Current Conditions Evaluation Work Plan

Refuse Hideaway Landfill
Town of Middleton, Dane County, WI

Revision 0
September 2019

Prepared For:

Wisconsin Department of Natural Resources
101 S. Webster Street
Madison, WI 53707

Prepared By:

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1.0 Introduction

1.1 Background

The Refuse Hideaway Landfill (RHL) is located at 7562 Highway 14 in the Town of Middleton, Wisconsin. The landfill closed in 1988 and became a Superfund site. The State of Wisconsin, through the Wisconsin Department of Natural Resources' (WDNR) Remediation and Redevelopment Program, is responsible for overseeing the operation of the landfill control systems. To this end, the WDNR put out a Specifications/Scope of Work in June 2019 that provided details of the landfill systems condition assessment and recommendations scope of work.

1.2 Purpose

This Work Plan has been prepared to describe the planned inspection activities at the RHL. The purpose of the Work Plan is to define technical details of the inspection and data gathering methods to be used during field activities.

1.3 Scope

This Work Plan consists of four sections, including:

- **Section 1** describes the background, purpose, and scope of the Work Plan.
- **Section 2** describes the field inspection scope of work.
- **Section 3** covers the details of field records.
- **Section 4** describes the schedule.

2.0 Scope of Work

TRC will perform the following field inspection program as described in the Specifications/Scope of Work dated June 3, 2019.

2.1 Landfill Cap

- Assess current cap conditions, and note areas with stressed vegetation, ponding, settling, rills, erosion, or other conditions that require repair. Collect photographs and GPS location of noted features as conditions allow.
    - Specifically, the inspector will walk the landfill cap on approximately 50-ft lines. This spacing will allow the inspector to look approximately 25-ft in either direction and make observations of the cap conditions. The GPS will be used to note locations of trees, erosion, other cap damage, and items of note. The inspector will also record notes on the inspection form. The inspector's lines of observation will change as needed such that the cap is completely inspected and for documentation of features.
- Evaluate surface run-off controls, sedimentation basin, and drainage features, with particular attention for stormwater management issues. Collect photographs and GPS location of relevant features as conditions allow.
    - The sedimentation basin influent area will be inspected to determine if water can enter the basin.
    - The sedimentation basin sides and bottom will be inspected for damage that would make the basin inefficient or inoperable. If the basin is dry, an estimate of soft sediment deposit thickness will be made. The type and growth of vegetation will be noted.
    - The surface run-off controls and drainage features will be inspected for damage that could make them inefficient or inoperable. For example, excessive run-off damage/erosion could change the gradation such that the feature is not operating as designed/intended. The surface run-off controls and drainage features will be inspected on an individual basis or for larger areas on approximately 50-ft lines similar to the cap inspection.
    - Any applicable features will be marked with the GPS. The inspector will record notes on each of the drainage features on the inspection form.
- Note any other issues observed while on-site, and not included above, that could reduce effectiveness of the cap. Collect photographs and GPS location of relevant features as conditions allow.

The landfill cap inspection will be performed by visual inspection on foot.

2.2 Leachate Extraction System

- Measure leachate elevations at 13 leachate/gas extraction wells using a water level indicator.

- Evaluate current conditions of the visible components of the leachate extraction system (well head tubing and connections, components in the control panels, components in the compressor building and visible components of the collection tank). Because leachate pumps were removed, cleaned, and evaluated on June 14, 2018 and have not haven't been functional since, the leachate pumps will not be pulled from the wells and evaluated. The 2018 O&M Report (WSP, August 2018) indicates that until the compressor is operational, the pumps cannot be tested. At least three of the seven leachate extraction pumps were operational as recently as August 2017.
- Observations will include whether system components are present or missing, and if present, appear to be functional or require repair. The electrician will evaluate electrical components that are present. For example, valves will attempt to be opened and if they cannot be will be marked as requiring replacement.
- Collect photographs and GPS location of relevant features as conditions allow.
- Document the location of visible leachate seeps around the perimeter of the landfill. Collect photographs and GPS locations of visible seeps as conditions allow.

The leachate elevation measurements will be completed on the same day. The visual survey of leachate seeps will be completed on foot.

2.3 Landfill Gas Extraction System

- Observe and document current conditions of the visible components of landfill gas extraction system (gas extraction well heads and connections, components in the control panels, and visible components of the flare and flare controls). Observations will include whether system components are present or missing, and if present, appear to be functional or require repair. The electrician will evaluate electrical components that are present. For example, valves will attempt to be opened and if they cannot be will be marked as requiring replacement.
- Use handheld field monitoring equipment (e.g., Landtec meter, magnehelic or equivalent) to screen gas conditions in up to six landfill gas wells (GW-1, GW-2, GW-5, GW-6, GW-11, and GW-13) and or other accessible monitoring port(s) in the gas control system. No additional monitoring ports with active gas are anticipated since the collection system is not in operation. Data collected during field screening may include; gas pressure, percent methane, percent oxygen, and percent carbon dioxide). The landfill gas measurements will be completed on the same day.
- Assess whether landfill gas collection could be economically viable for energy production.

2.4 Site Access Control

- Evaluate existing enclosures at RHL and the security of the wells (i.e. locks present/not).
- Document locations of potential concern for site security or access control. Collect photographs and GPS locations of noted access and site security issues as conditions allow.

2.5 Survey

- Subcontract with a professional land surveyor to complete a 1-foot topographic contour map of the extent of the landfill using the North American Vertical Datum.
- Set permanent control so the relationship between the topographic data and the section can be identified and reproduced in the future.
- Prepare survey map at 1" = 100' scale.
- Include benchmarks and control points/monuments used to complete the survey.
- Include location of features such as seeps, trees on cap, landfill roads, wells, gas probes, sedimentation basin, storm drainage features and other landfill control system components.

TRC will meet with the surveyor on the day of the TRC inspection. The survey is anticipated to last more than one day. Upon completion, the surveyor will provide the drawings and TRC will provide them to WDNR electronically for their use.

2.6 Electrical Inspection

- Coordinate with an electrician to be on-site the same day as TRC's visit to evaluate current conditions.
- Subcontract with an electrician to evaluate the electrical components of the Landfill Gas and Leachate Extraction Systems. Diagnostics will include assessment of current conditions, whether repair is viable, and list of items requiring replacement or repair.

TRC will have the electrician present the day of the TRC inspections and work alongside the electrician to document the outcomes of their evaluations. TRC will provide all documentation of the electrician's work including field notes and, where applicable, photographs in the photo log of the report.

3.0 Field Records

This section describes requirements and procedures for documenting field activities. All fieldwork personnel will be cognizant of the requirement that all field documentation must provide a clear, unbiased description of field activities.

Daily field activities and sampling data will be recorded on paper field forms, or electronically on a field tablet computer. Entries into the field forms will be legibly written and will provide a clear record of field activities. Entries will be made in waterproof ink, in language that is objective, factual, and generally free of personal opinions, or terminology that might later prove unclear or ambiguous. No field notes may be destroyed or discarded, even if they are illegible, or known to contain inaccuracies. Errors in the field notes will be indicated by drawing a single line through the text, such that the text in error remains legible. Errors addressed in this manner will be initialed by the person making the correction. The person filling out the field forms will sign and date each page and will identify the date, the time, the location on-site, the field personnel present, and the weather conditions observed.

Photographs are a required element for the documentation of the inspections. The fieldwork personnel will make every effort to make sure photos are in focus, show the subject object to scale, and are representative of site conditions.

4.0 Schedule

TRC will complete the inspection and reporting as follows:

Milestone	Projected Completion Date
Update HASP	August 22, 2019
Draft Work Plan	August 23, 2019
Finalize Work Plan	September 4, 2019
Site Inspections (Note 1)	September 2019
Draft Report	By October 9, 2019
Finalize Report	Thirty days after receipt of DNR Comments

Note:

1. Site Inspections also includes survey and electrical subcontractor inspection and will be coordinated based on the availability of TRC and the subcontractors.

TRC - GIS

LEGEND

- GAS PROBE
- GAS WELL
- MONITORING WELL
- PRIVATE WELL
- PARCEL BOUNDARY

NOTES

1. BASE MAP IMAGERY FROM ESRI/DANE COUNTY, 2017.
2. TOPOGRAPHY FROM DANE COUNTY LIDAR SURVEY, 2017.
3. PARCELS FROM WISCONSIN STATE CARTOGRAPHER'S OFFICE, 2018.
4. SITE FEATURES SHOWN ARE APPROXIMATE.

0 800 1,600 Feet

1 " = 800 '

1:9,600

PROJECT:	WISCONSIN DNR REFUSE HIDEAWAY LANDFILL
TITLE:	SITE OVERVIEW
DRAWN BY: J. PAPEZ	PROJ NO.: 335719.9990
CHECKED BY: M. WESTOVER	FIGURE 1
APPROVED BY: K. VATER	
DATE: APRIL 2019	

TRC
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FILE NO.: 335719-001.mxd

Plot Date: 4/17/2019, 10:51:57 AM by JPAPEZ – LAYOUT: ANSI B(11"x17")
Path: S:\1-PROJECTS\WI_DNR\RefuseHideaway\335719-GW_Proposal\335719-001.mxd
Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet (Foot US)
Map Rotation: 0

Attachment 1: Example Forms

Landfill Control System Inspection Report
Refuse Hideaway Landfill
Middleton, WI

(Revised: 8/2019)

General Information						
1	Facility Name: Refuse Hideaway Landfill		Date of Inspection:			
2	Facility Location: Middleton, WI		Inspector:			
3	Reason for Inspection: Condition Assessment for Leachate Extraction, Gas Extraction, Cover, and Site Access					
4	Temperature/Weather:					
5	Ground Conditions:					
Tank Farm Containment Cell						
6	**Condition Final Cover/Cap:**	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A	
7	Vegetation	☐ Good	☐ Fair	☑ Needs Maintenance	☐ N/A	
8	Erosion	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A	
9	Burrowing	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A	
10	Settlement	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A	
11	Leachate Seeps	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A	
12	Damage from wildlife?	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A	
13	Damage from unauthorized use?	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A	
14	Exposed Geotextile/Geomembrane	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A	
15	Other?	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A	
16	If "Fair" or "Needs Maintenance", provide description (attach photos with scale/reference) and indicate location on site map (Figure 1):					
17	**Condition of Perimeter Drainage:**	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A	
18	Vegetation? Erosion? Sediment? Other?					
19	If "Fair" or "Needs Maintenance", provide description (attach photos with scale/reference) and indicate location on site map (Figure 1):					

Landfill Control System Inspection Report
Refuse Hideaway Landfill
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20	**Leachate Extraction Wells/Equipment**	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A
21	Well head tubing and connections				
22	Components in the control panels				
23	Components in the compressor building				
24	Visible components of the collection tank				
25	Other				
26	Measure leachate elevations at 13 leachate/gas extraction wells, attach documentation table.				
27	If "Fair" or "Needs Maintenance", provide description (attach photos with scale/reference) and indicate location on site map (Figure 1):				
28	**Gas Extraction Wells/Equipment**	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A
29	Inspect visible components				
30	Field screen gas conditions in six locations, attach documentation table.				
31	Other				
32	If "Fair" or "Needs Maintenance", provide description (attach photos with scale/reference) and indicate location on site map (Figure 1):				
33	**Condition of Fence:**	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A
34	Damage to gates? Locks? Fencing? Signage? Vandalism? Other?				
35	If "Fair" or "Needs Maintenance", provide description (attach photos with scale/reference) and indicate location on site map (Figure 1):				
36	**Condition of Access Roads:**	☐ Good	☐ Fair	☐ Needs Maintenance	☐ N/A
37	Excessive rills/gullies? Standing water? Excess potholes? Scour? Other?				
38	If "Fair" or "Needs Maintenance", provide description (attach photos with scale/reference) and indicate location on site map (Figure 1):				

Landfill Control System Inspection Report
Refuse Hideaway Landfill
Middleton, WI

(Revised: 8/2019)

	Additional Comments/Observations	
39		
40	Name of Inspector/Company:	Date:
41	Inspector Signature:	Phone No.:
42		Email:

Notes: "N/A" = Not Applicable

(1) Describe issues, observations, and unexpected changes to assess whether the drainage features is effective and functioning as designed. Condition is a personal judgment based on experience and previous observations.

(2) Include representative photos to support observations and/or concerns.

(3) Areas of damage or concern must be indicated on a site map to accompany Inspection Checklist.

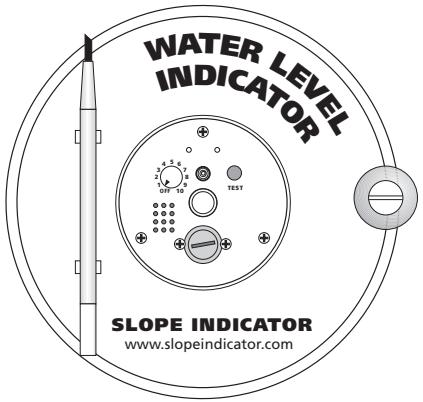
	Further Actions Required (to be completed by Engineer)		
	Actions Required:	Due Date:	Date Action Completed:

Attachment 2: Instrument Manufacturers' Instructions/Manuals

- Slope Indicator (or equivalent) – Water Level Indicator
- GEM-500 Operations Manual

Slope Indicator (or equivalent) – Water Level Indicator

Water Level Indicator

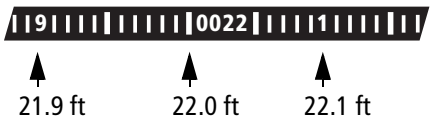


Taking Readings

1. Switch on. Set sensitivity to 5 or 6.
2. Lower probe into well. When probe touches water, light turns on and beeper sounds.
3. Read depth to water from cable mark that aligns with your reference (such as the top of the well).
4. Switch off.

Reading Cable Marks

Cable is graduated with 1/100 ft marks. White numbers are 1/10 ft. Yellow numbers are feet. Read as shown below:



Indicator Controls

On/Off/Sensitivity: The on/off switch also adjusts sensitivity. Sensitivity is set properly if beeper and light turn off immediately when probe is removed from contact with water. Use lower setting for very conductive water or to eliminate false triggering. Use higher setting for less conductive water.

Battery Test Button: Push the button to check the batteries. Light and beeper activate when batteries are good.

Replacing Batteries

The indicator uses two AA-size batteries. Press Test button to check batteries. Replace batteries if light and beeper do not activate.

1. Use coin or screwdriver to open battery holder. (¼ turn counter-clockwise)
2. Remove the two AA batteries. Insert new batteries with + terminals up, toward the cap.
3. Replace cap.

Cleaning the Indicator

Probe: Wash probe with detergent.

Reel: Wipe off the reel with a damp cloth. Do not immerse in water.

Cable: Wash the cable with a laboratory-grade detergent such as Alconox or Liquinox. Rinse with distilled water as required. Remove oily deposits with dish-washing detergent. Do not leave the cable immersed in detergent for a long time. Rinse in distilled water.

Do not use nitric acid, hydrochloric acid, MEK, Acetone, Toluene, or alcohol to clean the cable. Even short-term exposure to these substances can damage the polyurethane cable jacket.

Repairs

If your water level indicator is damaged, you can order replacement parts to fix it yourself or you can return it to the factory for repair.

To order replacement parts, please visit www.slopeindicator.com. Click on Support, then click on Water Level Indicator Parts.

To return the water level indicator to the factory for repair, contact the Slope Indicator factory for a return authorization:

Tel: 425-493-6200
Fax: 425- 493-6250
Email: solutions@slope.com

Check that the indicator is clean and dry, then package it, write the return authorization number on the outside, and send to:

Slope Indicator
12123 Harbour Reach Drive
Mukilteo, WA, USA
98275

Limited Warranty

Slope Indicator warrants all products manufactured by it to be free of defects of workmanship and material for a period of one year from the date of delivery to the customer, unless the customer is an authorized distributor of Slope Indicator products, in which case the warranty shall be for a period of one year from the date of delivery to the authorized distributor's customer. The obligation of Slope Indicator Company is hereafter limited to replacement or, at its option, repair of products returned to it with transportation charges to and from the Company paid by the customer (including prepayment of transportation charges to the Company) and which the company's examination shall disclose, to its satisfaction, were not free from such defects.

In no event shall Slope Indicator be liable for consequential or special damages, or for installation, adjustment or other expenses which may arise in connection with such products. This warranty extends only to the original customer of the company or its authorized distributor, as the case may be, and is expressly in lieu of all other warranties, express or implied, whether of merchantability or fitness for any particular purpose or use and of all other obligations and liabilities of any kind and character. Except for the warranty described on the face hereof, seller makes no warranty of merchantability of the goods or of the fitness of the goods for any purpose. There are no warranties which extend beyond the description on the face hereof.

SLOPE INDICATOR
www.slopeindicator.com

GEM-500 Operations Manual

GEM-500

OPERATION MANUAL

For further information contact:

CES-LANDTEC
850 S. Via Lata, Suite 112
Colton, CA 92324
Telephone: (909) 783-3636 / (800) LANDTEC
Fax: (909) 825-0591
www.CES-LANDTEC.com

TABLE OF CONTENTS:

Chapter 1 - Getting Started

Unpacking the GEM-500™

The GEM-500™ unit is normally shipped in a special protective Styrofoam shipping unit. An optional protective hard case with a foam interior offers additional protection, transportation convenience and component hardware storage. When properly sealed, the hard case is watertight. The hard case is equipped with a pressure relief valve (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 internal pressure is equalized by turning the pressure relief valve. When shipping a GEM-500™ back to CES-LANDTEC for calibration or service, always ship it in the original packaging to protect unit from damage.

Carefully unpack the contents of the GEM-500™, inspect and inventory them. The following items should be contained in your package:

- The GEM-500™ unit
- GEM-500™ Operation Manual
- Registration/Warranty Card and other instructional information
- Soft carrying case with replaceable protective window and carrying strap
- External (clear vinyl) sampling hose assembly (5 ft.) with external water trap filter assembly
- Blue ¼" vinyl pressure tubing 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
- 110-volt Nickel-Cadmium battery charger
- GEM-500™ download software on DataField 3.0 C.S. CD
- RS-232 serial cable for computer/printer data downloading
- Temperature probe (optional)
- Hard carrying case (optional)

Immediately notify shipper if the GEM-500™ unit or accessories are damaged due to shipping. Contact CES-LANDTEC if any items are missing. If you have any questions, please contact CES/ LANDTEC technical support at (800) 526-3832 or (800) LANDTEC. Complete the Registration/Warranty Card and return it to CES-LANDTEC. The model and serial numbers are located on the back of the GEM-500™ unit.

Attaching the Hose Assembly

The GEM-500™ hose assembly comes fully assembled but it needs to be connected to the GEM-500™. Connect the clear tubing with the external filter/water trap assembly to the static pressure/ sampling port (top left corner) on the GEM-500™ (See Figure 1.1). The shorter piece of tubing (from the water trap filter hosing) should be connected to the GEM-500™. This allows you to see any liquid entering the hose and shut the unit off before the liquid reaches the GEM-500™. Always connect the hose in the same direction. Connect the blue tubing to the impact pressure port on the GEM-500™ (See Figure 1.1). This port is located on the bottom left corner of the GEM-500™. **DO NOT** block the exhaust port (See Figure 1.1).

Quick Connect Fittings

The quick connect fittings will simplify taking well field readings. They are easy to install on your landfill gas extraction system and on perimeter probes. Many different types are available. CES-LANDTEC maintains a stock of fittings used on its equipment for your convenience.

The GEM-500™ comes with quick connect fittings for the AccuFlo™ wellhead. Insert the hose barb end of the male connector into the end of the clear and blue tubing.

GEM-500™ Keyboard and Port Descriptions

1. **Red On/Off Key**—Turns unit on or off.
2. **Blue Number/Letter Toggle Key**—Enables well ID code to be entered by toggling between number and letter mode and toggles contrast on the gas read screens.
3. **Receptacle Port**—Used for battery recharging, RS232 serial communications, temperature probe or gas pod.
4. **Backspace/Exit Key**—Acts as backspace key when pressed and held for one second, to correct entry of wrong number/letter, returns to previous procedure or steps back one layer of menus (similar to pressing the ESCAPE key in many computer programs).

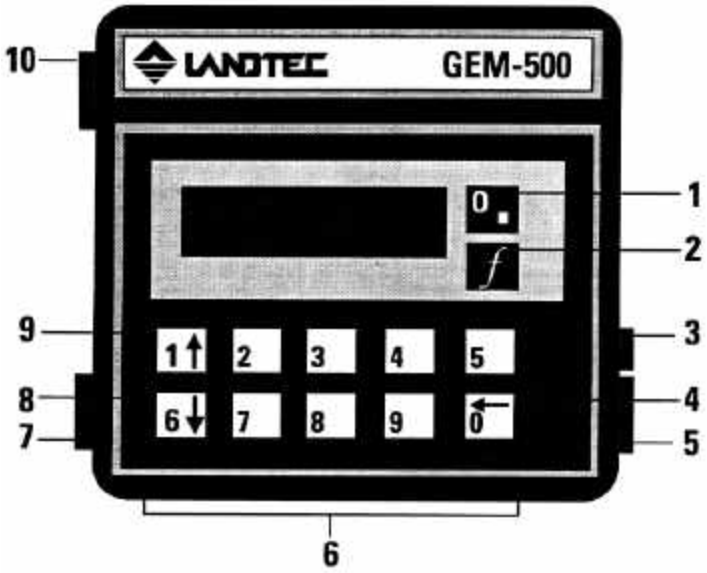


FIGURE 1.1

5. **Exhaust Port**—This port must be kept clear. If blocked while operating, over-pressurization may occur causing damage to internal components and case.
6. **Number Keys**—Enter numbers 0 through 9.
7. **Impact Pressure Port**—Measures impact pressure when connected to wellhead impact pressure port, pitot tube or orifice plate.
8. **Cursor-Down Key**—Enters number 6, scrolls down lines of information on display screens, and also scrolls down alphabetic character list.
9. **Cursor-Up Key**—Enters number 1, scrolls up lines of information on display screens, and also scrolls up alphabetic character list.
10. **Static Pressure/Sampling Port**—Measures static pressure and is inlet for gas sampling.

Must Do's Before Using the GEM-500™

Read Chapter 2 – *Using Menu Screens*.

Proper operation of the GEM-500™ requires the following functions to be completed before proceeding.

- Charge the unit with the battery charger
- Check the Time/Date
- Field Calibrate the unit

Calibration Gases

Calibration gases are required to field calibrate the GEM-500™. Portable Calibration Gas Kits and 4-unit or 12-unit cylinder cases are available from CES-LANDTEC. (See Chapter 2 -- *Field Calibration*)

Special Key Functions

Entering an ID code with Letters and Numbers
Use the blue toggle key (***f***) to shift back and forth between number mode and letter mode. When in number mode, use number keys to enter numbers. When switched to letter mode, use the **1** KEY (**UP ARROW**) or the **6** KEY (**DOWN ARROW**) to scroll to desired letter, press **0** KEY to enter the letter on the display. Repeat this process for all letters. After entry, the first four characters will remain as a default for ease in entering the next ID. If different characters are desired, replace the defaults by using the backspace function described below.

Backspace Function
To change or correct an entry, use the **0** KEY (**BACK ARROW**) as a backspace key by holding it down for one second. In normal use, this key is quickly pressed and released.

Contrast Adjustment
Contrast can be adjusted when the unit is either first turned on or while taking a reading. While taking a reading, use the Blue f KEY to enter the contrast adjustment screen. To adjust, use 1 KEY (UP ARROW) to darken the screen and the 6 KEY (DOWN ARROW) to lighten screen.

Starting Up the GEM

This procedure is the same each time the GEM-500™ is turned on by pressing the RED On/Off KEY. The following steps will allow you to proceed to the Main Menu Screen of the GEM-500™ .

1. Turn unit on by pressing the RED **On/Off** KEY (see Figure 1.1)

   Note: If the GEM is turned on and no additional keys are pressed within 15 minutes, the unit will automatically shut off.

2. The Warning screen appears for five seconds. This is a reminder that the GEM-500™ is not to be used in areas such as vaults, excavations or other confined spaces. An explosion could result causing serious injury or death.

FIGURE 2.1

3. The Service Contract screen may appear for five seconds if activated by CES-LANDTEC. Otherwise, the Not Covered screen is displayed. The GEM-500™ is a portable, scientific, field instrument that does require factory maintenance and calibration at recommended six-month intervals under normal landfill usage.

FIGURE 2.2

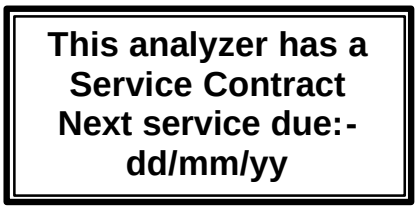


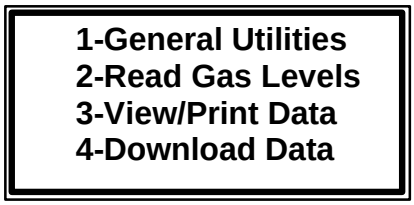
FIGURE 2.3

4. The CES-LANDTEC/Contrast screen allows the user to adjust the contrast of the characters on the liquid crystal display screen. Press and hold the **1** KEY (**UP ARROW**) to increase contrast. Press and hold the **6** KEY (**DOWN ARROW**) to decrease the contrast. Adjust the contrast as necessary (contrast levels are **NOT** saved when the unit is turned off). Press the **0** KEY to proceed to the Main Menu screen.

