# National Human Exposure Assessment Survey (NHEXAS)

## *Arizona Study*

# Quality Systems and Implementation Plan for Human Exposure Assessment

The University of Arizona
Tucson, Arizona 85721

Cooperative Agreement CR 821560

**Standard Operating Procedure** **SOP-UA-F-4.1**

**Title:** Operation, Calibration, and Maintenance of the Sentex Scentogun Portable Photoionization Detector

**Source:** The University of Arizona

U.S. Environmental Protection Agency
Office of Research and Development
Human Exposure & Atmospheric Sciences Division
Human Exposure Research Branch

***Notice:*** *The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development (ORD), partially funded and collaborated in the research described here. This protocol is part of the Quality Systems Implementation Plan (QSIP) that was reviewed by the EPA and approved for use in this demonstration/scoping study. Mention of trade names or commercial products does not constitute endorsement or recommendation by EPA for use.*

# Operation, Calibration and Maintenance of the Sentex Scentogun Portable Photoionization Detector

## 1.0 PURPOSE AND APPLICABILITY

This standard operating procedure describes the general procedures for the operation, calibration and maintenance of the Sentex Scentogun portable photoionization detector (PID).

## 2.0 DEFINITIONS

2.1 BUCKET - A plastic container with a buckle top. One bucket is assigned to each household to be visited. Household identification numbers are listed on the outside of the container. The bucket contains all paperwork to be completed by field staff or household respondents. It serves as the primary vehicle for securing and transporting forms, data and samples to and from the field through the course of the study.

2.2 eV - electron volt (unit of energy).

2.3 FIELD COORDINATOR - The employee of the research project who supervises field data collection and operations. The field coordinator collates individual data into HH packets. Upon completion of all visits, sampling and QA checks, he/she forwards the packet to the Data Coordinator.

2.4 FULL SCALE CALIBRATION - The purpose of this measurement is to establish the calibration curve of the Scentogun, using a standard gas.

2.5 HOUSEHOLD(HH) - The residence occupied by study respondents.

2.6 HOUSEHOLD IDENTIFICATION NUMBER(HHID) - A unique number and character combination which is assigned to each respondent household for identification purposes. This number must be recorded on all data(forms, samples, questionnaires and correspondence) generated by the household.

2.7 N/A - Not Applicable.

2.8 NULL CALIBRATION - The purpose of this measurement is to establish the Null or base signal value of the instrument which is deducted from all readings. The Null calibration value corresponds to the degree of the Scentogun's contamination. As long as the null calibration value is less than 250 ppm, the PID gun is functioning properly.

2.9 PID - Photoionization Detector, also referred to as the PID Gun.

2.10 PID SAMPLING DATA SHEET - A field form to record all necessary information regarding sampling, custody and quality control (Figure 1).

2.11 QUALITY ASSURANCE(QA) - All those planned and systematic actions necessary for ensuring the accuracy, validity, integrity, preservation and utility of collected data.

2.12 QUALITY CONTROL(QC) - Those quality assurance actions providing a means to control and measure the characteristics of a datum, process or adherence to established parameters.

2.13 SCENTOGUN - Total volatile hydrocarbon analyzer that operates on the principle of a PID.

2.14 TEAM LEADER - The member of the field team who is primarily responsible for respondent contact, data collection, field form and questionnaire completion and quality control checks in the field.

2.15 TEAM MEMBER - Member of the field team responsible for assisting the team leader in the collection of data and quality control checks in the field.

2.16 VISIT - A scheduled appointment with participating respondents at their place of residence (HH) for the collection of samples, questionnaires and other data.

## 3.0 REFERENCES

3.1 Lebowitz, M.D. 1993. Study Design (Revision of 31 Dec 1993).

EPA NHEXAS COOPERATIVE AGREEMENT.

3.2 Scentogun Operation/Instruction Manual. No Date Available.

## 4.0 DISCUSSION

The Scentogun is a total volatile hydrocarbon analyzer that operates on the principle of a PID. The PID is a nondestructive detector that uses UV light to ionize a sample. The positive ions formed migrate toward a negatively charged collector, generating a current proportional to the concentration of the ions. The extent of ionization or types of species ionized can be changed by substituting UV lamps of different energies.

The higher the energy of the lamp, the larger the number and variety of compounds that can be ionized. PIDs do not respond to methane, so benzene or isobutylene is often used as a calibration gas. The Scentogun sample pump draws air at about 400 ml/min through a 1/8" diameter probe extension. The instrument has three ranges(0-20, 0-200, 0-2000 ppm) with a 0.1 ppm low scale resolution. However its accuracy depends on the concentration of the calibration gas and on the volume of the minor components(other than the calibration gas) in the calibration chamber. The minor components in the "CALGAZ" calibration chamber used, compose 2% by volume. If 10 ppm of isobutylene is used for the calibration, the Scentogun's accuracy would be plus or minus 0.2 ppm.

This SOP is written for a full-scale calibration value of 10 ppm. Note that other full-scale calibration values (such as 50 ppm or 250 ppm) may be used. This SOP is fully applicable in such instances with the exception of the full-scale calibration value, and the appropriate 2% confidence interval. Side by side trials of three PID guns indicated that the guns are quite accurate when measuring concentrations around their calibration value(Appendix B.). Since the expected VOC concentrations inside the houses will be less than 10 ppm it was decided to calibrate the guns with 10 ppm isobutylene. As mentioned previously the theoretical accuracy would be plus or minus 0.2 ppm; however experimental trials showed a minimum accuracy of 2 ppm and a reliable high end value of 25 ppm (Appendix B.). In order to

detect concentrations higher than 25 ppm, the gun should be recalibrated with 50 or 250 ppm, depending on the expected concentrations.

PID measurements are taken in several different locations inside and outside the house. Appendices C, D and E display the results of lab experiments during the summer of 1994. The measurements are taken at three different heights to see if there is a vertical gradient. Some of the lab experimental measurements (Appendices C and E) indicate that there may be vertical gradient in the VOC distribution.

The detector provides 90% full response in less than 2 seconds. Readings on the digital display are obtained at 1 or 5 second time intervals. In the field, readings will be taken after 10 seconds. A 10.6 eV lamp is standard with the Scentogun, enabling the detection of a wide range of volatile organic compounds present in the air. Figure 3 provides a listing of compounds the PID will recognize. The Scentogun has data logging capabilities and can store 156 points (consisting of date, time, concentration and location) for downloading to a printer or computer (via an RS-232 port).

## 5.0 RESPONSIBILITIES

5.1 The Field Coordinator is responsible for:

(a) 10% Field QA Audits to insure proper operation of the Scentogun by the team members;
(b) keeping the Scentogun's memory printouts;
(c) comparing the Scentogun's memory printouts to the PID Sampling Data Sheet (Figure 1) for discrepancies.

5.2 The Team Leader is responsible for:

(a) the completion of the PID Sampling Data Sheet (Figure 1);
(b) printing the scentogun's memory records;
(c) submitting the printouts to the Field Coordinator.

5.3 The Team Members are responsible for:

(a) obtaining the sampling results according to protocol;
(b) entering all required information into Scentogun's memory;
(c) completing the PID Sampling Sheets.

## 6.0 MATERIALS AND REAGENTS

### 6.1 MATERIALS

6.1.1 The Scentogun(total weight 4 pounds) consists of the pistol-like probe body which contains the detector, digital LCD display, electronic assembly, and the pump.

6.1.2 The battery pack contains one battery and a charger for recharging the battery.

6.1.3 Gas calibration span kit consists of a zero-grade air bottle, 17 lt calibrant bottle of 10 ppm isobutylene, regulator, Tygon tubing and a carrying case.

6.1.4 Cotton tip applicators.

6.1.5 Lap-top computer with a RS-232 port or standard personal computer.

6.1.6 Printing cable.

### 6.2 REAGENTS

6.2.1 Isobutylene, 10 ppm (calibrant).

6.2.2 Iron oxide powder, 3.0 Micron (lens polisher).

## 7.0 PROCEDURE

### 7.1 PREPARATION

7.1.1 Field site selection criteria

PID measurements are taken in the main room, kitchen, all bedrooms, garage, storage shed, and fireplace. Three readings are taken at the middle of each room location; one at 1 foot above the floor, 4-6 feet above the floor and 8

feet or higher above the floor. If there is a fireplace, an additional reading will be taken at the midpoint of the fireplace opening. Outdoor PID measurements are sampled near the garage door openings, storage sheds and one measurement in each of the four cardinal directions greater than ten feet off the wall of the building. Samples should also be taken, both indoors and outdoors, at suspected point sources such as chemical storage cabinets, gas stoves, gas furnaces, etc.

a) Indoor sites: Main room
All bedrooms
Kitchen
Fireplace

b) Outdoor sites: Storage shed
All cardinal directions

7.1.2 Reagents

(a) 10 ppm isobutylene calibration gas for full scale calibration.
(b) Iron oxide powder, 3.0 micron, used for polishing the outside of PID lamp window.
(c) One canister of zero-grade air for null calibration.

7.1.3 Standards and Blanks

Before the gun is taken to the field or if it was used extensively at a previous HH visit, the PID must be checked by taking readings of the calibrant which has a known concentration(10 ppm). These readings should be in the range of 8 - 12 ppm. If not, the Scentogun has to be cleaned and recalibrated in the Field Office. Once the full scale calibration is reaccomplished, the procedure for null calibration (7.1.4 E below) should be followed.

7.1.4 Samplers

A. PID LAMP POLISHING (Record on Form Fig. 4)

PID Lamps will be cleaned every six months or earlier if necessary. This periodic cleaning will be documented on the PID Calibration/Cleaning Log Sheet (Fig. 4).
(a) Turn and pull off the nose of the gun.

