

# VOLATILE ORGANIC COMPOUND PROBES

## MODELS 984, 985, 986 AND 987

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OPERATION AND SERVICE MANUAL

P/N 6007661, REVISION A  
FEBRUARY 2014



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# Introduction

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TSI measures Volatile Organic Compounds (VOCs) in air by using Photo-Ionization Detection (PID). A PID sensor uses an ultraviolet (UV) light source to break down VOCs in the air into positive and negative ions. The PID sensor then detects or measures the charge of the ionized gas, with the charge being a function of the concentration of VOCs in the air.

TSI VOC probes are designed for evaluating or investigating indoor air quality (IAQ) conditions and are best suited for ambient, non-hazardous conditions. Common passive sensor monitoring applications include evaluating off-gassing of new building construction materials, point source location, comparing complaint to non-complaint areas and sensitization investigations.

The potential for adverse health effects depends on the type of chemical, concentration in air, time of exposure, and personal sensitivity to any specific VOC.

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# Chapter 1

## Unpacking and Parts Identification

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Carefully unpack the probe from the shipping container. Check the individual parts against the list of components below. If anything is missing or damaged, notify TSI immediately.

1. Probe
2. VOC calibration collar
3. CO<sub>2</sub> calibration collar (included with Models 986 and 987)
4. Calibration certificate
5. Manual

|           |   |
|-----------|---|
| Model 984 | Low concentration (ppb) VOC and temperature                             |
| Model 985 | High concentration (ppm) VOC and temperature                            |
| Model 986 | Low concentration (ppb) VOC, temperature, CO <sub>2</sub> and humidity  |
| Model 987 | High concentration (ppm) VOC, temperature, CO <sub>2</sub> and humidity |

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## Chapter 2

### Setting-up

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#### Connecting the VOC Probe to Instrument

The VOC probes have a “D” shape overmolding on the mini-DIN connector which must align with the connector at the base of the multi-functional instrument models 9565-X, 9565-P, TA465-X, TA465-P and 7575-X. This will ensure the probe is properly connected and remains so during use.

“D” Shaped  
mini-DIN connector



#### Using the Probe

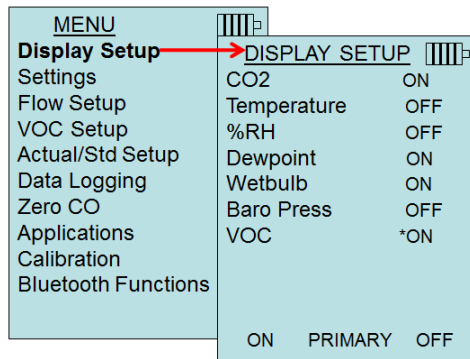
The sensing probe relies on the diffusion of air. For best results, try to keep the sensing probe surrounded by moving air. Do **not** breathe on the probe.

Humans exhale CO<sub>2</sub> levels exceeding 10,000 ppm and it may take time for the probes that measure CO<sub>2</sub> to re-stabilize, and high humidity from your breath can cause condensation on the UV light source in the PID sensor.

# Configuring the Probe and Instrument

## DISPLAY SETUP

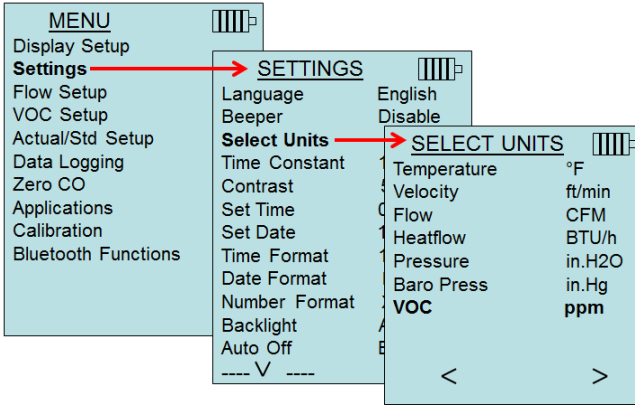
**Display Setup** menu is where you will setup the desired parameters to be displayed on the instrument screen. With a parameter highlighted you can then use the **ON** soft key to have it show up on the instrument screen or select the **OFF** soft key to turn off the parameter. Use **PRIMARY** soft key to have a parameter show up on the instrument screen in a larger display. A total of 5 parameters can be shown on the display, 1 primary (large font) and 4 secondary. Parameters shown in the Display Setup screen are dependent on the type of probe currently connected.



# SETTINGS

**Settings** menu is where you can set the general settings. These include Language, Beeper, Select Units, Time Constant, Contrast, Set Time, Set Date, Time Format, Date Format, Number Format, Backlight, and Auto Off.

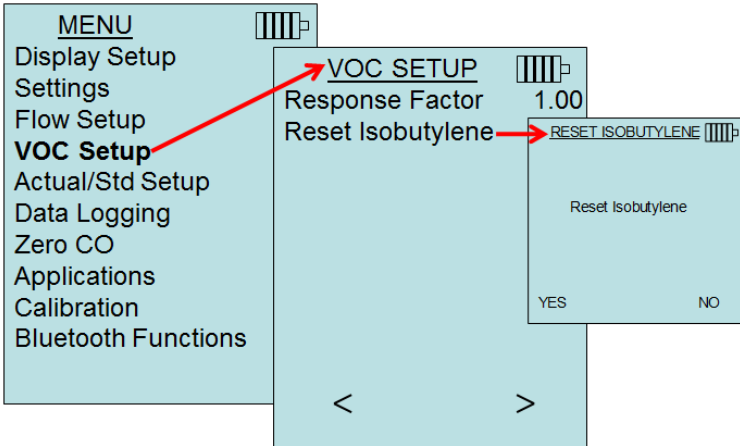
Use the ▲ or ▼ keys to select an option, and the ◀ or ▶ soft keys to change the settings for each option. Press the ← key to accept settings.



# VOC SETUP

The Response Factor of a specific gas can be inputted by the user.

- The response Factor is used to calculate the actual concentration of a specific VOC.
- Reset Isobutylene will restore the factory to factory conditions for Isobutylene (56.11).



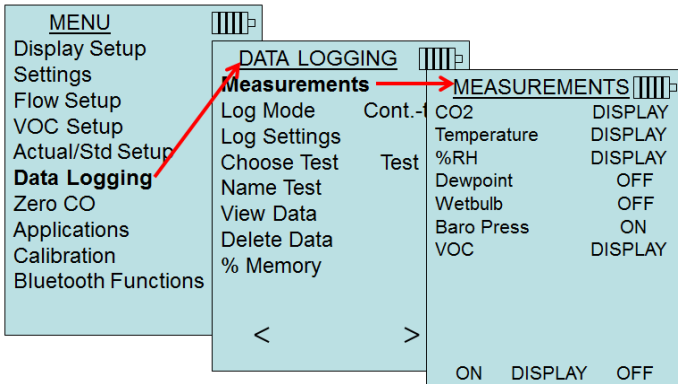
# DATA LOGGING

## Measurements

Measurements to be logged to memory are independent of measurements on the display, and must therefore be selected under **DATA LOGGING → Measurements**.

- When set to **ON**, measurement will be logged to memory.
- When set to **DISPLAY**, measurement will be logged to memory if it is visible on the main running screen.
- When set to **OFF**, measurement will not be logged to memory

Refer to the instrument manual (Chapter 3: Data Logging → “LogMode/Log Settings”) for information on the different logging formats available.



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# Chapter 3

## Response Factors

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TSI Volatile Organic Compound (VOC) probes are calibrated using isobutylene, but the sensor's Photo Ionization Detector (PID) is a broadband VOC detector with a sensitivity that differs for each VOC compound.

PID lamps can be created with a number of gasses, each of which has different photon energy. TSI's PID probes use Krypton gas, with photon energy of 10.6 eV (Electron Volt) that offers a long lamp life and responds to a wide range of gases.

If you know what VOC you are measuring, the table in this section will allow you to calculate the real concentration for your specific VOC that responds to a 10.6 eV lamp source.

**NOTE:** These are approximate values, so for best accuracy, you should calibrate with the relevant VOC.

**NOTE:** TSI PID sensors cannot measure all VOCs or gases. VOCs that have an electron-volt potential greater than or equal ( $\geq$ ) to 10.6 eV will give no response since they cannot be ionized by the 10.6 eV lamp source. Semi-Volatile Organic Compounds (SVOC) cannot be measured if the vapor pressure is too low (a few ppm at 20°C) to volatilize the compound.