FIGURE 2.4

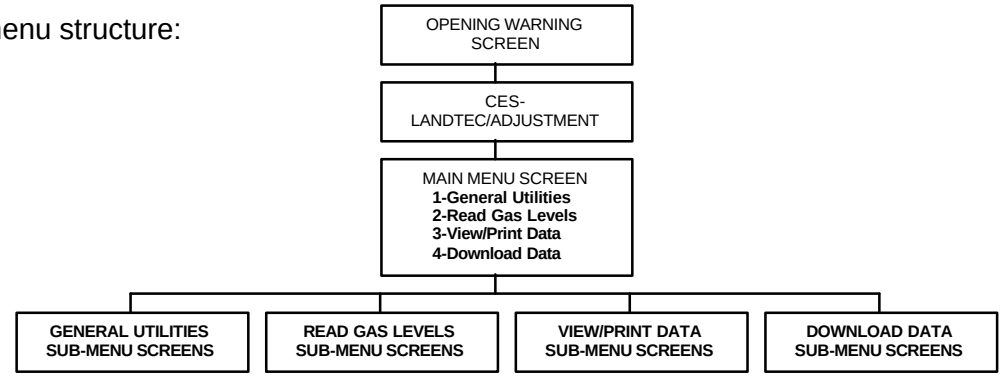
5. **The Main Menu Screen.** All the GEM-500™ functions are accessed from the Main Menu Screen. All subsequent instructions about the GEM-500™ functions will start from this screen.

FIGURE 2.5



GEM-500 Menu Tree

The overall menu structure:



Review of the Main Menu and Sub-Menu Screens

General Utilities
Refer to Chapter 4 for further information. The General Utilities function has sub-menu screens that allow housekeeping and other maintenance including:

1. CHECK TIME/DATE: Set or check time and date.
2. BATTERY STATUS: Graphic display of remaining power in batteries.
3. ZERO PRESSURES: Zero pressure transducers.
4. MEMORY: Check memory available or clear all data and ID information.
5. USA/METRIC UNITS: Select either USA standard or metric measurement units.
6. GAS CALIBRATION: Allow methane, Carbon Dioxide and oxygen to be field calibrated by the user with calibration gas mixtures for increased accuracy (see Chapter 3).
7. GAS ALARM: Set gas alarm levels.
8. ID MAINTENANCE: View, enter, edit or delete ID information.

Read Gas Levels
Refer to Chapter 5 for further information. Read Gas Levels function allows gas, pressure, flow and BTU readings to be viewed and recorded. Sub-menu screens include:

1. Read GAS with Existing ID code.
2. Read GAS without ID code.

View/Print Data
For further information, refer to Chapter 6. The View/Print Data function allows previously stored data to be scanned on the GEM-500™ display screen, individually displayed, or printed via the RS-232 cable to a serial printer.

Download Data
The Download Data function allows stored data to be downloaded via the RS-232 cable to a computer in a format that can be uploaded into DataField (CES-LANDTEC database management program) or onto spreadsheets. See Chapter 7 for further information.

Note: The 0 KEY (BACKSPACE) acts as an exit or ESCAPE key at the end of each sub-menu by returning to the Main Menu.

Chapter 3 - Field Calibration

Field Calibration is menu guided and can be completed in about ten minutes. To streamline the procedure, the pump remains running during field calibration. The GEM-500™ contains a calibration map accessed by its microprocessor for baseline reference data. This reference data was programmed into the GEM-500™ during factory calibration using various traceable gas mixtures in an environmental chamber. At any time, the GEM-500™ can be reset to factory settings which clears any user calibration settings and restores the GEM-500™ to its original factory calibration.

The factory calibration has been designed to give the best possible results over a wide range of conditions. However, the instrument's accuracy can be improved in specific operating ranges by performing a field calibration. Most field instruments are calibrated or adjusted prior to taking a series of gas or pressure readings. They may also be checked for calibration during and after readings in order to verify the accuracy of the data collected.

It is important to field calibrate the GEM-500™ on-site after the instrument has stabilized at working temperature. For this reason, a GEM-500™ that was calibrated in the cool of the morning may not read as accurately during the hottest part of the day.

Note: Field calibration of the GEM-500™ will improve the data collected in the range of the calibration gases used. Less accurate readings of concentrations outside the calibrated range may occur. For example, a GEM-500™ that was field calibrated using 50% CH_4 and 35% CO_2 will give improved readings for most gas extraction systems. Recommended gas mixtures for reading migration probes are 15% methane, 15% Carbon Dioxide with balance nitrogen. A 4.0% oxygen with balance nitrogen mixture may be used for both types of testing.

Calibration Gas/Span Gases

Field calibration requires two calibration gas mixtures. One gas mixture is used to span oxygen and zero methane. The other is used to span methane, Carbon Dioxide and zero oxygen. The oxygen has two curves: 0-5% and 0-25%. The zero point is the same for both curves; however, the span is different. The user need only span the instrument using calibration gas below 5% for the 0-5% range or calibration gas below 25% for the 0-25% range. Regardless of the ranges used, the instrument **must** be zeroed. Various calibration gas mixtures are available from CES-LANDTEC.

Zero Methane

Calibration of the GEM-500™ starts by establishing the bottom point of the methane gas curve. The methane (CH_4) is zeroed prior to taking readings at the start of each day. This function significantly improves the GEM-500™'s CH_4 accuracy over the entire range. **It is essential that the gas analyzer be clear of CH_4 when zeroed.** Care must be taken if the GEM-500™ is to be zeroed using air near a landfill site because there are situations where methane could be in the atmosphere.

Span Methane

A field calibration spans the methane range prior to taking readings at the start of each day. The best results are obtained after the instrument has stabilized at its working temperature. This procedure alters the methane calibration at all concentrations and stores the revised data in protected memory.

Note: Methane zero must be performed before setting the Methane Span.

Span Carbon Dioxide

Field calibration of CO_2 should be performed prior to taking readings at the start of each day after the instrument has stabilized at its working temperature. This procedure alters the calibration at all concentrations and stores the revised data in protected memory.

Zero Oxygen

This function is essential where low concentrations of oxygen are expected (below 5%). This establishes the zero point of an oxygen curve that is stored in the GEM-500™ protected memory.

Span Oxygen

The oxygen calibration map contains two span curves, one for oxygen below 5% and one for oxygen above 5%. The proper curve is automatically selected. If a calibration gas with less than 5% oxygen is used, the lower span curve is set. If the calibration gas has more than 5% oxygen, the higher calibration curve is set.

Note: The Oxygen zero must be set before setting the Oxygen Span.

Equipment

The following items are required to perform a field calibration:

1. Cylinder of methane and Carbon Dioxide span gas
2. Cylinder of 4/96 (4% O_2 and 96% N_2) calibration gas
3. Pressure regulators for the above cylinders capable of regulating in the range of 0 - 2 psig fitted with connectors suitable for ¼" tubing
4. CES-LANDTEC regulator and flow meter preset to deliver the required flow of 399-500 cc per minute at 2 psig. (See Figure 3.1a)
5. Interconnecting lengths of ¼" tubing

This equipment is available from CES-LANDTEC. The calibration equipment set up is shown in Figure 3.1.a and 3.1.b.

FIGURE 3.1.a Pressure/Flow Regulator

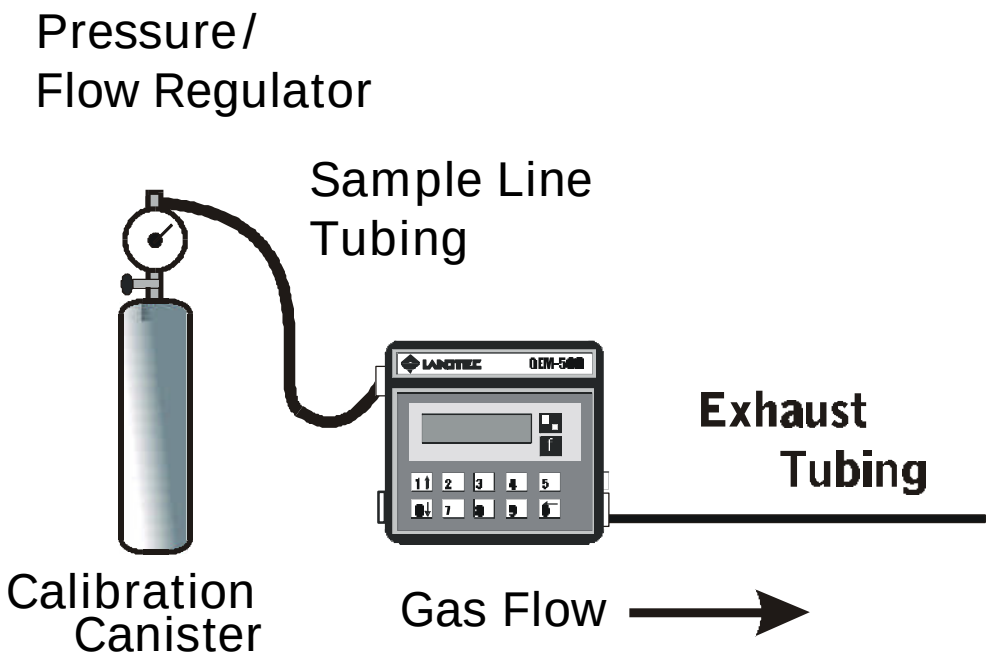
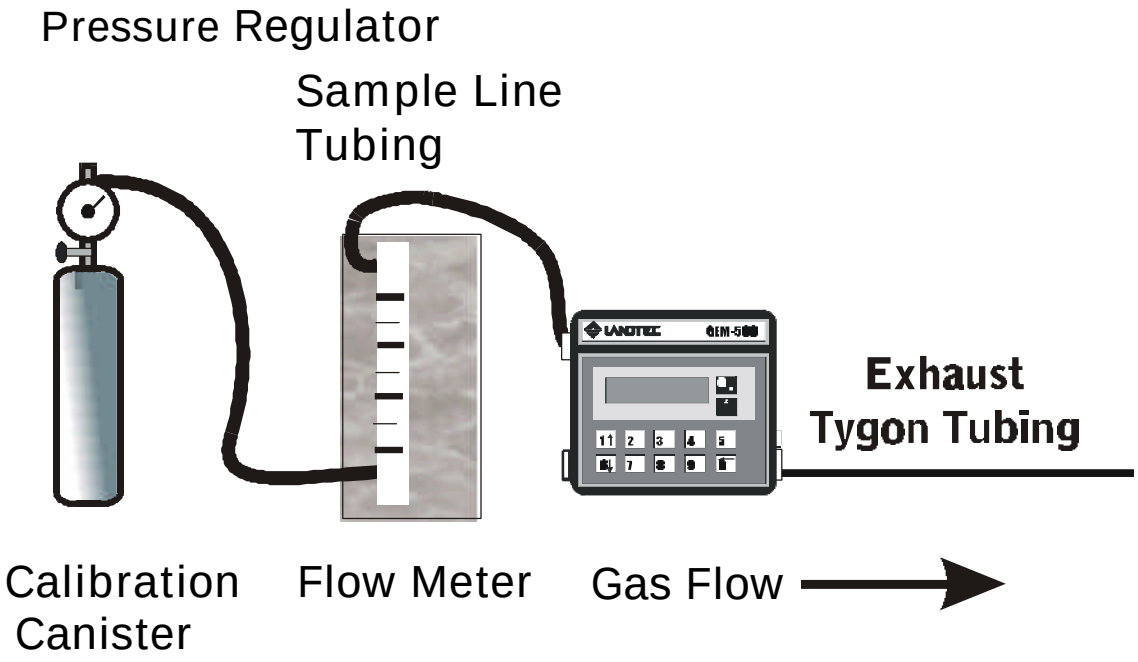


FIGURE 3.1.b Pressure Regulator with Flow Meter



Setting Up the Equipment

1. Connect the calibration gas cylinder to the pressure regulator.

2. Connect the sample input line to the regulator and to the GEM-500™.

3. Connect the second 24" section of ¼" tubing to the exhaust nozzle of the GEM-500™. Direct exhaust away from you and out of the immediate area.

4. If using a CES-LANDTEC regulator, no flow meter is required.

5. If **not** using the CES-LANDTEC regulator, adjust the regulator discharge pressure to 2 psig and the flow meter to 500 cc per minute. Pinch the gas supply hose that will attach to the GEM-500™ and verify the regulator discharge pressure does not exceed 5 psig. Turn off the cylinder valve.

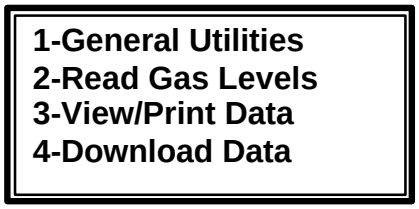
   Note: This procedure will be duplicated for the second span gas when oxygen is calibrated. The Oxygen/N_2 calibration gas cylinder will be substituted for the Methane/Carbon Dioxide calibration gas.

General Utilities KEY 5-Gas Calibration

The GEM-500™ is factory calibrated. To improve accuracy, all standard landfill gas instruments should be field calibrated, zeroed, or in other ways adjusted prior to every use. Field calibration is performed from the General Utilities Menu of the GEM-500™.

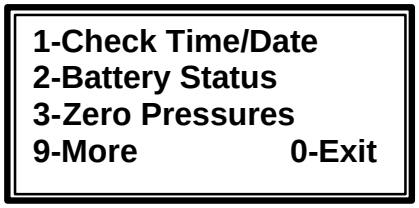
1. Press **1** KEY for **General Utilities** on the Main Menu Screen (See Figure 3.2.).

FIGURE 3.2



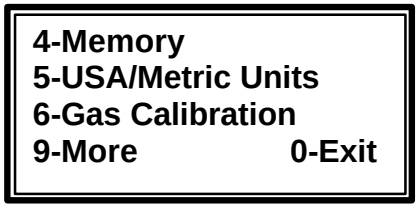
2. The General Utilities Screen appears as shown in Figure 3.3.

FIGURE 3.3



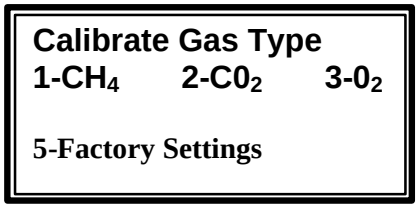
3. The gas calibration function is not on the first General Utilities screen. To reach this screen, press **9** KEY for **More** and **6** KEY for **Gas Calibration** (Figure 3.4). You may also press the **6** KEY while at the first General Utilities Screen to proceed directly to the Gas Calibration screen.

FIGURE 3.4



4. Pressing the **6** KEY for **Gas Calibration** on the General Utilities Sub-Menu screen, the first Gas Calibration screen is displayed as shown in Figure 3.5.

FIGURE 3.5



Methane (CH_4) Calibration - Zero CH_4

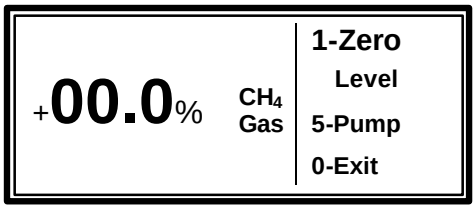
1. Press **1** KEY, **CH_4 Calibration**, to start the calibration procedure. Pressing the **0** KEY will exit the screen without changing the previous calibration.

FIGURE 3.6

2. Pressing **1** KEY, **Zero CH4**, initializes the Zero Methane procedure (Figure 3.7). A methane percentage will not display until the Infrared (IR) Bench warms up. A plus or minus sign may appear on the far left of the display. This symbol may be ignored.

DO NOT PERFORM THIS PROCEDURE IN THE PRESENCE OF METHANE.

FIGURE 3.7



3. If using air to zero methane, press the **5** KEY, **Pump**, to turn on the GEM-500™ sample pump. Calibration gas hoses should not be attached to the GEM-500™ during this procedure. Allow the pump to run for two minutes or until gas reading stabilizes. If using oxygen calibration gas to zero methane, see step 3-6 in the Span Methane section then return to step 2 of this section.

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

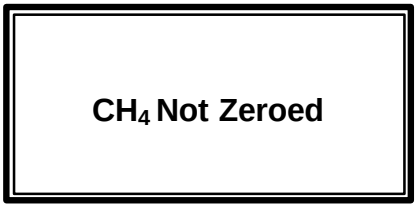


FIGURE 3.8

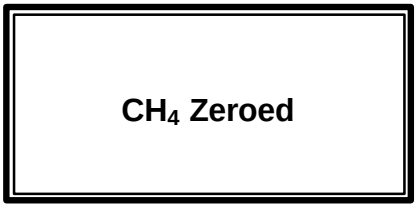
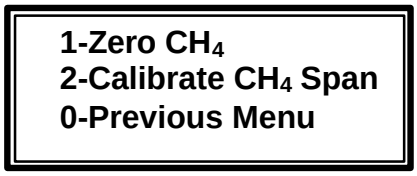


FIGURE 3.9

5. If the CH_4 Not Zeroed screen (Figure 3.8) is displayed, return to the Gas Calibration screen by pressing the **0** KEY, **Exit**. Verify methane is not present and re-zero the methane. If the problem continues, proceed to instructions contained in this section for Factory Settings.

6. If the CH_4 Zeroed OK screen (Figure 3.9) is displayed, press **0** KEY, **Exit,** to return to the Methane Calibration Screen (Figure 3.10). Press **2** KEY, **Calibrate CH_4 Span**, to proceed to the next section.

FIGURE 3.10



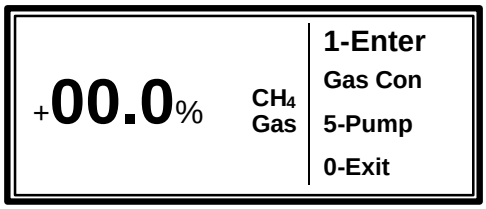
Methane (CH4) Calibration

1. Read the warning below before proceeding with the next steps.

WARNING! The GEM-500™ is not certified intrinsically safe. The following procedure MUST NOT be performed in a confined area (such as well vaults, underground or indoors) or where there is any possibility of sparking or ignition. Ensure that the exhaust port is not blocked and is properly vented away from you. Ensure that no leaks are present. Unless all above conditions are maintained, an explosion could occur resulting in serious injury or death.

2. After selecting the **2** KEY, **Calibrate CH_4 Span**, on the Methane Calibration screen, the following CH_4 Span screen appears (Figure 3.11).

FIGURE 3.11



3. Connect the ¼" tubing from the calibration gas regulator/flow meter to the GEM-500™ gas sample/impact port (Figure 1.1). It is **NOT** recommended to use the water trap sample tubing for calibration. Attach tubing to the exhaust port of the GEM-500™ and direct the exhaust flow away from you and out of the immediate area.

4. Press the **5** KEY, **Pump**, on the CH_4 Span screen to turn on the sample pump.

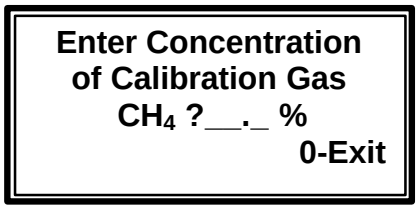
5. If not using CES-LANDTEC supplied regulator, make sure the calibration gas flow is 500 cc and pressure is no greater than 2 psig.

6. Allow the calibration gas to flow into the GEM-500™ for one minute or until instrument gas reading stabilizes.

7. After one minute, read the methane gas concentration on the screen. It should be stable and not changing more than a few tenths of one percent at the 15% gas level or 2% at the higher gas level.

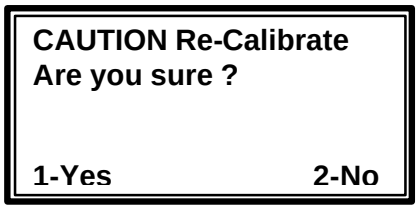
8. Press the **1** KEY, **Enter Gas Con**, and input the methane concentration of the calibration gas using the keyboard of the GEM-500™ (Figure 3.12). Enter the percentage as three digits XX.X%. (50% methane would be input as 500.) The GEM-500™ will automatically place a decimal point in the proper position. After the percentage is entered, press **0** KEY, **Exit**.

FIGURE 3.12



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

FIGURE 3.13



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

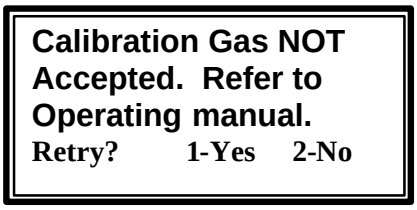


FIGURE 3.14

FIGURE 3.15

11. If the Calibration OK screen flashes (Figure 3.15), proceed to Step 13.

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

13. If required, proceed to $C0_2$ calibration Step 1.

14. Press the **0** KEY twice. Turn off the calibration gas cylinder. Remove the calibration gas hose attached to the gas sample/static pressure port on the GEM-500™. Leave the exhaust port hose connected and turn on the pump and allow it to purge the GEM-500™ with air for 60 seconds. Press the **5** KEY, **Pump**, again. The pump turns off and automatically returns to the Calibrate Methane screen.

15. If there is no further calibration, press the **0** KEY, **Exit**, to return to the Gas Calibration screen. Field calibration has successfully been completed.

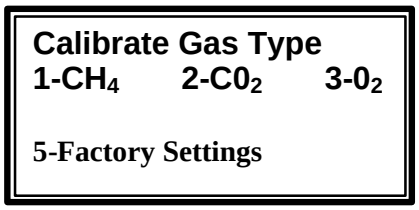
Carbon Dioxide (CO_2) Calibration

1. Because the cylinder used in this calibration contains methane, the following warning must be adhered to before proceeding with the steps below.

> **WARNING!** **The GEM-500™ is not certified intrinsically safe. The following procedure MUST NOT be done in a confined area (such as well vaults, underground or indoors) or where there is any chance of sparking or ignition. No smoking, exposed lighting, or other sources of ignition should be in the area. On the GEM-500™, ensure that exhaust port is not blocked and properly vented away from you. Ensure that no leaks are present. Unless all above conditions are maintained, an explosion could occur resulting in serious injury or death.**

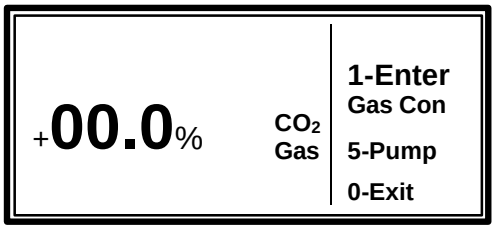
2. Press the **2** KEY, **CO_2 Calibration**, on the Gas Calibration screen (Figure 3.16).

FIGURE 3.16



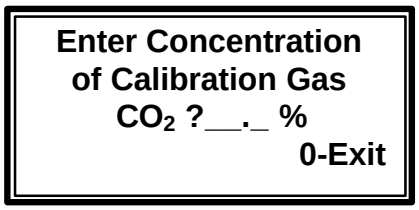
3. There is no Zero CO_2 function as there is in the methane or oxygen calibration procedures. The following CO_2 Span screen appears (Figure 3.17).

FIGURE 3.17



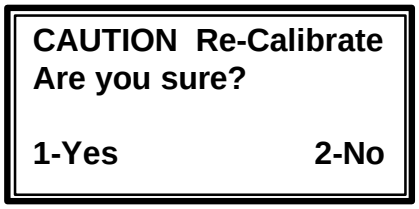
4. Press the **1** KEY, **Enter Gas Con**, to access the Enter Concentration screen (Figure 3.18). Input the percentage of Carbon Dioxide concentration of the calibration gas as three digits XX.X%. (40% Carbon Dioxide would be input as 400) The GEM-500™ will automatically place a decimal point in the proper position. After the percentage is entered, press the **0** KEY, **Exit**.

FIGURE 3.18



5. The next screen is the Caution Re-Calibrate screen (Figure 3.19).

FIGURE 3.19



6. Press the **1** KEY, **Yes**, and one of the two following messages will appear (Figure 3.20 or Figure 3.21). If the Calibration OK screen appears, go to step 9 below.

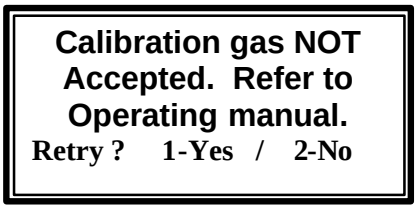


FIGURE 3.21

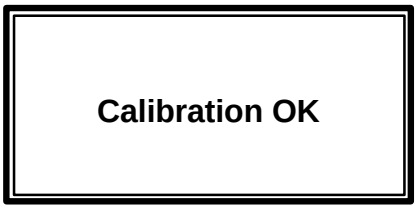


FIGURE 3.22

7. If the Calibration gas NOT Accepted screen appears, several things could have happened. Press the **1** KEY, **Yes,** and enter the percentage of Carbon Dioxide in the calibration gas. It is possible that the wrong percentage was input. If on a second attempt this does not work, press the **0** KEY, **No**, to return to the Gas Calibration screen and turn to the Factory Settings section for additional instructions.

8. If O_2 is to be zeroed, proceed to O_2 Calibration, step 1.

9. If no further calibration is needed, press the **0** KEY to **Exit** and return to the CO_2 Calibration screen shown on the prior page.

10. Turn off the calibration gas. Remove the calibration gas hose attached to the gas sample/static pressure port on the GEM-500™. Leave the exhaust port hose connected. Allow the GEM-500™ to purge with air for 60 seconds. Press the **5** KEY, **Pump**, to turn off the pump; then press the **0** KEY, **Exit**, to return to the Gas Calibration screen.

11. You have successfully completed a Carbon Dioxide Field Calibration. Immediately proceed to the next function, O_2 Calibration.

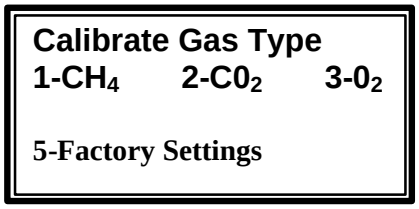
Oxygen (O_2) Calibration - Zero O_2

1. There are two calibration gas mixtures used for the calibration of oxygen. The methane/ Carbon Dioxide calibration gas previously used to calibrate the methane and Carbon Dioxide is used to Zero oxygen. A second calibration gas with a mixture of oxygen and nitrogen is used to set the oxygen level in the next section. Because the calibration gas used contains methane, the warning below must be followed before proceeding with the following steps.