(b) Remove three screws (Item A on Figure 2) that hold the gun together with a 7/64 Hex key.
(c) The gun housing can now be separated to expose PID lamp. Use caution when separating the housing.
(d) Remove ground wire (Item B on Figure 2) from PID knurled retainer housing (Item C on Figure 2) with a Phillips head screw-driver.
(e) Remove small screw (Item D on Figure 2) from nose of gun that holds PID housing in gun with a 1/16 Hex key.
(f) Unscrew lamp from PID teflon housing. Be careful not to touch bottom of lamp surface. If "O" ring sticks to lamp surface, remove carefully, and place "O" ring back in outer chamber seating.
(g) Clean lamp surface with polishing powder and cotton swabs:
    (i) Dip cotton swab into powder, shake off excess
    (ii) Buff lens surface gently in a circular motion
    (iii) Buff lens surface with clean cotton swab to remove powder.
    (iv) Repeat steps (i) through (iii) five times.
    (v) Gently blow on surface of lens to remove any remaining powder
(h) After cleaning lamp, screw lamp back into teflon housing. Be extremely careful not to over-tighten lamp. Surface of lamp can be easily cracked. Tighten until you feel a slight resistance.
    (i) Reassemble housing by reversing steps e-a in 7.1.4 A. Be careful not to crimp any wires or tubing when putting gun together.
    (j) Test gun to make sure it is operating properly by completing a full scale and a null calibration.

B. CHARGING THE BATTERY (Record on Form Fig. 4)

(a) Connect the battery to the battery charger through the socket on the battery pack. You don't need to turn the power switch on.
(b) Charge the battery for up to six hours. The charger will not damage the battery if it remains connected for longer periods.
(c) Connect the Scentogun to the socket of the battery pack.
(d) Turn on the battery pack switch on the battery pack. The Scentogun is now ready to use.

(e) Each time you turn the switch on, "LOW BATT" will appear on the display for 2 seconds. If "LOW BATT" remains on the display permanently the battery needs to be recharged.
(f) Label the charge date on each battery with a removable cloth label. Place the label next to the battery on-off switch.

C. SETTING THE CLOCK (Record/verify as appropriate.)

(a) Check the real-time clock in the PID Gun (which runs on its own battery for up to two years) by turning the switch on the unit to **SET CLOCK.**
(b) Depress both **SET DIGIT** and **SELECT DIGIT** at the same time. The hour (24-hour mode) will appear on the display.
(c) To change the clock, depress **SELECT DIGIT.** The digit will flash.
(d) To change the digit depress **SET DIGIT** several times until the desired digit appears.
(e) To change another digit depress **SELECT DIGIT** and continue as before.
(f) After the change, activate the trigger. The minutes will be displayed.
(g) Repeat steps c - e (7.1.4 C) for setting the minutes (by depressing **SET DIGIT** and **SELECT DIGIT**) to correct the clock.
(h) When finished, activate trigger again. The month is now displayed.
(i) Depress **SELECT DIGIT** and **SET DIGIT** to correct.
(j) Activate trigger. The day is now displayed.
(k) Depress **SELECT DIGIT** and **SET DIGIT** to correct.
(l) Activate trigger. The hour is displayed again.
(m) The clock is now set.

D. FULL SCALE CALIBRATION (Record on Form. Fig. 4)

Perform calibration in a well ventilated area, or under a vented hood assembly where possible. When performing Full Scale Calibration in the Field Office set code to 0001. Otherwise, leave the code as the currently designated HHID SET CODE.

(a) Set the switch to **SET FULL SCALE (SET F.S)**
(b) Depress both **SELECT DIGIT** and **SET DIGIT** at the same time. The present calibration value will appear on the display.
(c) To change the value, depress **SELECT DIGIT.**
(d) Adjust the digit setting by depressing **SET DIGIT.**
(e) Continue by selecting and setting the other digits.
(f) Activate the trigger to fix the value in the unit's memory.
(g) To set a decimal point(for low concentrations), depress the trigger and follow steps c-f (7.1.4 D).
(h) The Scentogun is ready for calibration. Use 10 ppm isobutylene as the calibration standard. Other ppm concentrations may be used in consultation with the Field Coordinator.
(i) Screw the regulator on the calibration bottle.
(j) Set the switch to **CALIBRATION FULL SCALE (CAL F.S)**
(k) Depress both **SELECT DIGIT** and **SET DIGIT** at the same time. Release. The display will clear.
(l) Open the regulator's valve.
(m) Direct the 10 ppm isobutylene through the regulator's tube in the nozzle of the Scentogun. The gas should enter the Scentogun's nozzle with a rate under 400 ml/min (Scentogun's pump rate). There is a small hole on the regulator's tube in order to relieve the pressure of the exerted gas.
(n) Activate the trigger. A number will appear on the display momentarily and will be followed by the Full Scale calibration value. Make a mental note of the first number. The Full Scale calibration value should range from 9.9 to 10.1.
(o) Release the trigger.
(p) Repeat steps (n) and (o) in 7.1.4 D until the number that first appears on the display, after you activate the trigger, is constant and the Full Scale value is between 9.9 and 10.1.
(q) The Scentogun is ready for null calibration and field use.

E. NULL CALIBRATION

(a) Verify location code = 0001 Field Office Calibration Site when performing null calibration in the Field

Office area, otherwise leave the CODE as the assigned HHID SET CODE.

(b) Turn the switch to **NULL CALIBRATION (CAL.NULL).**
(c) Depress both **SELECT DIGIT** and **SET DIGIT.**
(d) Release both buttons and the display is clear.
(e) Open the regulator to the zero air canister.
(f) Direct the zero air through the regulators tube and into the inlet nozzle of the PID Gun. The gas should enter at a rate less than 400 ml/min (the Scentogun's pump rate).
(g) Activate the trigger and hold until a number appears on the display. The number should be less than 250 counts.
(h) Repeat steps e-g in 7.1.4 E five times.
(i) All values should be less than 250 counts.

## 7.2 FIELD PROCEDURES

### 7.2.1 Standards and Blanks

When the trigger of the PID is depressed in ambient outdoor air, away from possible VOC sources the PID will produce a zero reading which is interpreted as an in-field calibration.

### 7.2.2 Samples

BEFORE TAKING THE READING IN THE FIELD:

A. SET CODE

(a) The SET CODE will represent the HHID. Since the code only allows values ranging from 1 through 1999 direct entry of HHID numbers ranging from 1 through 10,000 is not possible.
(b) Before taking any readings, the Field Team Member will record the last stored Set Code on the Field Data Sheet by calling up the previous Set Code.
    (i) Turn switch to **SET CODE**
    (ii) Depress both **SELECT DIGIT** and **SET DIGIT** to view and record the last stored set code.
    (iii) Record this set code on the PID Sampling Sheet.(fig 1.)

(c) Increment the **SET CODE** by 1 unit. For example, if the last stored **SET CODE** was 1536, the new entry would be 1537.
(d) Activate the trigger to store the code into the PID data logger. All values at this location will be preceded by the selected set code.
(e) Remember that SET CODE = 0001 represents the UA Field Office and should not be used for any other location.
(f) Once the data logger is down-loaded, the **SET CODE**, PID# and date can be used to compare data logger ppm values with those recorded on the PID Field Data Sheet.

B. NULL CALIBRATION IN THE FIELD

(g) Expose the Scentogun to clean ambient air.
(h) Turn the switch to **NULL CALIBRATION (CAL.NULL)**.
(i) Depress both **SELECT DIGIT** and **SET DIGIT.**
(j) Release. The display is now clear.
(k) Activate the trigger and hold for a few seconds.
(l) A number appears on the display. This number should be under 250 counts. This number corresponds to the contamination of the Scentogun. As the Scentogun becomes more contaminated the number increases.
(m) Release the trigger.
(n) Record the baseline null calibration on the PID Field Sheet.
(o) The Null Calibration will be performed before sampling at each Household. It may be necessary to perform a null calibration after high readings, i.e., readings greater than 20 ppm.
(p) If the Scentogun becomes contaminated, allow the pump to cycle for several minutes. The Scentogun will clear and the Null Calibration number will eventually drop. The Null Calibration reading must be less than 250 counts before use.

C. CHECKING THE DATE/TIME

(q) Turn the switch to **SET CLOCK.**
(r) Depress both **SELECT DIGIT** and **SET DIGIT.**
(s) The hour is displayed. Change if necessary.
(t) Activate trigger. The minutes are displayed. Change if

necessary.

(u) Activate trigger. The month is displayed. Change if necessary.

(v) Activate trigger. The date is displayed. Change if necessary.

(w) Record field checks on the appropriate sections of the Pre-Sampling checklist in the PID Sampling Data Sheet (Figure 1).

D. TAKING THE READINGS

(a) Go to the middle of the room to be sampled.

(b) Turn the switch to **ANALYZE.**

(c) The Scentogun is now ready to obtain the readings.

(d) Depress both **SELECT DIGIT** and **SET DIGIT.** The display will clear.

(e) Hold the Scentogun 1 ft. from the ground. Activate the trigger and hold until the reading on the display stabilizes, or ten seconds have elapsed - whichever comes first.

(f) Release the trigger. The reading will remain on the display. Record the value on the Field Data Sheet.

(g) Depress both **SELECT DIGIT** and **SET DIGIT** to store the reading into the unit's memory. The display will clear again.

(h) Repeat the above procedure at 4 to 6 ft. above the ground, at the same location. Record the value on the Field Data Sheet.

(i) Repeat the same procedure at 8 ft. or higher from the ground, at the same location.

(j) Turn the switch off and move to the next location.

(k) When the reading is taken by the fireplace (see 7.1.1) annotate the "Fireplace" portion under the "1 foot" column (see Figure 1) even if the reading is taken higher. Record the correct sampling height in the comments section.

(l) If the gun is exposed to high concentrations during sampling leave the switch on, let tthe pump work for several minutes and redo the Null Calibration before sampling at the next location.

(m) Continue to sample at all other locations.

(n) Be sure to log all samples in the PID Data-Logger in precisely the same order as they are to be recorded on the Field Data Sheet.

E. AFTER SAMPLING

(a) Make sure you have completed the PID Sampling Data Sheet.
(b) Notify the Team Leader that you are finished sampling.
(c) The Team Leader checks the completion of the PID Sampling Data Sheet and fills the appropriate sections at the bottom of the field form.

