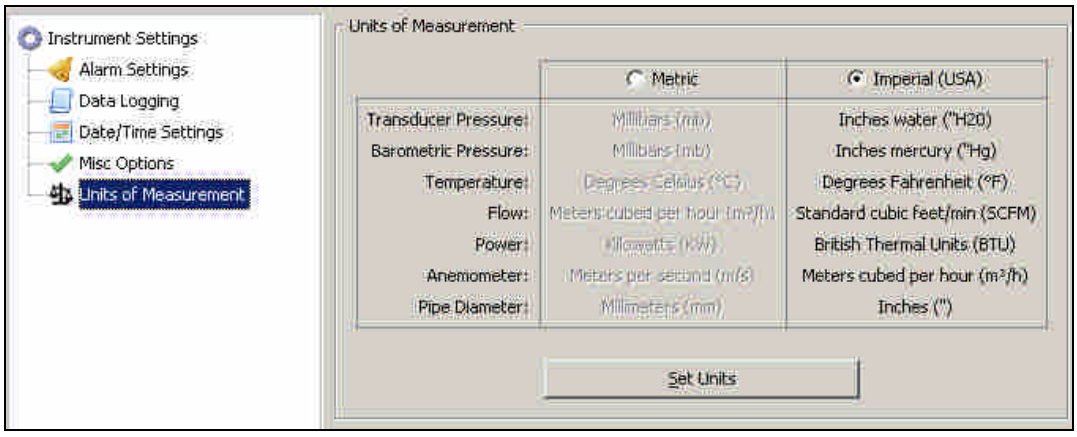
Automatically zero instrument
Activates and deactivates the automatic zero feature in the instrument

Show LEL on Instrument readings screen
Specifies whether or not Lower Explosive Limit (LEL) is displayed on screen, power instrument off and on for change to take effect.

Low Flow Warning
Specifies the point at which the instrument will indicate it is not able to extract the appropriate gas flow for analysis.

Purge Time
Specifies the duration the pump will run when activated by the purge feature of the instrument.

3.11 Units of Measurement



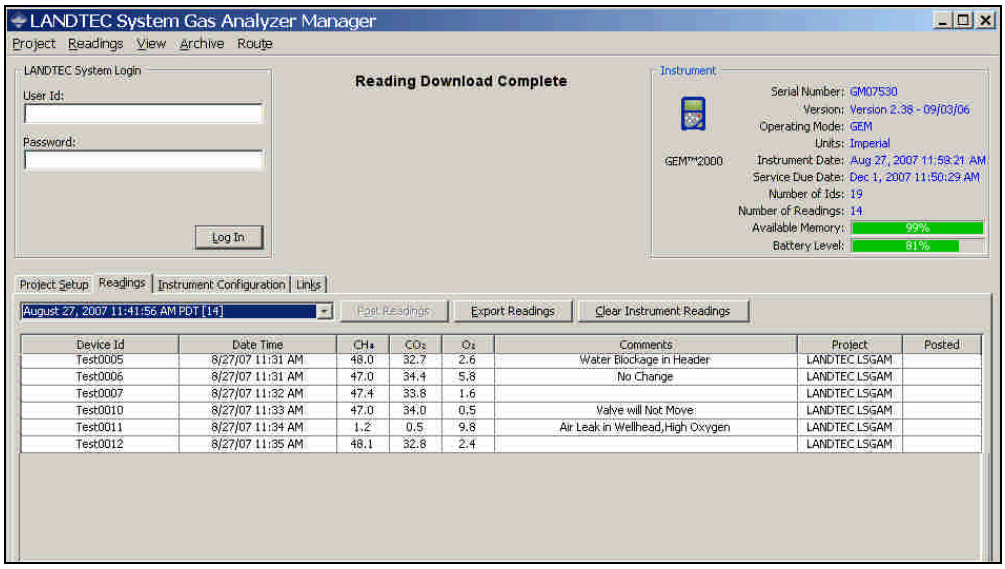
The Units of Measurement interface allows users to select whether to operate the instrument in metric or imperial units. The units for each parameter are displayed on the screen.

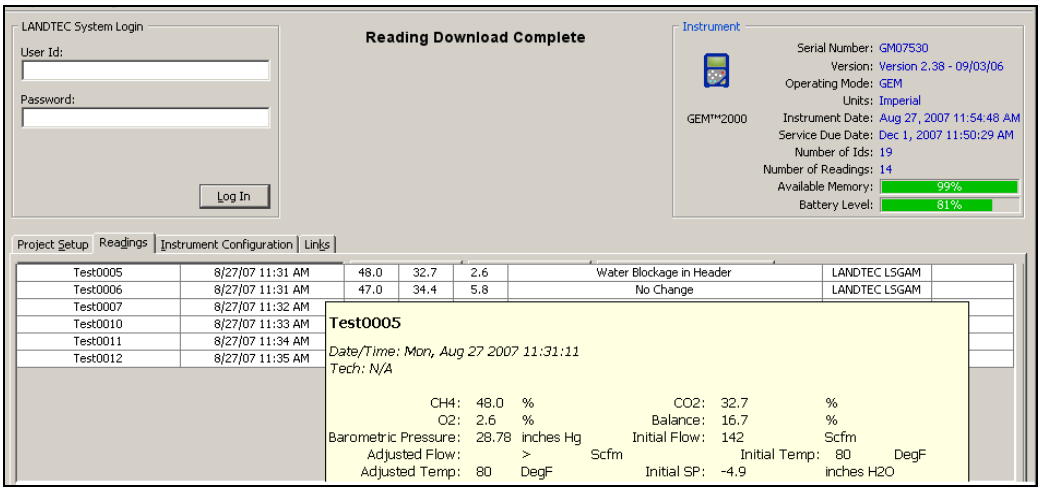
WARNING: *Units of Measure are as critical as the values of the readings stored. Be certain to verify the appropriate Units of Measure for your project prior to making a change to this option. Changing the Units of Measure will* ***NOT*** *convert any existing values stored in the instrument. To avoid confusion, download any stored readings prior the changing the Units of Measurement.*

3.12 Downloading Readings

After successfully creating projects, IDs, and setting appropriate instrument settings, the instrument is ready for field use. When used in the field, ***readings*** are collected and stored within the instrument's memory. The readings consist of the measured, input, and calculated parameters such as CH4, CO2, O2, Gas Temperature, Flow Rate, etc. These readings must be downloaded from the instrument to be reviewed on the computer and stored for review at a later time. This section of the Operation Manual reviews the process of downloading and storing readings from the instrument.