> **WARNING! The GEM-500™ is not certified as intrinsically safe. The following procedure MUST NOT be done in a confined area (such as well vaults, underground and indoors) or where there is any chance of sparking or ignition. No smoking, exposed lighting, or other sources of ignition should be in the area . On the GEM-500™, ensure that exhaust gas port is not blocked and properly vented away from you. Ensure that no leaks are present. Unless all above conditions are maintained, an explosion could occur resulting in serious injury or death.**

2. Press Key 3-O_2 Calibration on the Gas Calibration Screen (Figure 3.22).

FIGURE 3.22

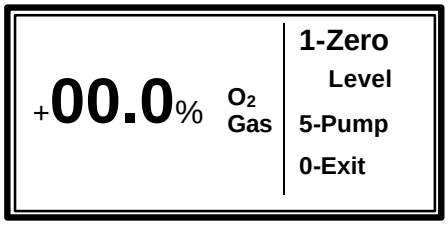


3. The Oxygen Calibration Screen will appear (Figure 2.23).

FIGURE 3.23

4. Pressing the **1** KEY, **Zero O_2**, will bring up the Zero Oxygen screen (Figure 3.24).

FIGURE 3.24



5. Read the oxygen Gas Concentration on the screen. It should be very near 00.0% and not changing more than a few tenths of one percent.

   Note: Even if the screen displays 00.0% oxygen, proceed with step 6 below, the Oxygen must be zeroed anyway.

6. Press the 1 KEY, Zero level, and one of the following screens (Figure 3.25 or Figure 3.26) is displayed for three seconds before returning to the Zero Oxygen screen shown above.

FIGURE 3.25

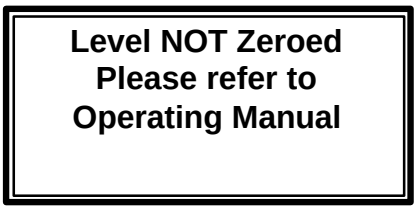


FIGURE 3.26

7. If the O_2 Zeroed screen displays, proceed to step 9 below.

8. If the Oxygen NOT Zeroed screen displays, return to the Oxygen Calibration screen. Check that the calibration gas contains no oxygen. Connect the correct gas and re-zero the oxygen. If the problem continues, proceed to instructions contained in this section for Factory Settings.

9. If the Oxygen Zeroed OK screen appears, turn off the calibration gas.

10. Remove the hose from the flow regulator to the GEM-500™. Let the pump run for at least 60 seconds to purge the instrument with air. Press the **5** KEY, **Pump**, to turn off the pump.

11. Press the **0** KEY, **Exit**, to return to the Oxygen Calibration screen and proceed to oxygen span.

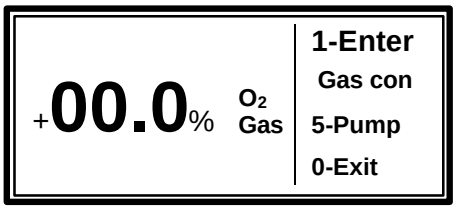
O_2 Calibration - O_2 Span

1. From the Gas Calibration screen, press the 3 KEY, zero O_2, and the Oxygen Calibration screen (Figure 3.27) will appear.

FIGURE 3.27

2. Press the **2** KEY, **Calibrate O_2 Span**, on the Oxygen Calibration screen will appear (Figure 3.28).

FIGURE 3.28



Note: The calibration gas used in this procedure is a mixture of oxygen and nitrogen. The oxygen concentration by volume can be 2-5% with the remainder N_2.

3. Change the calibration gas mixture to Oxygen/Nitrogen. Install the regulator/flow meter on the new calibration gas mixture as directed previously in *Setting Up the Equipment*, page 4. Check and adjust the gas flow to 500 cc and pressure to 2 psig. Turn off the gas.

4. Connect the ¼" tubing from the calibration gas regulator/flow meter to the GEM-500™ gas sample/static pressure port (Figure 1.1). Attach tubing to the exhaust port of the GEM-500™, if not already attached, and direct the exhaust away from you and out of the immediate area.

5. Press the **5** KEY, **Pump**, displayed on the O_2 Span screen shown above. (Figure 3.28)

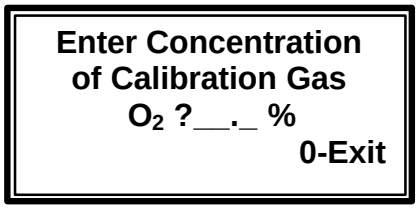
6. Turn on the calibration gas mixture of oxygen and nitrogen.

7. Allow the calibration gas to flow into the GEM-500™ for 60 seconds.

8. After 60 seconds, read the Oxygen Gas Concentration on the screen. It should be stable and not changing more than a few tenths of one percent.

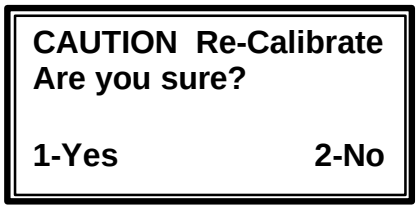
9. Press the **1** KEY, **Enter Gas Con**, and input the oxygen concentration of the calibration gas (typically 4%) using the keyboard of the GEM-500™ (Figure 3.29). Enter the percentage as three digits XX.X%. (4% O_2 would be input as 040) The GEM-500™ will automatically place a decimal point in the proper position. After the percentage is entered, press the **0** KEY to **Exit**.

FIGURE 3.29



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

FIGURE 3.30



11. Press the **1** KEY, **Yes**, and one of two screens will appear (Figure 3.31 or Figure 3.32).

12. If the Calibration OK Screen appears proceed to step 15.

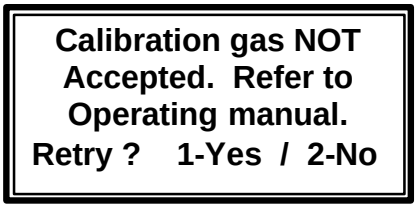


FIGURE 3.31

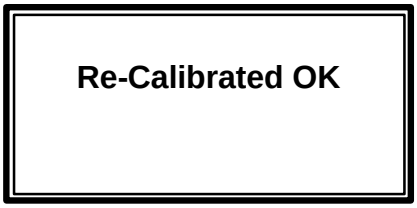


FIGURE 3.32

13. If the Calibration Gas NOT Accepted screen appears, press the **1** KEY, **Yes,** and re-enter the percentage of oxygen in the calibration gas. It is possible the wrong percentage was input. If, on a second attempt, this has not worked, press the **0** KEY, **No**, and return to the Oxygen Calibration Menu. Start the procedure over again. Zero and then calibrate the oxygen. If there are still problems, proceed to Factory Settings in this section.

14. Press the **0** KEY, **Exit**, to return to the Oxygen Calibration screen shown on the following page.

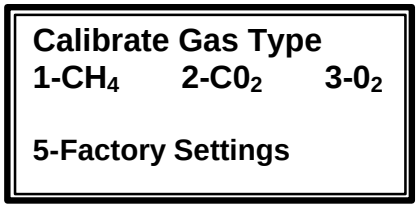
15. Turn off the calibration gas. Remove the calibration gas hose attached to the gas sample/static pressure port on the GEM-500™.

Factory Setting Calibrations

As previously mentioned, it is sometimes necessary to return the GEM-500™ to factory settings before trying to field calibrate the unit. If for some reason sampling conditions change radically, overall accuracy of the GEM-500™ can be improved by returning to factory settings and then re-calibrating. This procedure will overwrite previous field calibrations.

1. From the Gas Calibration screen, Figure 3.34, press the **5** KEY, **Factory Settings**.

FIGURE 3.34



2. The Caution screen, Figure 3.35, shown below will be displayed. If the **0** KEY, **No**, is pressed, the Not Set screen (Figure 3.36) appears for two seconds, then the Gas Calibration screen returns.

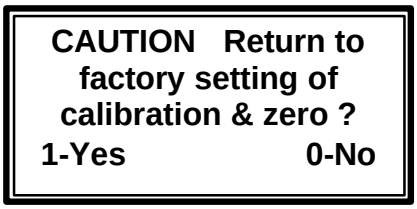


FIGURE 3.35

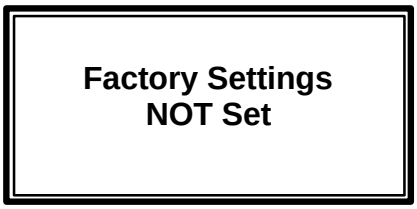


FIGURE 3.36

3. Press **1** KEY, **Yes**, and the Factory Setting Set OK screen (Figure 3.37) is displayed for three seconds before returning to the Gas Calibration screen shown in step 1.

FIGURE 3.37

4. After loading the factory settings, the methane and oxygen calibration **MUST BE RE-ZEROED PRIOR TO USE.** After completing the gas calibrations, the GEM -500™ is ready to read gas levels. Go to Chapter 5 of this manual, Read Gas Levels.

After Completing Gas Calibrations

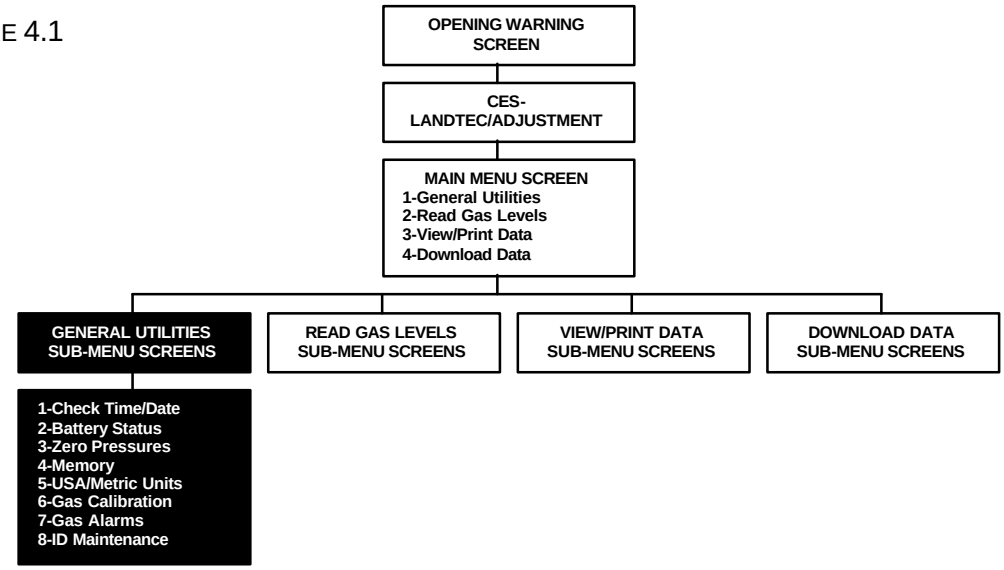
Additional general utilities functions should be addressed after the GEM-500™ is field calibrated. These functions are available on the General Utilities menu and include:

- **Check Time/Date** Assures that the data collected is properly time/date stamped.
- **Check Memory** Assures that there is enough memory space in the GEM-500™ to store the readings you plan to take. Otherwise the memory will need to be cleared. (See page 28, chapter 4)
- **Set Gas Alarms** Alerts the user to unusual gas conditions.

Chapter 4 - General Utilities Functions

General Utilities Screen Tree Diagram

FIGURE 4.1



General Utilities Menu

The General Utilities functions are displayed on three subsequent screens. (Figures 4.2, 4.3, & 4.4) Any of the functions may be selected while any of the three screens is displayed. Use the **9** KEY, **More**, to move from one screen forward to the next. Press the **0** KEY, **Exit**, to return to the main menu.

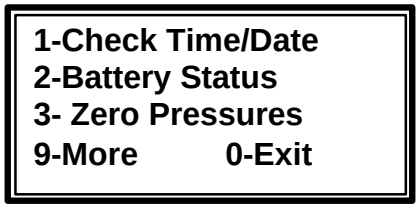


FIGURE 4.2

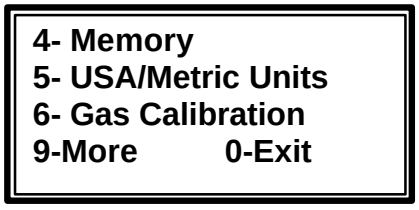


FIGURE 4.3

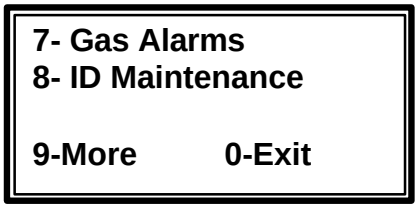


FIGURE 4.4

General Utilities Functions

1. **CHECK TIME/DATE:** Set or check time and date.

2. **BATTERY STATUS:** Graphic display of the percentage of power remaining in the batteries.

3. **ZERO PRESSURES:** Zero pressure transducers.

4. **MEMORY:** Check available memory and facilitate clearing of all data and ID information.

5. **USA/METRIC UNITS:** Select either USA standard (Imperial) or metric (SI) measurement units.

6. **GAS CALIBRATION:** Field calibrate methane, Carbon Dioxide and oxygen with special gas mixtures for increased accuracy.

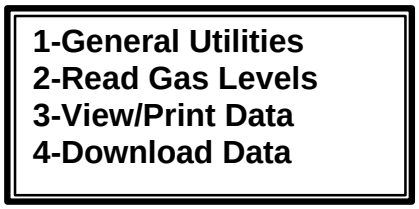
7. **GAS ALARMS:** Set gas alarm levels.

8. **ID MAINTENANCE:** View, enter, edit and delete well ID information.

Check Time/Date
There is an internal clock and calendar in the GEM-500™ powered by a secondary battery that maintains the clock function when the GEM-500™ is turned off. As each reading is stored in the GEM-500™, it is time and date stamped. Both the clock and calendar are set by CES-LANDTEC, however, they should be reset to the local time zone and checked weekly thereafter.

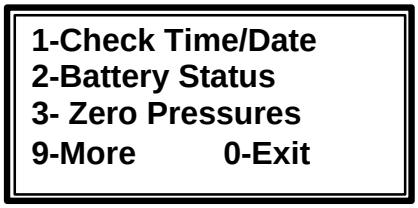
1. From the Main Menu, press the **1** KEY, **General Utilities**, for the General Utilities Sub-Menu screen.

FIGURE 4.5



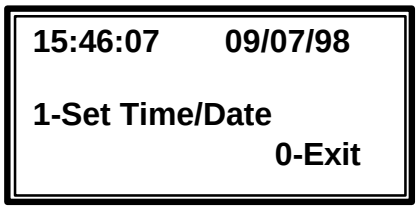
2. (Figure 4.6). Press the **1** KEY, **Check Time/Date**, on the General Utilities Sub-Menu screen to access the Check Time/Date function.

FIGURE 4.6



3. Press the **1** KEY, **Set Time/Date**, to proceed. (Figure 4.7)

FIGURE 4.7

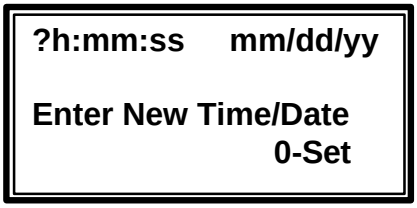


4. The time and date are displayed on the top line of the screen. A 24-hour clock or military time is used. If the time is after 12 noon, add 12 to the hour to convert it to the 24-hour format. Example: 3 p.m. is 12+3 = 15:00 hours. The time format is Hours: Minutes. Seconds. The date format used in the example is in U.S. calendar format with the month first and day second (mm/dd/yy).

5. If the time and date are accurate, end procedure by pressing the **0** KEY to **Exit** to the General Utilities Sub-Menu screen. If the time or date, or both, is wrong, press the **1** KEY, **Set Time/Date**.

6. Set the time and date by entering numbers from the GEM-500™ keyboard. For setting the time hh = hours, mm = minutes, and ss = seconds. The date is entered in the U.S. calendar format where mm = months, dd = days, and yy = years. When finished, press the **0** KEY to **Set**.

FIGURE 4.8



NOTE: If it is necessary to correct an entry error, use the 0 KEY as a Backspace Key by holding it down for 1 second. In normal use, the 0 KEY is quickly pressed and released.

7. After setting, one of two screens displays. If the date is valid, Figure 4.9 displays for three seconds. If the time or date is invalid, Figure 4.10 displays. The time or date is invalid when impossible numbers are entered into the field. For example, mm=15 is an invalid month. Return to step 5 above and reenter the correct time or date as instructed.

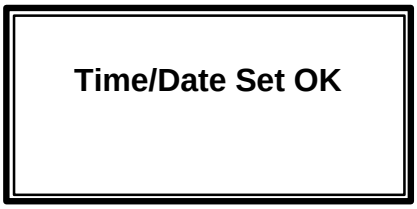


FIGURE 4.9

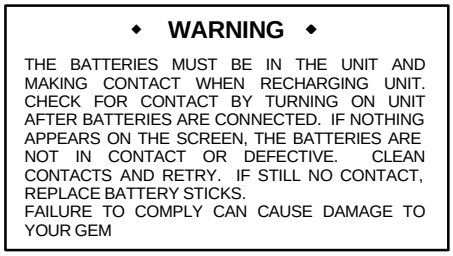
FIGURE 4.10

Battery Status

A Fast charger came with the GEM-500™. The Fast charger takes approximately 2.5 hours for a 90% charge, the charger will automatically switch to a slow charge after this time to prevent damage to the batteries. The fast charger may be left connected overnight without damage to the NiCad batteries. When the GEM-500™ is fully charged, it should be able to operate continuously for 6-8 hours depending upon the battery used and how it was charged. The GEM-500™ may be operated with Alkaline batteries, however, **ONLY** the NiCad batteries can be recharged. If the GEM-500™ is without batteries for more than 30-45 minutes, memory/data loss will occur and the internal back backup battery will run down. If this occurs, the unit will need to be returned to the lab for service.

WARNING! DO NOT TRY TO RECHARGE ALKALINE BATTERIES – DAMAGE TO THE UNIT WILL OCCUR. (Figure 4.11)

Figure 4.11



1. From the Main Menu, press the **1** KEY, **General Utilities**, for the General Utilities Sub-Menu screen.

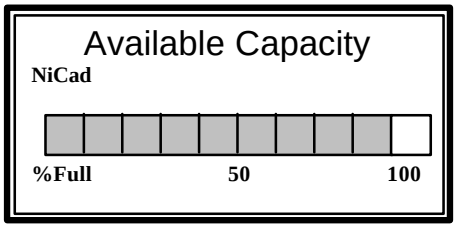
2. Press the **2** KEY, **Battery Status**, on the General Utilities Sub-Menu screen as shown in Figure 4.12.

FIGURE 4.12

.

3. The battery status graph displays the percentage of power remaining in the battery. When the graph reads 20-30%, a battery symbol indicator displays on the upper right of the screen, indicating approximately 1 hour of use remaining. When finished viewing the screen, press the **0** KEY to **Exit**.

FIGURE 4.13



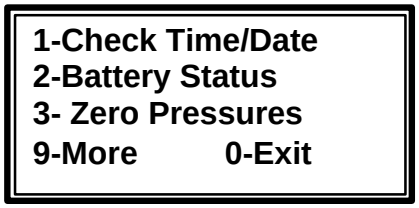
Zero Pressures
The GEM-500™ measures atmospheric pressure as part of the LFG flow calculation. To properly measure pressure and the vacuum used in landfill gas extraction systems, the pressure transducers must be reset to zero each time before taking a pressure or vacuum reading.

This procedure may also be done prior to doing any **Read Gas Levels** because the **Zero Pressures** function is also contained on the **Read Gas Levels** Sub-Menu screen as shown in Chapter 5.

1. From the Main Menu, press the **1** KEY, **General Utilities**, for the General Utilities Sub-Menu screen.

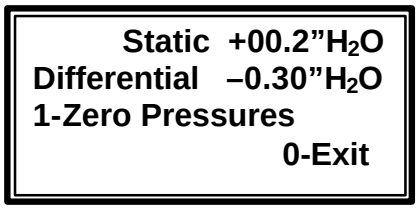
2. Press the **3** KEY, **Zero Pressures**, on the General Utilities Sub-Menu screen as shown in Figure 4.14.

FIGURE 4.14



3. Figure 4.15 displays the current readings of the static and differential pressure transducers. If both pressures do not read 00.0 **DISCONNECT ANY HOSES** ATTACHED TO THE GEM-500™ and press **1** KEY, **Zero Pressures**.

FIGURE 4.15



Note: Units displayed are inches of water column or (millibar) MB depending on measurement unit selected (USA or metric).

4. After the pressures have been zeroed, Figure 4.16 appears for three seconds. The Zero Pressures screen (Figure 4.15) then redisplays.

FIGURE 4.16

5. Press the **0** KEY, **Exit,** to return to the General Utilities Sub-Menu screen.

Memory

CAUTION: THIS FUNCTION CAN ERASE ALL STORED DATA. ONCE CLEARED, THE DATA CANNOT BE RECOVERED.

All well ID's and readings are stored in the GEM-500™'s memory. Eventually the memory becomes full. After each day's readings are completed, the remaining amount of memory should be checked. Normally, the readings for the day are downloaded to a computer. Downloading copies the information but does not clear it out of memory. That must be done manually, as described below. If the memory becomes full, a **MEMORY FULL** message displays. When this happens, the memory must also be manually cleared.

The GEM-500™ can store many well ID's. It is, therefore, possible to use it on several landfills.

1. From the Main Menu, press the **1** KEY, **General Utilities**, for the General Utilities Sub-Menu screen.

2. Since the **Memory** function is not on the first General Utilities screen, press the **9** KEY, **More**, for the next screen, or enter **4** at this screen.

3. Press the **4** KEY**, Memory**, on the General Utilities Sub-Menu screen (Figure 4.17).

FIGURE 4.17

```
4- Memory
5- USA/Metric Units
6- Gas Calibration
9-More        0-Exit
```

4. The amount of available memory left in the GEM-500™ displays on The Number of Free Readings screen. (Figure 4.18) Three choices may be made on this screen. Press the **1** KEY, **Clear Readings**, to erase all gas/data readings but leave the ID's. Press the **2** KEY, **Clear ID Info**, to erase all ID numbers and the associated readings that have accumulated in the GEM-500™ from the ID MAINTENANCE and READ GAS functions. Press the **0** KEY, **EXIT**, to ESCAPE from the procedure and return to the General Utilities Sub-Menu screen.

FIGURE 4.18

```
  0479 Free Readings
1-Clear Readings
2-Clear ID Info
              0-Exit
```

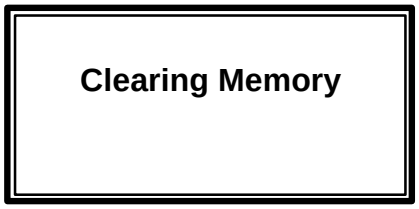
CAUTION: THIS STEP ERASES STORED DATA. YOU MAY WANT TO DOWNLOAD THE DATA FIRST SO IT IS NOT LOST.

5. After making your choice from the screen above, the Caution screen displays (Figure 4.19). As a final safety check, the code **0102** must be input from the GEM-500™ keyboard to clear the memory. **IF YOU DECIDE NOT TO CLEAR THE MEMORY AT THIS POINT, TURN THE GEM-500™ OFF BY PRESSING THE RED ON/OFF KEY** or enter an incorrect code then press the **0** KEY, **EXIT**, to return to the Memory screen. Do not input 0102 unless you want to clear the memory.

FIGURE 4.19

6. Enter 0102 from the keyboard and press the **0** KEY, Exit. The Clearing Memory screen displays for 3 seconds if the memory was erased.

FIGURE 4.20



After the Clearing Memory screen displays, the Number of Free Readings screen (Figure 4.18) redisplays. Press the **0** KEY to **Exit** to the General Utilities Menu screen.

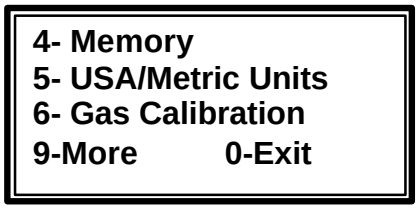
USA/Metric Units
The GEM-500™ can store and display data in 2 units of measure, Metric (SI) or Imperial (USA). This function allows setting the unit of measure.

1. From the Main Menu, press the **1** KEY, **General Utilities**, for the General Utilities Sub-Menu screen.

2. Since the **USA/Metric Units** function is not on the first General Utilities screen, press the **9** KEY, **More**, for the next screen, or enter **5** at this screen.

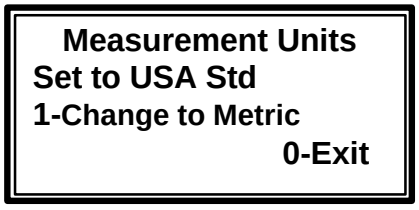
3. Press the **5** KEY, **USA/Metric Units**, on the General Utilities Sub-Menu screen (Figure 4.21).

FIGURE 4.21



4. The Measurement Units screen (Figure 4.22) displays how the GEM-500™ is currently set (Set to USA Std or Set to Metric). Press the **1** KEY to change from USA Std to Metric. (This setting acts as a toggle switching from one to the other.) If the GEM-500™ is currently displaying USA Std measurement units (Imperial — Btu's, Standard Cubic Feet, Fahrenheit temperatures, etc.) it switches to Metric and vice versa. When the GEM-500™ is set to the correct measurement unit, press the **0** KEY, **Exit,** to return to the General Utilities Sub-Menu screen.

FIGURE 4.22



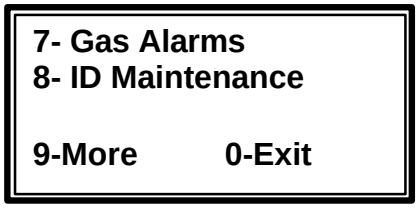
Gas Calibration
Please refer to Chapter 2 - Field Calibration for all information and instructions relating to the Gas Calibration function.

Gas Alarms
The GEM-500™ has two alarm options that can warn the operator if a gas sample contains concentrations of **Methane below** established levels or **Oxygen above** preset levels. If the alarms are activated, there is a beeping and the affected gas blinks when displayed on the Read Gas Levels screen.