F. BACK FROM THE FIELD
PRINT THE STORED DATA

NOTE: Stored data may be printed/down loaded by field team members with access to APC or laptop only. Remote field operations may preclude down loading of data before the PID memory is over-written.

(a) Connect the "printing" cable to the lower part of the Scentogun's handle with the connector on one end, and the other to the serial port of a computer.
(b) Load the Scentogun's software disk in the computer.
(c) Turn the printer to 'on'.
(d) Turn the switch on the Scentogun to **PRINT.**
(e) Turn on the battery switch.
(f) Depress both **SELECT DIGIT** and **SET DIGIT.**
(g) After 20-30 seconds the Scentogun will print its entire memory(156 points consisting of the date, time, Location(HHID) and VOC concentration).
(h) The memory points will also be saved in a file while printing.
(i) The Scentogun's memory will not be erased after printout. When the memory becomes filled, new data capture will begin erasing the old data.
(j) In order not to lose any data, printouts have to be taken before memory is filled (approximately every 4 or 5 households sampled).
(k) The printouts are given to Field Coordinator and the transfer is documented in custody section of the PID Sampling Data Sheet (see Figure 1).
(l) Connect the battery to the charger if it needs to be recharged so it will be ready for the next day's sampling. According to the manufacturer, there is no need to drain the battery before recharging.

(m) Download the results after each household visit, if possible. When more than threehouseholds need to be sampled before returning to the field office the PID will be downloaded in the field using a Lap-top computer.

(n) The PID memory must be downloaded by the Field Team Leader at the end of their Household visits for that day.

## 7.4 QUALITY CONTROL

### 7.4.1 TOLERANCE LIMITS

(a) Do not expose the unit to high temperatures (120°F and higher).

(b) Do not probe the Scentogun's nozzle into liquids or debris.

(c) Be careful not to bump the Scentogun while carrying or positioning the unit to collect a sample.

### 7.4.2 DETECTION LIMITS

(a) Detection Range: 0.1 - 2,000 ppm benzene.

(b) Accuracy: Depends on the calibration accuracy (see 4.0 Discussion). Typically this value is plus or minus 2% with the standard calibrant.

(c) Response time: 90% full scale response in less than 2 seconds.

(d) Readings less than 2 ppm or greater than 25 ppm will be considered invalid when the PID is calibrated with 10 ppm calibrant.(see 4.0 Discussion)

(e) Readings less than 25 ppm and greater than 75 ppm will be considered invalid when the PID is calibrated with 50 ppm calibrant(see 4.0 Discussion).

(f) For readings greater than 75 ppm, the 250 ppm calibrant will be used.

### 7.4.3 CORRECTIVE ACTIONS

(a) Consult section 7.1.4 for Scentogun's maintenance.

(b) Consult section 7.1.4 and 7.2.2 for information on calibration procedures.

(c) Record any comments that are worthy of mention and might affect the measurement or its collection on the PID Sampling Data Sheet (e.g open room windows, measurement in the garage just after the car pulled in, measurement by the fireplace while fire was burning, raining while collecting outdoor samples, etc.).

## 8.0 RECORDS

8.1 All analytical results are recorded on the PID Sampling Data Sheet (Figure 1). Printouts of the Scentogun's memory points will be available in addition to the Data Sampling Sheet. These printouts will serve as a back-up and function as an independent QA check of the recorded values by the Team Leader and Field Coordinator.

8.2 Schematic of the Sentex Scentogun Portable Photoionization Detector.(Fig. 2)

8.3 Alphabetical listing of Compounds Registered by the Sentex Scentogun.(Fig.3)

8.4 PID Calibration/Cleaning Log.(Fig.4)

8.4.1 This form is completed while performing routine calibration and cleaning of the PID in the Field Office. This log is maintained by the materials technician at the University of Arizona field office.

8.5 PID Data/Sample flow diagram.(Fig.5)

8.6 Time lines and information collected in Stages 1 & 2.(Fig.6)

8.7 Time lines and information collected in Stages 3, 4, & 5. (Fig.7)

8.8 Field notes and Troubleshooting Guide. (Fig 8.)

8.9 Appendix A - Materials Safety and Handling of Isobutylene

8.10 Appendix B - Results from a side by side comparison of three PID guns.

8.11 Appendix C - Lab trials in approximately thirty

settings.

8.12 Appendix D - Measurements at three locations of a vehicle which had recently been primed for painting.

8.13 Appendix E - Measurements at three locations one hour after a vehicle had parked in the garage.

FIGURE 1. PID Sampling Data Sheet. (Page 1 of 2)