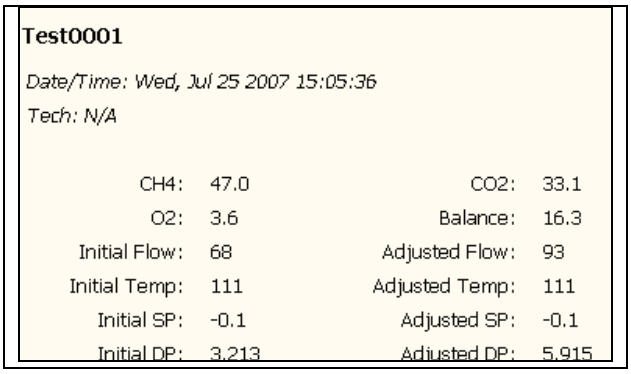
To view your downloaded readings from the instrument, select the Readings tab of the LANDTEC System Gas Analyzer Manager software.





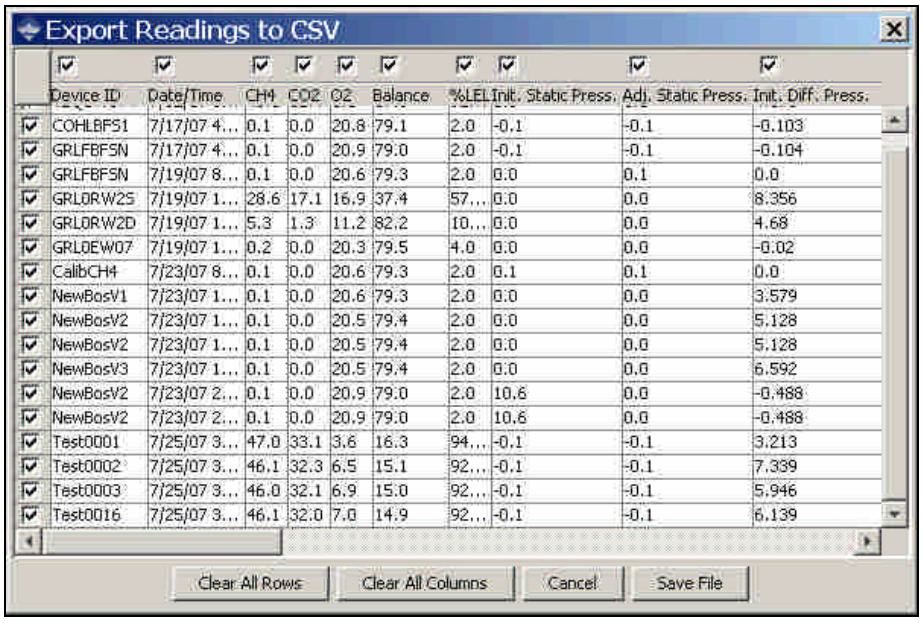
When the instrument is initially detected by the LSGAM software, the readings are automatically downloaded from the instrument, placed in the Readings tab table, and stored in your project previously set up on your computer.

Placing your mouse over a reading will display additional parameters of the reading.

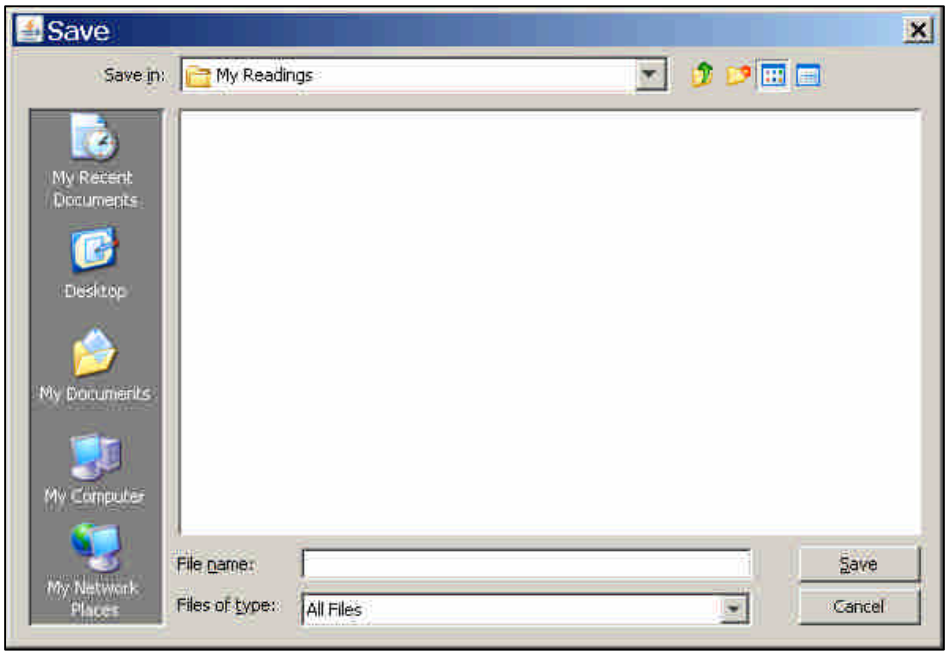


To clear the readings from your instrument, after the readings are downloaded successfully, click the ***Clear Instrument Readings*** button. A prompt will verify the permanent deletion of the readings from the instrument. This will clear information within the GEM and GA Mode **simultaneously**.

To export readings to a file, click the ***Export Readings*** button. This will open the ***Export Readings to CSV*** screen. This interface provides several options described below.