1. From the Main Menu, press the **1** KEY, **General Utilities**, for the General Utilities Sub-Menu screen.

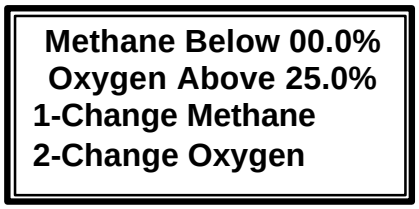
2. Since the **Gas Alarms** function is not on the first General Utilities screen, press the **9** KEY, **More**, for the next screen, or enter **7** at this screen. (Figure 4.23)

FIGURE 4.23



3. The Gas Alarm Set screen displays the alarm set point of both methane and oxygen and presents the functions to change them. (Figure 4.24). Chose one to change the methane alarm set point or two to change the oxygen alarm set point. If no change in alarm set points is required, press the **0** KEY, **Exit**, to return to the General Utilities Sub-Menu screen.

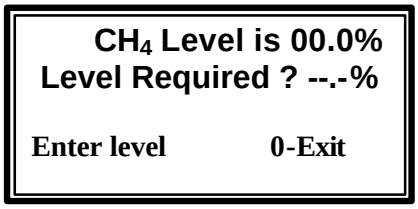
FIGURE 4.24



NOTE: To turn off alarms, set methane alarm to 00.0% and oxygen alarm to 25.0%.

4. If the **1** KEY, **Change Methane**, is pressed, the Methane Alarm Set Point screen displays. (Figure 4.25) Using the numbered keys on the GEM-500™ keyboard, input the new alarm level for methane (CH_4). All three digits must be entered (XX.X%). The decimal point is automatically inserted. Press the **0** KEY to save and **Exit**.

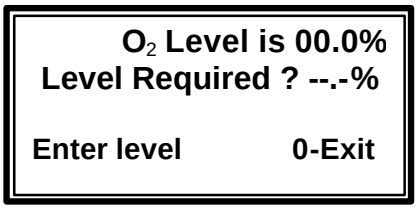
FIGURE 4.25



Note: If the GEM-500Ô receives CH_4 at or below this set point during the Read Gas Levels procedure, an audible alarm sounds to alert the operator.

5. If the **2** KEY, **Change Oxygen**, is pressed, the Oxygen Alarm Set Point screen displays. (Figure 4.26). Using the numbered keys on the GEM-500™ keyboard input the new alarm level for oxygen (O_2). All three digits must be entered (XX.X%). The decimal point is automatically inserted. Press the **0** KEY to save and **Exit.**

FIGURE 4.26



Note: If the GEM-500Ô receives O_2 at or above this set point during the Read Gas Levels procedure, an audible alarm sounds to alert the operator.

6. Press the **0** KEY**, Exit,** to return to the General Utilities Sub Menu screen.

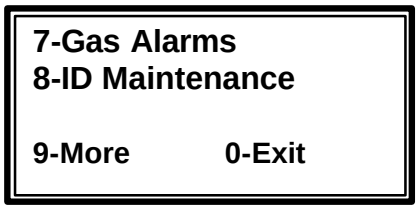
ID Maintenance

Each monitoring point on a site can be assigned a unique ID code using the ID Maintenance function. This code **must** be eight characters long. The characters can be any combination of letters and numbers. Typically, the landfill name or an abbreviation is used for the first four characters. After an ID code is entered (Step 4), the type of flow device (Accu-Flo, pitot tube, orifice plate or user defined) used at that ID location must also be entered (Step 5). Depending on the flow device selected, either no data, pipe ID (inner diameter), or both orifice and pipe ID size must also be entered.

1. From the Main Menu, press the **1** KEY, **General Utilities**, for the General Utilities Sub-Menu screen.

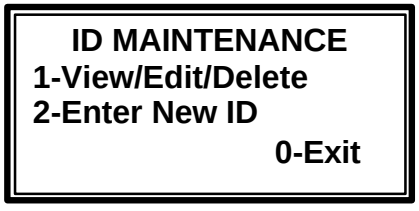
2. Since the **ID Maintenance** function is not on the first or second General Utilities screens, press the **9** KEY, **More**, twice or enter **8** at this screen. (Figure 4.27)

FIGURE 4.27



The ID Maintenance screen presents two options. If a well already has an ID number, option one, View/Edit/Delete should be accessed (Step *, Figure 4.*) If a well has no ID assigned in the GEM-500™, press the **2** KEY to **Enter New ID**.

FIGURE 4.28



Both numbers and letters can be input on the Enter ID screen. Use the **BLUE ¦** KEY to switch (toggle) between numbers and letters. See Keyboard Information in the Getting Started Section at the beginning of this Manual.

- For numbers, press the keypad **Number** KEYS (0-9). (Figure 4.29)
- For letters, press the **1** KEY (**UP ARROW**) or **6** KEY (**DOWN ARROW**) to scroll through the alphabet until the letter of choice appears. Press the **0** KEY to select the letter. (Figure 4.30)

After the final character is entered, the unit displays **0-Cont**. Press the **0** KEY if the ID is correct and ready to enter; otherwise, press and **hold** the **0** KEY to backspace and make corrections.

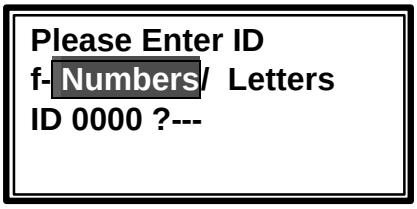


FIGURE 4.29

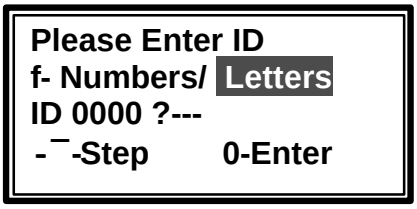
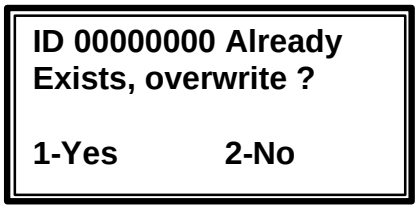


FIGURE 4.30

Note: When entering the very first well ID, four zeros will hold the first four places in the ID number. To replace these zeros with the well ID, use the 0 KEY to backspace over them by holding it down for more than a second. Then enter the first four characters of the well ID. These first four characters default to the second well ID entered, saving the user the time of reentering for each well.

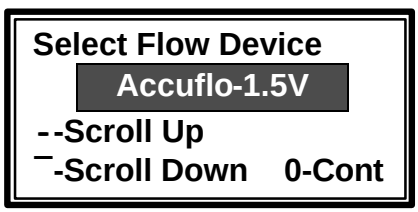
5. If an existing code is entered, the unit will ask if you want to overwrite. (Figure 4.31) If so, press the **1** KEY**, Yes**, to overwrite. If a mistake was made and an overwrite is not desired, press the **2** KEY, **No**, to return to the ID Maintenance screen. (Figure 4.28)

FIGURE 4.31



6. A well flow device is selected in the Flow Device screen. This selection is necessary for the GEM-500™ to be able to calculate flow when readings are taken. Use the **1** KEY (**UP ARROW**) or the **6** KEY (**DOWN ARROW**) to scroll through the choices listed in Figure 4.33. Once the desired flow device is located in the shaded selection window, press **0** to select and Continue. (Figure 4.32)

FIGURE 4.32



Note: Selection of User Input allows the entry of flow in SCFM, if known. Those without a flow device may wish to use this selection to record velocity or other relevant data. (For example, using a Kurz meter.)

FIGURE 4.33

Accuflo–1.5V (1½" Accu-Flo Model 150 Vertical Wellhead)
Accuflo–1.5H (1½" Accu-Flo Model 150 Horizontal Wellhead)
Accuflo–2V (2" Accu-Flo Model 200 Vertical Wellhead)
Accuflo–2H (2" Accu-Flo Model 200 Horizontal Wellhead)
Accuflo–3V (3" Accu-Flo Model 300 Vertical Wellhead)
Accuflo–3H (3" Accu-Flo Model 300 Horizontal Wellhead)
Orifice Plate (Orifice diameter and pipe inner diameter required)
Pitot Tube (Pipe ID required)
User Input (Pipe ID required)

7. If an Orifice Plate, Pitot Tube or User Input flow device is selected, additional information is required. If the pipe or orifice diameter screen appears, input the required size as necessary. Insert inches or centimeters (depending on whether US or Metric Units were selected on the USA/Metric Units screen). The unit uses XX.XX as the format and automatically enters the decimal point. Press the **0** KEY to enter and Continue.

FIGURE 4.34

Enter Pipe ID

?-.-- Inches

8. The ID Stored OK Screen displays for three seconds (Figure 4.35) then the ID Maintenance displays so the next ID can be entered (Figure 4.36).

FIGURE 4.35

ID Stored OK

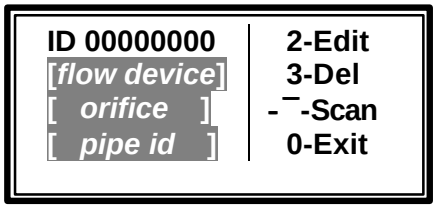
9. To View/Edit/Delete ID information, select the **1** KEY. (Figure 4.36)

FIGURE 4.36

ID MAINTENANCE
1-View/Edit/Delete
2-Enter New ID
0-Exit

10. The Well ID screen displays the Well ID and the associated flow device. The orifice and pipe data is also displayed if associated with a flow device. To scroll through the ID's stored in memory, use the **1** KEY, (**UP ARROW**) or the **6** KEY (**DOWN ARROW**). Press the **0** KEY to **Exit**.

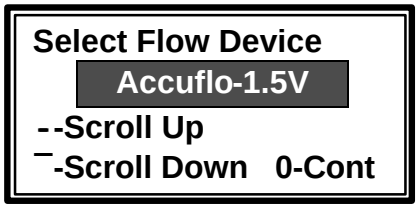
FIGURE 4.37



11. To edit the chosen Well ID information, press the **2** KEY, **Edit**. Use the **1** KEY (**UP ARROW**) or the **6** KEY (**DOWN ARROW**) to scroll through the choices listed in Figure 4.33. Once the desired flow device is located in the shaded selection window, press **0** to select and **Continue**. Press the **0** KEY, **Exit**, to return to the ID Maintenance screen. (Figure 4,38)

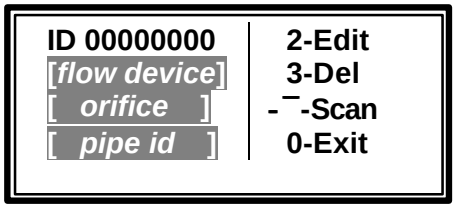
NOTE: Once the 2 KEY is pressed, the original flow device is erased and new data must be entered.

FIGURE 4.38



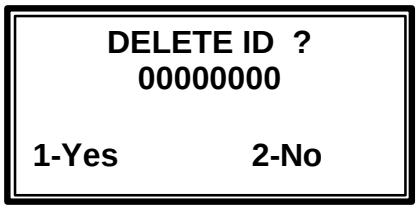
12. To delete a Well ID and the associated flow device, press the **3** KEY, **Del**ete.

FIGURE 4.39



13. The Delete ID screen displays the Well ID chosen and asks for confirmation of the delete. If this Well ID ***should not*** be deleted, press the **2** KEY, **No**, (Figure 4.40). The unit cancels the delete command and returns to the Well ID screen (Figure 4.39). If this Well ID ***should*** be deleted, press the **1** KEY, **Yes**. The ID is deleted and the unit returns to the Well ID screen (Figure 4.39). Press the **0** KEY to **Exit** to the ID Maintenance screen.

FIGURE 4.40



14. Before leaving this section, store at least three ID's. These will be necessary for use in the following chapters.

Chapter 5 - Read Gas Levels

This section instructs the operator in how to use the GEM-500™ to collect data from LFG extraction system wells and other monitoring points. Several things should be done prior to beginning to collect data readings with the GEM-500™.

The operator should have performed the following:

- Check the TIME/DATE. (See Chapter 4 - General Utilities)
- Charge the unit's factory provided nickel cadmium batteries. (See Chapter 8 - Maintenance)
- Perform a Field Calibration on the unit. (See Section 3 - Field Calibration)

The GEM-500™ is a sensitive measuring instrument. Vibration, shock, and great temperature changes can alter the field calibration. It is suggested that a field calibration be performed just prior to using the instrument at the site. Additional calibration is sometimes necessary in the field during the day.

WARNING! Review the warnings given in the beginning of this manual. The GEM-500™ is NOT to be used in dangerous, explosive or confined atmospheres. Do not use the GEM-500™ inside vaults, manholes, trenches or indoors. Do NOT block the exhaust port. If the exhaust port is blocked while the pump is operating, the pressure could force the unit to over-pressurize and damage the internal components and the case.

GEM-500™ Hose and Wellhead

The proper hoses must be connected from the GEM-500™ to the wellhead in order to collect data. As mentioned in the Getting Started Chapter, the clear tubing with the external filter/water trap assembly is attached to the static pressure port on the GEM-500™ (Figure 5.1). The almond colored male quick connect goes on the end of this tubing to read the static pressure on the Accu-Flo Wellhead and the blue hose is connected to the impact port of the GEM-500™.

On the following pages are examples of the Accu-Flo Wellhead, both vertical and horizontal models. Note the locations of the Static Pressure Port, Impact Pressure Port, Temperature Gauge, and Gas Sample Port.

Note: Five O-rings for quick disconnect fittings are supplied with Unit. Replace O-Rings when necessary because oxygen will be drawn into sample if O-rings are damaged. The GEM-500™ pump will pull up to 80" of vacuum.

FIGURE 5.1

1. Static Pressure/Sampling Port—Measures static pressure when connected to wellhead static pressure port by tubing. Always use water trap assembly.

2. Impact Pressure Port—Measures impact pressure when connected to wellhead impact pressure port by tubing.

3. Exhaust Port—This port must be kept clear. If blocked while operating, over-pressurization and damage to internal components and case could occur.

4. Data Port - Used for Temperature Probe, POD, downloading data, and battery recharging.

CES-LANDTEC Horizontal Accu-Flo Wellhead

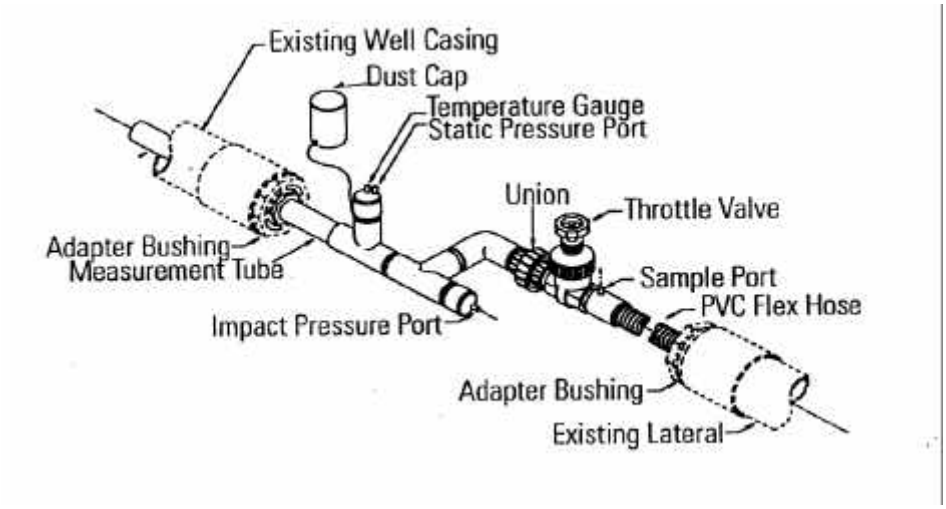


FIGURE 5.2

CES-LANDTEC Vertical Accu-Flo Wellhead

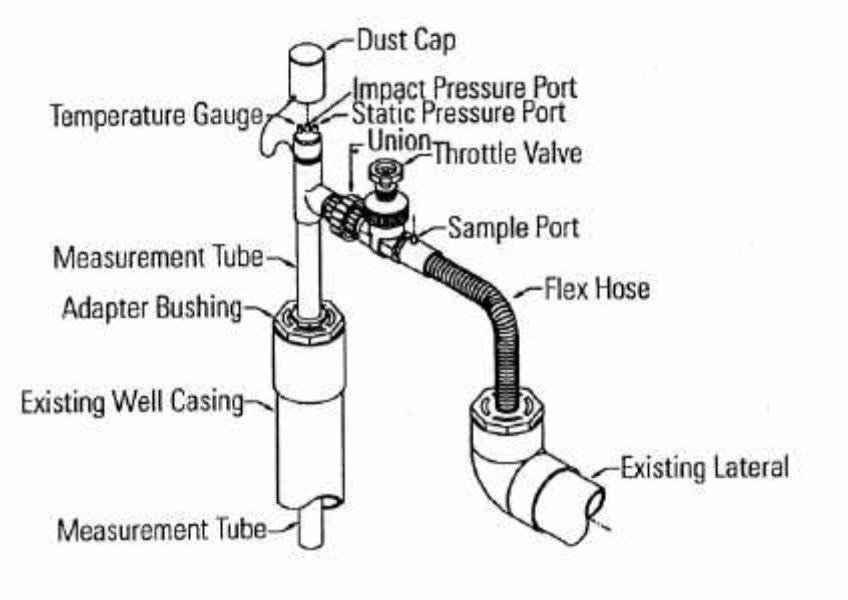
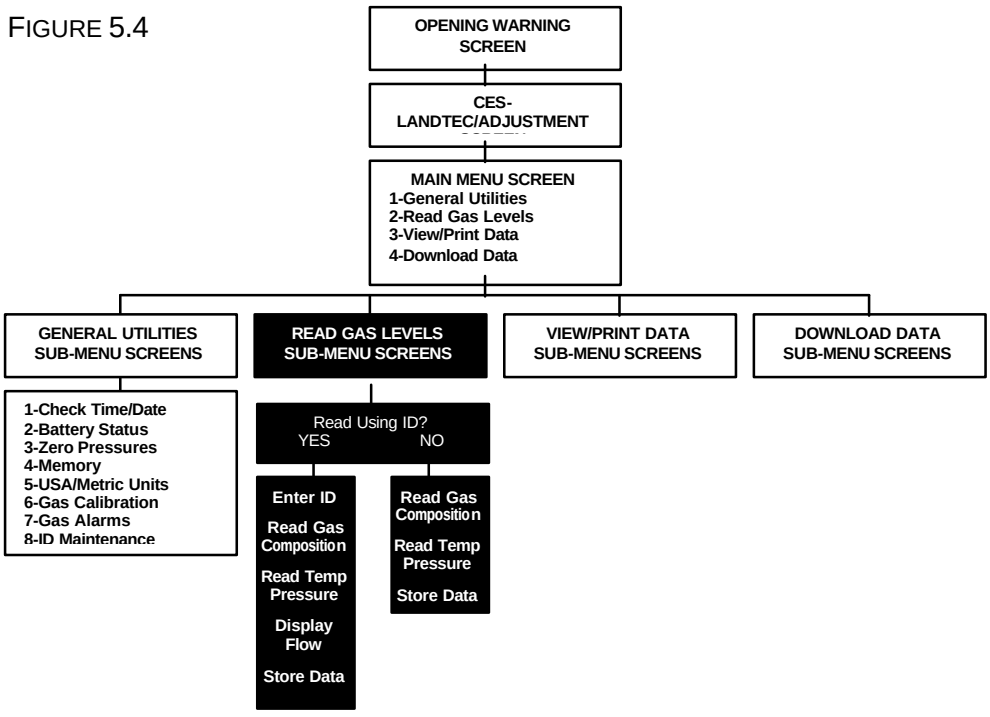


FIGURE 5.3

Read Gas Levels Screen Tree Diagram

FIGURE 5.4

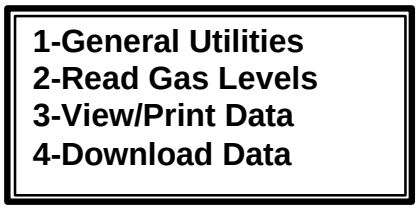


As shown in the screen tree diagram above (Figure 5.4), there are two menu paths that can be followed through the Read Gas Levels function. The path taken depends upon whether or not a well ID has been defined and stored in the GEM-500™. Well IDs can be added at several points during this procedure.

Read Gas Levels Menu – Read Using ID? No

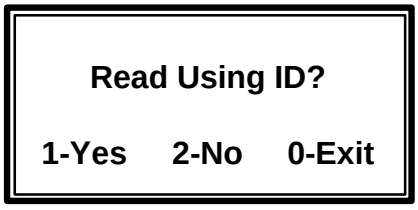
1. On the Main Menu screen press the **2** KEY (Figure 5.5) to initialize the Read Using ID screen.

FIGURE 5.5



2. The Read Using ID screen is displayed as shown in Figure 5.6. A choice needs to be made whether or not to read the well using an ID. If yes is chosen, a well ID is selected by scrolling through a list, or by entering the well ID manually. Typically, **NO** is chosen when a well only needs to be monitored or a well ID is not stored in memory in the unit.

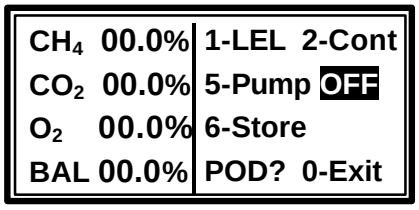
FIGURE 5.6



3. Select the **2** KEY, **No**.

4. Connect the GEM-500™ to the wellhead with supplied tubing—Static Pressure/Sampling Port to the Static Pressure Port and Impact Pressure Port to Impact Pressure Port. The Gas Levels screen is divided into two parts. The left side of the screen displays current percentages of CH_4, CO_2, O_2, and BAL, which is the balance of all other gases excluding the CH_4, CO_2, and O_2. The right side of the screen displays functional choices for this reading (Lower Explosive Limit, Continue to temperature and pressure data, Pump On/Off, Last Data, Exit) and POD reminder.

FIGURE 5.7



POD refers to interchangeable electrochemical gas pods that are used to extend the measurement capabilities of the GEM-500™ (Figure 5.8). These pods are available in seven different gases with nine different ranges and easily plug into the data port. The reminder lets the user know that if a pod were attached at this time, additional gas readings could be taken.

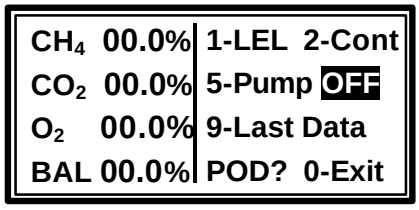
FIGURE 5.8

Interchangeable Electrochemical Gas Pods

Gas	Range (ppm)	Resolution (ppm)
H_2S	0 – 50	0.1
	0 – 200	1.0
CO	0 – 1000	1.0
SO_2	0 – 20	0.1
	0 – 100	1.0
NO_2	0 – 20	0.1
Cl_2	0 – 20	0.1
H_2	0 – 1000	1.0
HCN	0 – 100	1.0

5. Press the **5** KEY, **Pump**, to start the pump and draw a gas sample into the GEM-500™. The **5** KEY, **Pump**, works as a toggle switch to turn the pump on and off. Once the pump is turned on, the readings are not considered to be accurate until the percentages on the left side of the display stabilize, typically within 30-45 seconds. A timer displays on the screen to monitor the pump running time.

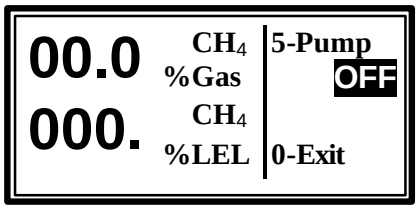
FIGURE 5.9



Note: The GEM-500™ may sound an alarm (beeping) while taking gas readings. The alarm means that gas levels set in General Utilities Gas Alarms (page 31) have been reached or exceeded. In addition to the alarm, the screen display of the gas that set off the alarm will also blink.

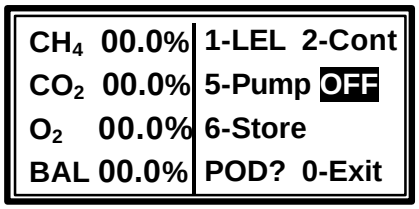
6. To monitor the LEL (Lower Explosive Limit), press the 1 KEY (Figure 5.9), to enter the LEL screen. If the LEL needs to be continuously monitored, just leave the pump running. When the LEL no longer needs to be monitored, press the 5 KEY again to toggle off the pump. Press the 0 KEY to Exit back to the Gas Levels screen.

FIGURE 5.10



7. To store the current readings press the **6** KEY, **Store**.

FIGURE 5.11



Since a well ID was not entered to begin with, one must now be entered. Use the **BLUE ¦** KEY to switch (toggle) between numbers and letters. See Keyboard Information in the Getting Started Section at the beginning of this Manual.

- For numbers, press the keypad **Number** KEYS (1-0). (Figure 5.12)
- For letters, press the **1** KEY (**UP ARROW**) or **6** KEY (**DOWN ARROW**) to step through the alphabet until the letter of choice appears. Press the **0** KEY to select the letter. (Figure 5.13)

After the final character is entered, the unit displays **0-Cont**. Press the **0** KEY if the ID is correct and ready to enter; otherwise, press and **hold** the **0** KEY to backspace and make corrections.

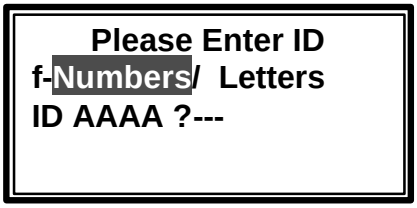


FIGURE 5.12

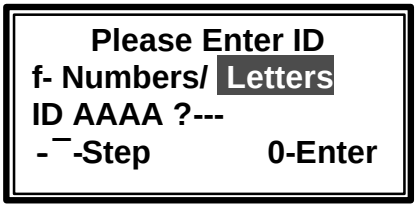


FIGURE 5.13

Note: Four letters from the previously entered ID default into the first four places of the ID number. To replace these letters, if needed, use the 0 KEY to backspace over them by holding it down for more than a second. Change the characters as needed.

9. On the Select Comments screen, use the **1** KEY to **Scroll Up** or the **6** KEY to **Scroll Down** through the comment list (Figure 5.15). When the correct comment appears in the comment display area, press the **2** KEY, to **Select**, then the **0** KEY to Store the readings.

