

DETECTO-PAK 4[®]

Users Manual



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This manual supersedes all previous manuals for the Heath Detecto-Pak 4.

HPN Manual: 100786-0 Rev D
HPN DP 4 Complete Unit: 100659-0

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Detecto-Pak[®] 4

Users Manual

Heath Consultants Incorporated
Houston, TX
713-844-1300
Fax: 713-844-1309

1-800-HEATH-US
www.heathus.com



*Safety, Leadership, Innovation, Performance
Then, Now and Tomorrow*

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INTRODUCTION

The HEATH Detecto-Pak 4 Flame Ionization Hydrocarbon Detector is designed to withstand normal field use and provide sensitive indication of the presence of hydrocarbon vapors.

This instruction manual is divided into nine chapters. Each chapter is designed to assure that the operator will obtain the best use of the Detecto-Pak 4. Chapter One, Detecto-Pak 4 features, should be required reading for all operating personnel prior to using the Detecto-Pak 4. Chapter Five, Operating the Detecto-Pak 4, outlines the steps necessary to make the instrument operational. Other chapters cover topics such as troubleshooting procedures, periodic maintenance, applications, etc.

FUNCTION

The Heath Detecto-Pak 4 Flame Ionization Hydrocarbon Detector is designed to detect and measure the presence of hydrocarbons (calibrated for methane). The instrument has five sensitivity ranges: 10, 50, 100, 1,000 (1K), and 10,000 (10K) ppm (1% gas).

This instruction manual describes the operation of the instrument and provides limited maintenance information. Heath firmly believes the Detecto-Pak 4, when properly maintained, will provide reliability and ease of operation for many years.

WARNING

EXPLOSIVE GAS MIXTURES CAN CAUSE SERIOUS INJURY OR DEATH. INHALATION OF VAPORS CAN CAUSE HEALTH IMPAIRMENT.

WARNING

IT IS ESSENTIAL THAT USERS OF THIS INSTRUMENT READ, UNDERSTAND, AND FOLLOW THE INSTRUCTIONS FOR OPERATION AND MAINTENANCE AND THE PRECAUTIONS CONTAINED IN THIS MANUAL TO ENSURE THE INSTRUMENT IS USED IN A PROPER AND SAFE MANNER.

WARNING

DO NOT ATTEMPT TO REPAIR THE INTERNAL FUEL REGULATOR. DISASSEMBLY COULD CAUSE DAMAGE TO THE DETECTO-PAK 4.

WARNING

DO NOT ATTEMPT TO REPAIR THE FUEL OR CALIBRATION CYLINDER/VALVE ASSEMBLY.

WARNING

THE BATTERY MUST BE CHANGED OR CHARGED IN AN AREA KNOWN TO BE NONFLAMMABLE TO REDUCE THE RISK OF IGNITING A FLAMMABLE ATMOSPHERE.

WARNING

CHAPTER ONE

I. DETECTO-PAK 4 FEATURES

This Chapter describes the features of the Detecto-Pak 4. Please refer to Figure 1 for illustration of individual parts.

DETECTO-PAK 4 COMPLETE

(Part No. 100659-0, 110 VAC)

(Part No. 100659-2, 220 VAC)

(Part No. 100659-1, 110 VAC High Alt.)

(Part No. 100659-3, 220 VAC High Alt.)

(Part No. 100659-4, 0-100K)



(Figure 1)

- | | |
|--|---|
| 1. Instrument Only
(Part No. 100581-0, 100581-1) | 5. Fuel Cylinder (2 included)
(Part No. 0618303) |
| 2. Probe, Sample
(Part No. 0111006) | 6. Gauge Adapter
(Part No. 0618302) |
| 3. Battery Charger (Auto)
(Part No. 100258-0, 110 HVAC) | 7. Carrying Strap W/Pad
(Part No. 100472-0) |
| 4. Filters, (Pkg/10)
(Part No. 0110163) | 8. Fuel Transfiller
(Part No. 0514937) |

1. INSTRUMENT

- Sensitivity Ranges: 0-10, 0-50, 0-100, 0-1,000 (1K), and 0-10,000 (10K) ppm
- Audible Alarm, continuous: Continuous alarm indicates flame is out.
- Audible Alarm, pulsating: Pulsating alarm indicates signal level above approximately 35 to 45% full meter scale.
- Fuel Cylinder Pressure Indicator: Gauge 0 - 3,000 psig
- Fuel Regulator, Internal: Inlet Pressure, 0 - 1,750 psig; Outlet Pressure, 22 - 42 psig; factory set for 30 cc/min fuel flow with 1,000 psig in fuel cylinder.
- Fuel Cylinder Holder: Holder located inside instrument to carry fuel cylinder. See opening at end of instrument.
- Weight of Instrument: 7 lbs. (3.2 kg), Operating

2. PROBE, Sample

- Adjustable Length: 25 to 41 inches (63 to 104 cm)
- Weight: 12 oz. (.340 kg)

3. BATTERY CHARGER

- Automatic Reduction: 16 hours to full charge
- Power: 110 VAC, 60 Hz
- Output: 14.5 VDC at 60ma

4. FILTRATION

- Replaceable Filters: Part No. 0110163, Pkg/100 or Part No. 0110683, Pkg/500

5. FUEL CYLINDERS

- Color: Black, DOT Rated 3E1800
- Volume: 100 cubic centimeters (approximate)
- Maximum Working Pressure: 1,750 psig
- Weight: 1 lb. (.453 kg)

6. GAUGE ADAPTER

- Gauge Adapter is used to indicate outlet pressure setting of internal regulator.
- Weight: 5.6 oz. (.159 kg)

7. CARRYING STRAP WITH PAD

- Strap: Strap facilitates carrying instrument over shoulder with cushioning pad.
- Weight: 6.4 oz. (.181 kg)

8. FUEL TRANSFILLER (Part No. 0514937)

- Fuel Transfiller is used for refilling fuel cylinders.
- Pressure Indicator: Gauge 0 - 3,000 psig
- Restrictor, INTERNAL: Restrictor prevents pressure surge when filling cylinders.
- Purge Valve: Purge Valve relieves pressure when filling cylinder is complete.
- Weight: 15.5 oz. (.439 kg)

9. CARRYING CASE, System

- Dimensions: 24 x 19 x 8.5 inches (60 x 48 x 21 cm)
- Weight: Empty 15 lbs. (6.8 kg)
Filled 29 lbs. (13.2 kg)
- Total weight in shipping carton: 31 lbs. (14.1 kg)

ADDITIONAL FEATURES (not shown)

- **Instruction Manual**

- **“O” Rings for fuel cylinder valve:**

Dimensions .145 ID x .070 CS inches

Material: Buna-N

- **“O” Ring Lubricant:**

Lubricant supplied for “O” Rings for fuel cylinder valves.

- **Sample Intake Rate:**

Pump, 2,000 cc per minute, (2 SLPM) nominal

- **Ignition Type:**

Glow Coil

- **Battery Indicator:**

Needle indication (three color) on instrument ppm meter shows battery status.

- **Power Supply:**

Internal, rechargeable NiMH Battery, 12 VDC, 1500 mah

- **Fuel Consumption:**

30 cc per minute, 40% Hydrogen - 60% Nitrogen at 22-42 psig

- **Daily Operating Life:**

Life is eight hours with fully- charged battery and two fuel cylinders filled to 1,750 psig.