To add or remove a single reading from export, click on a checkbox in the leftmost column.
To add or remove a specific parameter from export, click on the corresponding checkbox across the top.
To clear all rows click the ***Clear All Rows*** button at the bottom of the screen.
To clear all column selections, click on the ***Clear All Columns*** button at the bottom of the screen.
To exit the operation without saving, click the ***Cancel*** button.
To specify a filename and save the selection to a file, click the ***Save File*** button. Clicking this button will open a Save window.



Specify a filename and location then click the Save button. The selected readings will be saved in comma separated value (.CSV) format. The .CSV file may now be opened in another application.

4 General Operations Menu

The following features and functions are selectable from the main menu via key **'① Menu**' from the read gas levels screen. Navigation through the list is via the 2 '∧' and 8 '∨' cursor keys. Selection of the feature is by pressing the '↵' key.

4.1 Zero Transducers

This function allows the user to zero the pressure transducer(s). Upon selection, the current pressure reading is displayed. The operation will be carried out when the '↵' is pressed. When zeroing transducers it is important to allow them to stabilize first so an accurate zero is achieved. If ① is pressed the instrument will return to the gas reading screen without zeroing.

NOTE: Zeroing Transducers may take a few extra minutes in the field, but is a recommended step to ensure the best possible accuracy.

4.2 Update Site Data

Allows the user to answer questions (pre-defined in LSGAM software) relating to the site (e.g. name of operator, weather conditions, etc.). Site Questions are different from Site Comments.

This is covered in detail in section 3.7 of this manual.

4.3 Data Logging (GA mode only)

Enables the user to leave the Instrument unattended to take samples at pre-determined intervals. The reading interval and pump run time may be edited prior to commencing the logging cycle. The ID code may ONLY be set in LSGAM communication software.

Once the logging function is activated, the instrument will carry out a 30 second 'Warm-up' countdown (displayed bottom right) and begin the first sample. After each sample, the unit will automatically sleep to conserve power if the time between the pump ending and the next sample is greater than 30 seconds.

The instrument is reactivated (awakened) during a logging cycle, the LANDTEC logo will be displayed for a few seconds and the Gas Reading screen will be displayed. This will initiate a 30 second countdown to the next sample being taken unless the operator stops the logging function.

4.4 Operating Language

The operating language of the instrument can be set to English, German, Spanish, French, Italian or Brazilian Portuguese through this option.

4.5 View Data

The view data allows the user to see the readings that are in the GEM2000 / GEM2000 Plus memory. Often the amount of data stored is more than can be displayed adequately on one screen so pressing the ⑤ key will allow the user to see additional screens with stored data. The 2 '∧' and 8 '∨' cursor keys will move forward or backwards through the instruments memory. Pressing the ① key will exit to the Gas Reading screen.

4.6 Adjust Contrast

The GEM2000 automatically adjusts the screen contrast according to the ambient temperature to maintain normal viewing.

The contrast can be manually adjusted by using the 4 '<' and 6 '>' cursor keys. The manual contrast setting is stored when the '↵' key is pressed.

4.7 Field Calibration

Whenever carrying out a user calibration function it is important to ensure the correct value is entered. Additionally, in the case of a zeroing function, ensure only certified gas or ambient air is used and no connection is made to a probe or wellhead fitting. The calibration cylinders sold by LANDTEC have a volume of 17 liters. The regulator, sold by same, is set to 0.5 liters per minute and 15 psig maximum. A normal field calibration usually requires the gas to be running for about two minutes.

Upon selecting this option, the Field Calibration screen is displayed. A brief description of the user span calibration procedure and the current reading (row '**R**') and user span calibration gas values (row '**S**') are displayed.
The span gas values may be changed via the '③ **Edit Target Concentrations**' option. Once this option has been selected, **all** the gas values will require entry. Each entry is to be confirmed by pressing the '↵' key. It is important to confirm the concentration of the calibration gas(es) used and enter the value(s) properly.

4.7.1 Zero Channels

Selected from the '**Field Calibration**' - '↵**-Calibration Menu**' allows the relevant reading to be zeroed. When selected, a list of the available options will be displayed, this usually includes CH_4, and O_2, also the Gas Pod (if fitted).

Supply a zero gas mixture to the instrument for the gas to be zeroed. Ensure the reading for the selected gas has settled to its lowest value before selecting the zero function. When the required option is selected, the user zero function will be carried out automatically. The operation will be carried out when the '↵' key is pressed.

4.7.2 Span Channels

Spanning Channels should be carried out prior to use or when the ambient operating temperature changes greater than +/- 20 degrees Fahrenheit. Selected from the '**Field Calibration**' - '↵**-Calibration Menu**', allows the relevant reading to be span calibrated (in accordance with the calibration value entered). When selected, a list of the available options will be displayed, which includes CH_4, CO_2, O_2, (CO & H_2S for the Plus) and Gas Pod (if fitted).

When the required option is selected from the list, the span calibration function will be carried out automatically. When carrying out this procedure, ensure the span calibration procedure (as outlined below) is followed:

1. Apply the relevant known certified gas concentration through the inlet port of the Instrument.
2. Wait until the current gas reading has stabilized.
3. Select the required calibration option via the '↵**-Calibration Menu**'.

4.7.3 Factory Settings

This will clear any user zero and span calibration data. It will also restore the pre-programmed factory settings for **ALL** channels – CH_4, CO_2, O_2 (CO & H_2S for the Plus) or Gas Pod (if fitted) and pressure transducers.

4.7.4 Last Field Cal

Displays the date the last field calibration was carried out (zero or span).

4.8 Mode of Operation

Allows changing instrument between GA mode and GEM mode of operation.

4.9 Information Screen

The information screen will automatically display the following information:

Software Version- Date
Serial Number-GM00000
Date Format- USA
Language- American
Communication- 1920014

4.10 Exit Menu

The Exit Menu simply exits the main menu screen and returns to the gas reading screen.

5 Taking Probe Readings (GA Mode)

LANDTEC classifies non-extraction wells as Probes when **NOT** connected to an active vacuum extraction system. Probes, (commonly known as migration probes), are typically placed on the perimeter of the landfill to test for gas migration or may be placed next to a building or road to test for the presence of Methane. The GEM2000 / GEM2000 Plus instrument may be configured as a Gas Analyzer (GA mode) for sampling probes. To access this function from the gas read screen press '①' for menu and scroll down to **Mode of Operation**, press the '↵' key and highlight **Landfill Gas Analyzer**, pressing the '↵' key again will select GA mode of operation.