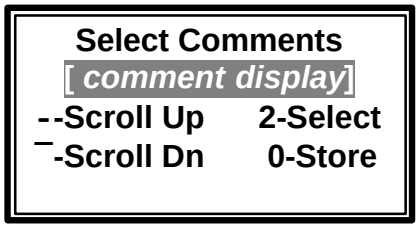


FIGURE 5.14

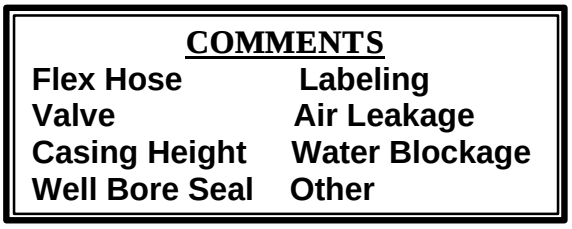


FIGURE 5.15

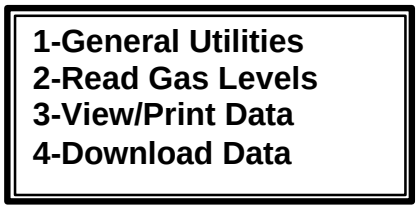
10. If the readings are successfully stored, the Readings Stored screen displays for three seconds (Figure 5.16). The Gas Levels screen (Figure 5.11) redisplays. The unit is now ready to accept another reading.

FIGURE 5.16

Read Gas Levels Menu – Read Using ID? Yes

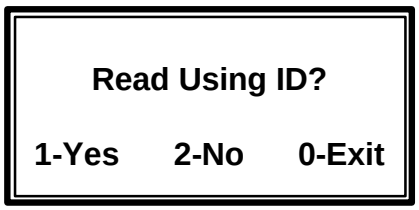
1. On the Main Menu screen, press the **2** KEY (Figure 5.17) to initialize the Read Using ID screen.

FIGURE 5.17



2. A choice needs to be made at the Read Using ID screen (Figure 5.18) whether or not to read the well using an ID. If **YES** is chosen, the well ID is selected by scrolling through a list or by entering the well ID manually. Typically, **NO** is chosen when a well only needs to be monitored or a well ID is not yet in memory.

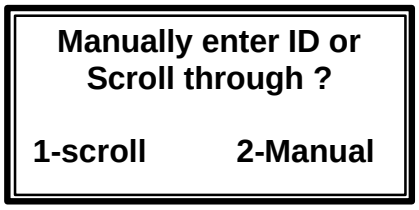
FIGURE 5.18



3. Select the **2** KEY **Yes**.

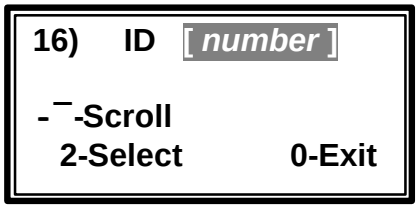
4. The Manually Enter ID screen allows the user to either scroll through a list of ID's that are already in memory or enter an ID manually. (Figure 5.19) If there are few ID's stored, it might be faster to use the scroll option; whereas the manual entry option might be faster to use if there are many ID's stored.

FIGURE 5.19



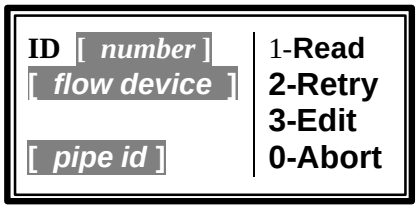
5. To scroll through the existing list of well ID's, press the **1** KEY, **scroll**. The Select ID screen displays a single ID at a time. (Figure 5.20) Use the **1** KEY (**UP ARROW**) or the **6** KEY (**DOWN ARROW**) to scroll through the list. When the ID of choice is displayed, press the **2** KEY, **Select.**

FIGURE 5.20



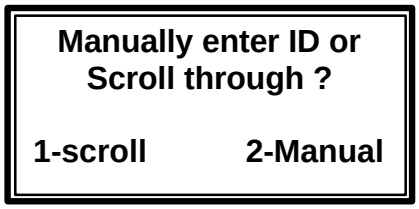
6. The chosen well ID and the type of flow device (Accu-Flo, Orifice Plate, Pitot Tube, or User Input) display on the left side of the screen and the Read, Retry, Edit, and Abort options display on the right. (Figure 5.21) Press the **1** KEY, **Read**, to continue to the Read Gas screen. (Skip to Step 14.)

FIGURE 5.21



7. To select manual entry press the 2 KEY, **Manual.**

FIGURE 5.22



8. Enter the well ID of choice. Use the **BLUE ¦** KEY to switch (toggle) between numbers and letters.

   - For numbers, press the keypad **Number** KEYS (0-9). (Figure 5.23)
   - For letters, press the **1** KEY (**UP ARROW**) or **6** KEY (**DOWN ARROW**) to step through the alphabet until the letter of choice appears. Press the **0** KEY to select the letter. (Figure 5.24)

   After the final character is entered, the unit displays **0-Cont**. Press the **0** KEY if the ID is correct and ready to enter; otherwise, press and **hold** the **0** KEY to backspace and make corrections.

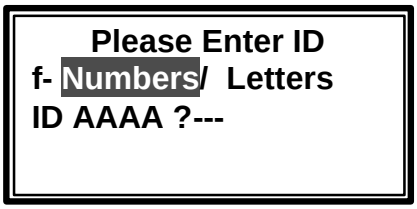


FIGURE 5.23

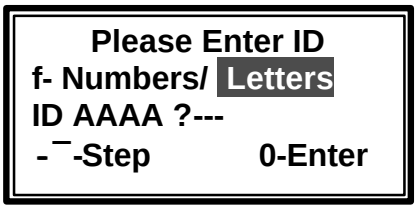
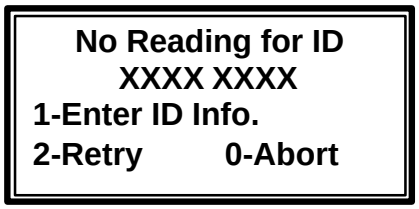


FIGURE 5.24

Note: Four letters from the previously entered ID default into the first four places of the ID number. To replace these letters, if needed, use the 0 KEY to backspace over them by holding it down for more than a second. Change the characters as needed.

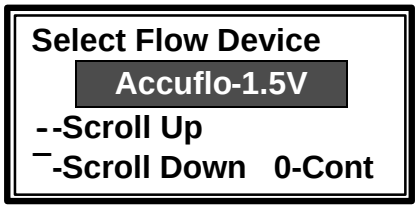
9. If the well ID is not yet entered into the unit, a No Reading screen appears. This screen provides three options. If the number is correct but has never been previously added, Enter ID Info. allows entry and flow device definition. If the well ID entered was in error, Retry takes the user back to the Manually Enter ID screen (Figure 5.22). The Abort command takes the user completely back out to the Main Menu (Figure 5.17). Press the **1** KEY, **Enter ID Info**.

FIGURE 5.25



10. A well flow device is selected in the Flow Device screen. This selection is necessary for the GEM-500™ to be able to calculate flow when readings are taken. Use the **1** KEY (**UP ARROW**) or the **6** KEY (**DOWN ARROW**) to scroll through the choices listed in Figure 5.27. Once the desired flow device is located in the shaded selection window, press **0** to select and continue.

FIGURE 5.26



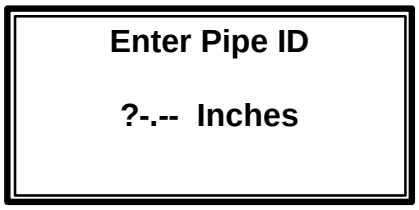
Note: Selection of User Input allows the eventual entry of flow in SCFM, if known (see Step 11). Those without flow devices may wish to use this selection to record velocity or other relevant data. (For example, when using a Kurz meter.)

FIGURE 5.27

Accuflo–1.5V (1½" Accu-Flo Model 150 Vertical Wellhead)
Accuflo–1.5H (1½" Accu-Flo Model 150 Horizontal Wellhead)
Accuflo–2V (2" Accu-Flo Model 200 Vertical Wellhead)
Accuflo–2H (2" Accu-Flo Model 200 Horizontal Wellhead)
Accuflo–3V (3" Accu-Flo Model 300 Vertical Wellhead)
Accuflo–3H (3" Accu-Flo Model 300 Horizontal Wellhead)
Orifice Plate (Orifice diameter and pipe inner diameter required)
Pitot Tube (Pipe ID required)
User Input (Pipe ID required)

11. If an Orifice Plate, Pitot Tube or User Input flow device is selected, additional information is required. If the pipe or orifice diameter screen appears, input the required size as necessary. Insert inches or centimeters (depending on whether USA or Metric Units were selected on the General Utilities USA/Metric units screen). The unit uses XX.XX as the format and automatically enters the decimal point. Press the **0** KEY to enter and continue.

FIGURE 5.28

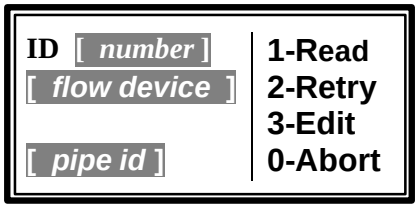


12. The ID Stored OK Screen displays for three seconds (Figure 5.29)

FIGURE 5.29

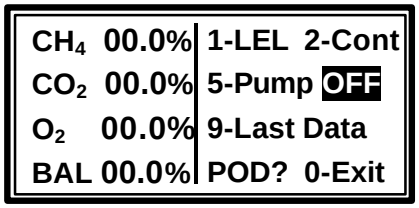
13. The chosen well ID and the type of flow device (Accu-Flo, Orifice Plate, Pitot Tube, or User Input) display on the left side of the screen and the Read, Retry, Edit, and Abort options display on the right. (Figure 5.30) Press the **1** KEY, **Read**, to continue to the Read Gas screen.

Figure 5.30



14. Connect the GEM-500™ to the wellhead with the supplied tubing—Static Pressure/Sampling Port to the Static Pressure Port and Impact Pressure Port to Impact Pressure Port. The Gas Levels screen is divided into two parts. The left side of the screen displays current percentages of CH_4, CO_2, O_2, and BAL, which is the balance of all other gases excluding the CH_4, CO_2, and O_2. The right side of the screen displays functional choices for this reading (Lower Explosive Limit, Continue to temperature and pressure data, Pump On/Off, Last Data, Exit) and a POD reminder.

FIGURE 5.31



POD refers to interchangeable electrochemical gas pods that are used to extend the measurement capabilities of the GEM-500™ (Figure 5.32). These pods are available in seven different gases with nine different ranges and easily plug into the data port. The reminder lets the user know that if a pod were attached at this time, additional gas readings could be taken.

FIGURE 5.32

Interchangeable Electrochemical Gas Pods

Gas	Range (ppm)	Resolution (ppm)
H_2S	0 – 50	0.1
	0 – 200	1.0
CO	0 – 1000	1.0
SO_2	0 – 20	0.1
	0 – 100	1.0
NO_2	0 – 20	0.1
Cl_2	0 – 20	0.1
H_2	0 – 1000	1.0
HCN	0 – 100	1.0

15. Press the **5** KEY, **Pump**, to start the pump and draw a gas sample into the GEM-500™. The **5** KEY, **Pump**, works as a toggle switch to turn the pump on and off. Once the pump is turned on, the readings are not considered to be accurate until the percentages on the left side of the display stabilize, typically within 30-45 seconds. A timer displays on the screen to monitor the pump running time.

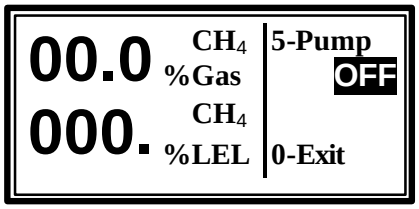
FIGURE 5.33

CH_4 00.0%	**1-LEL 2-Cont**
CO_2 00.0%	**5-Pump OFF**
O_2 00.0%	**9-Last Data**
BAL 00.0%	**POD? 0-Exit**

Note: The GEM-500™ may sound an alarm (beeping) while taking gas readings. The alarm means that gas levels set in General Utilities Gas Alarms (page 31) have been reached or exceeded. In addition to the alarm, the screen display of the gas that set off the alarm also blinks.

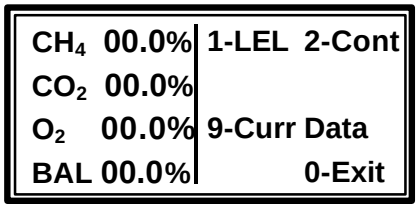
16. To monitor the LEL (Lower Explosive Limit), press the 1 KEY (Figure 5.33) to enter the LEL screen. If the LEL needs to be continuously monitored, just leave the pump running. When the LEL no longer needs to be monitored, press the 5 KEY again to toggle off the pump. Press the 0 KEY to Exit back to the Gas Levels screen (Figure 5.33).

FIGURE 5.34



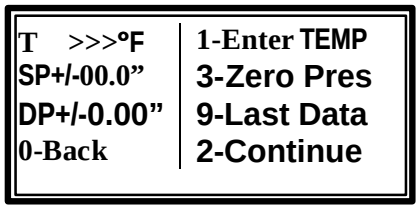
17. If at any time, while working on this screen, reference needs to be made to the prior reading on this wellhead, press the **9** KEY, **Last Data**. The unit displays the very last stored reading. The **9** KEY works as a toggle switch between the current reading and the last reading. From the Last Data (Figures 5.33 & 5.35) screen, the user can go directly into monitoring current LEL or continue directly to the current Temperature/Pressure screen.

FIGURE 5.35



18. From the Read Gas Levels screen (Figure 5.33), press the **2** KEY, Continue, for the Temperature and Pressure screen (Figure 5.36). This screen shows temperature, static pressure, differential pressure, and a number of functional options. If a temperature probe is used, it should be connected from the data port on the right side of the GEM-500™ (Figure 5.1) to the temperature gauge port on the wellhead. When the temperature probe is connected to the GEM-500™, the functional option Enter TEMP disappears as it displays only for manual entry. The temperature probe needs to remain in the wellhead until the entire reading is completed and stored. If a temperature probe is not used, the temperature can be read on a thermometer placed in the temperature gauge port on the wellhead and entered manually into the GEM-500™. To enter the temperature manually, press the **1** KEY, **Enter TEMP**.

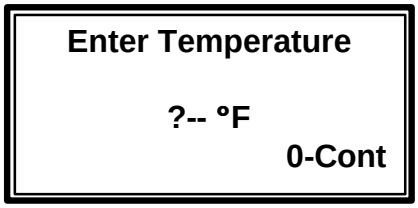
FIGURE 5.36



Note: If flow measurement is required, temperature must be entered either manually or with the optional temperature probe.

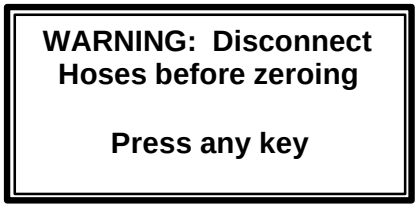
19. Temperature is entered in either Fahrenheit (F) or Celsius (C) depending on whether USA or Metric was chosen in the General Utilities USA/Metric Units screen (page 30). Number keys and leading zero(s) are used to enter a three digit temperature value, i.e., 78° is 078 and 5° is 005. Press the **0** KEY to Continue back to the Read Gas Levels screen (Figure 5.36).

FIGURE 5.37



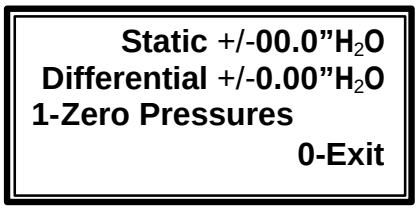
20. From the Read Gas Levels screen (Figure 5.36), press the **3** KEY, **Zero Pres**sures, before proceeding. This is necessary because by taking a LFG sample, the impact port pressure transducers have been pressurized. The **Warning Disconnect hoses** screen displays before the Zero Pressure screen. (Figure 5.38). Disconnect all the hoses from the GEM-500™ to the wellhead and press any key to continue.

FIGURE 5.38



21. The pressures displayed on the Static/Differential screen are displayed with either a positive or negative and need to stabilize (quit changing) before being zeroed. When stabilized, press the **1** KEY to **Zero Pressures**. (Figure 5.39)

FIGURE 5.39



Note: The units displayed are in inches of water column or MB depending on whether USA or Metric was chosen in the General Utilities USA/Metric Units screen (page 30).

22. The Zeroed OK screen (Figure 5.40) displays for 3 seconds, then the Static/Differential screen (Figure 5.41) redisplays. Occasionally the pressures will not zero completely. If this happens, press the **1** KEY, **Zero Pressures**, again until the pressures are completely zeroed. Once the static and differential pressures are zeroed, press the **0** KEY to **Exit.** The Temperature/Pressure screen then redisplays (Figure 5.42).

FIGURE 5.40

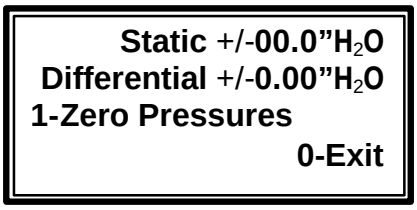


FIGURE 5.41

23. At the Temperature/Pressure screen, reconnect the tubing (Figure 5.43). Allow the instrument to read, then press the **2** KEY to Continue to the Flow/Btu screen.

FIGURE 5.42

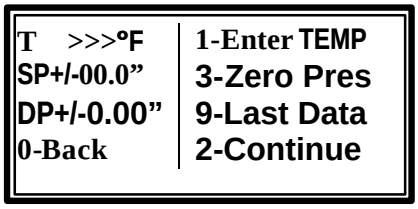


FIGURE 5.43

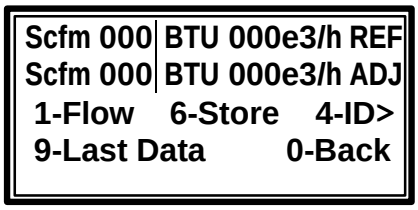
CONNECTIONS

1. **On an Accu-Flo wellhead, connect the Static Pressure/Sampling port (top left) on the GEM-500Ô to the Static Pressure Port on the wellhead, and the Impact Pressure Port on the wellhead. (Figures 5.1, 5.2, 5.3)**
2. **On a pitot tube, connect the hoses from the GEM-500Ô to the Impact and static Pressure ports.**
3. **On an orifice plate, connect the hoses on the GEM-500Ô to either side of the orifice plate.**

Note: To get a flow reading, the differential pressure (DP) must be positive with respect to the static pressure. If it is not, reverse the hoses.

The Flow screen displays the reference flow (REF) and adjusted flow (ADJ). The reference flow is static and will not change unless the Temperature/Pressure screen is re-accessed. Whereas the adjusted flow is active and is typically used to display changes in flow while adjustments are made. If an Accu-Flo, pitot tube, or orifice plate wellhead is in place, the GEM-500™ automatically calculates the reference and adjusted flow. Other functions available here are the ability to store the data, go to the next wellhead ID, view the last data on this wellhead, or go back to the Temperature/Pressure screen. The units displayed on this screen, Scfm (Standard cubic feet per minute) and BTU (British Thermal Units, in thousands) are the USA units that are selected in the General Utilities USA/Metric Units screen (page 30).

FIGURE 5.44



If the flow needs to be changed, adjust the control valve on the wellhead. Within a few seconds the new flow is displayed on the GEM-500™ as the adjusted value. When satisfied with the flow adjustment, press the **6** KEY to **Store** the information and continue to the Select Comments screen.

24. On the Select Comments screen, use the **1** KEY to **Scroll Up** or the **6** KEY to **Scroll Down** through a comment list (Figure 5.45). When the correct comment appears in the comment display area, press the **2** KEY, to **Select**, then the **0** KEY to store the readings.

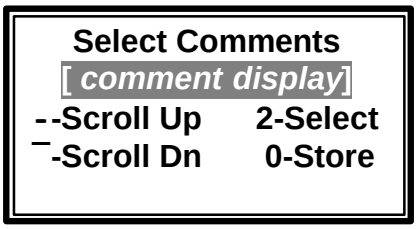


FIGURE 5.45

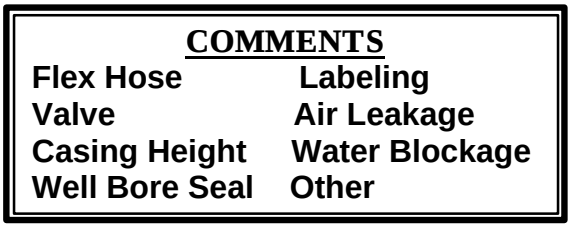


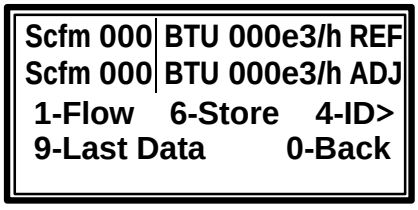
FIGURE 5.46

25. If the readings are successfully stored, the Readings Stored screen displays for three seconds (Figure 5.47). The Flow screen (Figure 5.44) redisplays.

FIGURE 5.47

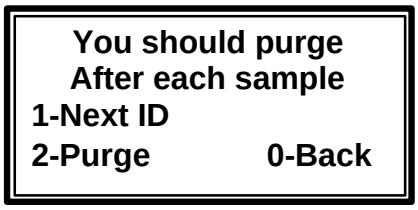
26. Press the **4** KEY, **ID** to advance to the next wellhead ID in memory. If the wellhead ID's were loaded into the GEM-500™ in order, the unit will purge and the next ID will display after purge is completed.

FIGURE 5.48



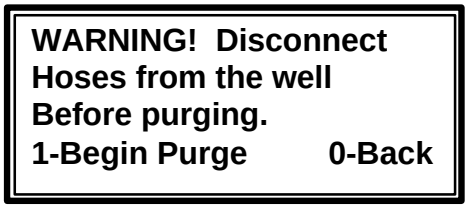
27. The Purge Prompt Screen (Figure 5.20) reminds the user that the GEM-500™ needs to have any residual gases purged from its system to guarantee the accuracy of the next reading. Press the **5** KEY, **Purge,** to initialize the purge process.

FIGURE 5.49



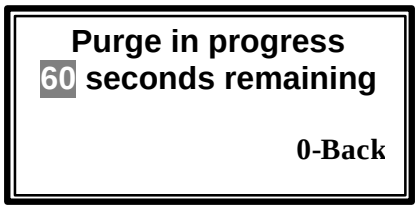
28. The Warning screen displays to remind the user to disconnect the hoses from the wellhead before starting the purge process. Once the hoses are removed, press the 1 KEY to begin the purge (Figure 5.50).

FIGURE 5.50



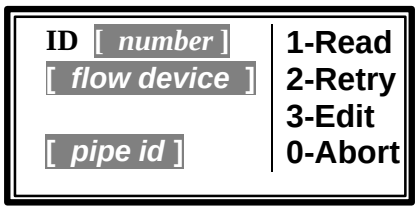
29. The pump starts and the Purge in Progress screen displays the number of seconds remaining in the purge (Figure 5.51). This purge process can be taking place while walking to the next wellhead.

FIGURE 5.51



30. The pump will run for 60 seconds and then shut off allowing the next well ID to be displayed. (Figure 5.52)

FIGURE 5.52

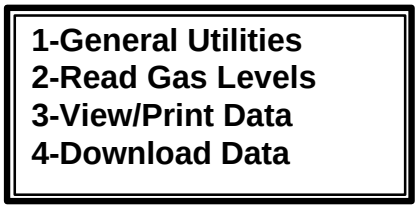


Chapter 6 - View Data

View Data

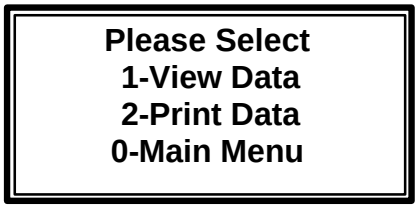
1. From the Main Menu, select the **3** KEY, **View Data** (Figure 6.1)

FIGURE 6.1



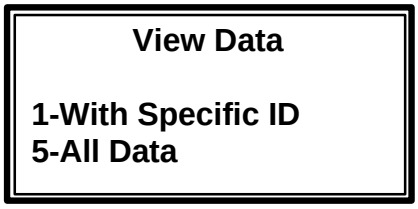
From the View/Print Select screen, the user can choose to view data, print data or return to the main menu. Press the **1** KEY, **View Data** to view data in memory in the GEM-500™.

FIGURE 6.2



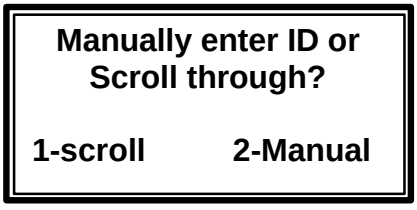
To view data from just one wellhead, press the **1** KEY, **With Specific ID**. This option allows manual entry of a single wellhead ID. If data from all wellheads needs to be viewed, press the **5** KEY, **All Data** and proceed to step 4.

FIGURE 6.3



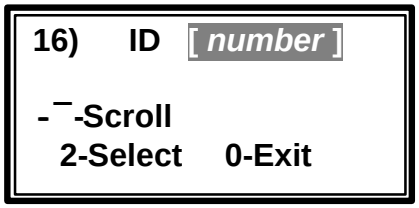
The Manually Enter ID screen allows the user to either scroll through a list of ID's that are already in memory or enter an ID manually. If there are few ID's stored, it might be faster to use the scroll option; whereas the manual entry option might be faster to use if there are many ID's stored (Refer to page 44 number 7). (Figure 6.4)

FIGURE 6.4



2. To scroll through the existing list of well ID's, press the **1** KEY, **Scroll**. The Select ID screen displays a single ID at a time. Use the **1** KEY (**UP ARROW**) or the **6** KEY (**DOWN ARROW**) to scroll through the list. When the ID of choice is displayed, press the **2** KEY, **Select.** (Figure 6.5)

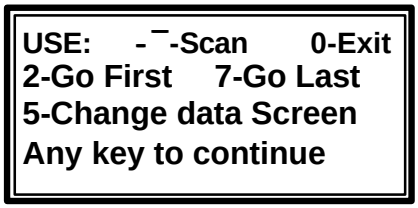
FIGURE 6.5



3. The following options are used to move around within the Data screens: (Figure 6.6)

- ↑↓-Scan – Use the **1** KEY (**UP ARROW**) or the **6** KEY (**DOWN ARROW**) to scroll through the list.
- 2-Go First – Use the 2 KEY to go to the first well ID in the list.
- 5-Change Data Screen – Use the 5 KEY to toggle between the Gas Concentrations screen (Figure 6.7) and the Flow screen (Figure 6.8).
- 7-Go Last – Use the 7 KEY to go to the last well ID in the list.
- 0-Exit – Use the 0 KEY to exit at any time.