The table includes four columns:

|                             |  |
|-----------------------------|--|
| <b>Gas/ VOC</b>             | The most common name for the VOC.  |
| <b>CAS No.</b>              | Find the VOC using the CAS No.   |
| <b>Formula</b>              | To assist in identifying the VOC and to determine the VOC's molecular weight.  |
| <b>Response Factor (RF)</b> | Multiply the displayed concentration by the Response Factor to calculate the actual concentration of the VOC.<br><b>NOTE:</b> The <b>Response Factor (RF)</b> can be programmed into the instrument via the <b>VOC SETUP</b> menu. |

| Gas/VOC                     | CAS No.   | Formula                                       | Response Factor |
|-----------------------------|-----------|---|-----------------|
| Acetaldehyde                | 75-07-0   | C <sub>2</sub> H <sub>4</sub> O               | 4.9             |
| Acetic Acid                 | 64-17-7   | C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>  | 36.2            |
| Acetic Anhydride            | 108-24-7  | C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>  | 4.0             |
| Acetone                     | 67-64-1   | C <sub>3</sub> H <sub>6</sub> O               | 0.7             |
| Acrolein                    | 107-02-8  | C <sub>3</sub> H <sub>4</sub> O               | 4.0             |
| Acrylic Acid                | 79-10-7   | C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>  | 2.7             |
| Allyl alcohol               | 107-18-6  | C <sub>3</sub> H <sub>6</sub> O               | 2.1             |
| Allyl chloride              | 107-05-1  | C <sub>3</sub> H <sub>5</sub> Cl              | 4.5             |
| Ammonia                     | 7664-41-7 | H <sub>3</sub> N                              | 8.5             |
| Amyl acetate, n-            | 628-63-7  | C <sub>7</sub> H <sub>14</sub> O <sub>2</sub> | 1.8             |
| Amyl alcohol                | 71-41-0   | C <sub>5</sub> H <sub>12</sub> O              | 3.2             |
| Aniline                     | 62-53-3   | C <sub>6</sub> H <sub>7</sub> N               | 0.5             |
| Anisole                     | 100-66-3  | C <sub>7</sub> H <sub>8</sub> O               | 0.5             |
| Arsine                      | 7784-42-1 | AsH <sub>3</sub>                              | 2.5             |
| Asphalt, petroleum fumes    | 8052-42-4 | C <sub>6</sub> H <sub>6</sub>                 | 1.0             |
| Benzaldehyde                | 100-52-7  | C <sub>7</sub> H <sub>6</sub> O               | 0.9             |
| Benzene                     | 71-43-2   | C <sub>6</sub> H <sub>6</sub>                 | 0.5             |
| Benzenethiol                | 108-98-5  | C <sub>6</sub> H <sub>5</sub> SH              | 0.7             |
| Benzonitrile                | 100-47-0  | C <sub>7</sub> H <sub>5</sub> N               | 0.7             |
| Benzyl alcohol              | 100-51-6  | C <sub>7</sub> H <sub>8</sub> O               | 1.3             |
| Benzyl chloride             | 100-44-7  | C <sub>7</sub> H <sub>7</sub> Cl              | 0.6             |
| Benzyl formate              | 104-57-4  | C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>  | 0.8             |
| Biphenyl                    | 92-52-4   | C <sub>12</sub> H <sub>10</sub>               | 0.4             |
| Bis(2,3-epoxypropyl) ether  | 2238-07-5 | C <sub>6</sub> H <sub>10</sub> O <sub>3</sub> | 3.0             |
| Bromine                     | 7726-95-6 | Br <sub>2</sub>                               | 20.0            |
| Bromobenzene                | 108-86-1  | C <sub>6</sub> H <sub>5</sub> Br              | 0.7             |
| Bromoethane                 | 74-96-4   | C <sub>2</sub> H <sub>5</sub> Br              | 5.0             |
| Bromoethyl methyl ether, 2- | 6482-24-2 | C <sub>3</sub> H <sub>7</sub> OBr             | 2.5             |
| Bromoform                   | 75-25-2   | CHBr <sub>3</sub>                             | 2.8             |
| Bromopropane, 1-            | 106-94-5  | C <sub>3</sub> H <sub>7</sub> Br              | 1.3             |
| Butadiene                   | 106-99-0  | C <sub>4</sub> H <sub>6</sub>                 | 0.8             |
| Butadiene diepoxide, 1,3-   | 1464-53-5 | C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>  | 4.0             |
| Butane, n-                  | 106-97-8  | C <sub>4</sub> H <sub>10</sub>                | 46.3            |
| Butanol, 1-                 | 71-36-3   | C <sub>4</sub> H <sub>10</sub> O              | 4.0             |
| Buten-3-ol, 1-              | 598-32-3  | C <sub>4</sub> H <sub>8</sub> O               | 1.2             |
| Butene, 1-                  | 106-98-9  | C <sub>4</sub> H <sub>8</sub>                 | 1.3             |
| Butoxyethanol, 2-           | 111-76-2  | C <sub>6</sub> H <sub>14</sub> O <sub>2</sub> | 1.1             |
| Butyl acetate, n-           | 123-86-4  | C <sub>6</sub> H <sub>12</sub> O <sub>2</sub> | 2.4             |
| Butyl acrylate, n-          | 141-32-2  | C <sub>7</sub> H <sub>12</sub> O <sub>2</sub> | 1.5             |
| Butyl lactate               | 138-22-7  | C <sub>7</sub> H <sub>14</sub> O <sub>3</sub> | 2.5             |
| Butyl mercaptan             | 109-79-5  | C <sub>4</sub> H <sub>10</sub> S              | 0.5             |
| Butylamine, 2-              | 513-49-5  | C <sub>4</sub> H <sub>11</sub> N              | 0.9             |
| Butylamine, n-              | 109-73-9  | C <sub>4</sub> H <sub>11</sub> N              | 1.0             |
| Camphene                    | 565-00-4  | C <sub>10</sub> H <sub>16</sub>               | 0.5             |
| Carbon disulfide            | 75-15-0   | CS <sub>2</sub>                               | 1.4             |
| Carbon tetrabromide         | 558-13-4  | CBR <sub>4</sub>                              | 3.0             |