5.1 Preliminary Checks

Prior to going to the test site, it is good practice to ensure:

- All necessary ID codes and readings have been uploaded via LSGAM software.
- The time and date are correct.
- The water trap has a clean and dry filter fitted.
- The inlet-port particulate filter is clean and dry.
- A supply of spare filters is available in case of accidental water blockage or contamination.
- The battery has a good charge (minimum 25% charge, even if only a few readings are required).
- The memory has sufficient space available.
- The CH_4, CO_2, and O_2 (CO & H_2S for the Plus or Gas Pod if fitted) readings have been zeroed, without gas concentration present.
- Check the span calibration with a known concentration calibration gas.

Travel to the site with the analyzer in the vehicle's interior - not in the trunk or truck bed, where it may be subjected to extremes of temperature and possible shock damage. Do not place the analyzer against anything hot (e.g. gas extraction pipe, car body or in an unattended car during the summer). This may cause erroneous readings.

When moving around a site, protect the instrument from strong direct sunlight, heavy rain or wind-chill. Strong direct sunlight can raise the temperature of the instrument beyond its operating range. If this occurs, the LCD display will appear almost black and the contrast setting cannot alter the contrast. Typically no permanent damage is done and after the instrument cools the screen will become readable again.

Always use the water trap! If the water trap becomes flooded, change the filter immediately and ensure all tubes are clear before re-use.

5.2 Update Site Data

Prior to taking the readings at a particular site, the Site Data and Technician Login should be updated (if programmed). This is accessed via the General Menu '①**'** then **'Update Site Data'**. This function removes the need for the site conditions to be recorded manually.

A series of up to five questions can be pre-programmed using LSGAM, see Section 3.7. If Site Questions were uploaded to the instrument, they should be answered at this time. The answers are stored and appended to each reading stored thereafter, until the Site Data is updated for another site.

5.3 Taking Readings – With ID

For this function to be used it is essential that the relevant ID be previously uploaded to the Instrument using LSGAM, see Chapter 3. An ID **cannot** be created by the Instrument alone.

1. When the Read Gas Levels screen is displayed, option **'③ Next ID'** should be selected. A list of stored IDs is displayed for selection via the '∧' and '∨' cursor keys, the 'next' ID on the list is

automatically highlighted. To confirm selection, press the '↵' key. The display may be toggled to display any relevant ID information available; such as a description of the probe location, work to be carried out, etc.

2. A reminder is displayed to disconnect sample tubes, as a clean air purge will automatically remove the previous sample from the instrument. Purge time may be set via LSGAM (default is 30 seconds). Once the '↵' key is pressed, purge will begin and the Read Gas Levels screen will be displayed upon completion. The purge may be aborted by pressing the '①**EXIT**' key.
3. The ID number selected and the pump runtime is displayed in the upper left corner of the read gas levels display.
4. At this point, connect the sample tube (with water trap) from the sample point to the inlet port of the instrument, ensuring the connector 'clicks' into place. Then connect the sample tube to the probe sample port. **Do not connect the sample tube to the probe port before connecting to the instrument as this will cause any pressure in the probe to dissipate and a proper pressure reading will not be taken.**
5. As soon as the connection is made, the relative/static pressure reading will be displayed. No sample is taken from the probe at this time. Once the reading stabilizes and the pump starts, the relative/static pressure reading is stored. The relative/static reading will remain displayed as the pressure last taken.
6. The pump will run for the pre-programmed time and a countdown timer will be displayed. The pump may be stopped or started at anytime by way of the '✇' (pump) key. The reading may be stored at anytime with the use of the '↵' key. When the pump automatically stops this should be used as a prompt to store the reading.
7. Upon storing the reading, any pre-programmed questions will be displayed for response. This may require a numeric, alphanumeric selectable comment, or exclusive comment answer. A maximum of eight selectable and exclusive comments may be entered.
8. Disconnect the sample tubing from the probe and start again at Step 1 for the next probe.

For each reading, the following information will be stored:

- ID code.
- Current time/date.
- Site data (if entered).
- All gas readings and balance (CH_4, CO_2, O_2 (, CO and H_2S for the Plus)).
- LEL CH_4.
- Barometric Pressure.
- Relative Pressure.
- Questions/comments.
- Temperature (if temperature probe is connected).
- Gas Pod (if connected).

When the instrument is switched off, a clean air purge is automatically started for a pre-determined period. This may be aborted with the use of the '↵' key, although it is not recommended.

A tone will sound and a flashing bell will be displayed next to the appropriate gas reading value if a preset alarm condition has been exceeded.

5.4 Taking Readings – Without ID

Gas Readings can be taken without an ID in the instrument by following the instructions below. To create and uploaded IDs to the instrument using LSGAM, see Chapter 3. An ID **cannot** be created by the Instrument alone.

1. From the Gas Reading Screen first select **'③ Next ID'** then press **'⑤ Select No ID**' or, if ID information has not been uploaded to the instrument, an ID list will not be available. In either case, the ID will be displayed and stored as '**- - - - - - - -**'.

2. A reminder is displayed to disconnect sample tubes, as a clean air purge will automatically remove the previous sample from the instrument. Purge time may be set via LSGAM (default is 30 seconds). Once '↵' is pressed, purge will begin and the Read Gas Levels screen will be displayed upon completion. The purge may be aborted by pressing the '①**EXIT**' key.
3. At this point, connect the sample tube (with water trap) from the sample point to the inlet port of the instrument, ensuring the connector 'clicks' in to place.
4. Now connect the sample tube to the probe sample port. **Do not connect the sample tube to the probe port before connecting to the instrument as this will cause any pressure in the probe to dissipate and a proper pressure reading will not be taken.**
5. The pump may be started or stopped at anytime by way of the '✇' (pump) key and a 'time-on' timer will be displayed. The pump should always be stopped using the '↵' key, before storing a reading.
6. Upon storing the reading, a virtual keyboard will be displayed for any alphanumeric comments to be entered.
7. Disconnect the sample tubing from the probe and proceed from step 1 for the next probe.