FIGURE 6.6



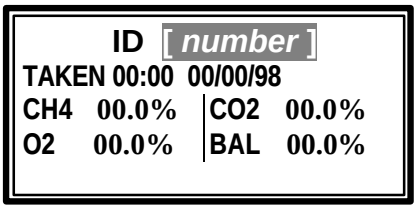


FIGURE 6.7

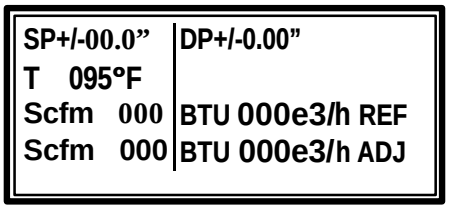


FIGURE 6.8

Chapter 7 – Communications

DataField 3.0CS Software

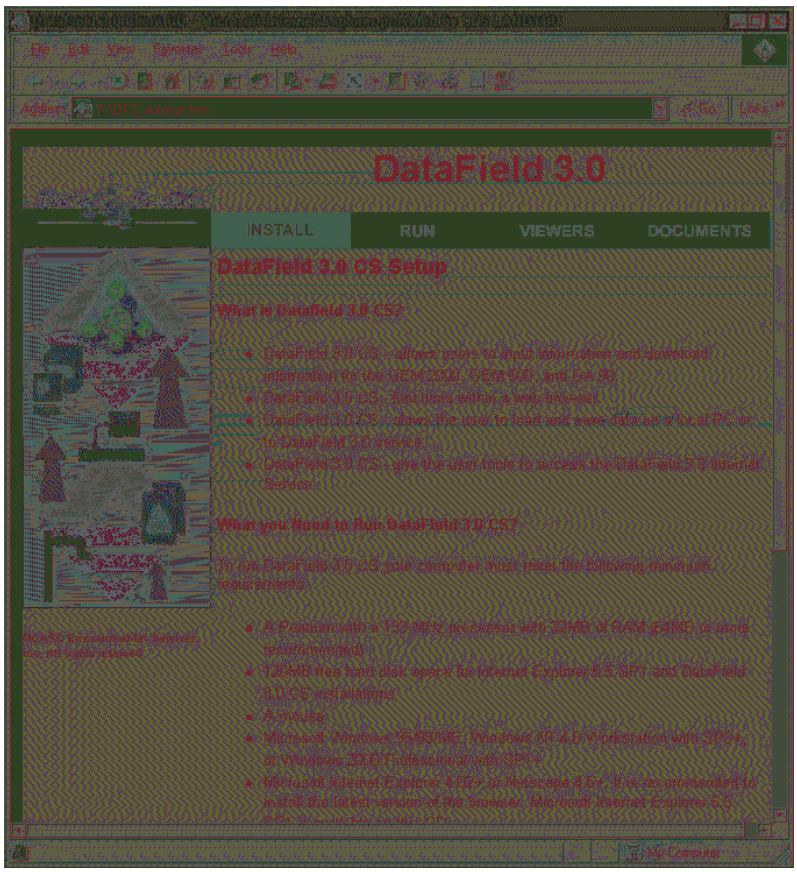
DataField 3.0CS is an integrated software program designed to communicate with the GEM™2000, 500 and GA90 instruments. The software will create files used for storing gas read data, ID data, comments and instrument configuration data. The files created are significantly different from the files created with GEM_COMM or GA_COMM software and are not compatible with these versions of software.

DataField 3.0CS is browser based (Java enabled) and will operate on Windows95b and higher Windows operating systems. Minimum hardware requirements are:

- Pentium 133 level microprocessor or equal.
- 32MB RAM.
- 120MB hard disk space.
- CDROM drive.
- Mouse or pointer system.
- Standard keyboard.
- Installed printer.

Installing DataField 3.0CS

Be sure your computer is turned on and all software programs have been properly closed. Place the program disk in the CD ROM drive and close the tray. DataField 3.0CS will self start and display the DataField C.S. setup screen.



Install – Scroll to the bottom of the setup screen and follow steps 1 thru 3.
Note: Make sure to remove CD and reboot the computer after step 1, after reboot install CD and proceed to step 2.
Run – Allows the user to run the application from the CD Rom Drive.
Note: This option could make the application run slower due to the speed of the CD Rom.
Viewers – Allows the viewing of electronic information as supplied by CES-LANDTEC (after installing the
appropriate viewer.)
Documents – Electronic Manuals and Data sheets.

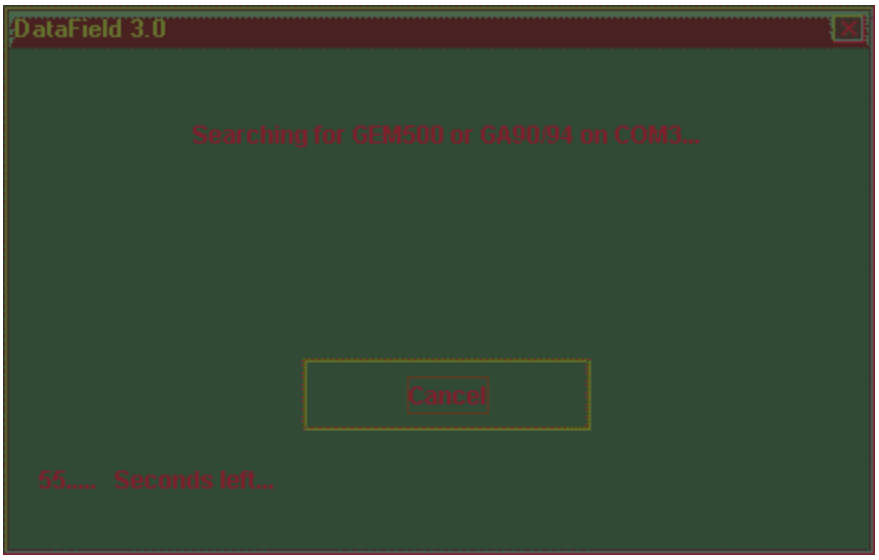
Establishing Communications

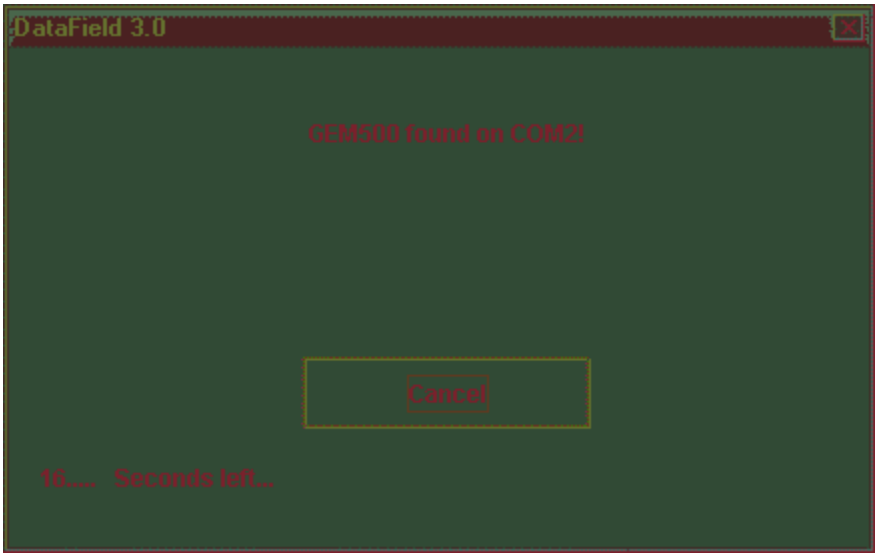
Click on the Start menu then Programs menu. Scroll to DataField and then DataField 3.0CS to start the software. The following screen will appear on the computer.

Click “NO” to connecting to the DataField 3.0 service.

Now select “GEM500 or GA90/94”

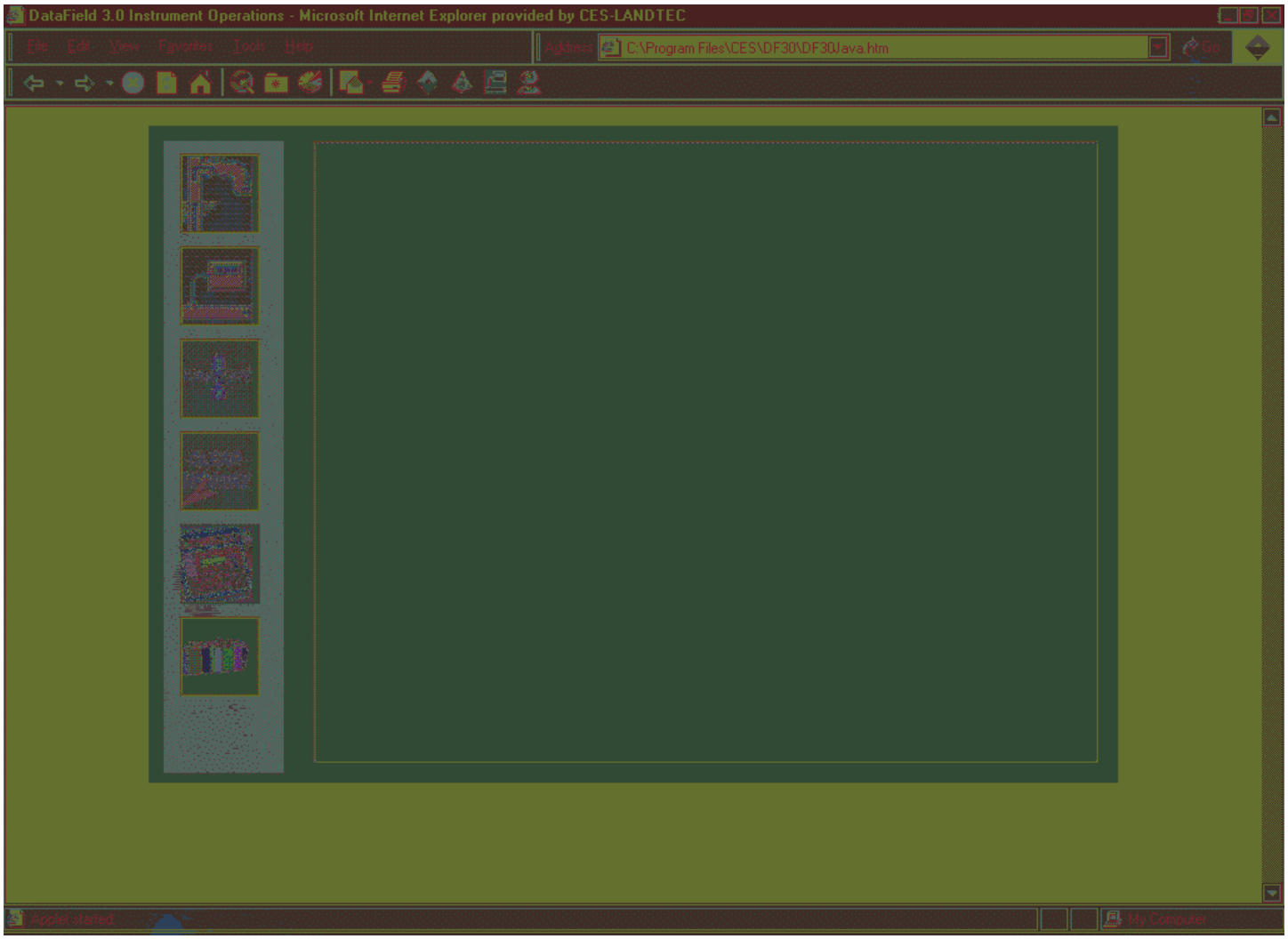
Before clicking OK connect cable to computer, plug cable into instrument, and turn on GEM500/GA90. Wait for self test. Then press “0” followed by “4” to go into download mode. Now the instrument is ready to establish communications, Press “OK”.





Main Screen

Once DataField 3.0CS establishes communications with the instrument, the main software screen will appear.



Six main categories (buttons) are listed down the left side of the screen: ID Functions, Download Comments, Clear Memory, Instrument Settings and Resource Links. Clicking on any one of the buttons will take the user to that functionality of the application.

File

Clicking on the **File** heading will allow you to select **Exit** from program. This will close all files and exit the program.

Communications

It is not possible to change instruments and establish communications without re-starting the software.

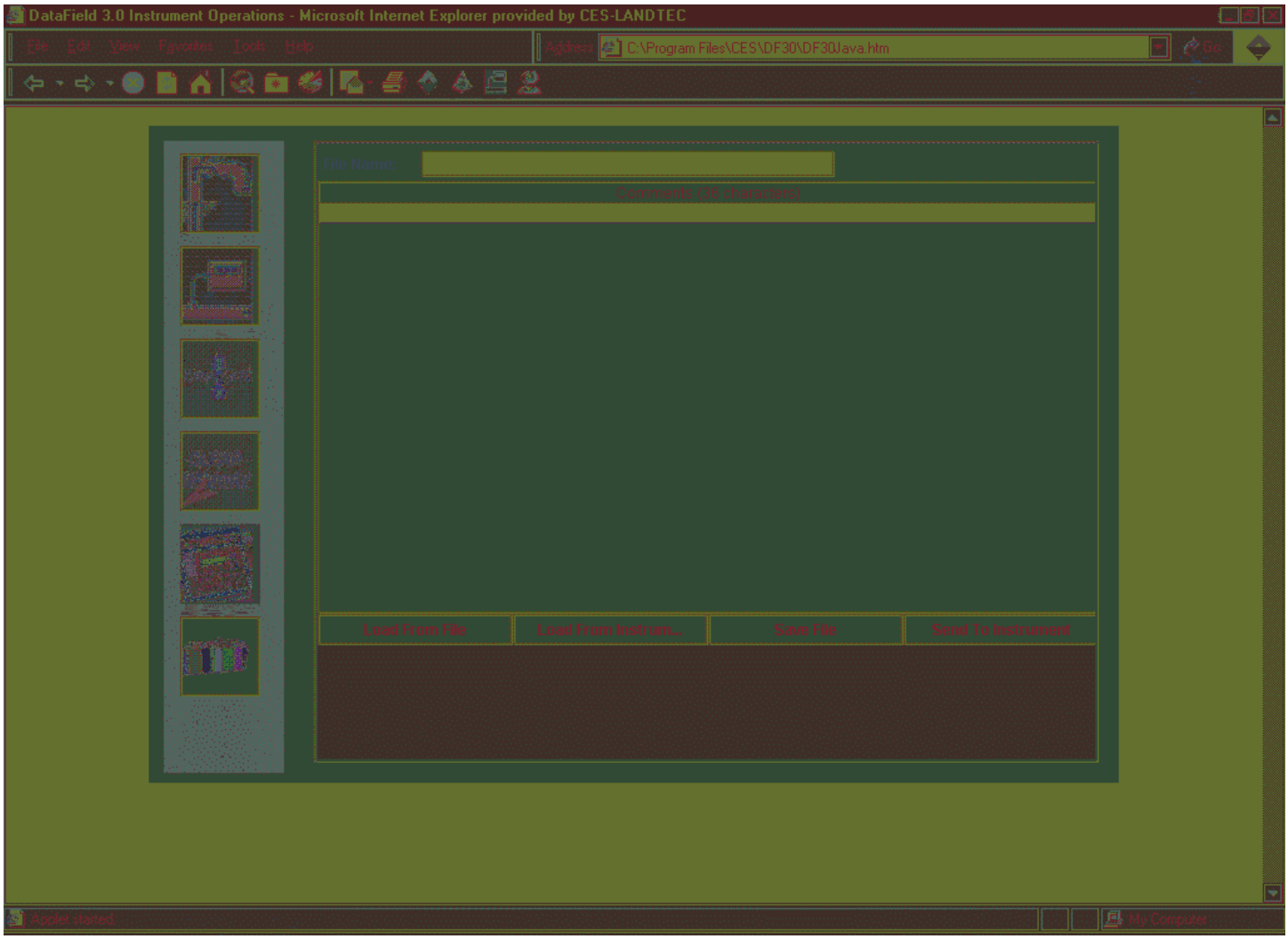
Functions

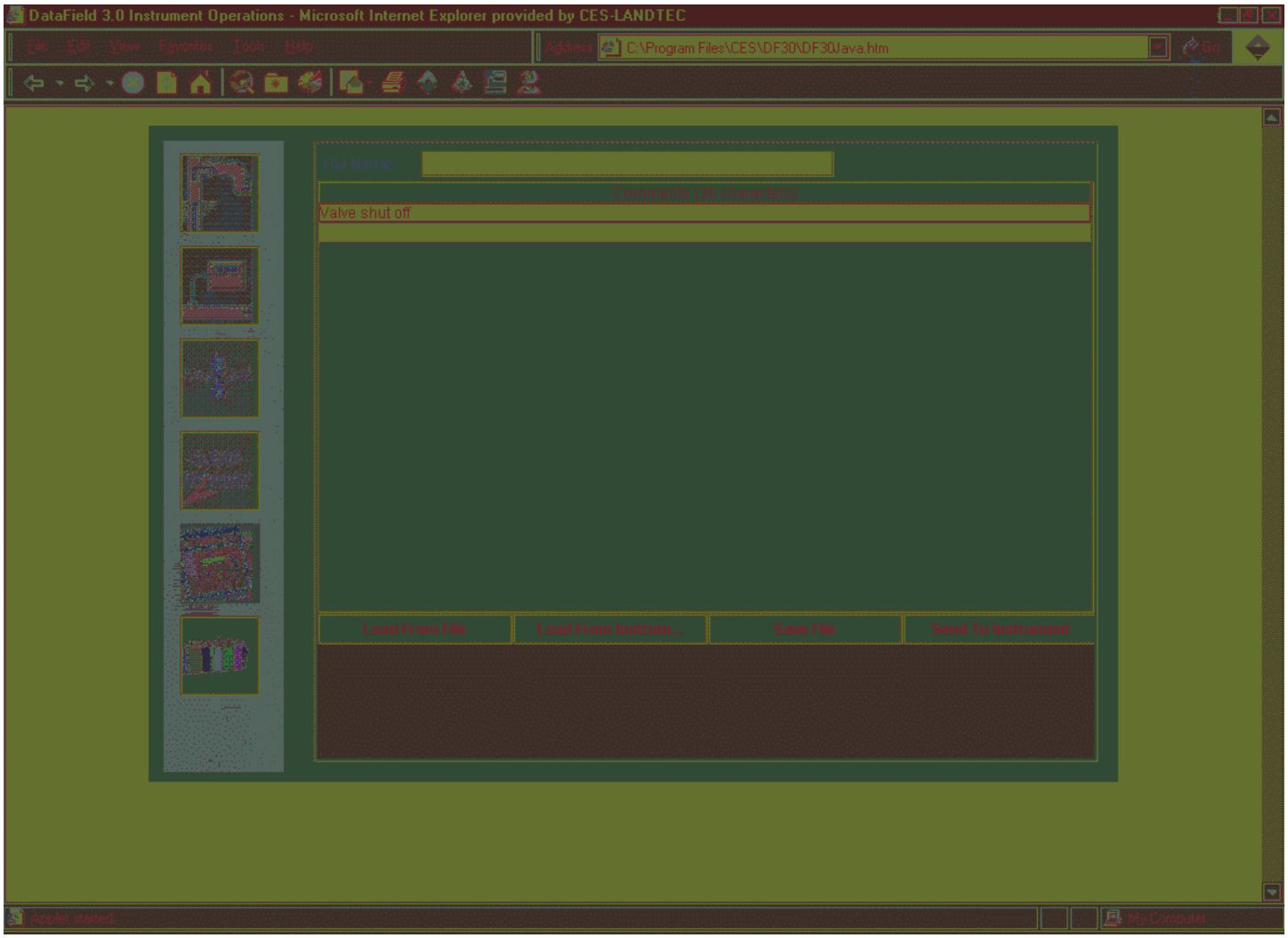
Each button has a specific function as listed below:

1. **Comments** – Allows entry of comments that may be selected for the ID's. A total of seven comments and one exclusive comment may be selected for each ID.
2. **ID's** – Used for adding new ID's, editing ID's or deleting ID's and entry of ID parameters such as pump run time, flow device, comments and questions for the ID.
3. **Readings** – Allows downloading and viewing data from instrument and uploading of previous data to the instrument.
4. **Clear Memory** – Allows the deletion if selective ID's, readings, comments, site questions or all memory loaded in instrument memory.
5. **Resource Links** – Allows the user to directly access information via the www.

Comments

DataField 3.0CS allows up to 64 comments to be created for upload to the GEM™500. Each comment may be 36 characters in length and may be alphanumeric or any character on the computer keyboard. From the opening screen, click on the **Comments** button to open the following screen.

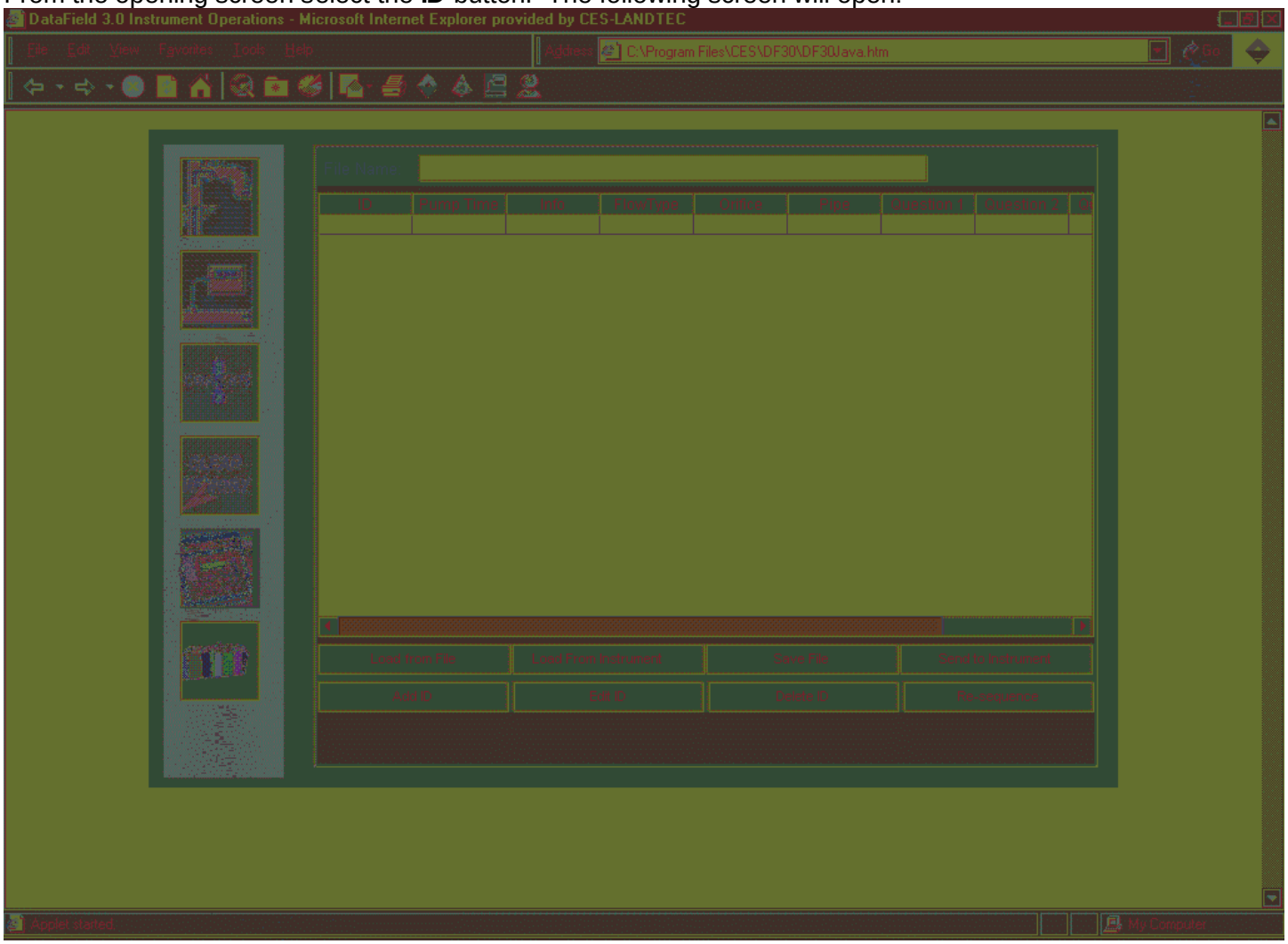




Enter the comment on the comment line and press **Enter** to continue entering comments until all the desired comments have been entered. Click on **Save File** to save the data to disk and then click on **Send to Instrument** to save the comments in the instrument. To delete a comment, click on the comment to highlight the comment and press the **Delete** key on the computer keyboard to remove the highlighted comment. It is always suggested to save the comment file because of the potential size and time required to recreate the comments. Once created, the comment file may be modified and saved under a different file name at any time.

Entering ID's

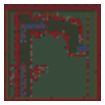
From the opening screen select the **ID** button. The following screen will open:



Selecting the **Save File** button will allow you to enter the name for the file you wish to save.