| Gas/VOC                      | CAS No.    | Formula   | Response Factor |
|------------------------------|------------|---|-----------------|
| Carvone, R-                  | 6485-40-1  | C <sub>10</sub> H <sub>14</sub> O               | 1.0             |
| Chlorine dioxide             | 10049-04-4 | ClO <sub>2</sub>                                | 1.0             |
| Chloro-1,3-butadiene, 2-     | 126-99-8   | C <sub>4</sub> H <sub>5</sub> Cl                | 3.2             |
| Chlorobenzene                | 108-90-7   | C <sub>6</sub> H <sub>5</sub> Cl                | 0.5             |
| Chloroethanol, 2-            | 107-07-3   | C <sub>2</sub> H <sub>5</sub> ClO               | 10.0            |
| Chloroethyl methyl ether, 2- | 627-42-9   | C <sub>3</sub> H <sub>7</sub> ClO               | 2.6             |
| Chlorotoluene, o-            | 95-49-8    | C <sub>7</sub> H <sub>7</sub> Cl                | 0.5             |
| Chlorotoluene, p-            | 108-41-8   | C <sub>7</sub> H <sub>7</sub> Cl                | 0.5             |
| Chlorotrifluoroethylene      | 79-38-9    | C <sub>2</sub> ClF <sub>3</sub>                 | 1.0             |
| Citral                       | 5392-40-5  | C <sub>10</sub> H <sub>16</sub> O               | 1.0             |
| Citronellol                  | 26489-01-0 | C <sub>10</sub> H <sub>20</sub> O               | 1.0             |
| Cresol, m-                   | 108-39-4   | C <sub>7</sub> H <sub>8</sub> O                 | 1.1             |
| Cresol, o-                   | 95-48-7    | C <sub>7</sub> H <sub>8</sub> O                 | 1.1             |
| Cresol, p-                   | 106-44-5   | C <sub>7</sub> H <sub>8</sub> O                 | 1.1             |
| Crotonaldehyde               | 4170-30-3  | C <sub>4</sub> H <sub>6</sub> O                 | 1.0             |
| Cumene                       | 98-82-8    | C <sub>9</sub> H <sub>12</sub>                  | 0.6             |
| Cyclohexane                  | 110-82-7   | C <sub>6</sub> H <sub>12</sub>                  | 1.3             |
| Cyclohexanol                 | 108-93-0   | C <sub>6</sub> H <sub>12</sub> O                | 2.9             |
| Cyclohexanone                | 108-94-1   | C <sub>6</sub> H <sub>10</sub> O                | 1.1             |
| Cyclohexene                  | 110-83-8   | C <sub>6</sub> H <sub>10</sub>                  | 0.8             |
| Cyclohexylamine              | 108-91-8   | C <sub>6</sub> H <sub>13</sub> N                | 1.0             |
| Cyclopentane                 | 287-92-3   | C <sub>5</sub> H <sub>10</sub>                  | 4.0             |
| Decane, n-                   | 124-18-5   | C <sub>10</sub> H <sub>22</sub>                 | 1.0             |
| Diacetone alcohol            | 123-42-2   | C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>   | 0.8             |
| Dibenzoyl peroxide           | 94-36-0    | C <sub>14</sub> H <sub>10</sub> O <sub>4</sub>  | 0.8             |
| Dibromochloromethane         | 124-48-1   | CHBr <sub>2</sub> Cl                            | 10.0            |
| Dibromoethane 1,2-           | 106-93-4   | C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>   | 2.0             |
| Dibutyl hydrogen phosphate   | 107-66-4   | HC <sub>8</sub> H <sub>18</sub> PO <sub>4</sub> | 4.0             |
| Dichloro-1-propene, 2,3-     | 78-88-6    | C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>   | 1.4             |
| Dichloroacetylene            | 7572-29-4  | C <sub>2</sub> Cl <sub>2</sub>                  | 5.0             |
| Dichlorobenzene o-           | 95-50-1    | C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>   | 0.5             |
| Dichloroethene, 1,1-         | 75-35-4    | C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>   | 1.0             |
| Dichloroethene, cis-1,2-     | 156-59-2   | C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>   | 0.8             |
| Dichloroethene, trans-1,2-   | 540-59-0   | C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>   | 0.7             |
| Dichloroethylene 1,2-        | 540-59-0   | C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>   | 0.8             |
| Dichloromethane              | 75-09-2    | CH <sub>2</sub> Cl <sub>2</sub>                 | 39.0            |
| Dicyclopentadiene            | 77-73-6    | C <sub>10</sub> H <sub>12</sub>                 | 0.9             |
| Diesel Fuel                  | 68334-30-5 |   | 0.8             |
| Diethyl ether                | 60-29-7    | C <sub>4</sub> H <sub>10</sub> O                | 0.9             |
| Diethyl maleate              | 141-05-9   | C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>   | 2.0             |
| Diethyl phthalate            | 84-66-2    | C <sub>12</sub> H <sub>14</sub> O <sub>4</sub>  | 1.0             |
| Diethyl sulphate             | 64-67-5    | C <sub>4</sub> H <sub>10</sub> SO <sub>4</sub>  | 3.0             |
| Diethyl sulphide             | 352-93-2   | C <sub>4</sub> H <sub>10</sub> S                | 0.6             |
| Diethylamine                 | 109-89-7   | C <sub>4</sub> H <sub>11</sub> N                | 1.0             |
| Diethylaminoethanol, 2-      | 100-37-8   | C <sub>6</sub> H <sub>15</sub> ON               | 2.7             |
| Diethylaminopropylamine, 3-  | 104-78-9   | C <sub>7</sub> H <sub>18</sub> N <sub>2</sub>   | 1.0             |

| Gas/VOC                           | CAS No.    | Formula   | Response Factor |
|-----------------------------------|------------|---|-----------------|
| Dihydrogen selenide               | 7783-07-5  | H <sub>2</sub> Se   | 1.0             |
| Dihydroxybenzene, 1,2             | 120-80-9   | C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>                | 1.0             |
| Dihydroxybenzene, 1,3             | 108-46-3   | C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>                | 1.0             |
| Diisobutylene                     | 107-39-1   | C <sub>8</sub> H <sub>16</sub>                              | 0.6             |
| Diisopropyl ether                 | 108-20-3   | C <sub>6</sub> H <sub>14</sub> O                            | 0.7             |
| Diisopropylamine                  | 108-18-9   | C <sub>6</sub> H <sub>15</sub> N                            | 0.7             |
| Diketene                          | 674-82-8   | C <sub>4</sub> H <sub>4</sub> O <sub>2</sub>                | 2.2             |
| Dimethoxymethane                  | 109-87-5   | C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>                | 1.4             |
| Dimethyl cyclohexane, 1,2-        | 583-57-3   | C <sub>8</sub> H <sub>16</sub>                              | 1.1             |
| Dimethyl disulphide               | 624-92-0   | C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>                | 0.2             |
| Dimethyl ether                    | 115-10-6   | C <sub>2</sub> H <sub>6</sub> O                             | 1.3             |
| Dimethyl phthalate                | 131-11-3   | C <sub>10</sub> H <sub>10</sub> O <sub>4</sub>              | 1.0             |
| Dimethyl sulphide                 | 75-18-3    | C <sub>2</sub> H <sub>6</sub> S                             | 0.5             |
| Dimethylacetamide N,N-            | 127-19-5   | C <sub>4</sub> H <sub>9</sub> NO                            | 1.3             |
| Dimethylamine                     | 124-40-3   | C <sub>2</sub> H <sub>7</sub> N                             | 1.4             |
| Dimethylaminoethanol              | 108-01-0   | C <sub>4</sub> H <sub>11</sub> NO                           | 1.5             |
| Dimethylaniline, NN-              | 121-69-7   | C <sub>8</sub> H <sub>9</sub> N                             | 0.6             |
| Dimethylbutyl acetate             | 108-84-9   | C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>               | 1.6             |
| Dimethylethylamine, NN-           | 598-56-1   | C <sub>4</sub> H <sub>11</sub> N                            | 0.8             |
| Dimethylformamide                 | 68-12-2    | C <sub>3</sub> H <sub>7</sub> NO                            | 0.9             |
| Dimethylheptan-4-one, 2,6-        | 108-83-8   | C <sub>9</sub> H <sub>18</sub> O                            | 0.8             |
| Dimethylhydrazine, 1,1-           | 57-14-7    | C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>                | 1.0             |
| Dinitrobenzene, m-                | 99-65-0    | C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub> | 3.0             |
| Dinitrobenzene, p-                | 100-25-4   | C <sub>6</sub> H <sub>4</sub> N <sub>2</sub> O <sub>4</sub> | 5.0             |
| Dinonyl phthalate                 | 84-76-4    | C <sub>26</sub> H <sub>42</sub> O <sub>4</sub>              | 1.0             |
| Dioxane 1,2-                      |            | C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>                | 1.5             |
| Dioxane 1,4-                      | 123-91-1   | C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>                | 1.5             |
| Dipentene                         | 138-86-3   | C <sub>10</sub> H <sub>16</sub>                             | 0.9             |
| Diphenyl ether                    | 101-84-8   | C <sub>12</sub> H <sub>10</sub> O                           | 0.8             |
| Disulphur dichloride              | 10025-67-9 | S <sub>2</sub> Cl <sub>2</sub>                              | 3.0             |
| Di-tert-butyl-p-cresol            | 2409-55-4  | C <sub>11</sub> H <sub>16</sub> O                           | 1.0             |
| Divinylbenzene                    | 1321-74-0  | C <sub>10</sub> H <sub>10</sub>                             | 0.4             |
| Dodecanol                         | 112-53-8   | C <sub>12</sub> H <sub>26</sub> O                           | 0.9             |
| Epichlorohydrin                   | 106-89-8   | C <sub>3</sub> H <sub>5</sub> ClO                           | 8.0             |
| Epoxypropyl isopropyl ether, 2,3- | 4016-14-2  | C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>               | 1.1             |
| Ethanol                           | 64-17-5    | C <sub>2</sub> H <sub>6</sub> O                             | 8.7             |
| Ethanolamine                      | 141-43-5   | C <sub>2</sub> H <sub>7</sub> NO                            | 3.0             |
| Ethoxy-2-propanol, 1-             | 1569-02-4  | C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>               | 2.0             |
| Ethoxyethanol, 2-                 | 110-80-5   | C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>               | 29.8            |
| Ethoxyethyl acetate, 2-           | 111-15-9   | C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>               | 3.0             |
| Ethyl(S)-(-)-lactate              | 97-64-3    | C <sub>5</sub> H <sub>10</sub> O <sub>3</sub>               | 3.0             |
| Ethyl acetate                     | 141-78-6   | C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>                | 3.6             |
| Ethyl acrylate                    | 140-88-5   | C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>                | 2.0             |
| Ethyl amine                       | 75-04-7    | C <sub>2</sub> H <sub>7</sub> N                             | 1.0             |
| Ethyl benzene                     | 100-41-4   | C <sub>8</sub> H <sub>10</sub>                              | 0.5             |