OPTIONAL ACCESSORIES

Calibration Kit With Gas:	This Calibration Kit is available to field calibrate the Detecto-Pak 4 to ensure proper sensitivity levels, and comes complete with Calibration Gas Cylinder. (Part No. 0123309-0).
Calibration Gas:	Calibration cylinder filled to approx. 1500 ± 200 psig of 100 ± 10 ppm methane, balance air, to use with above calibration kit. (Part No. 0123071)
Calibration Cylinder Transfiller:	Item used to refill above calibration gas cylinder, same as Item 8 above, except for CGA 590 inlet and CGA 170 outlet fittings. (Part No. 0124601)
Pressure Indicator:	Gauge 0 - 3,000 psig.
Restrictor, Internal:	Restrictor prevents pressure surge when filling cylinders.
Purge Valve:	Valve relieves pressure when filling of cylinder is complete.

CHAPTER TWO

II. FUEL MOTHER TANKS/FUEL CYLINDERS:

This Chapter discusses, in detail, the proper steps to take in transferring fuel to the fuel cylinder.

Recommendations for ordering fuel mother tanks, along with proper storage, are also discussed in detail.

A. FUEL GAS MIXTURE

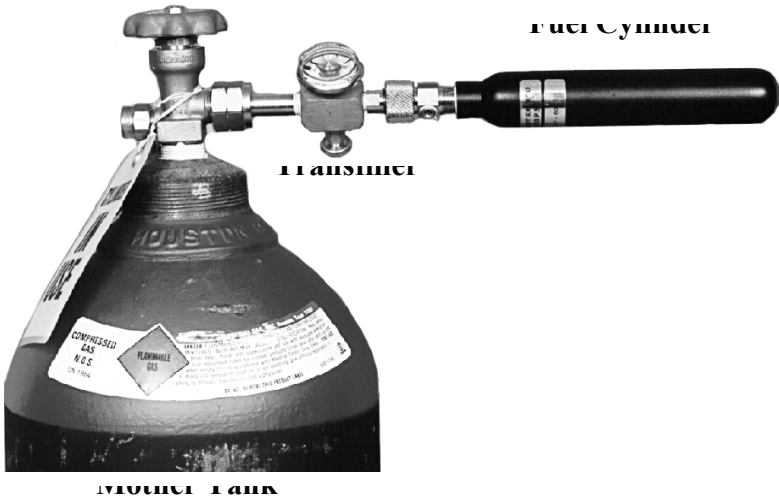
The fuel gas is a certified mixture of 40% hydrogen/60% nitrogen +/- 2% with less than .5 ppm of hydrocarbon.

B. TRANSFILLING FUEL CYLINDERS

Heath assumes no liability in refilling of fuel cylinders. If you wish to refill your own fuel cylinders, caution must be exercised during the refilling process. It is also recommended that all safety precautions be used in the handling of high-pressure, compressed flammable gases during the refilling process.

To refill the fuel cylinders, connect the fuel transfiller to a fuel mother tank, then attach a non-contaminated fuel cylinder to the transfiller. See (Figure 2) this Section and ****NOTE****, Paragraph C, of this Section.

**MOTHER TANK, TRANSFILLER & FUEL CYLINDER
CONNECTED FOR TRANFILLING**



(Figure 2)

1. Remove the safety cap or caps from the fuel mother tank.
2. Very slowly, open valve on the fuel mother tank a very small amount (crack). Then close it immediately. This will clean (blow) any contaminants out of the valve.
3. Firmly secure the hex nut on the transfiller to the fuel mother tank valve outlet using an appropriate wrench. (Note: notches in hex nut body indicate the nut threads are “Reverse Cut” threads.)
4. Finger tighten knurled nut on transfiller to valve outlet on fuel cylinder.
5. Close bleed off valve on transfiller by turning it completely clockwise.
6. Slowly open fuel mother tank valve counterclockwise until the pressure gauge on the transfiller continues to rise, or approximately one-half of a turn open.
7. Observe transfiller pressure gauge and turn off fuel mother tank valve at 1750 psig or when the pressure gauge stops rising below 1750 psig

level (determined by fuel mother tank internal pressure). DO NOT EXCEED 1750 psig pressure in the fuel cylinder.

8. Open bleed off valve on transfiller to eliminate pressure in transfiller.
9. Loosen knurled nut with finger pressure and remove fuel cylinder.
10. Remove transfiller from fuel mother tank, replace safety cap or caps, and safely store fuel mother tank. For storing and transporting of these fuel mother tanks/fuel cylinders, see Paragraphs D. and E. of this Section.

C. ORDERING FUEL MOTHER TANKS

When ordering a mother tank of fuel, it is recommended that a certified mix of 40% hydrogen/60% nitrogen +/- 2% with less than .5 ppm of hydrocarbon be requested.

The following companies can supply the proper fuel mixtures in fuel mother tanks. This list is not intended as an endorsement, and other suppliers may be available. If you are unable to locate a fuel source, please contact your nearest Heath representative.

****NOTE****

When ordering, it is extremely important to specify CERTIFIED. This helps ensure quality gas. Not ordering CERTIFIED gas increases the risk of not securing a 40% H₂ (hydrogen)/60% N₂ (nitrogen) mix of less than (0.5) ppm hydrocarbon background. See Chapter Eight, Section VIII, - A, Item 2b for example of negative effect.

SUPPLIERS OF FUEL GAS MIXTURES:

AIRCO

LINDE

ALPHAGAZ

LIQUID CARBONIC

MG INDUSTRIES

SCIENTIFIC GAS PRODUCTS

MATHESON GAS PRODUCTS

SCOTT SPECIALTY GASES

AIR PRODUCTS

****NOTE****

The need for a special mixture of high altitude fuel for operations located 3,000 feet or more above sea level may arise. When these circumstances occur, please contact the Heath representative in your area for assistance.

(See Chapter Five, Section V - B, IMPORTANT, covering high altitude operation for special instructions.)

D. STORING FUEL MOTHER TANKS OR CYLINDERS

The fuel mother tanks or fuel cylinders must be stored in accordance with D.O.T. and/or OSHA regulations. Simply stated, the regulations that apply are ones restricting storage of compressed, flammable gases near stored oxidizing agents such as compressed oxygen. Also applicable are regulations in regard to protecting the tanks from unauthorized tampering and/or mechanical damage.

E. SHIPPING FUEL MOTHER TANKS OR CYLINDERS

Fuel mother tanks or fuel cylinders contain compressed, flammable gas and must be shipped as hazardous cargo according to D.O.T. and/or OSHA regulations. Fuel gas mixtures are flammable when mixed with air or oxygen. They must be shipped by motor freight or other freight services that permit shipment of compressed, flammable gases.

In all cases, special labeling notation and documentation is required.

(See latest edition of “Hazardous Material Regulations of the Department of Transportation.”)

CHAPTER THREE

III. CALIBRATION MOTHER TANKS/CALIBRATION CYLINDERS:

This Chapter discusses, in detail, the proper steps to take in transferring calibration gas to a calibration cylinder.

Recommendations for ordering calibration gas mother tanks, along with proper storage, are also discussed.