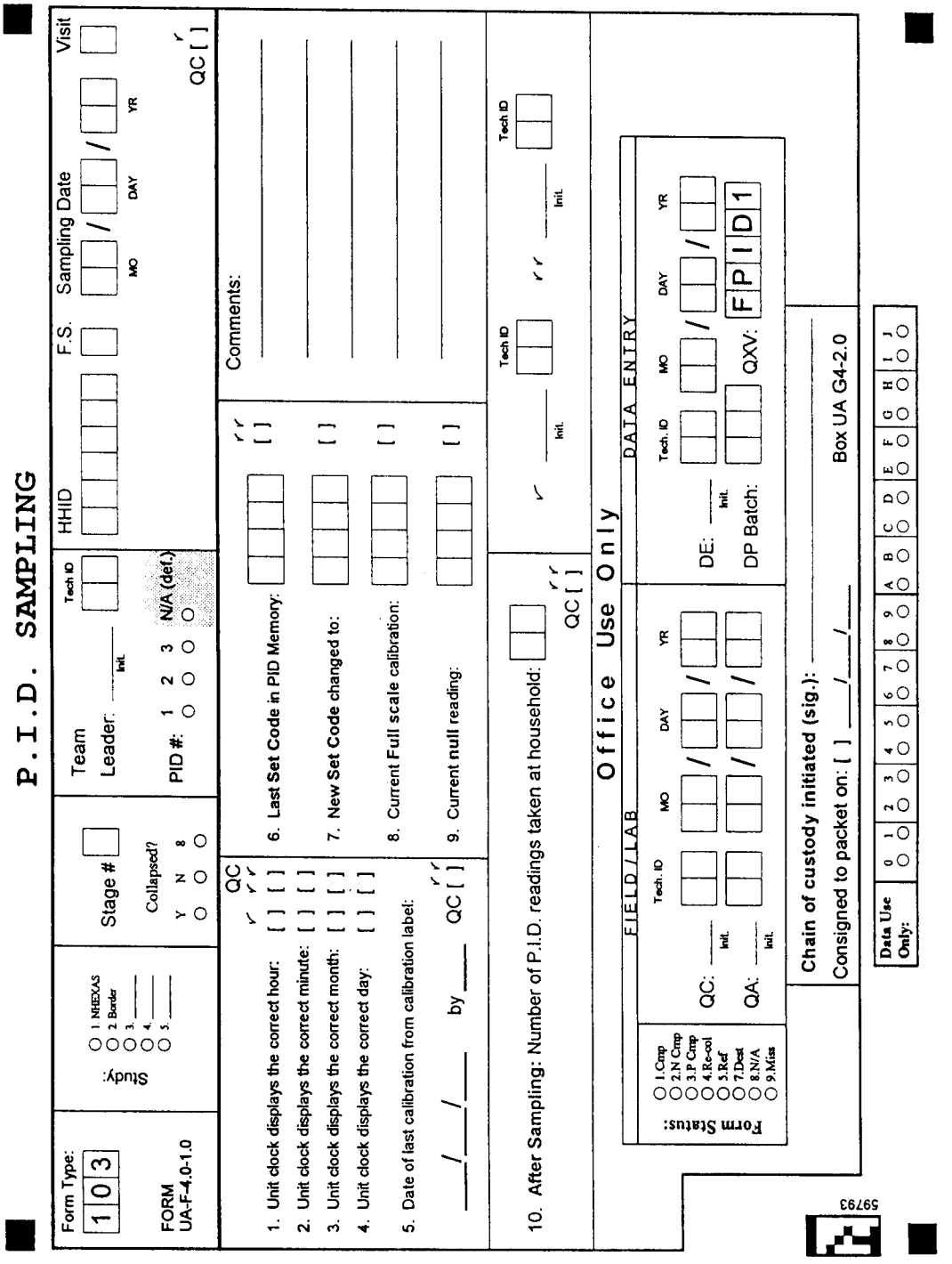

**FIGURE 1. PID Sampling Data Sheet. (Page 2 of 2)**

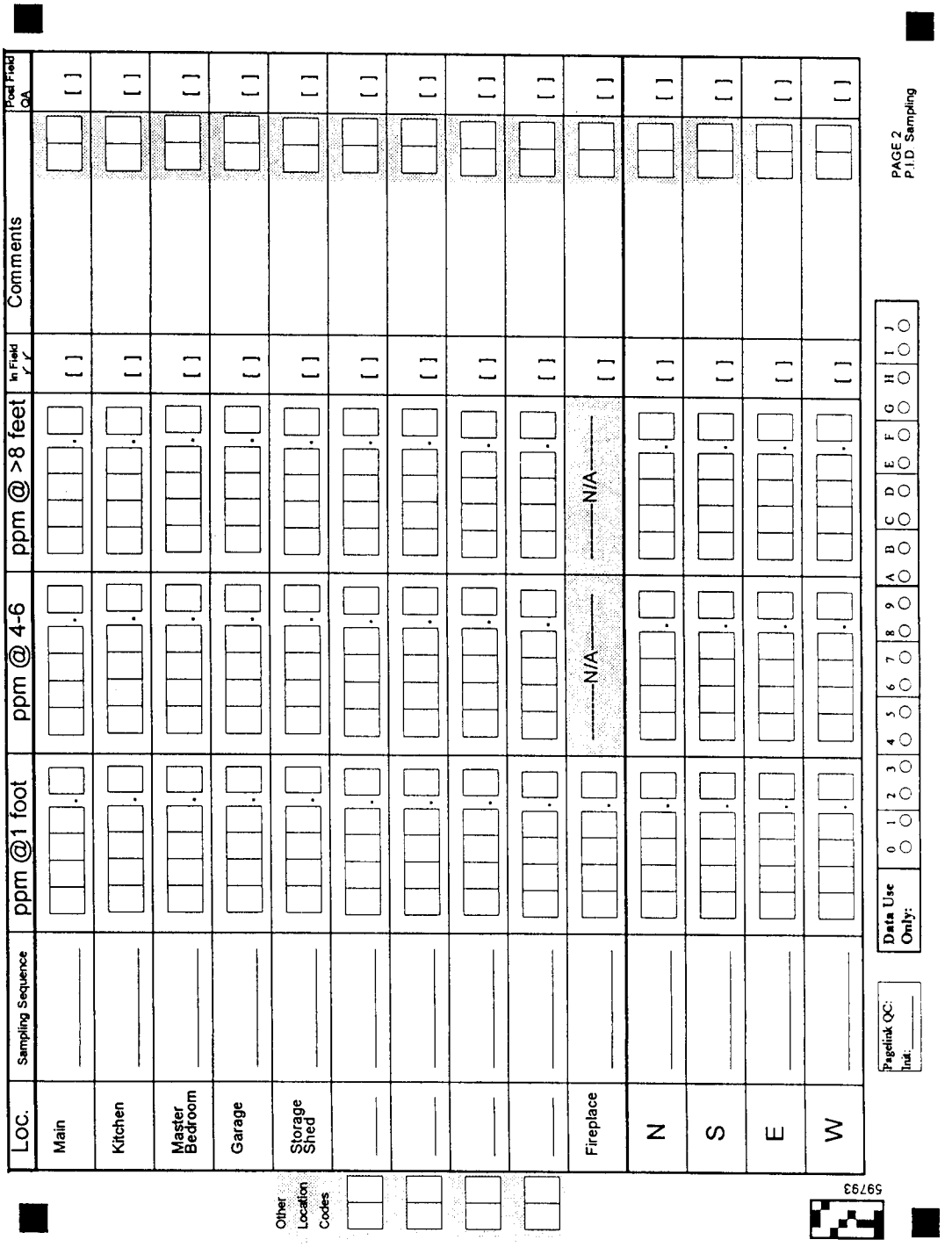

FIGURE 2. Sentex Scentogun Portable Photoionization Detector Schematic.

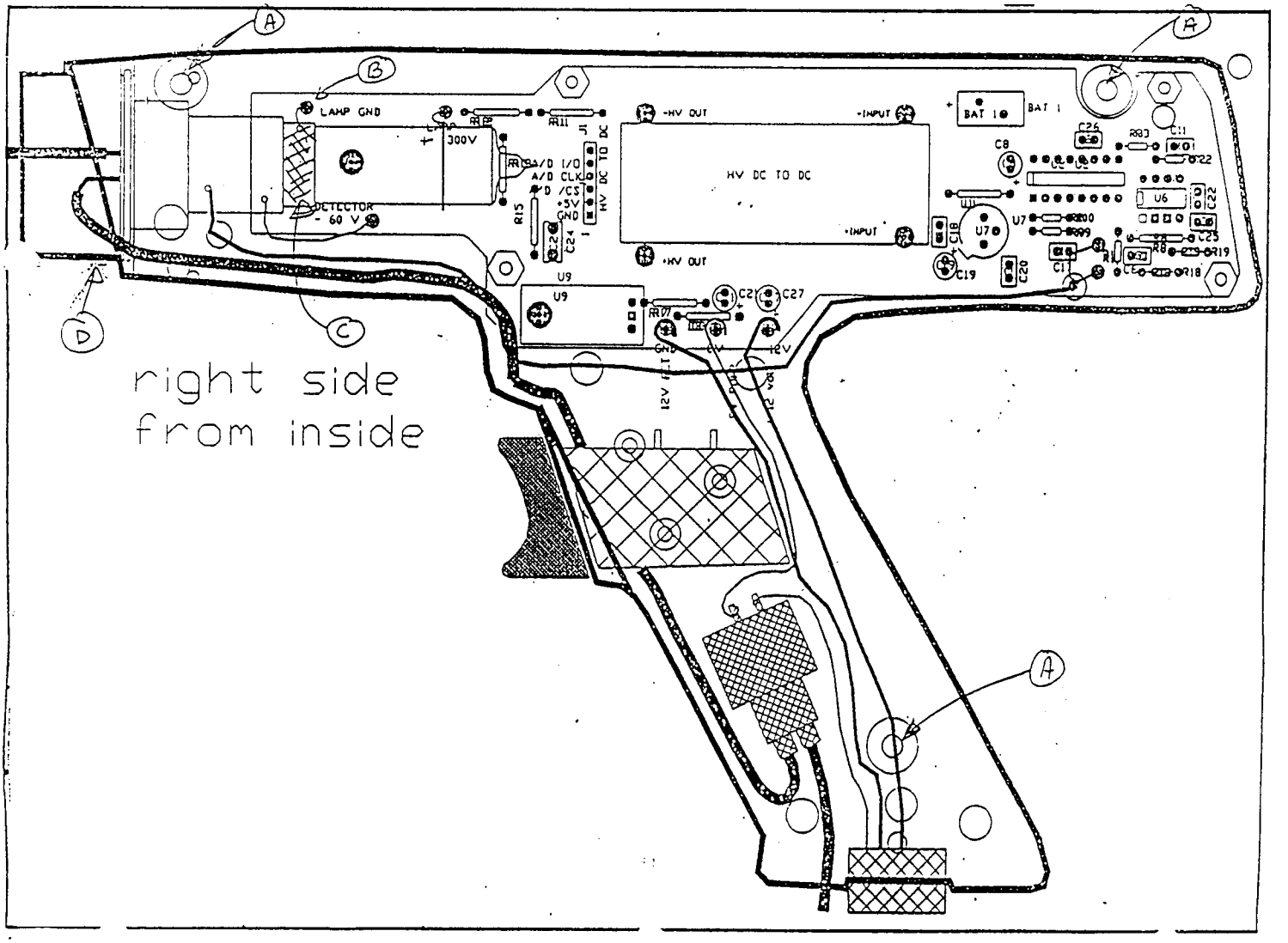

Figure 3. Alphabetical Listing of Compounds Registered by Sentex Scentogun (PID). (Page 1 of 5)

Acetaldehyde
Acetic Acid
Acetone
Acetylene Dichloride
Acetylene Tetrabromide
Acrolein
Acrylonitrile
Allene
Allyl Alcohol
Allyl Chloride
Aminoethanol
2-Amino Pyridine
Ammonia
n-Amyl Acetate
sec-Amyl Acetate
Aniline
Arsine
Benzaldehyde
Benzene
Benzenethiol
Bromobenzene
1-Bromobutane
2-Bromobutane
1-Bromobutanone
1-Bromo-2-chloroethane
Bromochloromethane
Bromodichloromethane
1-Bromo-3-chloropropane
Bromoethane
Bromoethene
Bromoform
1-Bromo-3-hexanone
Bromomethan
Bromomethyl Ethyl Ether
1-Bromo-2-methylpropane
2-Bromo-2-methylpropane
1-Bromopentane
1-Bromopropane
2-Bromopropane
1-Bromopropene
2-Bromopropene
3-Bromopropene
2-Bromothiophene
o-Bromotoluene
m-Bromotoluene
p-Bromotoluene
1,3-Butadiene
2,3-Butadione
n-Butanol
2-Butanol
n-Butane
2-Butanone
iso-Butanol
sec-Butanol
tert-Butanol
1-Butene
cis-2-Butene
trans-2-Butene
n-Butyl Acetate
t-Butylacetate
n-Butylalcohol
n-Butylamine
i-Butylamine
s-Butylamine
t-Butylamine
n-Butylbenzene
i-Butylbenzene
t-Butylbenzene
Butyl Cellosolve
i-Butyl Ethanoate
n-Butyl Mercaptan
t-Butyl Mercaptan
iso-Butyl Mercaptan
i-Butyle Methanoate
p-tert-Butyltoluene
1-Butyne
2-Butyne
n-Butyraldehyde
Carbon Disulfide
Cellosolve Acetate
Chloracetaldehyde
Chlorobenzene
Chlorobromomethane
1-Chloro-2-bromoethane
1-Chlorobutane
2-Chlorobutane

**FIGURE 3. Alphabetical Listing of Compounds Registered by Sentex Scentogun (PID). (page 2 of 5)**

1-Chlorobutanone
1-Chloro-2, 3-eposypropane
Chloroethane (Ethyl Chloride)
Chloroethene
2-Chloroethyoxyethene
1-Chloro-2-fluorobenzene
1-Chloro-3-fluorobenzene
cis-1-Chloro-2-fluoroethene
trans-1-Chloro-2-fluoroethene
o-Chloroiodobenzene
Chloromethylethyl Ether
Chloromethyl Ether
1-Chloro-2-methylpropane
Chloropropene
3-Chloropropene
p-Chlorostyrene
2-Chlorothiophene
o-Chlorotoluene
m-Chlorotoluene
p-Chlorotoluene
o-Cresol
m-Cresol
p-Cresol
Cumene (i-Propyl Benzene)
Crotonaldehyde
3-Cyanopropene
Cyclobutane
Cyclohexane
Cyclohexanol
Cyclohexanone
Cyclohexene
Cyclo-octatetraene
Cyclopentadiene
Cyclopentane
Cyclopentanone
Cyclopentene
Cyclopropane
2-Decanone
Diacetone Alcohol
1,3-Dibromobutane
1,4-Dibromobutane
Dibromochloromethane
Dibromochloropropane
1,1-Dibromoethane
Dibromomethane
1,2-Dibromopropane
2,2-Dibromopropane
Dibutyleamine
1,2-Dichlorobenzene
cis-1,4-Dichloro-2-butene
3,4-Dichlorobutene
cis-Dichloroethene
trans-Dichloroethene
1,1-Dichloroethene
Dichloroethyl Ether
1,1-Dichloropropanone
2,3-Dichloropropene
Dicyclopentadiene
Diethoxymethane
Diethylamine
Diethylamino Ethanol
Diethyl Ether
Diethyl Ketone
Diethyl Sulfide
1,2-Difluorobenzene
1,4-Difluorobenzene
Difluoromethylbenzene
1,1-Dimethoxyethane
Dimethoxymethane
Diiodomethane
Diisobutyl Ketone
Diisopropylamine
Dimethylaniline
2,3-Dimethylbutadiene
2,2-Dimethylbutane
2,2-Dimethylbutan-3-one
2,3-Dimethylbutane
2,3-Dimethyl-2-butene
3,3-Dimethylbutanone
Dimethyl Disulfide
Dimethyl Ether
3,5-Dimethy-4-heptanone
1,1-Dimethylhydrazine
2,2-Dimethyl-3-pentanone
2,2-Dimethylpropane
Dimethyl Sulfide
Di-n-propyl Disulfide
Di-n-propyl Ether
Di-i-propyl Ether
Di-n-propylamine