| Gas/VOC                               | CAS No.   | Formula   | Response Factor |
|---------------------------------------|-----------|---|-----------------|
| Ethyl butyrate                        | 105-54-4  | C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>   | 1.0             |
| Ethyl chloroformate                   | 541-41-3  | C <sub>3</sub> H <sub>5</sub> O <sub>2</sub> Cl | 80.0            |
| Ethyl cyanoacrylate                   | 7085-85-0 | C <sub>6</sub> H <sub>7</sub> O <sub>2</sub> N  | 1.5             |
| Ethyl decanoate                       | 110-38-3  | C <sub>12</sub> H <sub>24</sub> O <sub>2</sub>  | 1.8             |
| Ethyl formate                         | 109-94-4  | C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>    | 30.0            |
| Ethyl hexanoate                       | 123-66-0  | C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>   | 2.6             |
| Ethyl hexanol, 2-                     | 105-76-7  | C <sub>8</sub> H <sub>18</sub> O                | 1.5             |
| Ethyl hexyl acrylate, 2-              | 103-11-7  | C <sub>11</sub> H <sub>20</sub> O <sub>2</sub>  | 1.0             |
| Ethyl mercaptan                       | 75-08-1   | C <sub>2</sub> H <sub>6</sub> S                 | 0.7             |
| Ethyl octanoate                       | 106-32-1  | C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>  | 2.3             |
| Ethylene                              | 74-85-1   | C <sub>2</sub> H <sub>4</sub>                   | 8.0             |
| Ethylene glycol                       | 107-21-1  | C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>    | 20.0            |
| Ethylene oxide                        | 75-21-8   | C <sub>2</sub> H <sub>4</sub> O                 | 15.0            |
| Ferrocene                             | 102-54-5  | C <sub>10</sub> H <sub>10</sub> Fe              | 0.8             |
| Formamide                             | 75-12-7   | CH <sub>3</sub> ON                              | 2.0             |
| Furfural                              | 98-01-1   | C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>    | 1.4             |
| Furfuryl alcohol                      | 98-00-0   | C <sub>5</sub> H <sub>6</sub> O <sub>2</sub>    | 2.0             |
| Gasoline vapors                       | 8006-61-9 |   | 1.1             |
| Gasoline vapors92 octane              | 8006-61-9 |   | 0.8             |
| Germane                               | 7782-65-2 | GeH <sub>4</sub>                                | 10.0            |
| Glutaraldehyde                        | 111-30-8  | C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>    | 0.9             |
| Heptan-2-one                          | 110-43-0  | C <sub>7</sub> H <sub>14</sub> O                | 0.7             |
| Heptan-3-one                          | 106-35-4  | C <sub>7</sub> H <sub>14</sub> O                | 0.8             |
| Heptane n-                            | 142-82-5  | C <sub>7</sub> H <sub>16</sub>                  | 2.1             |
| Hexamethyldisilazane,<br>1,1,1,3,3,3- | 999-97-3  | C <sub>6</sub> H <sub>19</sub> NSi <sub>2</sub> | 1.0             |
| Hexamethyldisiloxane                  | 107-46-0  | C <sub>6</sub> H <sub>18</sub> OSi <sub>2</sub> | 0.3             |
| Hexan-2-one                           | 591-78-6  | C <sub>6</sub> H <sub>12</sub> O                | 0.8             |
| Hexane n-                             | 110-54-3  | C <sub>6</sub> H <sub>14</sub>                  | 4.2             |
| Hexene, 1-                            | 592-41-6  | C <sub>6</sub> H <sub>12</sub>                  | 0.9             |
| Hydrazine                             | 302-01-2  | H <sub>4</sub> N <sub>2</sub>                   | 3.0             |
| Hydrogen peroxide                     | 7722-84-1 | H <sub>2</sub> O <sub>2</sub>                   | 4.0             |
| Hydrogen sulfide                      | 7783-06-4 | H <sub>2</sub> S                                | 4.0             |
| Hydroquinone                          | 123-31-9  | C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>    | 0.8             |
| Hydroxypropyl acrylate 2-             | 999-61-1  | C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>   | 1.5             |
| Iminodi(ethylamine) 2,2-              | 111-40-0  | C <sub>4</sub> H <sub>13</sub> N <sub>3</sub>   | 0.9             |
| Iminodiethanol 2,2'-                  | 111-42-2  | C <sub>4</sub> H <sub>11</sub> NO <sub>2</sub>  | 1.6             |
| Indene                                | 95-13-6   | C <sub>9</sub> H <sub>8</sub>                   | 0.5             |
| Iodine                                | 7553-56-2 | I <sub>2</sub>                                  | 0.2             |
| Iodoform                              | 75-47-8   | CHI <sub>3</sub>                                | 1.5             |
| Iodomethane                           | 74-88-4   | CH <sub>3</sub> I                               | 0.4             |
| Isoamyl acetate                       | 123-92-2  | C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>   | 1.6             |
| Isobutane                             | 75-28-5   | C <sub>4</sub> H <sub>10</sub>                  | 8.0             |
| Isobutanol                            | 78-83-1   | C <sub>4</sub> H <sub>10</sub> O                | 3.5             |
| Isobutyl acetate                      | 110-19-0  | C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>   | 2.3             |
| Isobutyl acrylate                     | 106-63-8  | C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>   | 1.3             |

| Gas/VOC                        | CAS No.    | Formula   | Response Factor |
|--------------------------------|------------|---|-----------------|
| Isobutylene                    | 115-11-7   | C <sub>4</sub> H <sub>8</sub>                               | 1.0             |
| Isobutyraldehyde               | 78-84-2    | C <sub>4</sub> H <sub>8</sub> O                             | 1.2             |
| Isodecanol                     | 25339-17-7 | C <sub>10</sub> H <sub>22</sub> O                           | 0.9             |
| Isononanol                     | 2452-97-9  | C <sub>9</sub> H <sub>20</sub> O                            | 1.5             |
| Isooctane                      | 565-75-3   | C <sub>8</sub> H <sub>18</sub>                              | 1.1             |
| Isooctanol                     | 26952-21-6 | C <sub>8</sub> H <sub>18</sub> O                            | 1.7             |
| Isopentane                     | 78-78-4    | C <sub>5</sub> H <sub>12</sub>                              | 6.0             |
| Isophorone                     | 78-59-1    | C <sub>9</sub> H <sub>14</sub> O                            | 0.8             |
| Isoprene                       | 78-79-5    | C <sub>5</sub> H <sub>8</sub>                               | 0.7             |
| Isopropanol                    | 67-63-0    | C <sub>3</sub> H <sub>8</sub> O                             | 4.4             |
| Isopropyl acetate              | 108-21-4   | C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>               | 2.2             |
| Isopropyl chloroformate        | 108-23-6   | C <sub>4</sub> H <sub>7</sub> O <sub>2</sub> Cl             | 1.6             |
| Jet Fuel JP-4                  |            |   | 0.8             |
| Jet Fuel JP-5                  |            |   | 0.7             |
| Jet Fuel JP-8                  |            |   | 0.7             |
| Ketene                         | 463-51-4   | C <sub>2</sub> H <sub>2</sub> O                             | 3.0             |
| Maleic anhydride               | 108-31-6   | C <sub>4</sub> H <sub>2</sub> O <sub>3</sub>                | 2.0             |
| Mercaptoacetic acid            | 68-11-1    | C <sub>2</sub> H <sub>4</sub> O <sub>2</sub> S              | 1.0             |
| Mesitylene                     | 108-67-8   | C <sub>9</sub> H <sub>12</sub>                              | 0.3             |
| Methacrylic acid               | 79-41-4    | C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>                | 2.3             |
| Methacrylonitrile              | 126-98-7   | C <sub>4</sub> H <sub>5</sub> N                             | 5.0             |
| Methanol                       | 67-56-1    | CH <sub>4</sub> O   | 200.0           |
| Methoxyethanol, 2-             | 109-86-4   | C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>                | 2.7             |
| Methoxyethoxyethanol, 2-       | 111-77-3   | C <sub>5</sub> H <sub>12</sub> O <sub>3</sub>               | 1.4             |
| Methoxymethylethoxy-2-propanol | 34590-94-8 | C <sub>7</sub> H <sub>16</sub> O <sub>3</sub>               | 1.3             |
| Methoxypropan-2-ol             | 107-98-2   | C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>               | 3.0             |
| Methoxypropyl acetate          | 108-65-6   | C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>               | 1.2             |
| Methyl acetate                 | 79-20-9    | C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>                | 5.2             |
| Methyl acrylate                | 96-33-3    | C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>                | 3.4             |
| Methyl bromide                 | 74-83-9    | CH <sub>3</sub> Br  | 1.9             |
| Methyl cyanoacrylate           | 137-05-3   | C <sub>5</sub> H <sub>5</sub> O <sub>2</sub> N              | 5.0             |
| Methyl ethyl ketone            | 78-93-3    | C <sub>4</sub> H <sub>8</sub> O                             | 0.8             |
| Methyl ethyl ketone peroxides  | 1338-23-4  | C <sub>8</sub> H <sub>18</sub> O <sub>2</sub>               | 0.8             |
| Methyl isobutyl ketone         | 108-10-1   | C <sub>6</sub> H <sub>12</sub> O                            | 0.8             |
| Methyl isothiocyanate          | 556-61-6   | C <sub>2</sub> H <sub>3</sub> NS                            | 0.6             |
| Methyl mercaptan               | 74-93-1    | CH <sub>4</sub> S   | 0.7             |
| Methyl methacrylate            | 80-62-6    | C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>                | 1.6             |
| Methyl propyl ketone           | 107-87-9   | C <sub>5</sub> H <sub>10</sub> O                            | 0.8             |
| Methyl salicylate              | 119-36-8   | C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>                | 1.2             |
| Methyl sulphide                | 75-18-3    | C <sub>2</sub> H <sub>6</sub> S                             | 0.5             |
| Methyl t-butyl ether           | 1634-04-4  | C <sub>5</sub> H <sub>12</sub> O                            | 0.8             |
| Methyl-2-propen-1-ol, 2-       | 51-42-8    | C <sub>4</sub> H <sub>8</sub> O                             | 1.1             |
| Methyl-2-pyrrolidinone, N-     | 872-50-4   | C <sub>5</sub> H <sub>9</sub> NO                            | 0.9             |
| Methyl-4,6-dinitrophenol, 2-   | 534-52-1   | C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>5</sub> | 3.0             |