Except for the ID code information, which will be stored as '**- - - - - - - -**', and probe questions, for each reading the information stored will be the same as that for a reading with an ID.

A tone will sound and a flashing bell will be displayed next to the appropriate gas reading value if a preset alarm condition has been exceeded.

5.5 Temperature Probe Reading

The GEM2000 / GEM2000 Plus has the facility to automatically display and record the probe temperature via an optional Temperature Probe (TP-2000). When the Temperature Probe is fitted to the RS232 Communication Socket, the temperature will be displayed in the read gas levels screen and recorded with all other data. The temperature probe is part of the GEM2000 UL certification and is therefore certified for use under the same conditions as the instrument.

5.6 Cross-Gas Effects

5.6.1 Methane, Carbon Dioxide and Oxygen

The Methane reading is filtered to an infrared absorption frequency of 3.41μm (nominal), the frequency specific to hydrocarbon bonds. Instruments are calibrated using certified Methane mixtures and will give correct readings provided there are no other hydrocarbon gasses present within the sample (e.g. ethane, propane, butane, etc.). If there are other hydrocarbons present, the Methane reading will be higher (never lower) than the actual Methane concentration being monitored.

The extent to which the Methane reading is affected depends upon the concentration of the Methane in the sample and the concentration of the other hydrocarbons. The effect is non-linear and difficult to predict.

The Carbon Dioxide reading is filtered to an infrared absorption frequency of 4.29μm (nominal), the frequency specific to Carbon Dioxide. Therefore, any other gases usually found on landfill sites will not affect the Carbon Dioxide reading.

The Oxygen sensor is a newly developed galvanic cell type and suffers virtually no influence from CO_2, CO, H_2S, SO_2 or H_2, unlike many other types of Oxygen cell.

The infrared sensors will not be "poisoned" by other hydrocarbons. Normal operation will resume as soon as the gas sample has been purged.

Note - there has been one reported incident of a high reading due to the presence of Carbon Disulfide, which has a similar absorption frequency to Carbon Dioxide.

5.6.2 H_2S, CO and other Optional Gas Pods

The Gas Pods used to measure H_2S and CO do suffer from cross-gas effects. Such effects are not accurately specified. However, the following table may be useful as a guide. This table represents how many ppm would be read by a Gas Pod if 100ppm of the interfering gas was applied, (with no other cross-contaminates being present in the sample).

Cell	CO	H_2S	SO_2	H_2	CH_4	CO_2
CO	100	<3	0	<40	0	0
H_2S	<0.5	100	~20	~0.1	0	0

NOTE: All readings are given in parts per million (ppm). The life of an electrochemical cell is determined by exposure to gasses, typical life being one to two years. It is recommended that Gas Pods be field calibrated at regular intervals.

NOTE: Cross-gas effects can be mitigated by employing a filter for the gas not being tested.

5.6.3 GEM2000 Plus Internal Electrochemical Cells for Measuring H_2S and CO

The GEM2000 Plus employs two internal electrochemical cells to measure Hydrogen Sulfide (H_2S) and Carbon Monoxide (CO). Electrochemical cells which measure CO are typically susceptible to cross gas interference by Hydrogen (H_2) and Hydrogen Sulfide (H_2S). Two components that may be present in the Landfill Gas sample. This means that if H_2 and/or H_2S are/is present in the Landfill Gas sample a normal CO electrochemical cell would give an artificially high reading.

The GEM2000 Plus uses a 'hydrogen compensated' CO cell to counteract the interference by H_2. This is why the instrument displays an H_2 channel. H_2 is not directly measured, although a rough value, which is shown as LO, MED or HI, can be interpreted. If the H_2 value is displayed as LO or MED the H_2 compensation will mitigate the H_2 effect on the CO reading, however if the H_2 value is shown as high it is possible that there is more H_2 present than the compensation is capable of adjusting for. If that is the case the CO value may be artificially high due to cross gas interference by the H_2. Additionally, if a HI level of H_2 is encountered then a longer than normal purge time will typically be necessary to clear all the H_2 from the electrochemical cell. It is recommended that after encountering a HI level of H_2 the instrument be purged with clean air until the H_2 channel displays LO. This could take as long as five or ten minutes (if the H_2 channel was over ranged) but is necessary to ensure the subsequent readings are accurate.

The CO cell used in the GEM2000 Plus also utilizes an internal H_2S filter to eliminate H_2S cross gas interference. However, the filter does have a finite capacity. If the filter's capacity is exceeded then the CO cell will be susceptible to cross gas interference by any H_2S that is present in the gas sample. It is quite easy to determine if the capacity of the filter has been exceeded. After all the sample gas has been purged from the instrument, with clean air, and the CO reading is zero, run a certified gas that contains H_2S but not CO (the H_2S calibration gas) through the instrument. If the CO reading remains zero while the H_2S reading increases to the certified value then the internal H_2S filter has remaining capacity. If the CO reading increases with the H_2S reading then the internal filter's capacity has been exceeded and the cell will need to be replaced.

The GEM2000 Plus was designed to read a maximum H_2S concentration of 200ppm and a maximum CO reading of 2000ppm. If the gas sample contains more than the maximum concentration the instrument will be over ranged and display >>> as the reading. If the instrument is over ranged the readings typically stay artificially high for several minutes and will not go back to zero with a normal purge. While over ranging the instrument is not recommended and will slightly shorten the life span of the electrochemical cells the resulting high readings are not permanent. If one of the channels is over ranged it is recommended to purge the instrument, with clean air, until the reading returns to zero. This may take as long as five or ten minutes. The cell may need to be recalibrated but normally the extra long purge is all that is necessary.

6 Taking Extraction Well Readings (GEM Mode)

LANDTEC classifies gas-producing penetrations on landfills as wells when used with vacuum extraction systems and flow determining devices such as the Accu-Flo wellheads, orifice plates or pitot tubes. The GEM2000 / GEM2000 Plus may be configured as a Gas Extraction Monitor (GEM mode) for the purpose of sampling wells and obtaining flow measurements. To access this function from the gas read screen press '①' and scroll down to **Mode of Operation**, press the '↵' key and highlight **Gas Extraction Monitor**, pressing the '↵' key again will select GEM mode of operation.