**FIGURE 3. Alphabetical Listing of Compounds Registered by Sentex Scentogun (PID). (page 3 of 5)**

Di-n-propyl Sulfide
Epichlorohydrin
Ethanol
Ethanolamine
Ethanethio (Ethyl Mercaptan)
Ethene (Ethylene)
Ethyl Acetate
Ethyl Acrylate
Ethylamine
Ethyl Amyl Keton
Ethylbenzene
Ethyl Bromide
Ethyl Butyl Ketone
Ethyl Chloroacetate
Ethyl Ethanoate
Ethyl Ether
Ethyl Disulfde
Ethylene Chlorohydrin
Ethylene Dibromide (EDB)
Ethylene Oxide
Ethyl Formate
Ethyl Iodide
Ethyl Methanoate
Ethyl Isothiocyanate
Ethyl Methyl Sulfide
Ethyl Propanoate
Ethyl Trichloroacetate
mono-Fluorobenzene
mono-Fluoroethene
mono-Fluoromethanol
Fluorotribromomethane
o-Fluorotoluene
m-Fluorotoluene
p-Fluorotoluene
Formaldehyde
Freon ® 11 (Fluorotrichloromethane)
Freon 12 (Dichlorodifluoromethane)
Freon 13 (Chlorotrifluoromethane)
Freon 13 B-1 (Bromotrifluoromethane)
Freon 14 (Carbon Tetrafluoride)
Freon 21 (Dichlorofluoromethane)
Freon 22 (Chlorodifluoromethane)
Freon 113 (1,2-Dichlorotrifluoroethane)
Furan
Furfuryl Alcohol
Furfural
n-Heptane
2-Heptanone
4-Heptanone
n-Hexane
Hexanone
2-Hexanone
1-Hexene
sec-Hexyl Acetate
Hydrazine
Hydrogen Selenide
Hydrogen Sulfide
Hydrogen Telluride
Iodobenzene
1-Iodobutante
2-Iodobutane
Iodoethane (Ethyl Iodide)
Iodomethane (Methyl Iodide)
1-Iodo-2-methylpropane
1-Iodo-2-methylpropane
1-Iodopentane
2-Iodopropane
o-Iodotoluene
m-Iodotoluene
p-Iodotoluene
Isoamyl Acetate
Isoamyl Alcohol
Isobutane
Isobutylamine
Isobutyl Acetate
Isobutyl Alcohol
Isobutyl Formate
Isobutylene
Isobutyraldehyde
Isopentane
Isoprene
Isopropyl Acetate
Isopropyl Alcohol
Isopropylamine
Isopropylbenzene
Isopropyl Ether
Isovaleradehyde
Ketene
Mesitylene
Mesityl Oxide

FIGURE 3. Alphabetical Listing of Compounds Registered by Sentex Scentogun (PID). (page 4 of 5)

Methyl Acetate
Methyl Acrylate
Methylamine
Methyl Bromide
2-Methyl-l,3-butadiene
2-Methylbutanol
2-Methylbutane
2-Methyl-l-butene
3-Methyl-l-butene
3-Methyl-2-butene
Methyl n-butyl Ketone
Methyl Butyrate
Methyl Cellosolve
Methyl Cellosolve Acetate
Methyl Chloroacetate
Methylcyclohexane
Methylcyclohexanol
Methylcyclohexanone
4-Methylcyclohexene
Methylcyclopropane
Methyl Dichloroacetate
Methyl Ethanoate
Methyl Ethyl Ketone
Methyl Ethyl Sulfide
2-Methyl Furan
Methyl Iodide
Methyl Isobutyl Ketone
Methyl Isobutyrate
Methyl Isocyanate
l-Methyl-4-isopropylbenzene
Methyl Isopropyl Ketone
Methyl Methacrylate
Methyl Methanoate
Methyl Mercaptan
2-Methylpentane
3-Methylpentane
2-Methylpropane
2-Methylpropanol
2-Methyl-2-propanol
2-Methylpropene
Methyl n-propyl Ketone
Methyl Styrene
Monomethyl Hydrazine
Napthalene
Nitric Oxide
Nitrobenzene
p-Nitrochlorobenzene
n-Nonane
5-Nonanone
n-Octane
3-Octanone
4-Octanone
l-Octene
n-Pentane
cis-l,3-Pentadiene
trans-l,3-Pentadiene
n-Pentanal
2,4-Pentanedione
2-Pentanone
3-Pentanone
l-Pentene
Perfluoro-l-heptene
n-Perfluoropropyl Iodide
n-Perfluororopropyl-iodomethane
n-Perfluoropropyl-methyl Ketone
Phenol
Phenyl Ether
Phenyl Isocyanate
Phosphine
Pinene
Propadiene
n-Propanol
l-Propanethiol
n-Propanol
Propanone
Propene
Prop-l-3nd-2-ol
Prop-2-ene-l-ol
Propionaldehyde
n-Propyl Acetate
n-Propyl Alcohol
n-Propylamine
n-Propylbenzene
Propylene
Propylene Dichloride
Propylene Imine
Propylene Oxide
n-Propyl Ether
n-Propyl Formate
Propyne

**FIGURE 3. Alphabetical Listing of Compounds Registered by Sentex Scentogun (PID). (page 5 of 5)**

Pyridine
Styrene
Tetrabromoethane
Tetrachloroethene (PCE)
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrafluoroethene
Tetrahydrofuran
1,1,1,2-Tetrachloropropane
1,2,2,3-Tetrachloropropane
Thioethanol
Thiomethanol
Thiophene
1-Thiopropanol
Toluene
o-Toludine
Tribromoethene
1,1,1-Trichlorobutanone
1,1,2-Trichloroethane
Trichloroethene (TCE)
Trichloromethyl Ethyl Ether
1,1,2-Trichloropropane
1,2,3-Trichloropropane
Triethylamine
1,2,4-Trifluorobenzene
1,3,5-Trifluorobenzene
Trifluoroethene
1,1,1-Trifluoro-2-iodoethane
Trifluoroiodomethane
Trifluoromethylbenzene
Trifluoromethylcyclohexane
1,1,1-Trifluoropropene
Trimethylamine
2,2,4-Trimethyl Pentane
2,2,4-Trimethyl-3-pentanone
n-Valeradlehyde
Vinyl Acetate
Vinyl Bromide
Vinyl Chloride
4-Vinylcyclohexene
Vinyl Ethanoate
Vinyl Fluoride
Vinyl Methyl Ether
o-Vinyl Toluene
o-Xylene
m-Xylene
p-Xylene
2,4-Xylidine

FIGURE 4. PID Calibration/Cleaning Log Sheet. (page 1 of 2)

## PID CALIBRATION/CLEANING LOG

PID Gun # _____/_____ Date _____/_____/_____

Tech ID # _____

Date of last PID Cleaning (from label on gun) _____/_____/_____

Last Full-Scale Calibration _____

Last null Calibration _____

Download PID Memory and Submit to Field Coordinator? Y or N

### CLEANING

| Operations | yes or no | comments |
|---|---|---|
| Nose Removed | Y N | |
| Ground - Wire Removed | Y N | |
| 'O' ring identified | Y N | |
| 'O' ring replaced | Y N | |
| lens polished five times | Y N | |
| PID gun reassembled | Y N | |
| PID Functioning | Y N | |
| Discharge both batteries completely | Y N | |
| Recharge batteries for 6 hours | Y N | |
| Label charge date on batteries with a removeable label | Y N | |
| Set clock (Hour, Minute, Day, Month) | Y N | |
| Set Location Code to 0001 = Field Office Calibration Site | Y N | |

FIGURE 4. PID Calibration/Cleaning Log Sheet. (page 2 of 2)

CALIBRATION: FULL SCALE

Verify location code 0001 = Field Office Calibration Site
Y or N

Hood Fan is 'on' and Functioning
Y or N

Calibrant cylinder lot # _____

| Calibration Gas = _____ | PID Measurements |
|---|---|
| Gas @ _____ ppm | |
| Gas @ _____ ppm | |
| Gas @ _____ ppm | |
| Gas @ _____ ppm | |
| Gas @ _____ ppm | |

PID Gun is within 2 percent of Full Scale Calibration Value
Y or N
if no, contact Field Coordinator

Average Full Scale Calibration = _____

Comments: _____

_____

CALIBRATION: NULL

Verify location code 0001 = Field Office Calibration Site
Y or N

Hood fan is 'on' and functioning
Y or N

Calibrant cylinder lot # _____

| Calibration Gas = _____ | Reading #6 |
|---|---|
| Reading #1 | Reading #7 |
| Reading #2 | Reading #8 |
| Reading #3 | Reading #9 |
| Reading #4 | Reading #10 |
| Reading #5 | Reading #11 |

All PID Null Calibration readings should be less than 250 counts.