A. CALIBRATION GAS MIXTURES

The calibration gas is comprised of a mixture of 100 ppm \pm 10% methane, balance zero air. The calibration gas mixture is drawn into the instrument at the inlet of the filter housing to ensure proper sensitivity level (See Chapter Six for a detailed explanation of this method.)

B. TRANSFILLING CALIBRATION CYLINDERS

Heath assumes no liability in the refilling of calibration cylinders. If you wish to refill your own calibration cylinders, caution must be exercised during the refilling process. It is also recommended that all safety precautions be used in the handling of high-pressure compressed, flammable gases during the refilling process.

To refill the calibration cylinder, connect the calibration transfiller to a calibration mother tank, then attach a non contaminated calibration cylinder to the Transfiller. See Figure 3 this Section and ****NOTE****, Section II, C of Chapter Two.

MOTHER TANK, TRANSFILLER & CALIBRATION CYLINDER CONNECTED FOR TRANSFILLING



(Figure 3)

1. Remove the safety cap or caps from the calibration mother tank.
2. Very slowly, open valve on the calibration mother tank a very small amount (crack). Then close it immediately. This will clean (blow) any contaminants out of the valve.
3. Firmly secure the hex nut on the calibration transfiller to the calibration mother tank valve outlet using an appropriate wrench. (Note: notches in hex nut body indicate the nut threads are “Reverse Cut” threads.)
4. Tighten small hex nut on calibration transfiller to valve outlet on calibration cylinder.
5. Close bleed off valve on calibration transfiller by turning it completely clockwise.
6. Slowly open calibration mother tank valve counterclockwise until the pressure gauge on the calibration transfiller continues to rise, or approximately one-half of a turn open.
7. Observe calibration transfiller pressure gauge and turn off calibration mother tank valve at 1750 psig or when the pressure gauge stops rising below 1750 psig level (determined by calibration mother tank internal pressure). DO NOT EXCEED 1750 psig pressure in the calibration cylinder.

8. Open bleed off valve on calibration transfiller to eliminate pressure in calibration transfiller.
9. Loosen small hex nut and remove calibration cylinder.
10. Remove calibration transfiller from calibration mother tank, replace safety cap or caps, and safely store calibration mother tank.

C. ORDERING CALIBRATION MOTHER TANKS OR CALIBRATION CYLINDERS

Calibration mother tanks/calibration cylinders are available from Heath at the listed location. (See Chapter Two, Section II - C, Ordering Fuel Mother Tanks.)

The calibration cylinder consists of a gas cylinder/valve assembly filled with approximately 1,500 psig \pm 200 psig of calibration gas. This calibration cylinder can be refilled from a calibration mother tank of the same gas mixture, which is readily available from Heath.

When ordering calibration cylinder, use Heath Part No. 0123071.

D. STORING CALIBRATION MOTHER TANKS OR CYLINDERS

The calibration mother tanks or cylinders must be stored in accordance with D.O.T. and/or OSHA regulations. (See Chapter Two, Section II-E, Shipping Fuel Mother Tanks or Cylinders.)

E. SHIPPING CALIBRATION MOTHER TANKS OR CYLINDERS

Calibration mother tanks or cylinders contain compressed, flammable gas and must be shipped as hazardous cargo according to D.O.T. and/or OSHA regulations. Calibration gas mixtures may be flammable when mixed with air or oxygen. They must be shipped by motor freight or other freight services that permit shipment of compressed, flammable gases.

In all cases, special labeling notation and documentation is required.

(See latest edition of “Hazardous Material Regulations of the Department of Transportation.”)

CHAPTER FOUR

IV. CHARGING SYSTEMS

The Detecto-Pak 4 Flame Ionization Detector utilizes a 1.5 amp hour Nickel Metal Hydride rechargeable battery pack as the source of its power. The instrument was designed for 8 hours of continuous operation however this battery, when properly cared for, will provide adequate power to operate the instrument for 10 plus hours under normal conditions. In freezing conditions the battery capacity is reduced between 10% and 20% depending on the health of the battery.

In order to give the user a means to roughly determine the battery capacity, a Battery Test Switch is included on the Detecto-Pak 4 control panel. Pressing and holding this switch will indicate the approximate charge level of the battery on the instrument meter. The meter is color coded on the center scale with green indicating adequate capacity, yellow indicating reduced capacity and a recommendation for recharging, and red indicating questionable capacity and the need to recharge. The instrument will continue to operate in the yellow an up to mid scale in the red, however continuing to operate in the red means the instrument will gradually become unstable and ultimately will loose sensitivity. Operating in the red is not recommended.

Part of the charging system includes an approved, automatic electronically controlled battery charger to recharge the nickel metal hydride battery. For export, when required, a 220 VAC, 50 Hz to 110 VAC converter for your battery charger is available. Because of a wide range of 220 VAC receptacles encountered around the world, the customer must provide an adapter on the input side of the converter to fit the 220 VAC receptacle.

A. NICKEL METAL HYDRIDE (NiMH) RECHARGEABLE BATTERY

Due to the nature of the battery, more energy must be put back into the battery then is drawn from it. Normally, it requires 10 to 12 hours of charging to completely recharge the Nickel Metal Hydride battery. Shorter charging periods may have a negative effect on the health of the battery and are not recommended.

B. BATTERY CHARGER

It is very important to use ONLY the approved charger supplied with the Detecto-Pak 4 to recharge the battery pack. Substitute chargers may damage the battery pack. After the charger has been plugged into the Detecto-Pak 4 for 10 hours, the charger will automatically reduce itself to the float mode. The float mode will maintain a charge in the battery as long as it is connected to the charger. We recommend the Detecto-Pak 4 be connected to the charger whenever it is not in use. This will ensure the battery is charged and the instrument is ready for use.

C. CHARGING PROCEDURE

WARNING

THE BATTERY MUST BE CHARGED OR CHANGED IN AN AREA KNOWN TO BE NONFLAMMABLE TO REDUCE THE RISK OF IGNITING A FLAMMABLE ATMOSPHERE.

The charging procedure is to set the Detecto-Pak 4 instrument Power Switch to "Off." Plug the battery charger into a 120 VAC receptacle, then plug the battery charger output plug into the charger jack on the Detecto-Pak 4. If connected in this correct sequence, the charger is on and in the high charge mode.

Charging time is normally a 10 to 12 hour period if the instrument has been operated for 8 to 10 hours. Although shorter charging times are not recommended, if it becomes necessary use a 1.5 to 1 ratio to time in use. Example: If you use the instrument for 4 hours, charge the battery for 6 plus hours to completely recharge it.

D. GENERAL INFORMATION - NICKEL METAL HYDRIDE BATTERY

1. We recommend that a new replacement Nickel Metal Hydride battery be cycled 2 times before regular use. First, fully charge the battery, then discharge the battery by operating the instrument for 8 to 10 hours or preferably until it ceases functioning. Then fully recharge for 10 plus hours. This is not necessary for new instruments shipped from the factory and put into use within 2 weeks because the cycling was accomplished in the factory.