| Gas/VOC                              | CAS No.    | Formula   | Response Factor |
|--------------------------------------|------------|---|-----------------|
| Methyl-5-hepten-2-one, 6-            | 110-93-0   | C <sub>8</sub> H <sub>14</sub> O                            | 0.8             |
| Methylamine                          | 74-89-5    | CH <sub>5</sub> N   | 1.4             |
| Methylbutan-1-ol, 3-                 | 123-51-3   | C <sub>5</sub> H <sub>12</sub> O                            | 3.4             |
| Methylcyclohexane                    | 108-87-2   | C <sub>7</sub> H <sub>14</sub>                              | 1.1             |
| Methylcyclohexanol, 4-               | 589-91-3   | C <sub>7</sub> H <sub>14</sub> O                            | 2.4             |
| Methylcyclohexanone 2-               | 583-60-8   | C <sub>7</sub> H <sub>12</sub> O                            | 1.0             |
| Methylheptan-3-one, 5-               | 541-85-5   | C <sub>8</sub> H <sub>16</sub> O                            | 0.8             |
| Methylhexan-2-one, 5-                | 110-12-3   | C <sub>7</sub> H <sub>14</sub> O                            | 0.8             |
| Methylhydrazine                      | 60-34-4    | CH <sub>6</sub> N <sub>2</sub>                              | 1.3             |
| Methyl-N-2,4,6-tetranitroaniline, N- | 479-45-8   | C <sub>7</sub> H <sub>5</sub> N <sub>5</sub> O <sub>8</sub> | 3.0             |
| Methylpent-3-en-2-one, 4-            | 141-79-7   | C <sub>6</sub> H <sub>10</sub> O                            | 0.7             |
| Methylpentan-2-ol, 4-                | 108-11-2   | C <sub>6</sub> H <sub>14</sub> O                            | 2.8             |
| Methylpentane-2,4-diol, 2-           | 107-41-5   | C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>               | 4.0             |
| Methylpropan-2-ol, 2-                | 75-65-0    | C <sub>4</sub> H <sub>10</sub> O                            | 3.5             |
| Methylstyrene                        | 25013-15-4 | C <sub>9</sub> H <sub>10</sub>                              | 0.5             |
| Mineral oil                          | 8042-47-5  |   | 0.8             |
| Mineral spirits                      | 64475-85-0 |   | 0.8             |
| Naphthalene                          | 91-20-3    | C <sub>10</sub> H <sub>8</sub>                              | 0.4             |
| Nitric oxide                         | 10102-43-9 | NO  | 8.0             |
| Nitroaniline 4-                      | 100-01-6   | C <sub>6</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub> | 0.8             |
| Nitrobenzene                         | 98-95-3    | C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>               | 1.7             |
| Nitrogen dioxide                     | 10102-44-0 | NO <sub>2</sub>   | 10.0            |
| Nitrogen trichloride                 | 10025-85-1 | NCl <sub>3</sub>  | 1.0             |
| Nonane, n-                           | 111-84-2   | C <sub>9</sub> H <sub>20</sub>                              | 1.3             |
| Norbornadiene, 2,5-                  | 121-46-0   | C <sub>7</sub> H <sub>8</sub>                               | 0.6             |
| Octachloronaphthalene                | 2234-13-1  | C <sub>10</sub> Cl <sub>8</sub>                             | 1.0             |
| Octane, n-                           | 111-65-9   | C <sub>8</sub> H <sub>18</sub>                              | 1.6             |
| Octene, 1-                           | 111-66-0   | C <sub>8</sub> H <sub>16</sub>                              | 0.7             |
| Oxydiethanol 2,2-                    | 111-46-6   | C <sub>4</sub> H <sub>10</sub> O <sub>3</sub>               | 4.0             |
| Paraffin wax, fume                   | 8002-74-2  |   | 1.0             |
| Paraffins, normal                    | 64771-72-8 |   | 1.0             |
| Pentacarbonyl iron                   | 13463-40-6 | FeC <sub>5</sub> O <sub>5</sub>                             | 1.0             |
| Pentan-2-one                         | 107-87-9   | C <sub>5</sub> H <sub>10</sub> O                            | 0.8             |
| Pentan-3-one                         | 96-22-0    | C <sub>5</sub> H <sub>10</sub> O                            | 0.8             |
| Pentandione, 2,4-                    | 123-54-6   | C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>                | 0.8             |
| Pentane, n-                          | 109-66-0   | C <sub>5</sub> H <sub>12</sub>                              | 7.9             |
| Peracetic acid                       | 79-21-0    | C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>                | 2.0             |
| Petroleum ether                      | 64742-82-1 | C <sub>6</sub> H <sub>14</sub>                              | 0.9             |
| Phenol                               | 108-95-2   | C <sub>6</sub> H <sub>6</sub> O                             | 1.2             |
| Phenyl propene, 2-                   | 98-83-9    | C <sub>9</sub> H <sub>10</sub>                              | 0.4             |
| Phenyl-2,3-epoxypropyl ether         | 122-60-1   | C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>               | 0.8             |
| Phenylenediamine, p-                 | 106-50-3   | C <sub>6</sub> H <sub>8</sub> N <sub>2</sub>                | 0.6             |
| Phosphine                            | 7803-51-2  | PH <sub>3</sub>   | 2.0             |
| Picoline, 3-                         | 108-99-6   | C <sub>6</sub> H <sub>7</sub> N                             | 0.9             |