All Null Calibration readings less than 250 counts?
Y or N
if no, contact Field Coordinator

Comments: _____

_____

Average Full Scale and Null Calibration values recorded on a cloth label with date and initials and place on PID Gun next to LCD Screen
Y or N

Final
Comments: _____

_____

FORM = UA-F4.0-2.1

FIGURE 5. PID Data/Sample Flow Diagram.

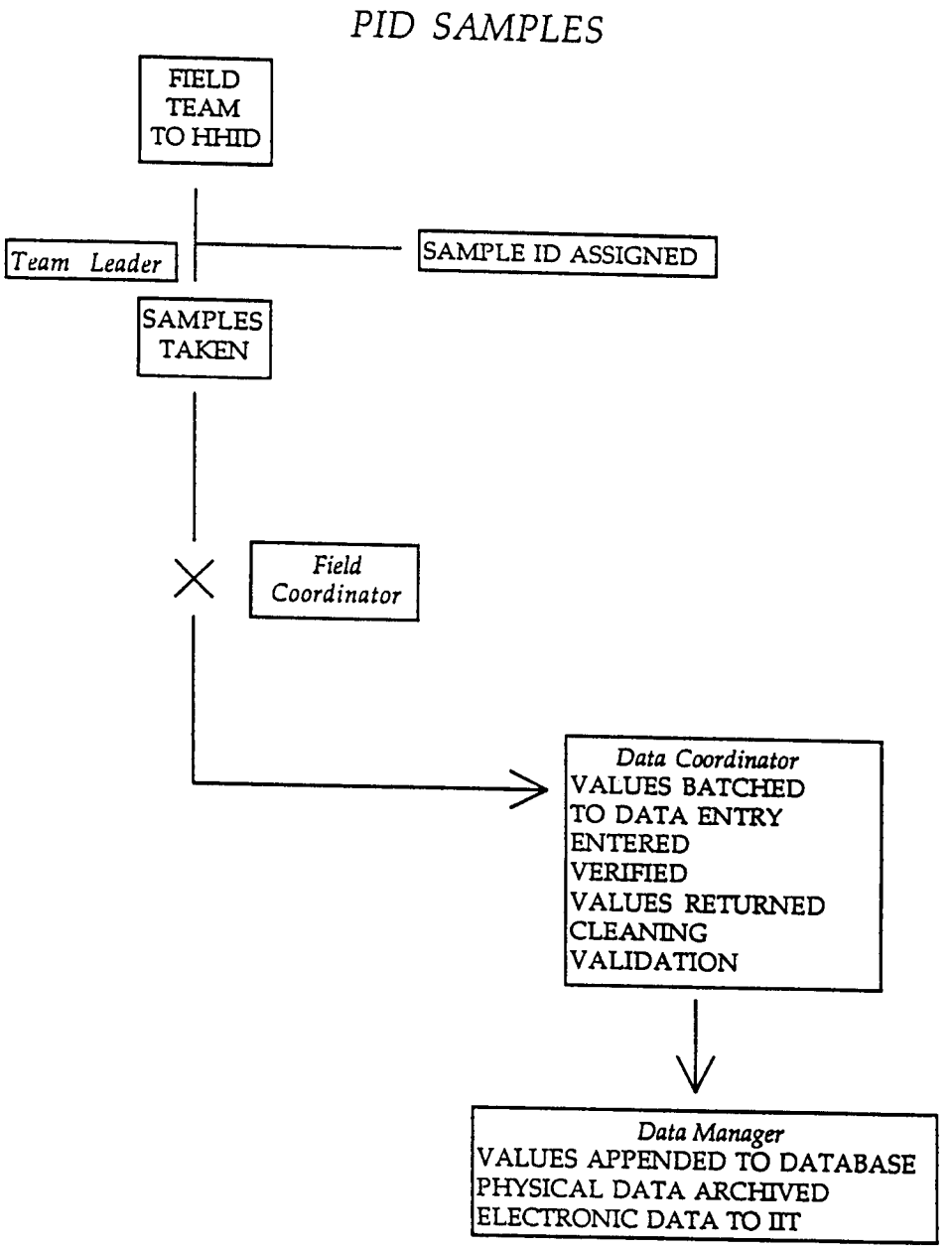

FIGURE 6. Time lines and information collected in Stages 1 & 2.

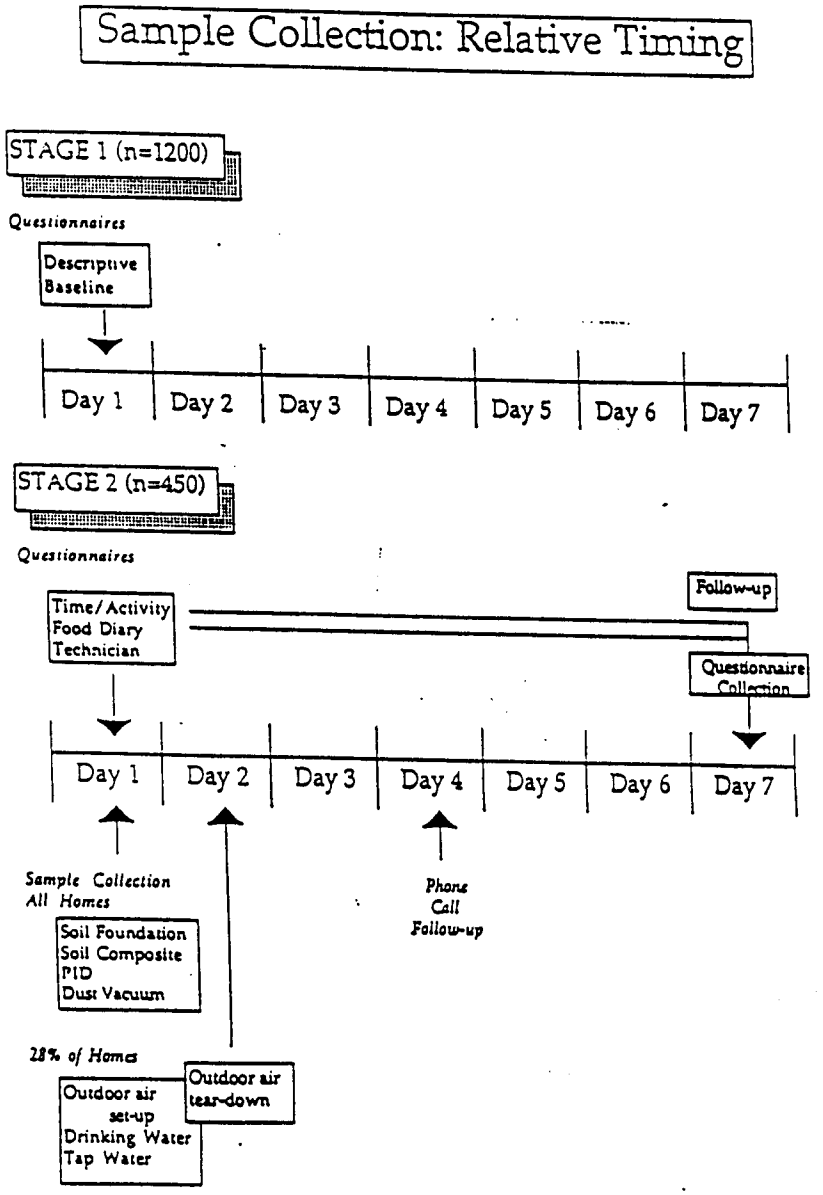

FIGURE 7. Time lines and information collected in Stages 3,4,&5.

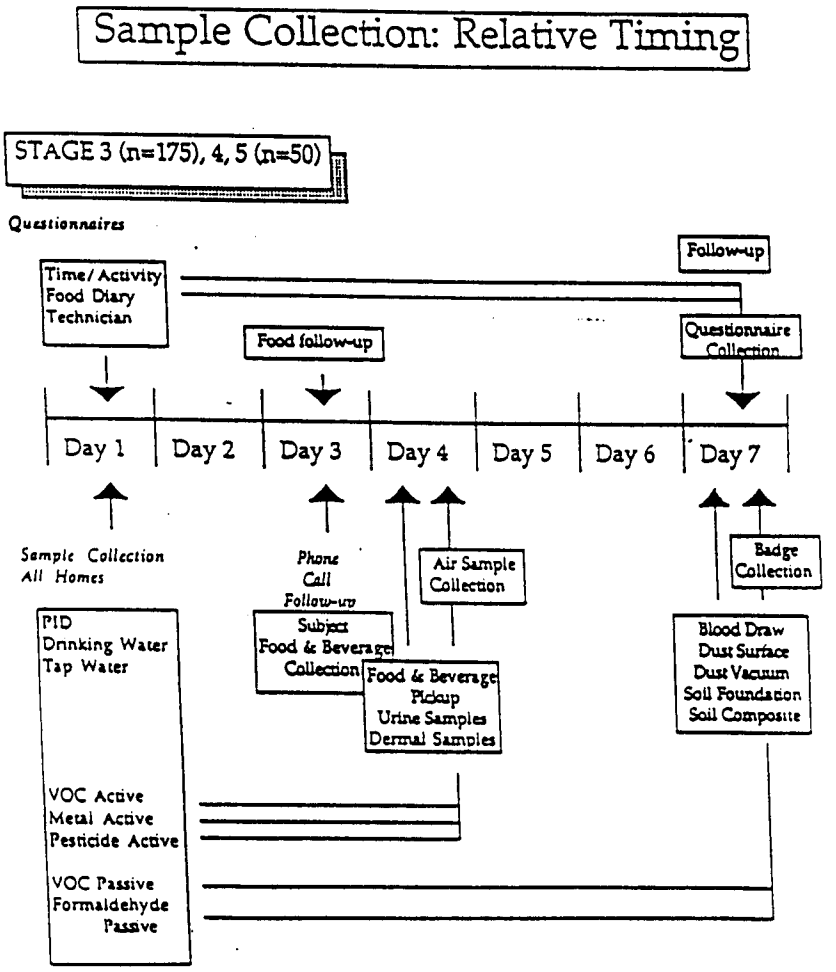

**FIGURE 8. Field Notes and Troubleshooting Guide for PID.**

(a) Take PID measurements before vacuuming.
(b) Check the battery before going out to the field.
(c) Check the null calibration often and each time you get a high reading (i.e. greater than 20 ppm).
(d) When taking the measurements, wait until the reading on the display stabilizes. If the reading is not stable record the reading taken after 10 seconds.
(e) The PID will store up to 156 sample values before the memory overwrites previous data. Download the results after each household visit, if possible. When more than three households are needed to be sampled, the PID will be downloaded in the field using a lap-top computer.