2. Put the nickel metal hydride battery through a charge/discharge cycle at least once a month when the instrument is not in use. Nickel metal hydride batteries function best when frequently used.
3. Only use a Heath supplied nickel metal hydride battery and accompanying approved battery charger as they are matched for optimum performance and safety.
4. Do NOT use a nickel metal hydride battery when it is fully discharged. When the battery is depleted, it must be recharged before use.
5. Do not attempt to charge other types of batteries with a nickel metal hydride charger or try to charge the nickel metal hydride battery with a charger other than the one designed for this nickel metal hydride battery.

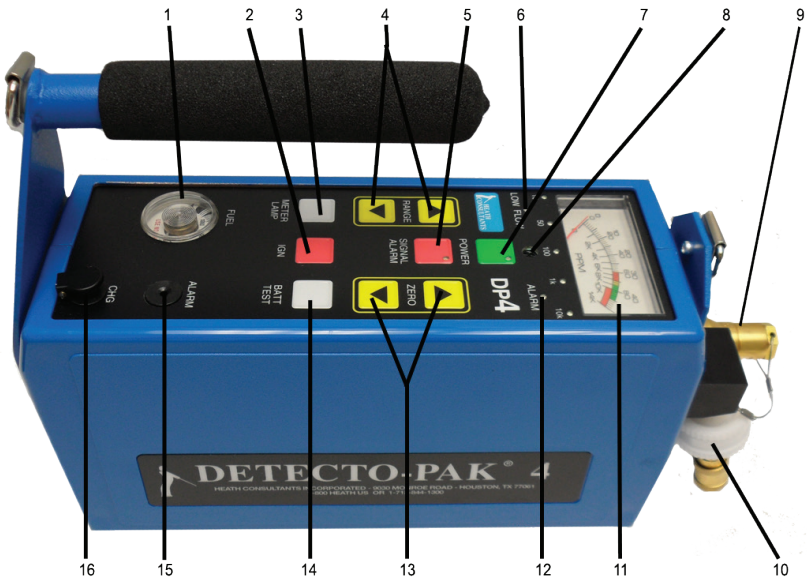
CHAPTER FIVE

V. OPERATING THE DETECTO-PAK 4

This Chapter explains and contains a detailed illustration of the control panel. Operating and shutdown procedures are also discussed.

Detecto-Pak 4, Instrument Only, Part No. 100581-0, 100581-1

(Figure 4)



- | | |
|---|--------------------------------|
| 1. Fuel Gauge | 10. Sample Inlet Filter Holder |
| 2. Ignition Switch | 11. Meter |
| 3. Meter Lamp Switch | 12. Alarm LED |
| 4. Range Up/Down Switch | 13. Zero Up/Down Switch |
| 5. Signal Alarm Switch | 14. Battery Test |
| 6. Low Flow Alarm LED | 15. Signal Alarm |
| 7. Power Switch | 16. Charger Jack |
| 8. Range LED's | |
| 9. External Pressure Gauge
Connector (not shown) | |

A. INSTRUMENT LAYOUT AND CONTROLS.

1. FUEL GAUGE: Mechanical fuel gauge used to indicate the pressure in the fuel cylinder.
2. IGNITION SWITCH: Pressing firmly down on the ignition switch produces voltage across the coil in the detector cell to ignite the air/fuel mixture.
3. METER LAMP SWITCH: Press to enable meter lamp for backlight.
4. RANGE UP/DOWN SWITCH: These two switches are used to select the respective ppm range. They are single press only switches and will single step the current range to the next available range. The ppm range will wrap around in either direction, i.e., range up from 10K ppm will step to 10 ppm and visa versa.

****NOTE****

The detector cell must have its' flame ignited for the meter range to follow the range selected. If the flame has not been ignited, it is not possible to step through the ranges and the meter will only respond on the 10 k ppm range. This is done to prevent accidental damage to the meter movement due to attempted ignition on a lower range or due to high sample concentrations which would drive the meter beyond full scale.

5. SIGNAL ALARM SWITCH: Used to enable / disable the signal set point alarms (LED and audible). A blinking LED on the signal alarm switch indicates the alarms are enabled. The pulsating signal and blinking LED alarms occur at approximately 35 to 45 percent of meter full scale, regardless of which ppm range is selected. As a safety factor, the signal alarm switch does not affect the continuous flame out alarm.

The Detecto-Pak 4 may flame out when exposed to high gas concentrations.

6. LOW FLOW ALARM LED: Blinking LED used to visually alert the operator of low sample flow. Low sample flow is normally caused by a dirty or clogged sample filter or mud in the sample probe inlet.
7. POWER SWITCH: Pressing this switch either turns on the instrument or shuts it down. The instrument powers up in the 10K ppm range, with the signal alarm enabled, and with the flame out alarm on. The flame out alarm will sound until the fuel has ignited and the detector cell has begun to warm up (approximately 10 seconds beyond pressing the igniter).

Pressing the switch again will shut off the fuel flow to the detector cell which will extinguish its' flame. The instrument will then automatically turn off.

8. RANGE LEDs: Blinking LEDs used to indicate the selected ppm range.
9. EXTERNAL PRESSURE GAUGE CONNECTOR: Used to check the internal regulator output pressure with an external pressure gauge.
10. SAMPLE INLET/FILTER HOLDER HOUSING: The hose from the Sample Probe connects to the instrument at this location. A sample filter is located within the filter holder housing and is easily changed by manually unscrewing the filter holder housing from the instrument.
11. METER: Indicates the ppm concentration depending on which range is selected and the battery level.
12. ALARM LED: Provides a visible indication of the ppm level exceeding the alarm set point. The alarm led blinks in conjunction with the pulsating audible alarm and both are enabled/disabled by the signal alarm switch.
13. ZERO UP/DOWN SWITCH: These two switches provide fine meter zeroing and are effective on the 10, 50, and 100 ppm ranges only. A single press of either switch will shift the meter by approximately 1 meter division on the 10 ppm range (.2 ppm). Subsequent presses must be at least 1 second apart as the switches also provide fast zeroing. Fast zeroing is achieved by pressing and holding down either switch for at least 1 second. For every second the switch is held down, the meter zero will change by approximately 1 ppm. The audible alarm will beep at every 1 second interval to verify fast zeroing. Single switch presses and held switch pressed may be used in any order. Typically the fast zero will be used first and then single switch presses will be used to set the final meter zero. Fast zeroing will wrap around its range if the switch is held down longer than 10 seconds. On power-up, the fine zero position is automatically set to mid range.
14. BATTERY TEST SWITCH: Pressing and holding this switch will indicate the charge level of the battery on the instrument meter. The instrument should be operated only while the meter needle registers in the green zone. Movement into the yellow or red zone indicates that a complete recharge (10-12 hours minimum) is required.

****NOTE****

The instrument must be on to check the battery level.

15. SIGNAL ALARM: Audible alarm used to indicate the various types of alarm conditions which may exist. A continuous alarm is used for flame out, low sample flow, or in the rare event of detector cell over-heating. A pulsating alarm is used for indicating the signal level exceeds the alarm set point.
16. Please use Heath supplied charger only to charge DP4 through this charger jack.

****NOTE****

The instrument will verify all control switch operations by making a short beep. This is normal and does not indicate an alarm. Alarms typically last several seconds or as long as the condition lasts.

B. OPERATING PROCEDURES

The Detecto-Pak 4 is easy to operate. It is important that the following procedure be carefully read and followed in order to obtain the maximum benefits of its many features.