| Gas/VOC                             | CAS No.    | Formula  | Response Factor |
|-------------------------------------|------------|--|-----------------|
| Pinene, alpha                       | 80-56-8    | C <sub>10</sub> H <sub>16</sub>                              | 0.3             |
| Pinene, beta                        | 127-91-3   | C <sub>10</sub> H <sub>16</sub>                              | 0.3             |
| Piperidine                          | 110-89-4   | C <sub>5</sub> H <sub>11</sub> N                             | 0.9             |
| Piperylene                          | 504-60-9   | C <sub>5</sub> H <sub>8</sub>                                | 0.7             |
| Prop-2-yn-1-ol                      | 107-19-7   | C <sub>3</sub> H <sub>4</sub> O                              | 1.3             |
| Propan-1-ol                         | 71-23-8    | C <sub>3</sub> H <sub>8</sub> O                              | 4.8             |
| Propane-1,2-diol, total             | 57-55-6    | C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>                 | 10.0            |
| Propene                             | 115-07-1   | C <sub>3</sub> H <sub>6</sub>                                | 1.4             |
| Propionaldehyde                     | 123-38-6   | C <sub>3</sub> H <sub>6</sub> O                              | 1.7             |
| Propionic acid                      | 79-09-4    | C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>                 | 8.0             |
| Propyl acetate, n-                  | 109-60-4   | C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>                | 2.5             |
| Propylene oxide                     | 75-56-9    | C <sub>3</sub> H <sub>6</sub> O                              | 7.0             |
| Propyleneimine                      | 75-55-8    | C <sub>3</sub> H <sub>7</sub> N                              | 1.3             |
| Pyridine                            | 110-86-1   | C <sub>5</sub> H <sub>5</sub> N                              | 0.8             |
| Pyridylamine 2-                     | 504-29-0   | C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>                 | 0.8             |
| Styrene                             | 100-42-5   | C <sub>8</sub> H <sub>8</sub>                                | 0.4             |
| Terphenyls                          |            | C <sub>18</sub> H <sub>14</sub>                              | 0.6             |
| Terpinolene                         | 586-62-9   | C <sub>10</sub> H <sub>16</sub>                              | 0.5             |
| Tert-butanol                        | 75-65-0    | C <sub>4</sub> H <sub>10</sub> O                             | 2.6             |
| Tetrabromoethane, 1,1,2,2-          | 79-27-6    | C <sub>2</sub> H <sub>2</sub> Br <sub>4</sub>                | 2.0             |
| Tetracarbonylnickel                 | 13463-39-3 | NiC <sub>4</sub> O <sub>4</sub>                              | 1.0             |
| Tetrachloroethylene                 | 127-18-4   | C <sub>2</sub> Cl <sub>4</sub>                               | 0.7             |
| Tetrachloronaphthalenes,all isomers | 20020-02-4 | C <sub>10</sub> H <sub>4</sub> Cl <sub>4</sub>               | 1.0             |
| Tetraethyl orthosilicate            | 78-10-4    | C <sub>8</sub> H <sub>20</sub> O <sub>4</sub> Si             | 2.0             |
| Tetrafluoroethylene                 | 116-14-3   | C <sub>2</sub> F <sub>4</sub>                                | 1.0             |
| Tetrahydrofuran                     | 109-99-9   | C <sub>4</sub> H <sub>8</sub> O                              | 1.6             |
| Tetramethyl succinonitrile          | 3333-52-6  | C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>                | 1.0             |
| Therminol                           |            |  | 1.0             |
| Toluene                             | 108-88-3   | C <sub>7</sub> H <sub>8</sub>                                | 0.5             |
| Toluene-2,4-diisocyanate            | 584-84-9   | C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>  | 1.6             |
| Toluenesulphonylchloride, p-        | 98-59-9    | C <sub>7</sub> H <sub>7</sub> SO <sub>2</sub> Cl             | 3.0             |
| Toluidine, o-                       | 95-53-4    | C <sub>7</sub> H <sub>9</sub> N                              | 0.5             |
| Tributyl phosphate                  | 126-73-8   | C <sub>12</sub> H <sub>27</sub> O <sub>4</sub> P             | 5.0             |
| Tributylamine                       | 102-82-9   | C <sub>12</sub> H <sub>27</sub> N                            | 1.0             |
| Trichlorobenzene 1,2,4-             | 120-82-1   | C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>                | 0.6             |
| Trichloroethylene                   | 79-01-6    | C <sub>2</sub> HCl <sub>3</sub>                              | 0.7             |
| Trichlorophenoxyacetic acid, 2,4,5- | 93-76-5    | C <sub>8</sub> H <sub>5</sub> O <sub>3</sub> Cl <sub>3</sub> | 1.0             |
| Triethylamine                       | 121-44-8   | C <sub>6</sub> H <sub>15</sub> N                             | 0.9             |
| Trimethylamine                      | 53-50-3    | C <sub>3</sub> H <sub>9</sub> N                              | 0.5             |
| Trimethylbenzene, 1,3,5-            | 108-67-8   | C <sub>9</sub> H <sub>12</sub>                               | 0.3             |
| Turpentine                          | 8006-64-2  | C <sub>10</sub> H <sub>16</sub>                              | 0.6             |
| TVOC                                |            |  | 1.0             |



| <b>Gas/VOC</b>            | <b>CAS No.</b> | <b>Formula</b>                               | <b>Response Factor</b> |
|---------------------------|----------------|--|------------------------|
| Undecane, n-              | 1120-21-4      | C <sub>11</sub> H <sub>24</sub>              | 0.9                    |
| Vinyl acetate             | 108-05-2       | C <sub>4</sub> H <sub>6</sub> O <sub>2</sub> | 1.1                    |
| Vinyl bromide             | 593-60-2       | C <sub>2</sub> H <sub>3</sub> Br             | 1.0                    |
| Vinyl chloride            | 75-01-4        | C <sub>2</sub> H <sub>3</sub> Cl             | 2.1                    |
| Vinyl-2-pyrrolidinone, 1- | 88-12-0        | C <sub>6</sub> H <sub>9</sub> NO             | 0.9                    |
| Xylene mixed isomers      | 1330-20-7      | C <sub>8</sub> H <sub>10</sub>               | 0.4                    |
| Xylene, m-                | 108-38-3       | C <sub>8</sub> H <sub>10</sub>               | 0.4                    |
| Xylene, o-                | 95-47-6        | C <sub>8</sub> H <sub>10</sub>               | 0.6                    |
| Xylene, p-                | 106-42-3       | C <sub>8</sub> H <sub>10</sub>               | 0.6                    |
| Xylidine, all             | 1300-73-8      | C <sub>8</sub> H <sub>11</sub> N             | 0.7                    |

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# Chapter 4

## Field Testing and Calibration

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### Overview

Due to the nature of the PID sensor and the presence of VOCs in air along with other environmental factors such as altitude, temperature and relative humidity, the zero value of the VOC probe will shift over time. **TSI recommends testing the probe performance each time the instrument is used to make measurements.** This is a common practice within the gas measurement community which includes IAQ consultants and industrial hygienists.

### Probe Verification

Verifying the probe performance can easily be accomplished in the field by comparing it to certified zero and span calibration gases. To do this, attach the probe with the calibration collar to a bottle of Zero Gas and compare to the instrument readings (also referred to as a “Bump Test”). If the probe reads any number other than 0, the PID sensor has drifted and needs to be re-calibrated.



**NOTE:** With probe attached, power on the instrument for 10 minutes before verifying performance. This allows the instrument and probe electronics to stabilize to produce best results.

## TSI Recommended Accessories for Testing or Calibrating PID Probes

- Zero Gas—80% Nitrogen/20% Oxygen
- Span Gas—1 ppm Isobutylene in balance Nitrogen—use with ppb probe
- Span Gas—10 ppm Isobutylene in balance Nitrogen—use with ppb probe
- Span Gas—20 ppm Isobutylene in balance Nitrogen—use with ppm probe
- Span Gas—100 ppm Isobutylene in balance Nitrogen—use with ppm probe
- 0.3 to 0.5 L/min flow rate Continuous Flow Regulator
- Tygon<sup>®</sup> tubing 0.250 in. (6.35 mm) OD, 0.125 in. (3.175 mm) ID
- VOC probe calibration collar (included with probe)

When spanning with an isobutylene gas, select a concentration value that is closest to the desired measurement range. This will result in maximum accuracy of the PID sensors readings.

### Example 1 (ppb)

If you have a ppb PID probe and want to measure VOCs in the low ppb range, span calibrating with a 1 ppm isobutylene gas will give more accurate results than span calibrating with a 10 ppm isobutylene gas. If you would like to measure VOCs in the mid to upper range of the PID sensor, calibrating with 10 ppm isobutylene span gas would be appropriate.

### Example 2 (ppm)

If you have a ppm PID probe and want to measure VOCs in the low ppm range, span calibration with a 20 ppm isobutylene gas will give more accurate results, than span calibrating with 100 ppm isobutylene gas will. If you would like to measure VOCs in the mid to upper range of the PID sensor, calibrating with 100 ppm isobutylene span gas would be appropriate.

Zero, Span gasses and regulators that meet TSI's requirements are available internationally from PortaGas at [www.portagas.com](http://www.portagas.com) in 103 liter bottle configurations.

## PID Probe Calibration

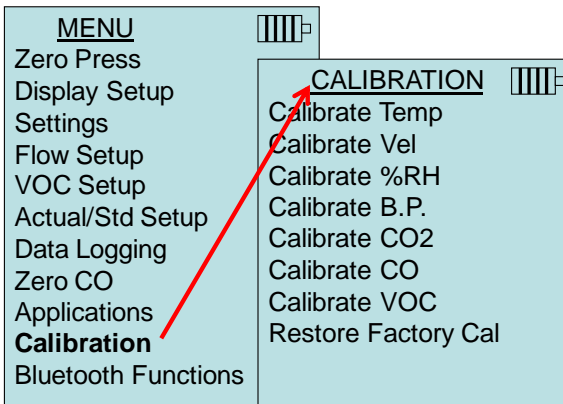
If the probe reads any number other than 0 when tested against a zero gas, the PID sensor has drifted and needs to be re-calibrated using the following instructions. These instructions are also applicable if the PID sensor has been replaced in the field.