# Appendix A. Material Safety and Handling of Isobutylene (page 1 of 2).



LIQUID AIR CORPORATION
ALPHAGAZ DIVISION

ADDITIONAL DATA

RECOMMENDED FIRST AID TREATMENT: (Continued)

with lukewarm water. DO NOT USE HOT WATER. A physician should see the patient promptly if the cryogenic "burn" has resulted in blistering of the dermal surface or deep tissue freezing.

TIME WEIGHTED AVERAGE EXPOSURE LIMIT (Continued)

TWA (OSHA, 1985) for LPG (Liquefied Petroleum Gas) is 1,000 molar PPM.

LIQUID AIR CORPORATION
ALPHAGAZ DIVISION

ALPHAGAZ

Specialty Gas

## Material Safety Data Sheet

| | |
|---|---|
| PRODUCT NAME | Isobutylene |
| TELEPHONE (415) 977-6800 EMERGENCY RESPONSE INFORMATION ON PAGE 2 | |
| LIQUID AIR CORPORATION ALPHAGAZ DIVISION, Gas Conference Plaza, Suite 200, 2121 N. California Blvd., Walnut Creek, California 94596 | TRADE NAME AND SYNONYMS: Isobutylene |
| | CHEMICAL NAME AND SYNONYMS: Isobutane, Isobutylene, 2-Methylpropene |
| ISSUE DATE AND REVISIONS: OCTOBER 1, 1986 CORPORATE SAFETY DEPT. | FORMULA: (iso) $C_4H_8$ MOLECULAR WEIGHT: 56.03 |
| | CHEMICAL FAMILY: Monolefin |
| | CAS NUMBER: 115-11-7 |

See last page.

### HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE: Isobutylene is defined as a simple asphyxiant. Oxygen levels should be maintained at greater than 18 molar percent at normal atmospheric pressure which is equivalent to a partial pressure of 135 mm Hg. (ACGIH, 1984-85)

SYMPTOMS OF EXPOSURE

Inhalation: Moderate concentrations so as to exclude an adequate supply of oxygen to the lungs causes dizziness, drowsiness and eventual unconsciousness. It also has a very mild anesthetic effect which might cause lack of co-ordination or lessened mental alertness.

Skin and Eye Contact: It is mildly irritating to mucous membranes. Due to its rapid rate of evaporation, it can cause tissue freezing or frostbite on dermal contact.

TOXICOLOGICAL PROPERTIES

It has a very mild anesthetic effect; however, the major property is the exclusion of an adequate supply of oxygen to the lungs.

Frostbite effects are a change in color of the skin to gray or white possibly followed by blistering.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Listed as Carcinogen or Potential Carcinogen | National Toxicology Program | Yes ☐ No ☒ | I.A.R.C. Monographs | Yes ☐ No ☒ | OSHA | Yes ☐ No ☒ |

RECOMMENDED FIRST AID TREATMENT

PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE TO ISOBUTYLENE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS AND BE COGNIZANT OF EXTREME FIRE AND EXPLOSION HAZARD.

Inhalation: Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, given mouth-to-mouth resuscitation and supplemental oxygen. Medical assistance should be sought immediately.

Dermal Contact or Frostbite: Remove contaminated clothing and flush affected areas

(Continued on last page.)



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# Appendix A. Material Safety and Handling of Isobutylene (page 2 of 2).

Page 2

Isobutylene is flammable over a wide range in air.

## PHYSICAL DATA

| | |
|---|---|
| 19.18°F (-7.12°C) | 39.09 lb/ft³ (626.2 kg/m³) |
| 2.70°F (21.1°C) = 38.43 psia (265 kPa) | .148 lb/ft³ (2.37 kg/m³) |
| Insoluble | -220.63°F (-140.35°C) |

Colorless gas with an unpleasant odor similar to that which is emitted when burning anthracite coal. Specific gravity 870°F (Air = 1.0) is 1.98.

## FIRE AND EXPLOSION HAZARD DATA

| | | |
|---|---|---|
| -105°F (-76°C) Closed cup | 869°F (465°C) | LEL: 1.8 UEL: 9.6 |
| Water, carbon dioxide, dry chemical | | Class 1, Group not specified |

If possible, stop the flow of isobutylene. Use water spray to cool surrounding containers.

Isobutylene is heavier than air and may travel a considerable distance to a source of ignition. Should flame be extinguished and flow of gas continue, increase ventilation to prevent flammable mixture formation in low areas or pockets.

## REACTIVITY DATA

| | | |
|---|---|---|
| Stable | X | |

Oxidizers

None

| | | |
|---|---|---|
| Will not occur | X | |

## SPILL OR LEAK PROCEDURES

Evacuate all personnel from affected area. Use appropriate protective equipment. If leak is in user's equipment, be certain to purge piping with an inert gas prior to attempting repairs. If leak is in container or container valve, contact the closest Liquid Air Corporation location.

Do not attempt to dispose of waste or unused quantities. Return in the shipping container properly labeled, with any valve outlet plugs or caps secured and valve protection cap in place to Liquid Air Corporation for proper disposal. For emergency disposal, contact the closest Liquid Air Corporation location.

**EMERGENCY RESPONSE INFORMATION**
**IN CASE OF EMERGENCY INVOLVING THIS MATERIAL, CALL DAY OR NIGHT (800) 231-1366**
**OR CALL CHEMTREC AT (800) 424-9300**

## SPECIAL PROTECTION INFORMATION

Page 3

Positive pressure air line with mask or self-contained breathing apparatus should be available for emergency use.

| | | |
|---|---|---|
| Hood with forced ventilation | to prevent accumulation above the LEL. | |
| | In accordance with electrical codes. | |

Plastic or rubber

Safety goggles or glasses

Safety shoes, safety shower, eyewash "fountain"

## SPECIAL PRECAUTIONS*

DOT Shipping Name: Liquefied petroleum gas DOT Hazard Class: Flammable gas
DOT Shipping Label: Flammable gas I.D. No.: UN 1075

Use only in well-ventilated areas. Valve protection caps must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure reducing regulator when connecting cylinder to lower pressure (<250 psig) piping or systems. Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder.

For additional handling recommendations consult L'Air Liquide's Encyclopedia de Gas or Compressed Gas Association Pamphlet P-1.

Protect cylinders from physical damage. Store in cool, dry, well-ventilated area of non-combustible construction away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed 130F (54C). Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Full and empty cylinders should be segregated. Use a "first in-first out" inventory system to prevent full cylinders being stored for excessive periods of time. Post "No Smoking or Open Flames" signs in the storage or use area. There should be no sources of ignition in the storage or use area.

For additional storage recommendations consult L'Air Liquide's Encyclopedia de Gas or Compressed Gas Association Pamphlet P-1.

Isobutylene is noncorrosive and may be used with any common structural material.

Earth-ground and bond all lines and equipment associated with the isobutylene system. Electrical equipment should be non-sparking or explosion proof. Compressed gas cylinders should not be refilled except by qualified producers of compressed gases. Shipment of a compressed gas cylinder which has not been filled by the owner or with his (written) consent is a violation of Federal Law (49CFR).

*Various Government agencies e.g. Department of Transportation, Occupational Safety and Health Administration, Food and Drug Administration and others may have specific regulations concerning the transportation, handling, storage or use of this product which may not be contained herein. The purchaser or user of this product should be familiar with these regulations.

Appendix B. Results from a side by side comparison of three PID guns.

| SIDE BY SIDE READINGS<br>These readings show the greatest deviation from expected values | | | | | | |
|---|---|---|---|---|---|---|
| | P.I.D 1 | | | P.I.D 3 | | |
| Calibration: | 10 ppm | 50 ppm | 250 ppm | 10 ppm | 50 ppm | 250 ppm |
| Ambient | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| 0 air | 1.5 | 1.5 | 1.7 | 0.0 | 0.0 | 0.0 |
| 10 ppm | 8.5 | 15.4 | 14.4 | 9.7 | 14.0 | 12.5 |
| 50 ppm | 28.0 | 49.4, 50.6 | 45.0 | 35.0 | 48.6 | 43.0 |
| 250 ppm | 110 | 307 | 249, 251 | 177 | 304 | 249 |

| SIDE BY SIDE READINGS | | | | | | |
|---|---|---|---|---|---|---|
| | P.I.D 1 | | P.I.D 2 | | P.I.D 3 | |
| Calibration: | 10 ppm | 50 ppm | 10 ppm | 50 ppm | 10 ppm | 50 ppm |
| Ambient | 0.0, 0.0, 0.0 | 0.0, 0.0, 0.0 | 0.2, 0.0, 0.1 | 0.4, 0.4 | 0.0, 0.2, 0.2 | 0.9, 1.0 |
| 0 air | 0.3, 0.3, 0.3 | 0.2 | 1.4, 1.4, 1.6 | 2.7 | 0.1, 0.2, 0.6 | 1.2 |
| 10 ppm | 9.7, 9.5, 9.4<br>10.2, 10.2, 10.2<br>9.7 | 14.4 | 9.7, 9.7<br>10.2, 10, 10.3<br>10.6 | 15.9 | 10.0, 10.0, 10.0<br>11.3, 11.3, 11.3<br>12.3 | 15.1 |
| 50 ppm | 32.7 | 49.6 | 30.8 | 48.2 | 39.2 | 48.9 |