****NOTE****

The Detecto-Pak 4 should only be turned on and zero adjusted in a nonflammable (clean air) atmosphere.

1. Carefully unpack all items from the system carrying case.
2. Always start with a fully charged battery. (See Chapter Four, Section IV, A-D)
3. Always start with enough fuel in the fuel cylinder to last the expected operating time. 1,750 psig in the two (2) fuel cylinders will ensure at least eight hours of operation. Do not allow pressure in the fuel cylinder to drop below 50 psig.

****NOTE****

Fuel cylinders with negative pressure (vacuum) are supplied on the initial shipment. The operator must fill cylinders to operating fuel level before start up of the Detecto-Pak 4.

****NOTE****

Apply a very small amount of supplied "O" ring lubricant to small "O" ring on the stem of the cylinder valve at least once a week.

4. Insert the fuel cylinder into the cylinder holder at the rear of the instrument. Turn the cylinder clockwise until the high pressure gauge moves upscale. Turn cylinder an additional 1/4 to 1/2 turn, or until snug. Do not over-tighten the cylinder.
5. Replace the sample inlet filter if dirty, contaminated, or wet. A clean filter should always be inserted in the filter cup prior to each use. Replace filter daily or more often if required. (See Chapter Eight, Section VIII - B, Filter Replacement, for details.)
6. Attach extended probe assembly to the Detecto-Pak 4 by firmly pressing the connector on the end of hose into the quick connector on the filter housing.
7. Depress the POWER switch. Continuous alarm will sound until the fuel is ignited in the detector cell. NOTE: When first turned on, the alarm will sound and then will be silent for approximately eight (8) seconds. Then the continuous flame out alarm will sound until instrument is ignited.
8. Press Battery test switch. Meter needle should indicate in the green zone.
9. Depress Range switch to put instrument in the 10K ppm range and allow one (1) minute for fuel line to purge.

CAUTION

Instrument MUST be ignited in the 10K ppm range.

10. Press the Igniter button. The continuous “flame out” alarm should stop within twenty five (25) seconds. This indicates the fuel in the detector cell is ignited. If continuous alarm is still on, repeat this step until the continuous alarm stops.
11. Allow five (5) minutes for the Detecto-Pak 4 to warm up. Warm up may take up to fifteen (15) minutes during cold weather. It is advisable to store the Detecto-Pak 4 in a warm room overnight rather than to leave it outside in cold weather.
12. Zero meter using the ZERO switches

CAUTION

Care should be taken that instrument and operator are in a nonflammable (clean air) atmosphere.

13. To check pulsating signal alarm operation by press zero up switch until pulsating alarm sounds. Allow time for the meter to settle. The pulsating alarm should turn on at a meter reading between 35-45% of full scale. Return meter reading to zero.
14. To verify that the instrument is operational, the Detecto-Pak 4's sensitivity should be tested by introducing a small sample of a known hydrocarbon gas to the sample inlet. The meter should swing upscale and return to zero.
15. The Detecto-Pak 4 is now operational.

C. ZERO PROCEDURES

Zero the instrument as needed by the following procedure.

Before zeroing the Detecto-Pak 4, two conditions must be met:

1. The instrument must be fully charged, and
2. Either zero air from a demand regulator or a verified hydrocarbon free atmosphere must be used. Zero air is recommended. The Average background level of methane in the atmosphere is 2 ppm.

Zeroing Procedure:

- a. With the instrument's power off, mechanically zero the meter using a small blade screwdriver.
- b. Start and warm-up the instrument as described under "OPERATING PROCEDURES", Chapter Five, Section V, B.
- c. Coarse zero the instrument on the 10 K ppm range. A micro screwdriver will be needed to adjust the potentiometer (RP8) located behind the right-hand (inner most) access plug on the rear of the instrument below the fuel bottle holder. Remove the plug to access the adjusting potentiometer. Refer to Figures 7 and 8 in the manual.

****NOTE****

The fine zero control is automatically centered upon power-up. Do not adjust the fine zero (by using the zero controls on the top panel) at this time.

- d. Select the 50 ppm range and re-adjust the coarse zero.
- e. Re-insert the plug into the right hand access port.

- f. Select the 10 ppm range and fine zero the instrument using the zero controls on the top panel. Press and release a zero control to make adjustments. Wait at least one second between zero control presses.

****NOTE****

While in operation, it is normal for the zero to drift with ambient temperatures and small changes in the methane background concentration. The fine zero controls also support a “fast” mode equal to 10 single presses. Fast mode is enabled by holding down either zero control for longer than one second. Every second thereafter will produce the equivalent to 10 single presses followed by a beep. Release the zero control to exit the fast mode.

The Detecto-Pak 4 should now be zeroed to within 1 ppm.

D. SHUTDOWN PROCEDURES

The following procedure must be followed in order to maintain the Detecto-Pak 4 in good working order. This procedure should be followed whenever the Detecto-Pak 4 remains inactive for two or more days. The battery charging procedure is all that will change.

****NOTE****

The Detecto-Pak 4 should only be shut down and the battery changed or charged in a nonflammable (clean air) atmosphere. Instrument should be in 10K range.

1. Disconnect and remove the fuel cylinder from the instrument. Install the protective cap on the fuel cylinder valve and store the cylinder in its proper compartment in the carrying case.
2. Wait for the fuel to purge from the system tubing. The continuous “flame out” alarm will sound when the fuel is purged and the flame goes out.
3. Press the Power function switch to turn the Detecto-Pak 4’s electronics off.
4. Disconnect the probe and store the instrument and probe in their proper compartments in the carrying case, or connect the instrument to its automatic battery charger. (See Chapter Four for battery charging procedures.)

CHAPTER SIX

VI. CALIBRATION:

The Heath Detecto-Pak 4 is factory calibrated. It is recommended that the Detecto-Pak 4 be calibrated once a week. However, it is recognized that the Detecto-Pak 4 will be used for a wide range of applications and for varying lengths of time. Such variables may cause the operator to develop his or her own calibration schedule. The operator may see a need for a more or less frequent calibration schedule.

The Detecto-Pak 4 should also be calibrated after any repair or replacement of any parts and at any time the operator suspects the instrument's calibration has changed.

In addition to calibrating the instrument on a regular basis, the instrument should be run through a diagnostic check before each use. The check should include an observation of the external sampling system. Also, a daily operational check, with a known sample of gas is recommended to insure the instrument is operating.

A. CALIBRATION GAS

The type of calibration gas and the concentration level of the calibration gas will be dictated by the particular detection needs requirements.

The most reliable detection results will be obtained when the Detecto-Pak 4 is calibrated with a calibration gas containing the same gas component anticipated in the test area.

Additionally, the concentration of the calibration gas should represent the level nearest the critical area of detection required. That is, if an anticipated detection level of a particular gas is 100 ppm, then a calibration gas of that species at a $100 \text{ ppm} \pm 10\%$ concentration level would be the best calibration gas to use.

Methane has been accepted in the industry as a general calibration standard for flame ionization detectors such as the Detecto-Pak 4. It is recommended the Detecto-Pak 4 be calibrated with 100 ppm of methane $\pm 10\%$ in air for general detecting applications.