6.1 Preliminary Checks

Prior to going on site, it is good practice to ensure:

- All necessary ID codes and readings have been uploaded via LSGAM software.
- The time and date are correct.
- The water trap has a clean and dry filter fitted.
- The inlet-port particulate filter is clean and dry.
- A supply of spare filters is available in case of accidental water blockage or contamination.
- The battery has a good charge (minimum 25% charge, even if only a few readings are required).
- The memory has sufficient space available.
- The CH_4, CO_2 and O_2 (CO & H_2S for the Plus or Gas Pod if fitted) readings have been auto-zeroed without gas concentration present.
- Check the span calibration with a known concentration calibration gas.

Travel to the site with the analyzer in the vehicle's interior - not in the trunk or truck bed, where it may be subjected to extremes of temperature and possible shock damage. Do not place the analyzer against anything hot (e.g. gas extraction pipe, car body or in an unattended car during the summer). This may cause erroneous readings.

When moving around a site, protect the instrument from strong direct sunlight, heavy rain or wind-chill. Strong direct sunlight can raise the temperature of the instrument beyond its operating range. If this occurs, the LCD display will appear almost black and the contrast setting cannot alter the contrast. Typically no permanent damage is done and after the instrument cools the screen will become readable again.

Always use the water trap! If the water trap becomes flooded, change the filter immediately and ensure all tubes are clear before re-use.

6.2 Update Site Data

Prior to taking the readings at a particular site, the Site Data and technician login should be updated (if programmed). This is accessed via the General Menu '①'. This function removes the need for the site conditions to be recorded manually. A series of up to five questions can be pre-programmed with the use of LSGAM and answered at this time. The answers to these questions are stored and appended to each reading stored thereafter, until the site data is updated for another site.

6.3 Taking Gas and Flow Readings (GEM Mode)

The GEM mode of operation is designed to allow for gas flow (SCFM) and energy measurements (BTU) to be calculated at the wellhead. This function requires the use of an ID that has been uploaded from LSGAM software with the type of flow device defined. **Gas flow and BTU will not be calculated if this action has not been performed.**

1. When the gas read screen is displayed select **'③ Next ID'**. A list of stored IDs will be displayed for selection via the '∧' and '∨' cursor keys, the 'next' ID is automatically highlighted, to confirm the selection press the '↵' key. The screen may be toggled to display any relevant ID information such as a description of the well location, work to be carried out, etc.
2. A reminder is displayed to disconnect sample tubes, as a clean air purge will automatically remove the

previous sample from the instrument. Purge time may be set via LSGAM (default is 30 seconds). Once the '↵' key is pressed, purge will begin and the Read Gas Levels screen will be displayed upon completion. The purge may be aborted by pressing the '①**EXIT**' key.

3. Connect the sample tubes (with water trap filter) to the wellhead ensuring the gas sample tube and impact pressure tubes are properly oriented. Insert the temperature probe if used.
4. Press the '✇' key to start the sample pump; a countdown timer will be displayed in the upper left area of the display. The pump may be stopped and restarted and any time by pressing the '✇' key. The pump run time is set in LSGAM software. Allow the gas readings to stabilize and press '⑤**Measure Flow**' key, this will store the gas level readings and display the '**PRESSURE READINGS**' screen. Note; a flashing bell will be displayed next to the appropriate gas and a beeping tone will be heard, if a preset alarm condition has been exceeded.
5. The '**PRESSURE READINGS**' screen will prompt the user to disconnect the sample tubes and allow the pressure to stabilize. Once the pressure has stabilized press '↵ **Zero Transducers**'. Press '①' to continue. **Note**; if Accu-Flo wellheads are used this zero function may be performed prior to connecting the sample tubes to the well head by selecting **'①** **MENU**' and highlighting '**ZERO TRANSDUCERS**'. This eliminates the need to disconnect and re-connect the sample tubes on the same wellhead.
6. If a temperature probe is not connected, the user is prompted to manually input the gas temperature, press the '↵' key when entry is finished.
7. The gas flow and energy screen is now displayed showing all the gas level readings taken in the gas read screen as well as the level of gas flow (SCFM) and power (BTU). In addition, Adjusted, Current and Previous (if downloaded) readings are displayed so modifications may be made to the well if required.
8. Pressing '↵ **STORE**' will save the readings to memory. Then, the comments screen (if comments were loaded) will display and allow you to answer questions or select comments about the condition of the well. A total of seven comments and one exclusive comment may be stored with each ID.
9. Press '③ **NEXT ID**' and proceed to the next wellhead. An automatic purge will be performed at this time to ensure the sample has been exhausted from the instrument.

For each reading, the following information will be stored:

- ID code.
- Current time/date.
- Site data (if entered).
- All gas readings and balance gas (CH_4, CO_2, O_2 (CO & H_2S for the Plus)).
- Barometric Pressure.
- Temperature.
- Gas Pod (if connected).
- Gas flow (SCFM) and Power (BTU).
- Comments and exclusive comment.

When the Instrument is switched off, a clean air purge is automatically started for a pre-determined global period. This may be aborted by pressing the '↵' key, although we do not recommend this action.

7 Field Operations

7.1 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 solid waste landfill, the refuse is entrained 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-CH_4.

If Oxygen is reintroduced into the landfill, those areas are returned to an aerobic (Oxygen present) state and the Methane-producing bacteria population is 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 condition. 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 residual Nitrogen 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, the 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 over pull. 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 a gas chromatography. 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.

7.2 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, Carbon Dioxide, and Hydrogen Sulfide are indicators of poorly supported combustion within the landfill.

7.3 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 improper operation of the well field. Later the best use of these techniques to optimize landfill gas control will be discussed.

7.3.1 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 well to control it. It is useful to note the relative position of the valve, and essential to know which valves are fully open or fully closed.

7.3.2 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 affect while performing day-to-day well field adjustments. As decomposition, moisture, and other conditions change, this method shows itself to be inadequate and imprecise.