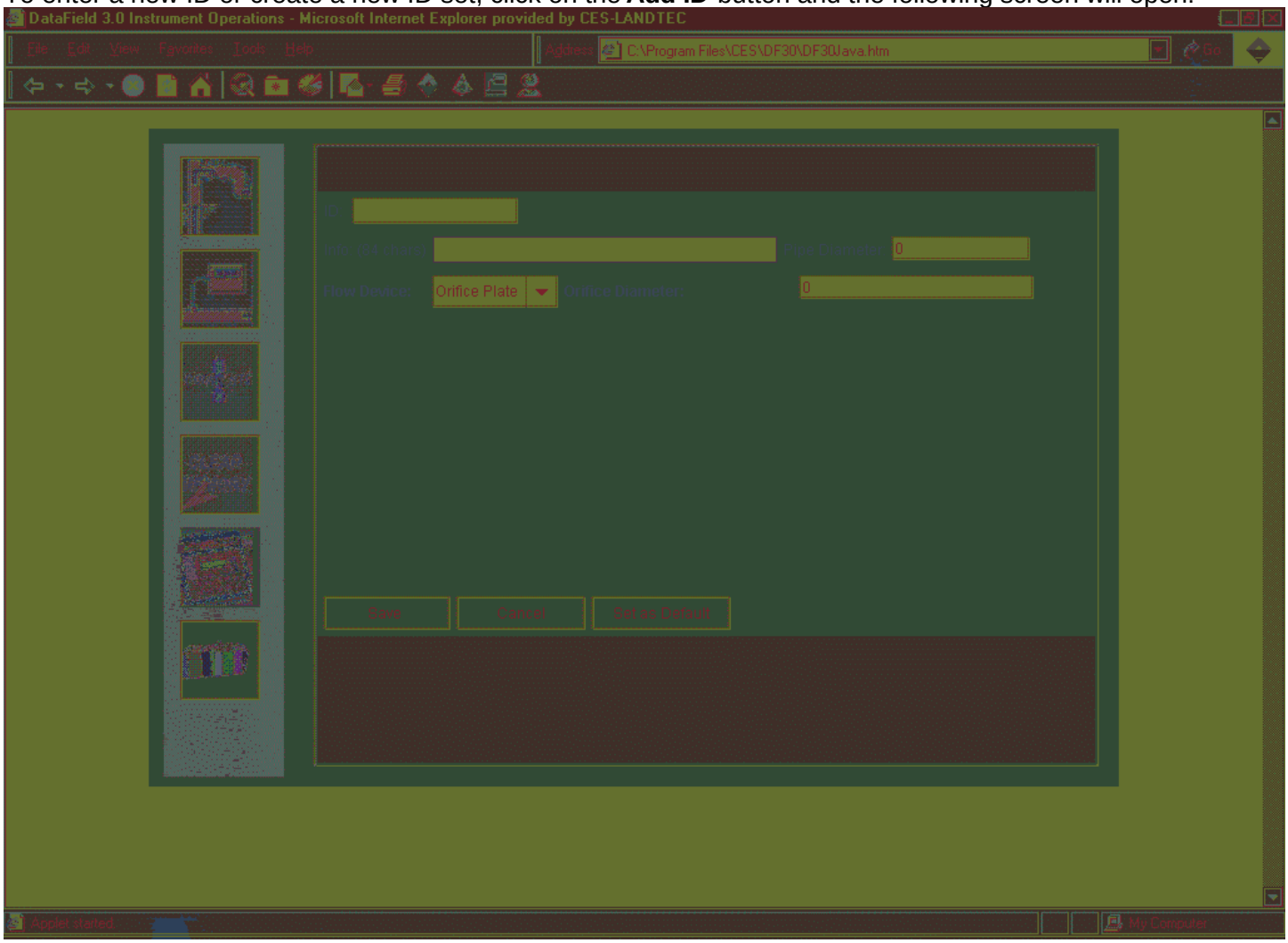
Selecting the **Load from File** button will allow a previously created file to be loaded from the computer disk drive.

Selecting the **Load from Instrument** button will allow previously loaded ID's in the instrument to be downloaded for modification such as increasing the pump run time or adding additional comments to a specific ID.



Add ID button is used for the creation of a new ID or multiple ID's that may be sent to the instrument or saved to a new file for later use.

To enter a new ID or create a new ID set, click on the **Add ID** button and the following screen will open:



Enter the Well ID in any combination of alpha or numeric characters for a maximum of eight characters. **All eight characters must be used**. Enter the type of flow device used with the well (Accu-Flo wellhead, Pitot tube, or orifice plate); user input may also be selected (GEM500 only). If Pitot tube or orifice plate is selected, the **inside** pipe diameter and **orifice diameter** must be entered. If the flow device is going to be the same for multiple wells, click on **Set as Default** to lock the values.

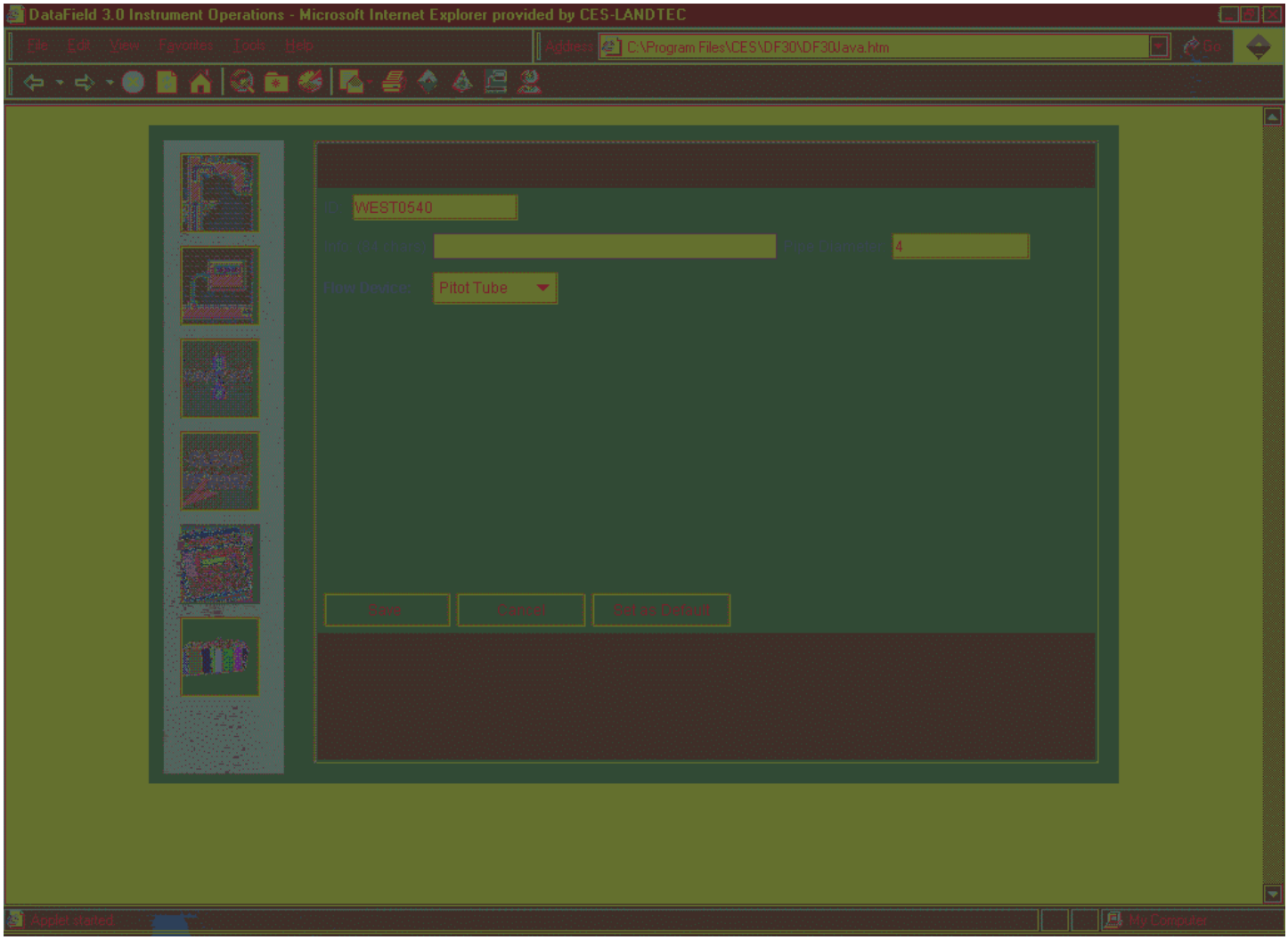
Click on **Add** to add this to the editor screen seen below. If additional ID's need to be entered, simply click on **Add ID** and enter the data as before.

Once all the ID's have been entered, click **Save to File** button to save the ID data to a file or **Send to Instrument** button if data is to be uploaded to an instrument for field sampling.

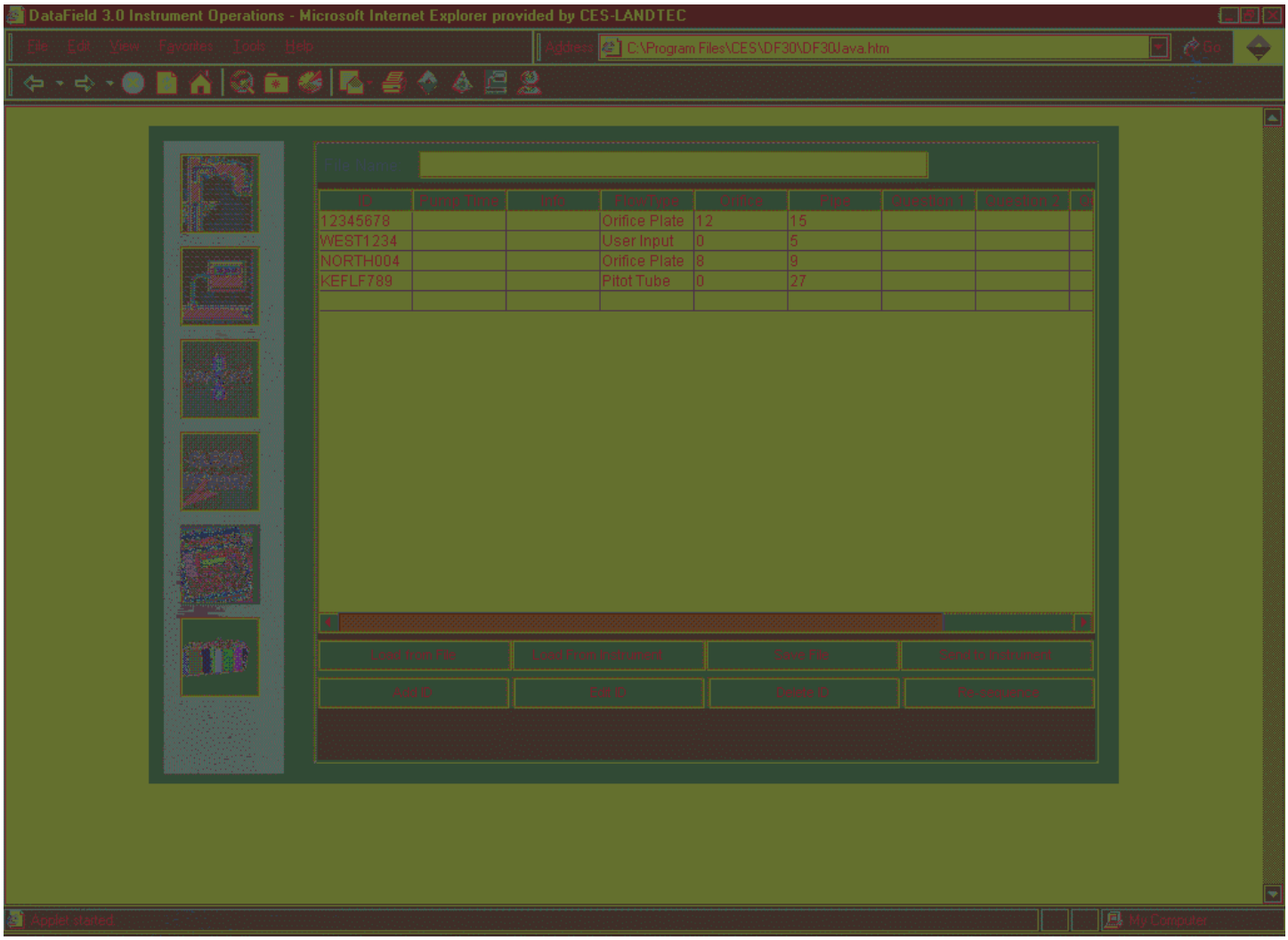
Editing ID's

ID's may be edited in a similar manner to entering a new ID. Click on the **ID** button. Click on **Load from File** button if the ID's to be edited are in a saved file on disk or click on **Load from Instrument** if the ID's to be edited reside in the instrument. Once the ID's have been opened, the **ID Editor** screen will appear as below.

To select an ID for editing, click on the ID to highlight the ID, and then click on **Edit ID** at the bottom of the screen. The Edit ID screen will open and allow information for the selected ID to be changed. When finished with the changes, click on **Save** to save the edited ID to the ID list.



When editing is completed, click on **Save File** to save the edited data to disk or **Send to Instrument** to update data in the instrument.

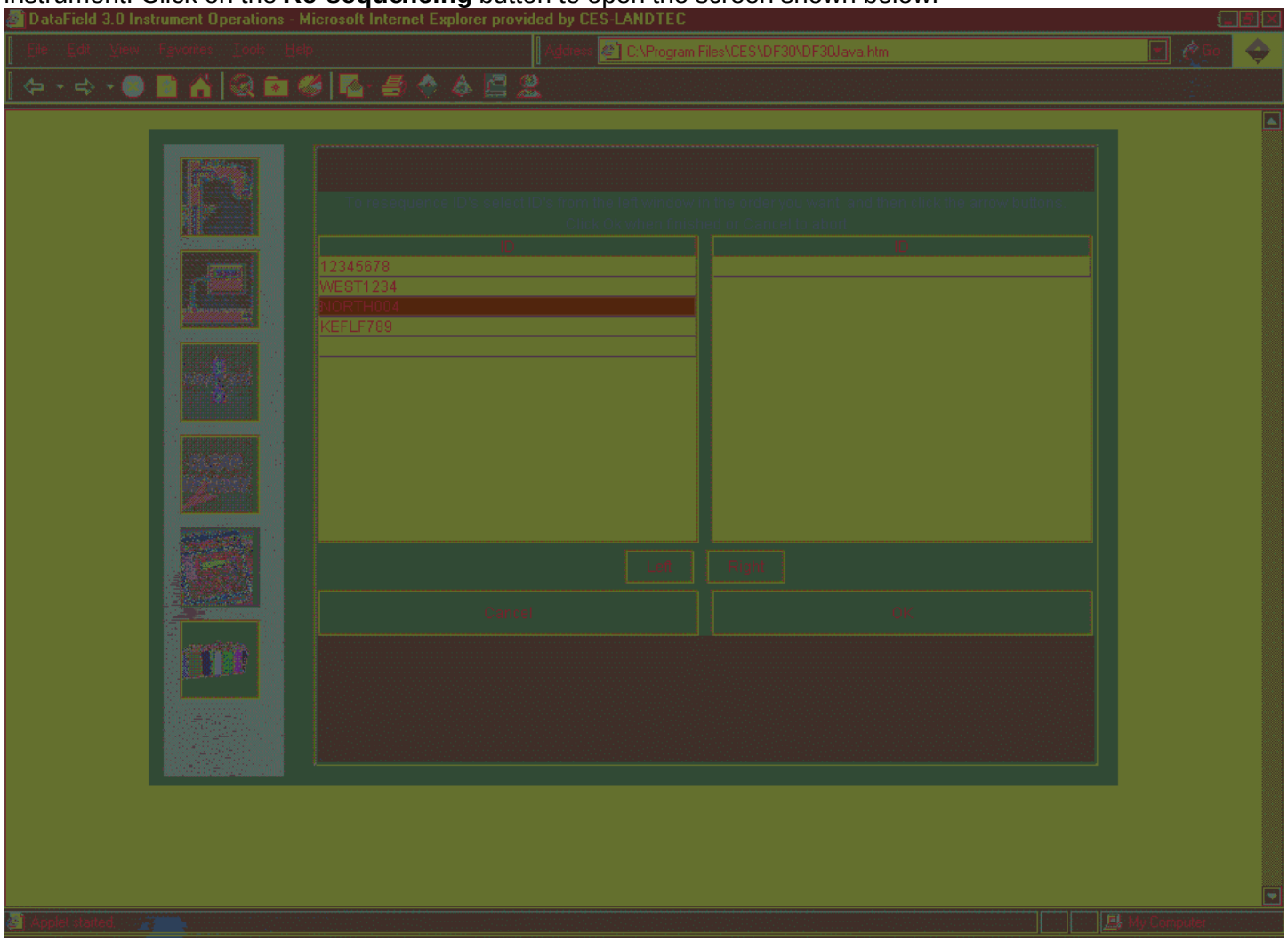


Delete ID's

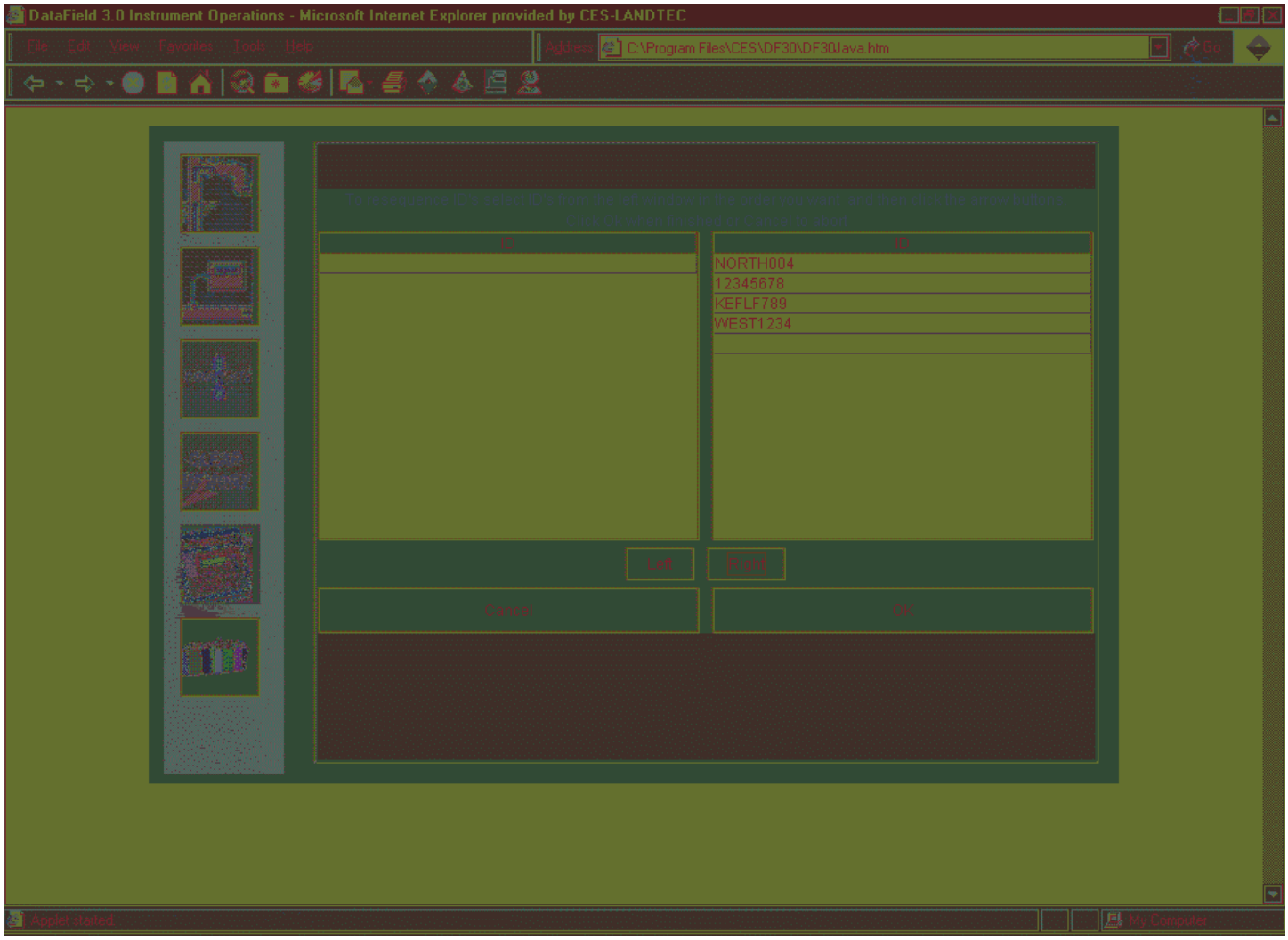
To delete an ID select either **Load from File** (if the ID to be deleted is in a file saved on disk) or **Load from Instrument** (if the ID to be deleted is in the instrument). The **ID Editor** screen will open with the ID information listed. Select the ID to delete and click on the ID to highlight the ID. Click on **Delete ID** at the bottom of the screen. A prompt will appear to verify the action. Clicking **Yes** will delete the ID. Click on **Save File** to save the updated file to disk or click on **Send to Instrument** to update the instrument for field sampling.

Re-sequencing

With DataField 3.0CS it is possible to change the order of the ID's in a file to be in the same order as they are sampled in the field, this is called **Re-sequencing**. To re-sequence an ID data set, click on the **ID** button to open the ID editor. Load the ID data set from a file or download the data set from the instrument. Click on the **Re-sequencing** button to open the screen shown below.



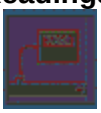
Select the ID from the left side window and click on the **Right** button to move ID to the right window to create the new sequence order. Repeat this process moving all ID's to the right side of the desired order.

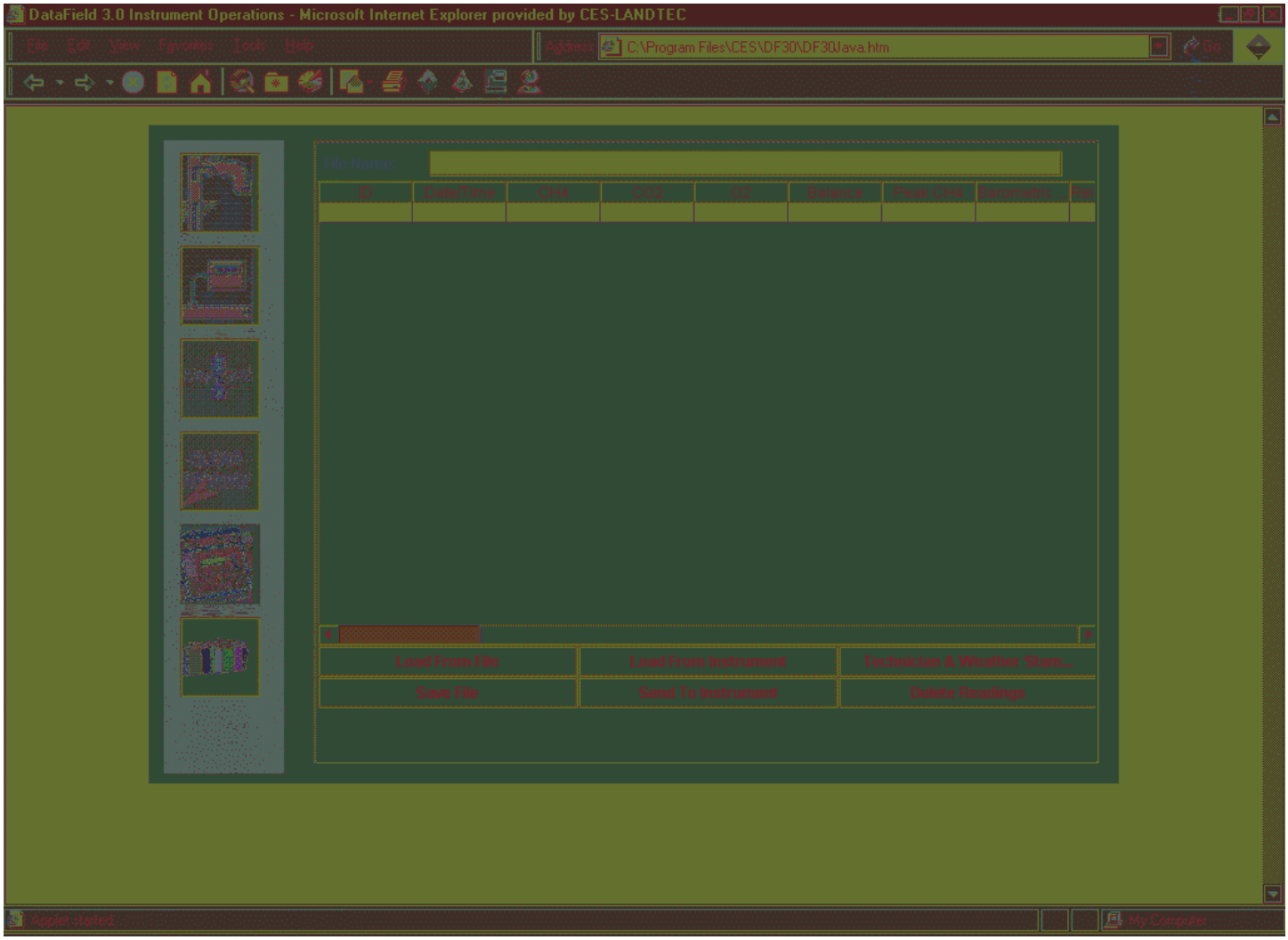


Click OK when the desired new sequence is obtained. Click on the **Save File** button to save the new data set to a file on disk or click on **Send to Instrument** to upload the new data to the instrument. Either action will overwrite the previous data.