****NOTE****

The calibration of the Detecto-Pak 4 with a particular gas species will provide reliable ppm readings for a target gas of the same species. Meter readings observed from the testing of a target gas containing a gas different from the calibration gas species may not represent the actual ppm concentration in the sampled target gas.

B. CALIBRATION PROCEDURES (Figure 6)

****NOTE****

A calibration kit & calibration cylinders are available to calibrate the Detecto-Pak 4. Any other method will not insure proper calibration levels. Allow instrument to warm up 15 minutes prior to calibration.

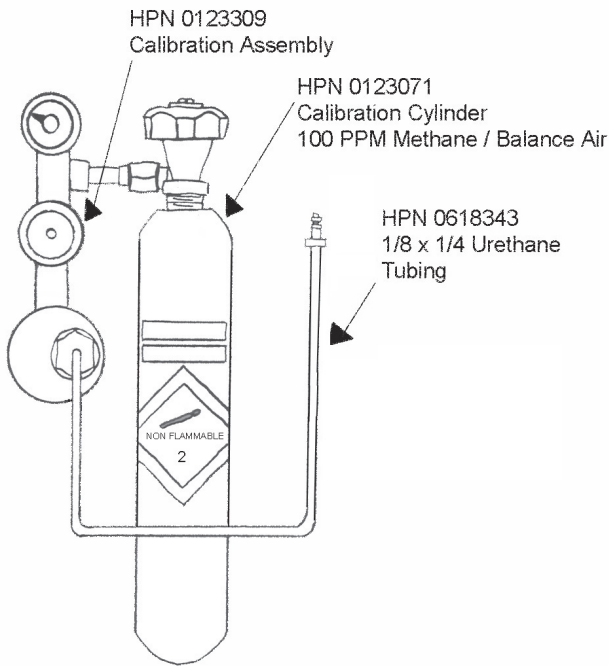
1. Start with the Detecto-Pak 4 in operation as described under "OPERATING PROCEDURES." (See Chapter Five, Section V, B)
2. Set the instrument on a flat, horizontal surface. The instrument must remain in this position throughout the calibration procedure. On power-up, the fine zero position is automatically set to mid range electronically. If any fine zero adjustments are made after power-up, they will be reset when the instrument is powered off.
3. Put the instrument in the 10 ppm range. The meter needle should be set to zero. If the needle is not on zero, you will need to reset the instrument with coarse zero (RP8) port.
4. If an adjustment is necessary to bring the meter needle to zero on the 10 ppm meter scale, an adjusting control is inside the bottom rear of the instrument as indicated in Figures 7 & 8. Access the ZERO adjustment through the RIGHT-HAND ACCESS PORT on the rear of the instrument located directly below the fuel cylinder holder.
5. Remove the plug from the port and use a micro-screwdriver to adjust the ZERO level using RP8 as required.
6. Put the instrument in the 100 ppm range. There should be no significant drift or movement of the meter needle. The needle should remain relatively stable on zero.

****NOTE****

Calibration must be conducted in a hydrocarbon-free (clean air) atmosphere.

7. Attach calibration kit regulator assembly to calibration cylinder; turn calibration cylinder valve knob counterclockwise (one-half to one turn). DO NOT FORCE THE KNOB ALL THE WAY COUNTERCLOCKWISE (OPEN)

8. Attach calibration kit outlet connector to the portable unit by pushing the connector firmly into the sample inlet quick connector on the filter housing. Within 30 seconds, the meter needle should start moving upscale. Allow another one-half minute (30 seconds) before checking the meter.



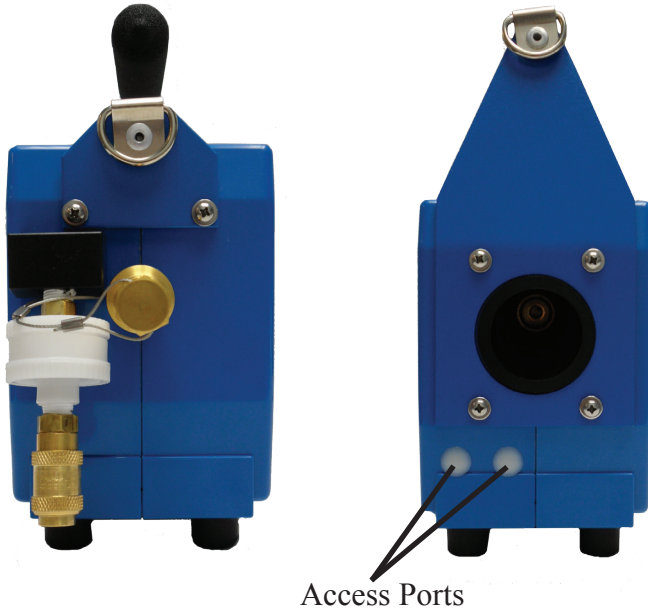
(Figure 6)

IMPORTANT

Special procedures must be followed when using the Detecto-Pak 4 at high altitudes (over 3,000 feet above sea level). A slightly richer fuel mixture (42% hydrogen/58% nitrogen) and increased fuel and sample flow rate (50-55 cc/m and 850 cc/m, respectively) are required. The instrument must be calibrated at elevation and re-calibrated if the elevation changes by 1000 feet or more. DO NOT use these settings below 3000 feet as the flame ionization detector (FID) will burn too hot and possibly cause operational and/or physical problems. If an improper (hydrogen higher than 42%) fuel mix is used, the possibility of damage to the detector cell could be realized as excessive heat is generated. Please contact servicing Heath Office for proper ordering procedures.

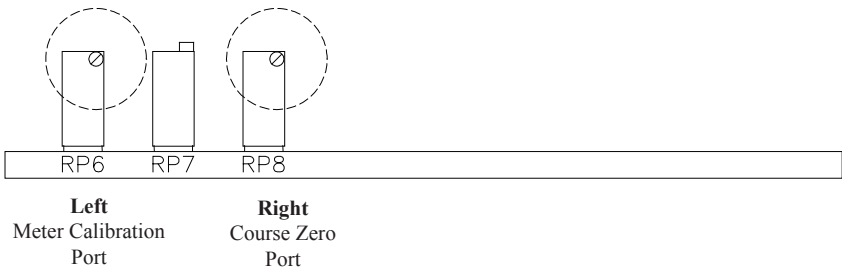
9. The meter needle should register 100 (or same as calibration gas used) on the 100 ppm range. If the needle is not on 100, you will need to reset the instrument with the calibration (RP6) port.
10. If an adjustment is necessary to bring the meter needle to 100 (or same as calibration gas used) on the 100 ppm meter scale, an adjusting control is inside the bottom rear of the instrument as indicated in Figures 7 & 8. Access the CALIBRATION adjustment through the LEFT-HAND ACCESS PORT on the rear of the instrument located directly below the fuel cylinder holder.
11. Remove the plug from the port and use a micro-screwdriver to adjust the CALIBRATION level using RP6 as required.
12. Repeat the above steps to verify the ZERO and CALIBRATION levels.
13. Disconnect the calibration hose fitting from the sample inlet quick disconnect on the filter housing and close the calibration cylinder valve. Calibration is now complete.