### NOTES

- With probe attached power on the instrument for 10 minutes before calibrating the probe. This allows the instrument and probe electronics to stabilize to produce best results.
- Field calibration is required if a new replacement PID sensor is installed on the probe.
- Restore to Factory Calibration before performing field calibration.
- After restoring Factory Calibration, try the “Bump Test” again at 0 ppm and/or at a known concentration of Isobutylene in balance Nitrogen gas. If readings are still out of tolerance, then proceed with field calibration procedure.

## Accessing the Calibration Menu

To access the CALIBRATION menu, press the **MENU** key and scroll down to CALIBRATION and press **ENTER**. Highlight Calibrate VOC and then press **ENTER**.



## NOTE

The measurement capabilities of the instrument and probe will determine what appears in the main MENU and CALIBRATION menu. Instrument models using detachable probes must have the probe attached to perform field calibrations. This screen display above is from the 9565-P VelociCalc<sup>®</sup> Multi-Function Ventilation Meter with VOC probe attached.

## Calibrate VOC

A probe calibration collar (included with probe), zero calibration gas, gas regulator and tubing are required to perform the calibration. The gas regulator used to control the flow should be capable of providing 0.3 L/min. Follow the on-screen instructions to complete the calibration.

**Step 1**—Grasp probe handle and pull PID sensor protective cap off.



**Step 2**—Slide calibration collar onto probe and attach to gas cylinder using tubing.



**Step 3—Zero Calibration.**

After pressing **ENTER** with the zero calibration gas connected, the instrument begins to take data. A bar graph will appear showing the time remaining. *The time allocated by the instruments firmware for zero is sufficient for zeroing.*

CALIBRATE VOC



Connect zero gas  
then press  
**ENTER**

## Step 4—Span Calibration.

For best results, *run the span gas with the probe attached for 60 seconds before pressing the **ENTER** button to conduct the span calibration.*

After pressing **ENTER** with the span calibration gas connected, the instrument begins to take data. A bar graph will appear showing the time remaining.

CALIBRATE VOC



Connect span gas  
then press  
ENTER

## Step 5—Span Adjustment

Once the countdown is complete, the VOC concentration as measured by the probe is displayed along with the percent of adjustment.

In this example, the span gas is rated at 10 ppm. Use the UP or DOWN arrow keys to adjust offset to match the span gas concentration. Press **ENTER** to accept and to return to the CALIBRATION menu.

CALIBRATE VOC



9.41 ppm  
0.0 % Adjustment

## Calibrate CO<sub>2</sub>

This calibration option applies to meters and probes capable of measuring CO<sub>2</sub>. A probe calibration collar, zero calibration gas, span calibration gas, gas regulator and tubing are required to perform the calibration. The gas regulator used to control the flow should be capable of providing 0.3 L/min. Follow the on-screen instructions to complete the calibration.

## Requirements

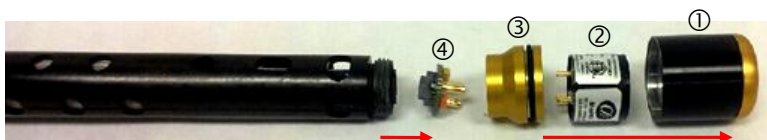
- Probe calibration collar (included with IAQ and VOC probes)
- Span calibration gas, 5000 ppm maximum
- Zero Gas – 80% Nitrogen / 20% Oxygen
- 0.3 L/min flow rate Continuous Flow Regulator
- Tygon tubing 0.250 in. (6.35 mm) OD, 0.125 in. (3.175 mm) ID



## NOTE

If probe measures VOC gasses, remove VOC sensor first.

- Pull PID sensor protective cap off ①
- Remove PID sensor ②
- Unscrew collar ③
- Gently remove small PCB ④



**Step 1**—Slide calibration collar onto probe and attach to gas cylinder using tubing.



### Step 2— Bump Test

Measure concentration with 0 ppm calibration gas flowing through the calibration collar. Do the same with the Span Gas. If readings are out of tolerance, Restore CO<sub>2</sub> Factory Calibration (see [RESTORE FACTORY CAL](#)) and then perform the Bump Test again at 0 ppm and Span. If readings are still OOT, proceed with Field Calibration.

### Step 3—Zero Calibration.

After pressing **ENTER** with the zero calibration gas connected, the instrument will begin to take data. A bar graph will appear showing the time remaining.

CALIBRATE CO<sub>2</sub> 

Connect zero gas  
then press  
**ENTER**

### Step 4—Span Calibration.

After pressing **ENTER** with the span calibration gas connected, the instrument will begin to take data. A bar graph will appear showing the time remaining.

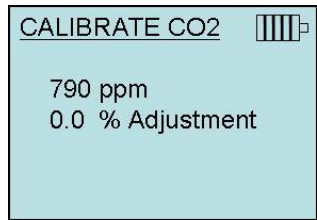
CALIBRATE CO<sub>2</sub> 

Connect span gas  
then press  
**ENTER**

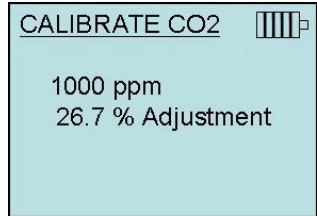


### Step 5—Span Adjustment.

Once the countdown is complete, the CO<sub>2</sub> concentration as measured by the probe is displayed along with the percent of adjustment.



In this example, the span gas is rated at 1000 ppm. Use the UP or DOWN arrow keys to adjust offset to match the span gas concentration. Press **ENTER** to accept and to return to the CALIBRATION menu.

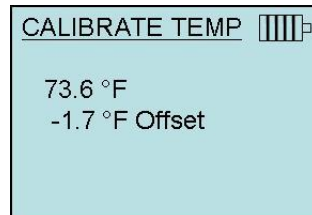
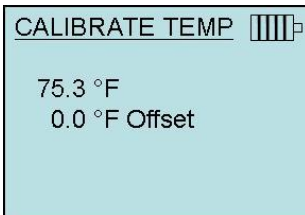


### Calibrate Temp

This calibration option applies to all meters and probes capable of measuring temperature. The temperature calibration can be adjusted  $\pm 6.0^{\circ}\text{F}$  ( $\pm 3.3^{\circ}\text{C}$ ). Compare the instruments temperature reading to a reference standard and make changes as required.

**Step 1**—Use the UP or DOWN arrow keys to adjust offset.

**Step 2**—Press **ENTER** to accept and to return to CALIBRATION menu.



In this example, the temperature measured by the probe is 75.3°F and the reference temperature is 73.6°F. Adjusting the offset by -1.7°F allows the probe to match the reference standard.

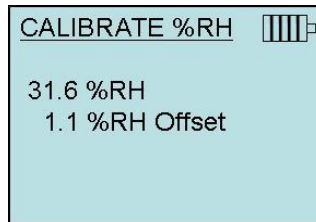
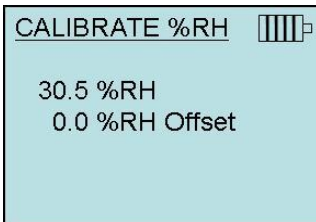
## Calibrate %RH

This calibration option applies to meters and probes capable of measuring relative humidity. Compare the instruments relative humidity reading to a reference standard and make changes as required. The Offset can be adjusted  $\pm 12.0\%$  RH.

**Step 1**—Use the UP or DOWN arrow keys to adjust offset.

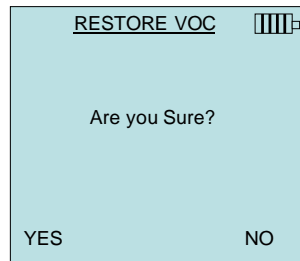
**Step 2**—Press **ENTER** to accept and to return to CALIBRATION menu.

In this example, the relative humidity measured by the probe is 30.5 %RH and the reference humidity is 31.6 %RH. Adjusting the offset by 1.1% allows the probe match the reference standard.



## RESTORE FACTORY CAL

This option resets the field calibration for any measurement parameter back to the last factory calibration. To restore the last factory calibration for any measurement parameter, the probe must be attached to the meter on models with detachable probe.



# Chapter 5

## Probe Maintenance

The electronics in the PID sensor in the VOC probes are not accessible. However, periodic sensor maintenance of the electrode stack and lamp may be needed for optimal performance.