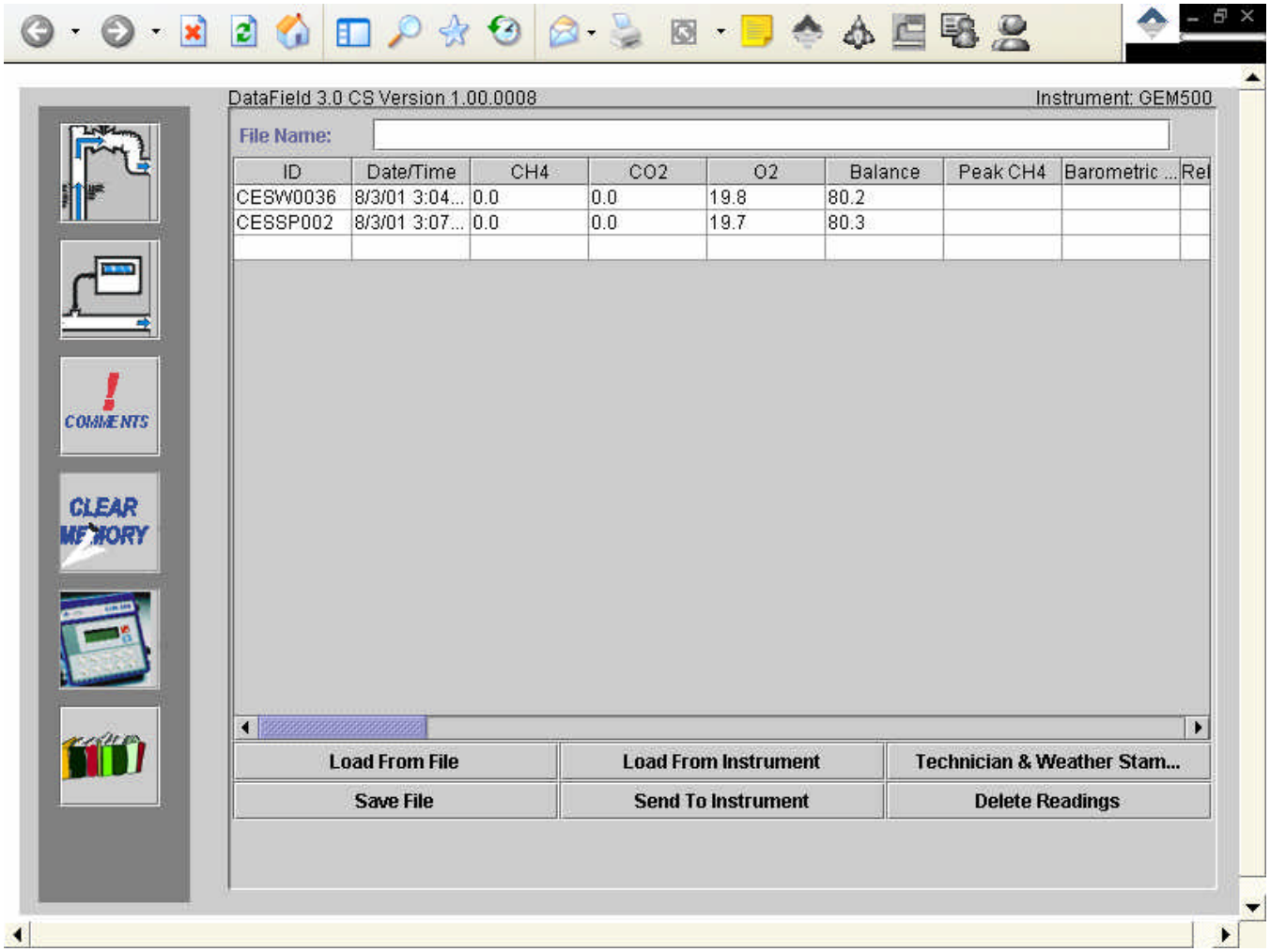
Readings

The Readings screen provides the capability to download, upload, view, save data to a file and delete individual or multiple readings from a data set. Click on **Readings** to open the screen shown below.





Click on **Load from File** to open a file folder of saved data on the disk drive or click on **Load from Instrument** to download data from the instrument. Either action will open the following screen.



Once the file has been opened or data downloaded from the instrument, either **Save File** or **Send to Instrument** may be selected. If an attempt is made to save the data to an existing file, a warning message will display indicating the file will be overwritten and data lost. Data sent to the instrument will be displayed as the previous sampled readings for the selected ID.

To delete data from the data set, click on the button to the left of the desired ID to highlight that ID and click on **Delete Readings**. If multiple consecutive readings need to be deleted, click and highlight the first reading, hold down the **Shift** key on the computer keyboard and click on the last reading to highlight all consecutive readings. (See figure 7.6A) Click on **Delete Readings** to delete the selected readings. If multiple separated readings need to be deleted, highlight the first reading; hold down the **Ctrl** key on the computer keyboard and click on subsequent readings to be deleted. (See figure 7.6B) When all the readings have been selected, click on **Delete Readings**.

Fig. 7-6A

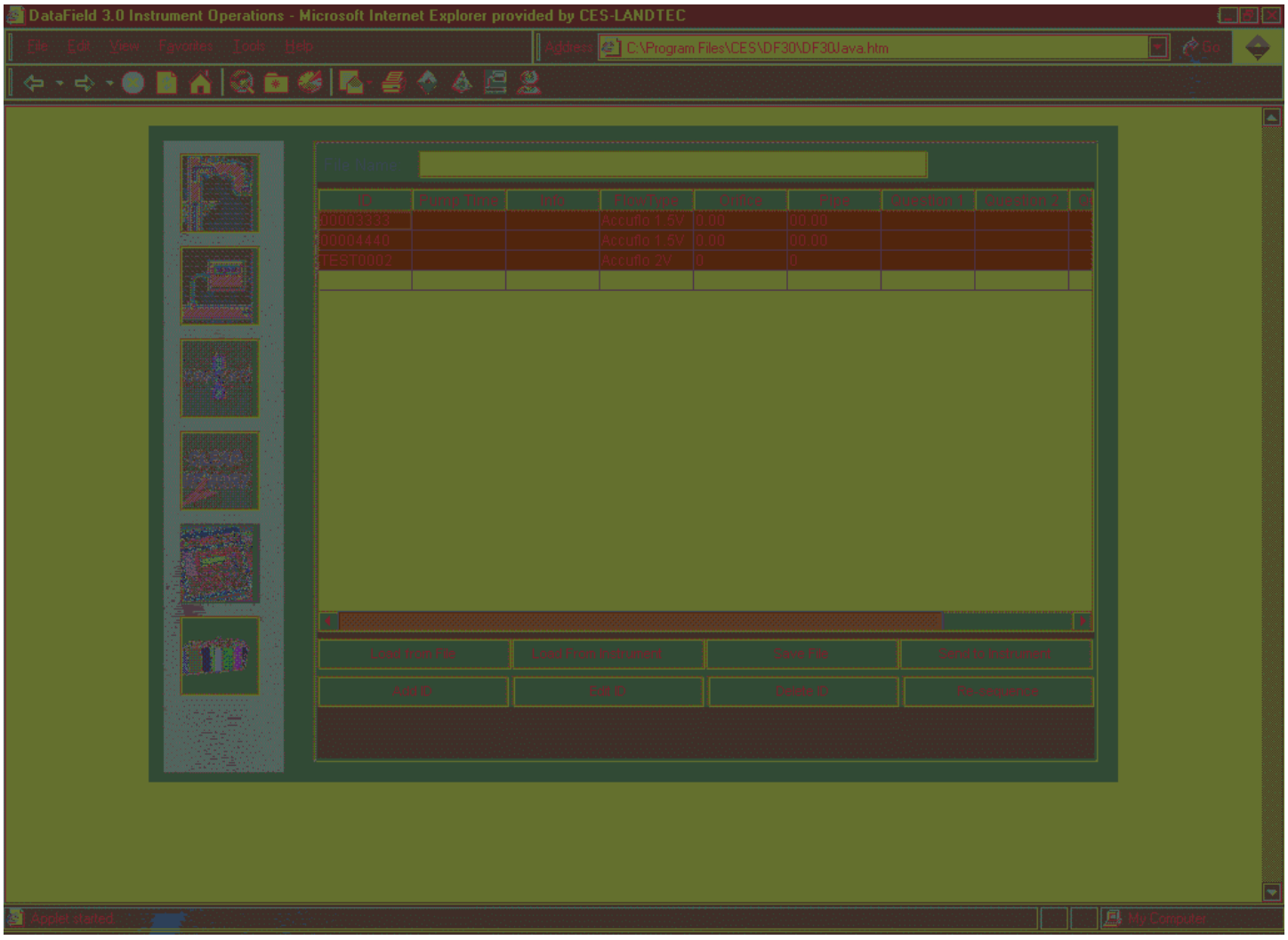
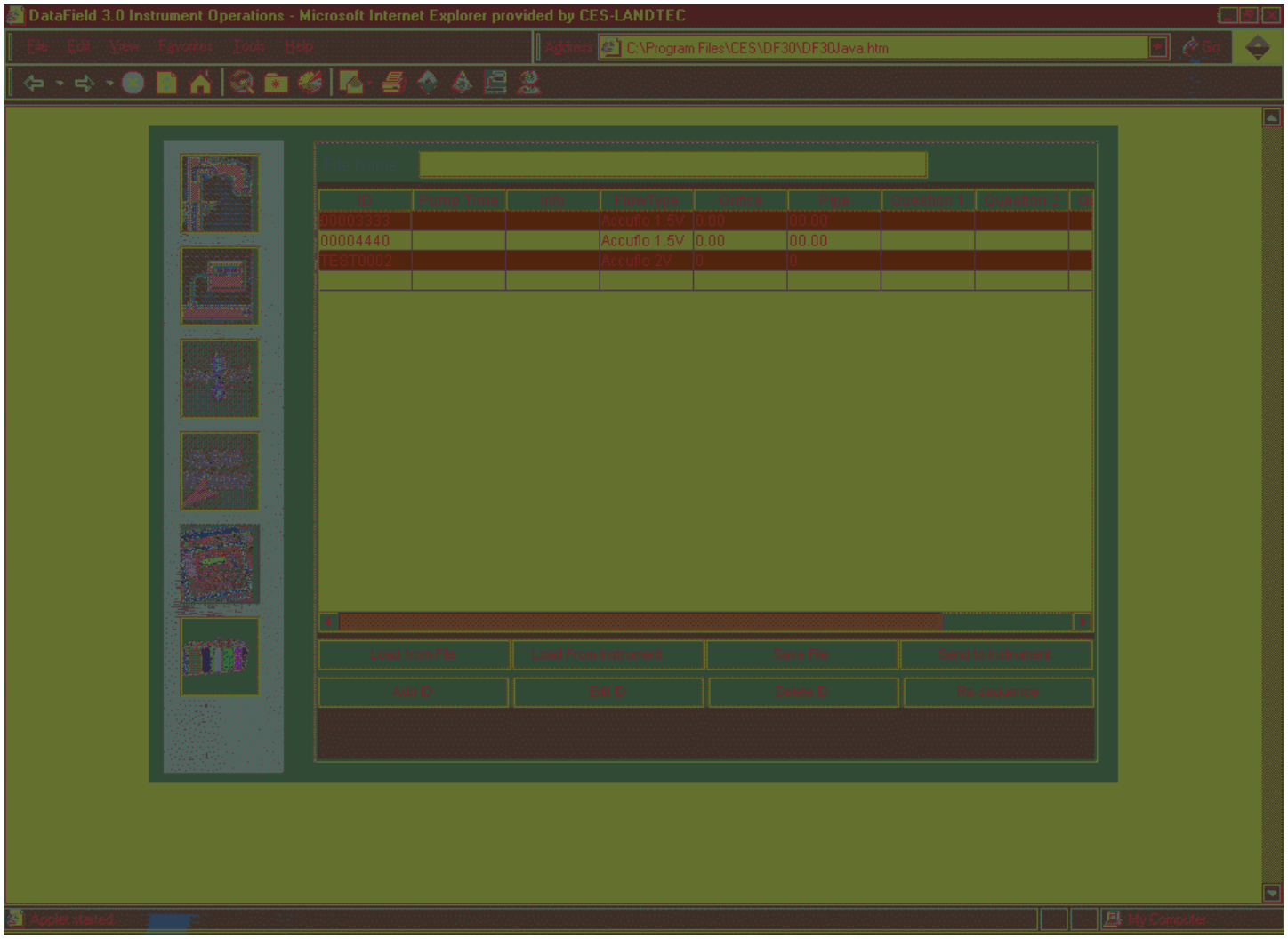
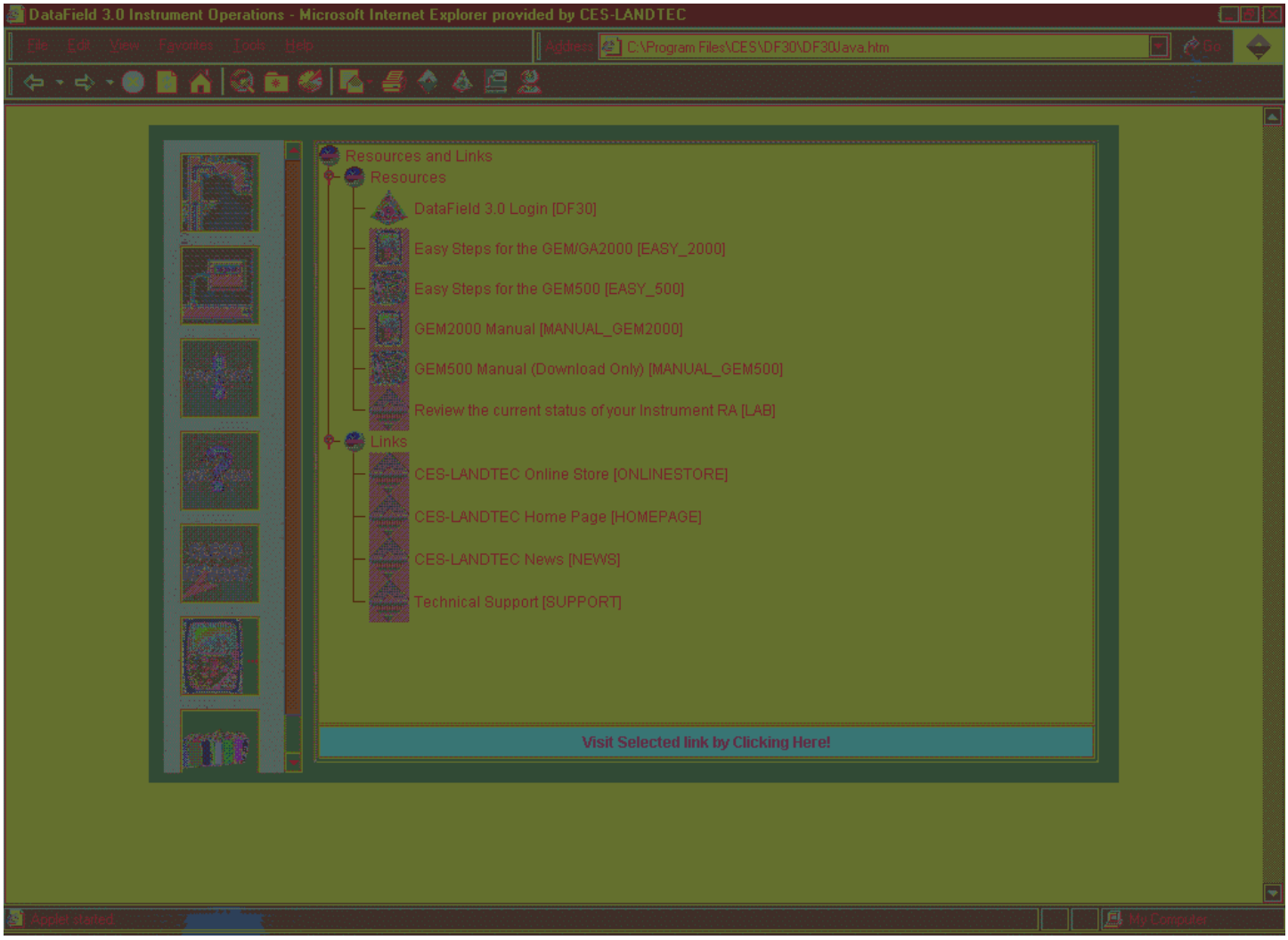


Fig. 7-6B



Resource Links

By clicking on the supplied link the user is taken directly to the www and the information listed.



Chapter 8 - Maintenance

Servicing

The GEM-500™ has been electronically and functionally tested before leaving the factory. It is recommended that with normal usage, the unit should be serviced every **six months** for routine factory service and maintenance which includes:

- Replace all Filters and O-rings.
- Perform Bench Test with 10 Test Gases.
- Minor Adjustments.
- Check Overall Performance.
- If needed, run through Environmental Chamber.
- Check Charging Circuit and Battery Pack.
- Check Inlet Port Fittings.
- Calibrate Transducers.
- Check the Pump.
- Check the Flow Fail.
- Perform Leak Test.

Cleaning

Protect the GEM-500™ by keeping it in its protective soft case. The keypad (polycarbonate membrane) should be wiped clean with soapy water and a damp cloth. Other cleaning agents may damage the membrane.

Sunlight and Heat

The GEM-500™ should not be left out in direct sunlight for long periods of time as this raises the temperature inside the case and may cause damage to the components. The unit may not operate or may operate erratically if it gets too hot or cold. The operating temperature range may be extended by use of heat packs in extremely cold conditions or cold packs in extreme heat conditions, these packs may be placed in the rear pouch of the soft case.

Dust Cap

Always keep the protective dust cap in place when the data port is not in use.

Filters

The GEM-500™ is equipped with two filters:

Water Trap Filter — This filter is external to the GEM-500™ and is located in-line in the sample hose. Unscrewing the two halves of the filter holder gives easy access to the filter. This filter should be routinely changed every one hundred hours of use or when water is sucked through the filter. The filter should also be replaced when the sample pump has difficulty drawing a sample of gas through it and into the unit. When this happens, the GEM-500™ sounds a continuous audible warning and a **Flow Fail** message appears on the screen.

Particulate Filter — This filter is inside the GEM-500™ and is located just inside the Static Pressure/Sampling port. (Figure 1.1, Figure 5.1) This filter is accessed by unscrewing the port (counter-clockwise) using the wrench provided.

Both filter holders are sealed with o-rings. Periodically inspect the o-rings to check their condition. Replace the o-rings if they become nicked, cut, swollen, or otherwise damaged. The GEM-500™ unit is shipped with a spare filter of each type. Only genuine CES-LANDTEC filters should be used and can be purchased through the CES-LANDTEC Sales Department by dialing 1-800-LANDTEC or on our web page at CES-LANDTEC.COM.

Travel and Storage

Travel – The GEM-500™ is a delicate scientific instrument and should be stored in its optional protective hard case when carrying it from site to site. This case affords maximum protection for the unit and offers enough storage space to take along all of the required accessories for the GEM-500™.

Storage – If the unit is to be stored for a long period, the internal batteries should be charged prior to storage. Recharge the unit every two weeks during storage.

When loading the GEM-500™ into its protective hard case, place the unit with the keyboard facing out and the CES-LANDTEC logo (upside down) closest to the handle on the front of the case. This will assure that the unit is stored right-side up when the case is closed and standing with its handle up in the carry position.

Battery Charging

The internal battery pack of the GEM-500™ is designed to be recharged many times, but as with all nickel-cadmium cells, certain rules should be observed or the batteries might not provide their full power or operating time. Please follow these instructions carefully.

WARNING! ONLY CHARGE A GEM-500™ WITH A LANDTEC BATTERY CHARGER (PROVIDED WITH THE UNIT).

1. Let the batteries almost fully discharge before recharging.

2. Do not top off an almost full battery charge because memory patterns can be established and the battery may not provide its full capacity.

   Note: If the GEM-500™ is repeatedly given small "top-off" charges, the battery capacity can be reduced. To restore the battery to full capacity, totally discharge the unit and then charge it for a full 14 hour period.

   When charging the batteries, let them charge at least 12 to14 hours. If using the optional CES-LANDTEC Smart Charger, batteries can be completely recharged in approximately 3 hours.

3. Never let the batteries charge for more than three or four days.

4. Disconnect the charger from the GEM-500™ after the batteries have charged.

Note: Heat from the battery compartment makes the front of the GEM-500™ (under the GEM-500™ label) warm to the touch while the batteries are charging.

Battery Shut-Off

A circuit within the GEM-500™ continuously monitors the battery voltage. If the battery voltage falls below a predetermined level, the unit automatically shuts itself off in order to prevent memory loss. If the unit shuts itself off, it requires a full charge of 14 hours (approximately 3 hours with the CES-LANDTEC Smart Charger) to restore the battery to its maximum level.

Battery Low Symbol

This Battery Symbol displays in the top right corner of the display screen. It displays as the battery capacity reaches about 10% of full charge. There are only about 30-45 minutes of full pump power left in the GEM-500™ when the symbol is displayed.

Automatic Power-Off

The GEM-500™ has an automatic power-off timer to conserve battery power. If no key is pressed for 15 minutes, the unit automatically switches itself off (no stored readings are lost).

Emergency Battery Power

In emergencies, the GEM-500™ may be operated with 6 “C” sized alkaline batteries. To use alkaline cells, remove the nickel-cadmium battery pack by using a Phillips screwdriver on the back battery compartment of the GEM-500™. Insert the alkaline battery “C” cells in the correct direction.

WARNING! DO NOT USE THE BATTERY CHARGER FOR STANDARD ALKALINE BATTERIES AS THEY MAY EXPLODE.

WARNING! BE SURE TO REPLACE BATTERIES IN CORRECT DIRECTION OR UNIT WILL BE DAMAGED.

Chapter 9 - 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 the factory.
"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 – see chapter 8 Maintenance.
Readings taken are not what was expected	Unit may be cut out of calibration – calibrate unit with known gas concentration. Water trap filter or particulate filter are clogged – replace filter.
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 (see chapter 7). Contact the factory.
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 the factory.
Oxygen readings drift	Perform a field calibration – zero and span (see chapter 3) Contact the factory
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 (see chapter 2) Contact factory
Nothing happens when the Gas Pod is installed	Remove and re-seat the Gas Pod. Contact the factory.
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 the factory.

Chapter 10 - Measurement Units & Specifications

Measurement Units

Screen 1

Type	Displayed As	USA (Imperial)	Metric (SI)
Methane	CH_4%	% by volume	% by volume
Carbon Dioxide	CO_2%	% by volume	% by volume
Oxygen	O_2%	% by volume	% by volume
Balance	BAL	% by volume	% by volume

Screen 2

Type	Displayed As	USA (Imperial)	Metric (SI)
Methane	CH_4%	% by volume	% by volume
Lower Explosive Limit	CH_4% LEL	% of 5% CH_4	% of 5%CH_4

Screen 3

Type	Displayed As	USA (Imperial)	Metric (SI)
Static Pressure	SP"	"w.c. (H_2O)	mb (millibar)
Differential Pressure	DP"	"w.c. (H_2O)	mb (millibar)
Temperature	T °F/°C	°F (degrees Fahrenheit)	°C (degrees Celsius)

Screen 4

Type	Displayed As	USA (Imperial)	Metric (SI)
Ref (past) BTU	BTU Ref	per cubic foot	
Ref (past) BTU	KJ Ref		per cubic meter
Ref (past) Gas Flow	scfm Ref	std. cubic feet per min.	
Ref (past) Gas Flow	scfm Ref		std. cubic meters per min.
Adj. (present) BTU	BTU ADJ		per hr.
Adj. (present) BTU	KJ ADJ		per hr.
Adj. (present) Gas Flow	scfm ADJ		std. cubic feet per min.
Adj. (present) Gas Flow	scfm ADJ		std. cubic meters per min.

Operating Temperature

10 to 104° F/-10 to 40° C

Range and Resolution

	Sensor Range Imperial	Resolution Imperial
Methane	0-100%	0.1
Carbon Dioxide	0-50%	0.1
Oxygen	0-25%	0.1
Pressure-Differential	0-10 “w.c.	0.01
Pressure-Static	0-100 “w.c.	0.1

Typical Accuracy

Gas	0 - 5% Volume	5% - 15% Volume	15% - Full Scale
Methane	0.3%	1.0%	3.0%
Carbon Dioxide	0.3%	1.0%	3.0%
Oxygen	0.5%	1.0%	1.0%

Chapter 11 - Field Operations

Landfill Gas Generation

A brief overview of the theory of landfill gas generation and methane recovery follows. Initially, when decomposable refuse is placed into a 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 are destroyed. A period of time must pass before the productive capacity is returned to normal. Since there is some methane of a given quality within the landfill void space, a decline in methane quality is only gradually apparent depending upon the size of the landfill.

Carbon Dioxide is also produced under either an aerobic or anaerobic 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.

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.

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.

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.

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.

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.

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.

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 can not be overemphasized.

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 GEM-500™ or magnehelic) or other device (anemometer/velometer)
- Velocity head (P or PT) (from GEM-500™ or pitot tube and magnehelic)

- Wellhead gas flow (from GEM-500™, or pitot tube & magnehelic, or anemometer/velometer)
- Wellhead adjustment valve position (initial and adjusted)
- New wellhead vacuum and flow information after adjustment
- Calculation of each well's LFG and methane flow and sum total
- Observations/comments

Additionally, Carbon Monoxide (CO) or Hydrogen Sulfide (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.

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 GEM-500™, GA-90 or magnehelic)
- Velocity head (P or Pt) (from GEM-500™ or pitot tube and magnehelic)
- Wellhead gas flow (from GEM-500™, or pitot tube and magnehelic, or anemometer/velometer)
- Wellhead adjustment valve position (initial and adjusted)
- New wellhead vacuum and flow information after adjustment
- Observations/comments

Line vacuums and gas quality may be taken at key points along the main gas collection header and at subordinate branches. This helps to identify locations of poor performance, excessive pressure drop, or leakage. Perform systematic monitoring of the 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.

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.

Following are well field adjustment criteria for consideration.

- Methane quality (ranging from 26 percent upwards)
- The degree to which conditions within the landfill favor methane production. Typical conditions include:
  - 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

Establishing Target Flows

For a given individual well, a target flow is established which will likely support maintenance of methane and oxygen quality objectives while maximizing the recovery of landfill gas. Typically, small adjustments are made in flow to achieve and maintain quality objectives. The well must not be allowed to 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.

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.

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.

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.
- Avoidance of well over pull and maintenance of a healthy anaerobic state within the landfill.
- Optimize LFG recovery for energy recovery purposes.
- Control nuisance landfill gases 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.

CES-LANDTEC Technical Tips

Landfill Control Technologies regularly produces technical landfill related information and educational material. Please call CES-LANDTEC at (800) LANDTEC, to receive the current series of these Technical Tips.