7.3.3 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 well field. Reliance on this information can lead to improper operation of the well field. 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 over-correction. 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 well field and has a disruptive effect on the operation of the well field. 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 well field adjustment are the time expended, cost, and probably most important, responsiveness to the needs of the well field for timely adjustment. The laboratory equipment required is also very costly. Some analysis is recommended for verification of field readings from time to time. It is recommended a monthly sample of the composite gas be taken at the inlet to the flare or gas recovery facility.

7.3.4 Controlling by Flow Rate

This is a more exacting 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 the 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 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, the quantity of Methane extracted (LFG flow x percent Methane) or the quantity of BTUs recovered per hour (LFG flow x percent Methane x BTUs per cubic foot of Methane x 60 minutes per hour) can be calculated. It is conventional to measure BTUs 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 well field. 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 CO_2 and gas temperature and later as increased Oxygen from well over-pull. In time, the Methane will also decline. This is the 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.

7.4 Well field Monitoring

The frequency of LFG well field monitoring varies 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.

7.5 Typical Field Readings

- Name of person taking readings
- Date/time of each reading
- Methane (CH_4)
- Oxygen (O_2)
- Carbon Dioxide (CO_2)
- Balance Gas (primarily Nitrogen N_2)
- Wellhead gas temperature (flowing)
- Ambient air temperature
- Static pressure (PS) (from GEM2000 or magnehelic) or other device(anemometer/velometer)
- Velocity head (P or PT) (from GEM2000 or pitot tube and magnehelic)
- Wellhead gas flow (from GEM2000, 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 (H_2S) 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.

7.6 Abbreviated Field Readings

- Name of person taking readings
- Date/time of each reading
- Methane (CH_4)
- Oxygen (O_2)
- Wellhead gas temperature (flowing)
- Ambient air temperature
- Static pressure (PS) (from GEM2000 or magnehelic)
- Velocity head (P or Pt) (from GEM2000 or pitot tube and magnehelic)
- Wellhead gas flow (from GEM2000, 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 well field, 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 and submitted to management on a timely basis.

7.7 Well Field Adjustment Criteria

There are several criteria used in well field adjustment. The primary criterion 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. Due to this, several criteria must be considered at once.

Conditions within the landfill favor Methane production. Following are well field adjustment criteria and typical conditions for consideration:

- Methane quality (ranging from 26 percent upwards)
- pH
- Temperature
- General overall quality
- Moisture conditions
- Waste stream characteristics
- Placement chronology
- Insulation characteristics
- Oxygen quality (ranging below 1 percent, preferably less then ½ 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 topography 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
- Design of the gas collection system
- Landfill perimeter gas migration and surface emission control, or energy recovery objectives
- Diurnal fluctuation (day to night) of atmospheric pressure

7.8 Establishing Target Flows

The goal is to establish a target flow which will likely produce the best possible Methane quality and minimum Oxygen levels 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 over pull. High well temperatures, (130° to 140°F and greater), are an indication of aerobic activity and, thus, well over-pull. 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 over-pull is recognized. Every effort should be made to make adjustments and operations as smooth as possible. Dramatic adjustments, or operating while switching between a high flow mode and a well shutoff mode, should be avoided.

7.9 Well Field 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 allows well monitoring and adjustment to be significantly more effective.

7.10 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 down trending of Methane or up trending 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.

7.11 Well Field Adjustment—Purpose and Objectives

The objective of well field adjustment is to achieve a steady state of 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.
- Avoid well “over-pull” and maintain of a healthy anaerobic state within the landfill.
- Optimize LFG recovery for energy recovery purposes.
- Control nuisance landfill gas odors.
- Prevent or control subsurface LFG fires.
- Protect structures on and near the landfill.
- Meet environmental and regulatory compliance requirements.

Well field 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. Well field evaluation and adjustment consist of a collection of techniques, which may be used, in combination, to achieve a steady state of well field operation.

8 Troubleshooting

Problem	Corrective Action/Reason
Unit does not turn on or operation is erratic	Battery charge is too low-recharge batteries. Unit is too hot - cool down unit and try again. Contact Factory Service.
"Flow Fail" is displayed and an audible alarm is heard	The inlet is blocked. Remove blockage and retry. The particulate filter or water trap filter needs replacing.
Readings taken are not what was expected	Unit may be out of calibration. Calibrate unit with known gas concentration. Water trap or particulate filters are clogged. Replace filter(s).
Readings swing up or down wildly as they are being taken	Cell phones and other sources of RF interference can affect Methane readings. Don't use your cell phone while taking readings.
Unit displays***** or >>>>>	These symbols are substituted when the measured reading is out of range of the instruments capabilities in some fields or when a value needs to be entered manually such as temperature.
Oxygen reading is high on all wells	Check that the water trap housing is screwed on tight. Check or replace O-rings on the water trap and instrument inlet. Check the wellhead inset for cracks, replace O-ring on insert. Field calibrate Oxygen channel.
Unit will not download readings or an error occurs while downloading.	Verify that the communications software is the right version for the instrument being used. Check that the proper serial port is selected in the software. Contact Factory Service.
Methane and Carbon Dioxide readings drift	Perform a field calibration and check well again. Verify cal gas is flowing when regulator is turned on. Verify all connections are tight and filters are not clogged. Contact Factory Service.
Oxygen readings drift	Perform a field calibration - zero and span. Contact Factory Service.
Black screen displayed when unit turned On	Charge unit over night and try again. Unit too hot - cool down and try again. Try adjusting contrast level. Contact Factory Service.
Nothing happens when the Gas Pod is installed	Remove and re-seat the Gas Pod. Contact Factory Service.
Temperature does not update when temperature probe is installed	Check the probe fitting is fully seated. Check the probe plug is screwed together tightly. Contact Factory Service.

9 Service & Maintenance

9.1 Factory Service

LANDTEC is the ONLY authorized service center for the GEM™2000 / GEM™2000 Plus instruments. Factory service includes but is not limited to the following;

General operations
The main functions of the gas analyzers operation are checked to ensure that they are within specification.