Front and rear view of the Detecto Pak 4



(Figure 7)

Location of the Access Ports



(Figure 8)

Rear View of the Detecto-Pak 4 PCB

CHAPTER SEVEN

VII. APPLICATIONS FOR THE DETECTO-PAK 4

The Detecto-Pak 4 is a non-specific hydrocarbon detector. Its use as a hydrocarbon leak detector has many applications. This Chapter lists some of the various types of inspections and areas, which might be surveyed using this instrument.

A. GAS DISTRIBUTION SYSTEMS

Service Line Inspections	Inside Meter Inspections
Main Line Inspections	Business District Surveys
Mobile Leak Surveys	Feeder Line Inspections
Mobile Patrols	Customer Leak Complaints

B. GAS TRANSMISSION COMPANIES

Cross-country Pipeline Inspections
Compressor Station Inspections
D.O.T. Class 3 and 4 Inspections
Mobile Leak Surveys

C. LP-GAS (PROPANE) COMPANIES

Main Line Inspections	Customer Leak Complaints
Service Line Inspections	Business District Surveys

D. INDUSTRIAL/MANUFACTURING/REFINING FACILITIES

Fugitive Emissions Monitoring - EPA Method 21
In-plant Piping Inspections
Confined Space Entry Testing
Inside Building Piping Industrial Hygiene Monitoring Inspections
Tracer Gas Inspections for Leaks

E. TELEPHONE COMPANIES

Inside Piping Inspections
Outside Piping Inspections
Tracer Gas Inspections for Gas Leaks
Pressurized Cable Leaks

F. HOUSING AUTHORITIES/APARTMENT COMPLEXES/
MOBILE HOME PARKS/MASTER METER FACILITIES

Inspection of On-site Gas Lines and Services
Customer Leak Complaints

G. SANITARY LANDFILL/WASTE STORAGE/
ENVIRONMENTAL STUDY AREAS

Hydrocarbon Contamination Inspection
Head Space Analysis Sites
Leaking Storage Tank Monitoring
Perimeter Inspections

CHAPTER EIGHT

VIII. MAINTENANCE INFORMATION

TROUBLESHOOTING PROCEDURES AND PERIODIC MAINTENANCE

This chapter deals with troubleshooting procedures and periodic maintenance.

Each instrument utilized for leak detection and evaluation should be operated in accordance with the manufacturer's operating instructions.

1. Instrument should be periodically "checked" while in use to ensure that the recommended voltage requirements are available.
2. Instrument should be tested daily or prior to use to ensure proper operation, to ensure that the sampling system is free of leakage, and to ensure that the filters are not obstructing the sample flow.
3. This instrument is now equipped with an improved cell base and fuel flow system.

CELL BASE: Changes to the cell base include an improved ceramic flame orifice and re-designed flashback arresters.

FUEL FLOW SYSTEM: Changes to the fuel flow system include an improved fixed fuel flow restrictor that replaces the adjustable restrictor. The .005" in-line restrictor has also been removed. Also, a 5 micron filter has been added.

When the instrument is calibrated and adjusted at the factory, a sticker is placed on the side and end of the case and on the inside housing to indicate the proper pressure gauge set point for correct fuel flow rate. Outside will vary from 16-24 psi. Inside flow rate is a constant 30 cc/min.

Before calibration, and at least once daily, plug in the external pressure gauge assembly and check the gauge pressure.

If it does not match the set point pressure on the sticker (using a fuel cylinder with 1000 psig of fuel), remove the plastic hole plug from the bottom of the instrument and with a 3/16" Allen wrench turn the

internal regulator set screw clockwise to increase the gauge pressure or counterclockwise to decrease the gauge pressure until it matches the sticker set point pressure. Re-install the plastic hole plug.

A. TROUBLESHOOTING THE INSTRUMENT

In the event the Detecto-Pak 4 fails to perform satisfactorily, look through the following list to try to find the reason for the malfunction and its corrective action.

Some fixes are simple ones, such as refilling the fuel cylinder, recharging the battery, or replacing the filter. Other corrective actions are complicated and require mechanical and/or electronic equipment to determine their specific causes.

1. Instrument Inoperative

- a. Check battery indication, and, if reading is in red zone, recharge battery as described in Chapter Four.
- b. If battery indicator reads in green zone but instrument is still not operational, refer to 2. Malfunction and Corrective Action (see below).

2. Malfunction and Corrective Action

- a. **FUEL WILL NOT IGNITE OR STAY LIT.** Check internal regulator outlet pressure. Remove the protective cap from the quick connector located on the front of the portable unit. Connect the external gauge adapter to the quick connect stem on the unit by pushing in until it snaps tightly. The gauge should be posted pressure setting on the side and/or bottom of the instrument. With 1000 psig in the fuel cylinder. If an adjustment of the internal regulator is required, insert an Allen- type wrench through the access port and adjust the screw.
- b. **METER READOUT IS ERRATIC.** Check fuel certification. Operate with previously known fuel to ensure that contamination is not causing the instrument's erratic behavior. If the 40% - 60% mix (Hydrogen - Nitrogen) is not certified, a variance in specific combustion ratios will cause the instrument to function unsatisfactorily. Also, if the hydrocarbon content in the fuel is higher than 0.5 ppm methane, reductions in sensitivity or erratic meter indications may be experienced. Also check calibration to ensure that it is not set too high. (See Chapter Six for Calibration Procedures.)

3. **PORTABLE UNIT WILL NOT OPERATE FOR FULL EIGHT HOURS**

- a. The fuel cylinders may not have been filled to recommended pressure (1,750 psig maximum). Try refilling the cylinders.
- b. There may be a leak between the fuel cylinder valve and regulator. Check “O” ring on valve stem.
- c. The rechargeable battery may not have been fully charged. Recharge battery per instructions in Chapter Four.

B. FILTER REPLACEMENT

1. Unscrew bottom half of white plastic filter housing.
2. Remove old filter and “O” ring. Gently tap housing upside down on a hard surface (table), if necessary, to remove residual pieces of filter. Inspect inside both halves of filter housing and remove any trapped dust or debris.
3. Insert “O” ring and then new filter into bottom half of filter housing. Smoother side of filter should be right side up or visible.
4. Replace bottom half of white plastic filter housing and tighten.