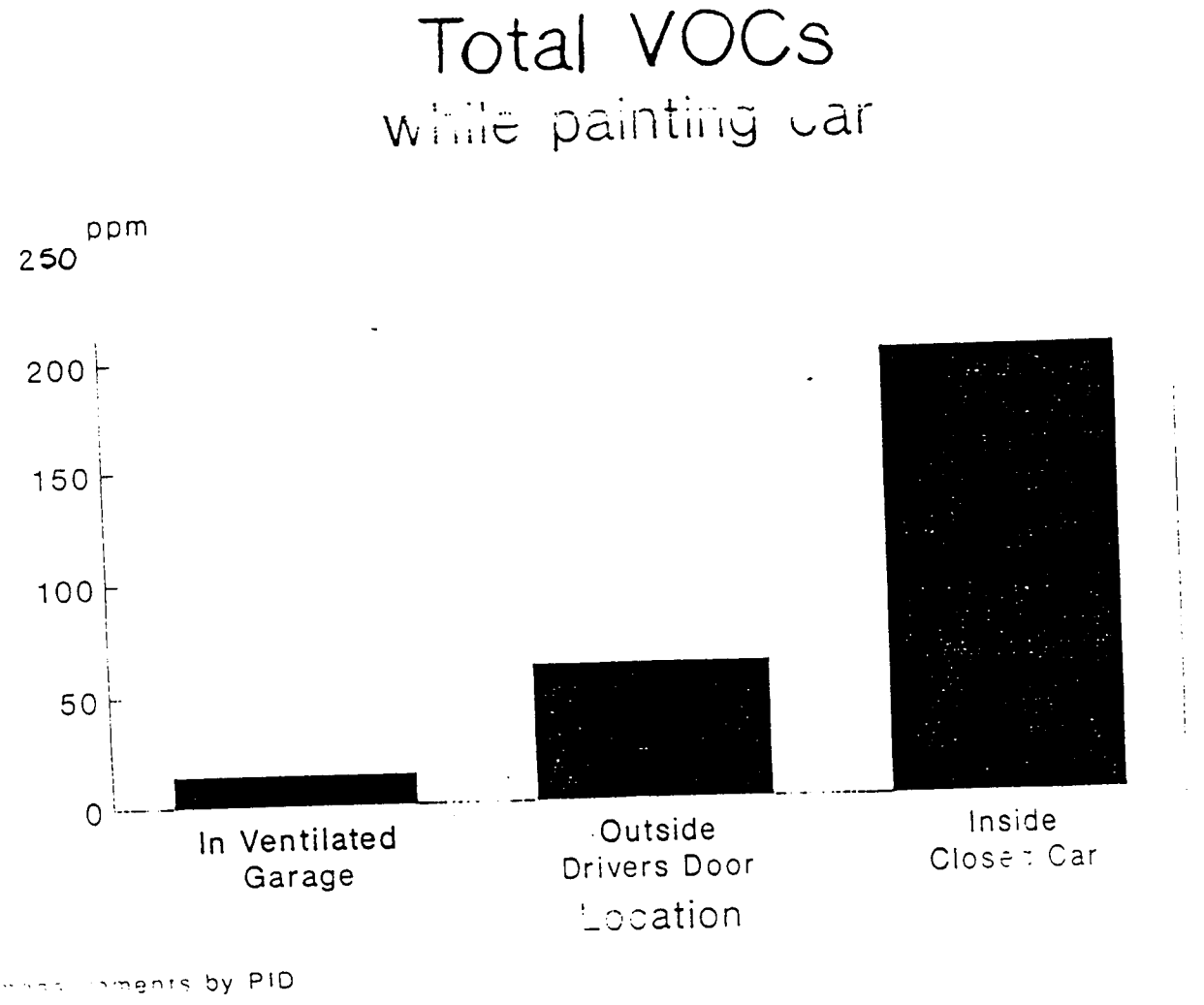
# Appendix C. Lab trials in approximately thirty settings.

**PID READINGS (250 ppm calibration)**

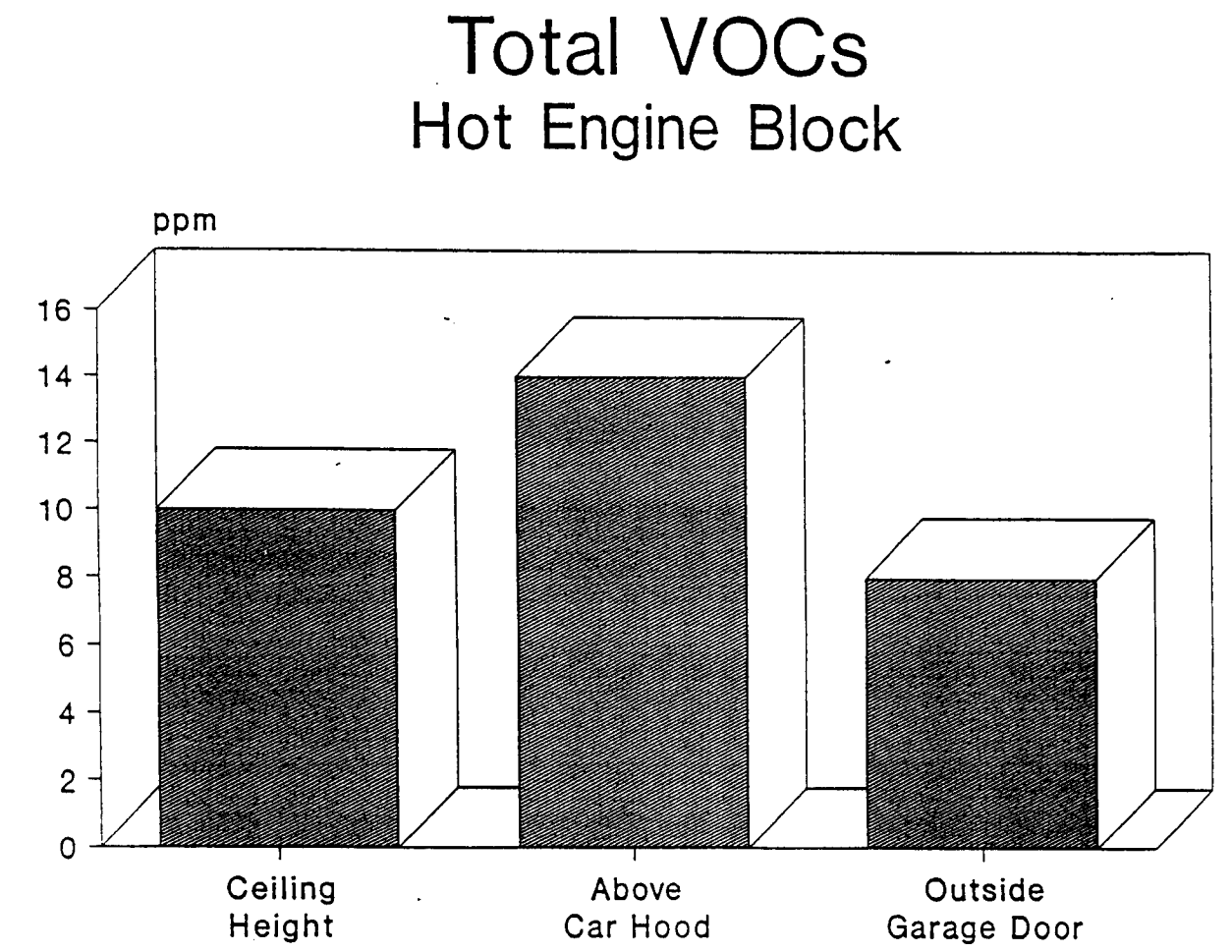
| HHID | DATE | MAIN | BD1 | KITCHEN | GARAGE | FIREPLACE | OTHER |
|---|---|---|---|---|---|---|---|
| 1005A | 940719 | 0 | 0 | 0 | N/A | N/A | 0 (car painting) |
| 2676A | 940725 | 0 | 0 | 0 | 202,62,14 | 0 | N/A |
| 2920A | 940727 | 0 | 0 | 0 | N/A | N/A | N/A |
| 225A | 940727 | 0 | 0 | 0 | N/A | 0 | N/A |
| 2923A | 940725 | 0 | 0 | 0 | N/A | N/A | N/A |
| 1073A | 940728 | 0 | 0 | 0 | N/A | 0 | N/A |
| 110A | 940727 | 0 | 0 | 0 | 0 | 0 | 22 (gas grill) |
| 1437A | 940713 | 0 | 0 | 0 | N/A | N/A | N/A |
| 771A | 940712 | 0 | 0 | 0 | N/A | 7 | N/A |
| 258A | 940713 | 0 | 0 | 0 | N/A | 0 | N/A |
| 926A | 940719 | 0 | 0 | 0 | N/A | 0 | 180 (painting house) |
| 667A | 940725 | 0 | 0 | 0 | N/A | 0 | N/A |
| 880A | 940706 | 0 | 0 | 0 | 0 | 0 | N/A |
| 139A | 940712 | 0 | 0 | 0 | 25.4 (paint thinner) | N/A | .4 |
| 2690A | 940706 | 0 | 0 | 0 | 0 | 0 | N/A |
| 691A | 940715 | 0 | 2.4 | 6,1.4, 2.0 | 7.0 | 0 | N/A |
| 135A | 940714 | 0 | 0 | .2 | N/A | N/A | N/A |
| 665A | 940720 | 0 | 0 | N/A | N/A | N/A | N/A |
| 525A | 940708 | 0 | 0 | 0 | 10,14,8 | N/A | N/A |
| 737A | no samp. | none | none | no samp. | no samp. | no samp. | no samp. |
| 2727A | 940727 | 0 | 0 | 0 | N/A | 0 | N/A |

2676A = Primer on car.
926A = Samples taken over open car of paint thinner when the house was being spray painted.
691A = House had high formaldehyde several years ago.
525A = Samples taken in garage and outside door. Car had been parked one hour prior to sampling.
934A = Cancelled visit.
737A = No sampling done.

**Appendix D. Measurements at three locations of a vehicle which had been recently primed for painting.**



Appendix E. Measurements at three locations one hour after a vehicle had parked in the garage.




Car parked in attached garage 1 hour