Barometric pressure reading
The barometric pressure reading is checked to ensure it is within specification. This is carried out by way of comparing the atmospheric reading against a known standard. If necessary, reprogramming is quoted.

Static and differential pressure readings
The static and differential pressure transducers are checked to ensure they are within specifications. This is carried out by comparing instrument readings to a known standard, applying a known pressure and noting both readings. If necessary, reprogramming will be quoted.

Pump functionality (flow and vacuum)
All flow and vacuum functions of the internal pump are checked to ensure the operation is within specification.

Water ingress/blockage
The internal filters are checked for cleanliness and moisture ingress to ensure they are not contaminated.

Flow fail setting
The flow fail function is checked to ensure proper operation within the specified limits.

Gas pod and Temperature probe connectivity reading
The connectivity of the gas analyzer is checked to ensure correct operation and reading performance with accessories.

Computer controlled gas check
Inward and outward gas checks are carried out by way of connecting the gas analyzer to a custom built computer controlled 'gas checking rig' and proprietary software. At the inward stage, two sets of readings are taken - one using the customer's calibration settings and a second set using factory calibration settings. During this process a range of gases are used that span the reading range of the gas analyzer.

Structural and aesthetics check
The instrument is checked for cracks, scratches and broken or missing pieces.

9.2 Factory Service Facilities

LANDTEC North America
850 S. Via Lata, Suite 112
Colton, CA 92324
USA
Tel: 800-821-0496 or +1-909-783-3636
Web: www.ces-landtec.com

LANDTEC Europe
Formerly Geotechnical Instruments
Sovereign House Queensway
Leamington Spa, Warwickshire CV31 3JR,
England
Tel: +44(0)1926 338111
Web: www.geotech.co.uk

LANDTEC South America
LANDTEC Produtos e Servicos Ambientais Ltda.
Rua Pedroso de Carmargo, 237 - Chácara
Santo Antonio - SP/SP CEP 0417-010
Brazil
Phone: +55(11) 5181-6591
Web: www.landtecbrazil.com.br

9.3 User Maintenance

This instrument is designed to be low maintenance and rugged however field calibrations are recommended prior to use or when the ambient operating temperature of the instrument changes more than +/- 20 degrees Fahrenheit. See section 4.7 for further information on field calibrations. Additionally it may be necessary to change the user accessible filters and o-rings from time to time.

There are two user accessible filters, the particulate filter is located in the back of the instrument, see section 2 for location, and the water trap filter which is part of the included hose kit. There are four user changeable o-rings, one on the particulate filter cover, one on the outside of the water trap filter housing, one on the inside of the water trap filter housing, and ones on the ends of the male quick connect fittings included on the hose kits.

10 Technical Specifications

10.1 Physical

Weight	4.4 lbs.
Size	L 2.48" x W 7.48'' x D 9.92".
Case material	Anti-static ABS.
Keys	Membrane panel.
Display	Liquid Crystal Display 40 x 16 characters. Fiber optic woven backlight for low light conditions.
Filters	User replaceable integral fiber filter at inlet port and external PTFE water trap filter.

10.2 General

Certifications	UL Certified to Class 1, Zone 1, AEx Ib d IIa T4
Temperature measurement	With optional probe 14°F to 167°F.
Temperature accuracy	±0.4ºF (± probe accuracy).
Visual and audible alarm	User selectable CO_2, CH_4 and O_2 Min/Max levels via LSGAM CS software.
Communications	RS232 protocol via download lead with variable baud rate.
Relative pressure	±250 mbar from calibration pressure

10.3 Power supply

Battery type	Rechargeable Nickel Metal Hydride battery pack containing six 4AH cells. **Not user replaceable**. Lithium Manganese battery for data retention.
Battery life	Typical use 10 hours from fully charged condition.
Battery charger	Separate intelligent 2A battery charger powered from AC voltage supply (110-230V).
Charge time	Approximately 2 hours from complete discharge.
Alternative power	Can be powered externally for fixed-in-place applications only. Contact LANDTEC for further information.
Battery lifetime	Up to 1,000 charge/discharge cycles.

10.4 Gas Ranges

Detection principle	CO_2 and CH_4 by dual wavelength infrared cell with reference channel. O_2 (and CO & H_2S in Plus) by internal electrochemical cell.
Oxygen cell lifetime	Approximately 18 months in air.
Typical Accuracy 0 - Full Scale	**Gas** **0-5% volume** **5-15% volume** **15%-FS** **CH_4** ±0.3% ±1% ±3% (100%) **CO_2** ±0.3% ±1% ±3% (60%) **O_2** ±1% ±1% ±1% (21%) **CO & H_2S in Plus Instruments** ±10%FS from 0-Full Scale
Response time, T90	CH_4 ≤20 seconds CO_2 ≤20 seconds O_2 ≤20 seconds

Range	CH_4 0-70% to specification, 0-100% reading. CO_2 0-40% to specification, 0-100% reading. O_2 0-25% CO (in Plus Instruments) 0-2000ppm H_2S (in Plus Instruments) 0-500ppm

10.5 Pump

Typical flow	300 cc/min.
Flow fail point	50 cc/min approximately.
Flow with 200 mbar vacuum	250 cc/min approximately.
Vacuum	70 inches H_20.

10.6 Operating Conditions

Operating temp range	32°F to 104°F.
Relative humidity	0-95% non-condensing.
Atmospheric pressure range	700-1200 mbar. Displayed in Inches of Mercury (5.9 – 35.4“Hg). Not corrected for sea level.
Atmospheric pressure accuracy	±5 mbar approximately.
Case seal	IP65.

10.7 Optional Gas Pods

Typical Accuracy (Subject to User calibration).	**Gas** **0-Full Scale** CO ±10% FS H_2S ±10% FS SO_2 ±10% FS H_2 ±10% FS HCN ±10% FS
Response time, T90	CO ≤60 seconds H_2S ≤60 seconds SO_2 ≤60 seconds H_2 ≤60 seconds HCN ≤60 seconds
Range	CO 0-500ppm H_2S 0-50 or 0-200ppm SO_2 0-20 or 0-100ppm H_2 0-1000ppm HCN 0-100ppm