C. PARTS LIST

Part No.	Description
0111006*	PROBE, SAMPLE
0110518	BELLOWS, RUBBER
0111129	FILTER, SCREEN PROBE
0111965	FITTING, HOSE BARBED
0112069	CAP, REAR, SAMPLE PROBE
0112070	CAP W/VENT, FRONT, SAMPLE PROBE
0112267	WASHER, STOP, NEOPRENE
0618343	HOSE 1/8" ID X 1/4" OD, URETHANE
8300335	PLUG, QUICK-DISCONNECT, 1/8 BARB
0618302*	GAUGE, EXT. LOW PRESSURE CHECK
0618320	GAUGE, LO-PRESSURE, 0-60 PSI
0618321	QC BODY W/VALVE
0514942*	CAP, LECTURE BOTTLE VALVE
0514965	O-RING, .145 ID*.070 CS, BUNA-N - SINGLE
0514966*	O-RING, LECTURE BOTTLE \PKG 10
100212-1*	INSTRUMENT, Detecto-Pak 4
0110164	FILTER HOLDER DELRIN, 25MM
0114493	"O" RING INSIDE FILTER HOLDER
0518083	ALARM, STAR MICRONICS, QMB-06
0518088	TUBING 1/16"ID X 1/8" OD, URETHANE
100699-0	BUMPER, RUBBER
0518128	FILTER IN-LINE 5 MICRON 1/16"
0618304	ASSY, INTERNAL REGULATOR, DP-3/OVD
0518047	FITTING, HOSE BARB, 10-32X1/16
0518048	GASKET FOR 10-32 FITTINGS
0618323	QC STEMS W/VALVE
0518015	ASSY-CELL TOP, P-F II/DP III/ DP 4
0618319	RETAINER, FUEL CYLINDER
0618324	SWAGELOCK STEM PROTECTOR BQC4SP
0618331	FITTING, Q.D BODY LESS VALVE
8300326	SOCKET, QUICK-DISCONNECT, 1/8MPT
100583-0	METER, ppm, DP III/OVD/ DP4
0618343	HOSE 1/8" ID X 1/4" OD, URETHANE
0618354	CONNECTOR, TUBING - T
0618355	FITTING, INLET, REGULATOR, DP III, DP 4
0111472	RING 3/4" NICKEL (CLIP & D)
56112716	HANDLE GRIP, FOAM
8305928	WASHER, FLT,.25X.625X.031, NYLON
8300322	HOSE BARB, 1/8 HOSEX1/8MPT, BRASS
0110163	FILTERS, DPII/III, PF-II, 100
0111689	PISTON, PROBE

0111690	ADAPTER, SLEEVE, SAMPLING PROBE
8300322	HOSE BARB, 1/8MPT*1/8 HOSE, BRASS
0114732	HANDLE, PROBE
0114733	INNER STEM PROBE
9990009	DOW CORNING 111 LUBRICANT
0514937	TRANSFILLER, FUEL
0123227	GAUGE, 0-3000PSI 1.42OD 1/8 MPT
0123328	ORIFICE FOR TRANSFILLER
0518133	NIPPLE, OUTLET, TRANSFILLER
0518134	NUT, KNURLED
3515094	STEEL LEADER, 20LB TEST, 12”
0618303	LECT BTLE/VLV ASSY, PF-2,DP-3
0618353	ASSY, VALVE, LECT BTL W/0 PORT
0110163	PACKAGE 100 FILTERS
0110683	PACKAGE 500 FILTERS

* Specifies Detecto-Pak 4 assemblies.

CHAPTER NINE

IX. SERVICE INFORMATION:

A. WARRANTIES AND WARRANTY REPAIR

All instruments and products manufactured by Heath Consultants Incorporated and its Heath Manufacturing Division are warranted to be free from defects in material and workmanship for one (1) year from the date of shipment.

In addition, the Heath Pipe and Cable Locator (Sure-Lock) product line is warranted for two (2) years and the Plunger Bar (handles) is warranted for 90 days.

Furthermore, the warranty on authorized repairs in the Houston factory service center (FSC) and other regions is ninety (90) days materials and thirty (30) days labor. This repair warranty does not extend any other applicable warranties.

Our warranty covers only failures due to defects in materials or workmanship, which occur during normal use. It does not cover failure due to damage which occurs in shipment, unless due to improper packing, or failures which result from accident, misuse, abuse, neglect, mishandling, misapplication, alteration, modification, or service by anyone other than a Heath warranty repair location.

Battery and damage from battery leakage and all expendable items such as filters and Plunger Bar rods are excluded from this warranty. Also, O-rings, gaskets, and seals for the Petro-Tite product line are excluded from warranty coverage.

Heath's responsibility is expressly limited to repair or replacement of any defective part, provided the product is returned to an authorized warranty repair location, shipped pre-paid, and adequately insured. Return shipping charges and insurance will be paid by Heath warranty expense.

We do not assume liability for indirect or consequential damage or loss of any nature in connection with the use of any Heath product.

There are no other warranties expressed, implied, or written except as listed above.

The following suggestions will expedite the repair of your instrument:

- Package carefully, using the original shipping carton if available, and return all components.
- Specify your complete shipping and billing addresses.
- Specify the instrument or product name, model number, and serial numbers on all correspondence.
- Include a brief description of the problem you are experiencing and specify the person to be contacted for information.

CUSTOMER ASSISTANCE, MANUFACTURING AND SERVICE LOCATIONS

CORPORATE HEADQUARTERS

Heath Consultants Incorporated

9030 Monroe Road
Houston, Texas 77061
Phone: (713) 844-1300
Fax: (713) 844-1309

MANUFACTURING AND WARRANTY SERVICE CENTERS

Heath Consultants Factory Service Center

9030 Monroe Road
Houston, Texas 77061
Phone: (713) 844-1350
Fax: (713) 844-1398

DIVISION OFFICES

Northeast Region

1051 Garden Street
Greensburg, PA 15601
Phone: (724) 836-7830
Fax: (724) 836-7835

Central Region

9030 Monroe Road
Houston, Texas 77061
Phone: (713) 844-1300
Fax: (713) 844-1309

Southeast Region

1645 Murfreesboro Road, Suite E
Nashville, TN 37217
Phone: (615) 361-8306
Fax: (615) 361-8651

Western Region

4100 S. Fremont Avenue, Suite 150
Tucson, AZ 85714
Phone: (520) 790-4971
Fax: (520) 790-5016

GLOSSARY

CGA	Compressed Gas Association
calibration	the act of fixing or correcting the graduations of a measuring instrument
ceramic flame orifice	inert, high temperature-resistant ceramic opening on the unit that allows shaping of the flame for greater reliability
contaminants	impure or corrupting substances
D.O.T.	Department of Transportation
Ensure	to make sure
Erratic	irregular; random
flame out	a failure of ignition during operation
flammable	easily set on fire
flashback arresters	safeguards that prevent danger of flashback to operator and environment
float mode	the mode the battery charger enters after unit is fully charged
hazardous	dangerous
hydrocarbon vapors	vapors containing a compound of hydrogen and carbon
impairment	state of worsening or lessening
inhalation	the process of breathing in
knurled	small beads or ridges, as along the edge of a coin
mvdc	millivolts, direct current
methane	a colorless, odorless, flammable gas formed by the decomposition of vegetable matter, as in marshes

Nickel metal hydride battery (NiMH)	a battery with its elements primarily composed of nickel, a silver-white metallic element, and cadmium, a metallic chemical element used in alloys
nonflammable	not easily set on fire
non-specific	not pertaining to a specific kind or type
optimum	most favorable or best
ohm	unit of electrical resistance
OSHA	Occupational Safety and Health Administration
ppm range	range showing parts per million
preclude	make impossible; prevent
proprietary	belonging to a proprietor, as under a patent or copyright
psig	pounds per square inch gauge; used to measure the difference between normal atmospheric pressure and pressure being tested
purge	to cleanse of impurities
reverse cut threads	threads turned in the opposite direction
SLPM	Standard liters per minute
supersedes	replaces or succeeds
VAC	Volts, alternating current
wetted parts	parts likely to become wet

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Heath Consultants Incorporated operates under a continual product improvement program and reserves the right to make improvements and/or changes without prior notification.

Heath Consultants Incorporated
Houston, TX
713-844-1300
Fax: 713-844-1309
1-800-HEATH-US
www.heathus.com



*Heath...Safety, Leadership, Innovation, Performance
Then, Now and Tomorrow*