The PID lamp will need cleaning from time to time. How often depends on the environment you are measuring in. If you are measuring indoor air quality where the VOC concentrations are low and there are few particulates, then a monthly or even less frequent cleaning may be adequate. However, if you are measuring high VOC concentrations and particulates are present in high concentrations, check calibration frequently and clean the lamp. When the PID has lost sensitivity, change the stack as explained below in the sections entitled "[Removing Electrode Stack and Lamp](#)" and "[Refitting Electrode Stack and Lamp](#)".

The PID needs maintenance if:

| Condition   | Recommended Action      |
|---|-------------------------|
| Sensitivity has dropped too much (note the change required when checking calibration) | Clean lamp              |
| The baseline is climbing after you zero the PID                                       | Replace electrode stack |
| The PID becomes sensitive to humidity   | Replace electrode stack |
| The baseline is unstable or shifts when the PID is moved                              | Replace electrode stack |

### Removing the Electrode Stack and Lamp

**CAUTION:** Always use the Electrode Stack Removal Tool (included with replacement stack); any other tools may damage your PID and void the warranty.

1. Remove cap and PID sensor from VOC probe, as shown in Figure 1.
2. Gently pull the sensor from the probe.
3. Place the PID, top side down, onto a clean surface.
4. Insert electrode stack removal tool into the two slots on the sides of the PID (as shown in Figure 2) and squeeze together until electrode stack and lamp are released.

**CAUTION:** Electrode stack and lamp may jump off sensor and become lost if removed when the PID is right-side up.

- Carefully lift the PID body away from the electrode stack and lamp.



**Figure 1. Removing Cap and PID Sensor from VOC Probe**

**NOTES:**

- If the lamp lodges in the sensor, use tweezers to carefully remove it.
- If the spring behind the lamp also comes out, replace it in the sensor housing.



**Figure 2. Using Electrode Stack Removal Tool**

## Cleaning the PID Lamp

Cleaning the PID lamp is recommended as a first step for PIDs needing service. Use the procedure described below. Recalibrate the sensor after cleaning the lamp.

To check for a lamp that needs cleaning, hold it in front of a light source and look across the window surface as shown in Figure 3. A dirty lamp will have a “blue hue” on the detection window.

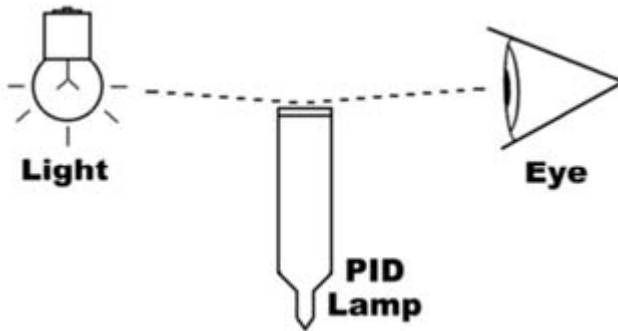


Figure 3. Checking Lamp for Contamination

Only clean the lamp using the lamp cleaning kit (P/N 801782) while following the instructions below. To avoid contaminating the sensor and affecting accuracy, do **not** touch the lamp window with bare fingers. You may touch the body of the lamp with clean fingers.

1. [Remove Electrode Stack and Lamp](#) from sensor and probe.
2. Open the container of alumina polishing compound. With a clean cotton swab, collect a small amount of the powder.
3. Use this cotton swab to polish the PID lamp window. Use a circular action, applying light pressure to clean the lamp window, as shown in Figure 4. Do **not** touch the lamp window with fingers.
4. Continue polishing until an audible “squeaking” is made by the cotton swab moving over the window surface. Squeaking usually occurs within 15 seconds.

Remove the residual powder from the lamp window with a clean cotton swab. Care must be taken not to touch the tips of cotton swab that are to be used to clean the lamps as this may contaminate them with finger oil.



**Figure 4. Cleaning Lamp Window**

Ensure the lamp is completely dry and any visible signs of contamination are removed before replacing.

## **PID Lamp Cleaning Kit P/N 801782**

The vial of cleaning compound contains alumina (CAS Number 1344-28-1) as a very fine powder. Key safety issues are identified below.

### **Hazard identification:**

May cause irritation of respiratory tract and eyes.

### **Storage:**

Keep container closed to prevent water adsorption and contamination.

### **Handling:**

- Do **not** breathe in the powder. Avoid contact with skin, eyes and clothing.
- Wear suitable protective clothing.
- Follow industrial hygiene practices: Wash face and hands thoroughly with soap and water after use and before eating, drinking, smoking or applying cosmetics.
- The powder carries a TVL (TWA) limit of  $10 \text{ mg/m}^3$ .

## **Replacing the Lamp**

A PID lamp will last a long time, typically a few thousand hours. However, the sensitivity of the PID sensor is approximately proportional to the lamp light intensity. As the bulb ages and loses intensity, the response to a gas concentration decreases and may become noisier. If cleaning the window does not restore sensitivity, replace the lamp. Recalibrate the sensor after replacing the lamp.

## Replacing the Electrode Stack

While the PID electrode stack can last the lifetime of the PID if used in clean environments, it may only last a month if used in heavily contaminated sites. Therefore, TSI recommends having a replacement electrode stack if you are working in dirty environments.

Replace the electrode stack if the sensor shows signs of contamination after the lamp window has been cleaned or is known to have been subjected to severe contamination. Recalibrate the sensor after replacing the electrode stack.

## Discarding the Electrode Stack

Discard the contaminated electrode stack. The electrode stack does not have any toxic components unless contaminated in the field by toxic materials.

## Refitting Electrode Stack and Lamp

**WARNING:** Do not refit a damaged lamp.

1. Place the lamp inside the O-ring seal in the electrode stack as shown in Figure 5. Twisting the lamp slightly during insertion will help to ensure the lamp window is snug against the pellet's front electrode. The lamp should be freely supported by the O-ring.



**Figure 5. Inserting Lamp into Electrode Stack**

2. Continuing to hold the electrode stack between forefinger and thumb, carefully insert the lamp into recess in the sensor ensuring that the lamp remains in position. Press the electrode firmly, to ensure that the wing clips are engaged, and the top faces of the electrode stack and sensor housing are flush.
3. Refit the sensor into the VOC probe and replace the sensor cover.
4. Re-calibrate the gas detector.

## Spare Components

If you need spare components, then order the necessary parts listed below:

|        |   |
|--------|---|
| 800706 | 10 ppm Cal Gas (for ppb probe)                        |
| 800707 | 100 ppm Cal Gas (for ppm probe)                       |
| 801780 | Replacement Lamp                                      |
| 801781 | Replacement Electrode Stack (for ppm Sensor) and Tool |
| 801786 | Replacement Electrode Stack (for ppb Sensor) and Tool |
| 801782 | Lamp Cleaning Kit with Spring                         |
| 801783 | Replacement ppm sensor                                |
| 801784 | Replacement ppb sensor                                |

## Recalibration

To maintain a high degree of accuracy in your measurements, TSI recommends that you return your VOC probe to TSI for annual recalibration. Please contact one of TSI's offices or your local distributor to make service arrangements and to receive a Return Material Authorization (RMA) number. To fill out an online RMA form, visit TSI's website at <http://service.tsi.com>.

| <b>U.S.</b>   | <b>International</b>   |
|---|--|
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# Chapter 6

## Troubleshooting

Table 6-1 lists the symptoms, possible causes, and recommended solutions for common problems encountered with the instrumentation. If your symptom is not listed, or if none of the solutions solves your problem, please contact TSI.

**Table 6-1: Troubleshooting instrument and VOC probes**

| Symptom   | Possible Causes                                 | Corrective Action  |
|---|---|--|
| No Display  | Unit not turned on                              | Switch unit on.  |
|   | Low or dead batteries                           | Replace batteries or plug in AC adapter.                 |
|   | Dirty battery contacts                          | Clean the battery contacts.                              |
| No measurements shown on display                              | DISPLAY SETUP measurement parameters set to OFF | Set measurement parameters to ON.                        |
| No response to keypad   | Keypad locked out                               | Unlock keypad by pressing ▲▼ keys simultaneously.        |
| Instrument Error message appears                              | Memory is full                                  | Download data if desired, then <b>DELETE ALL</b> memory. |
|   | Fault in instrument                             | Factory service required on instrument.                  |
| Probe Error message appears                                   | Fault in probe                                  | Factory service required on probe.                       |
| Probe is plugged in, but the instrument does not recognize it | Probe was plugged in when the instrument was ON | Turn instrument OFF and then turn it back ON.            |

### WARNING!

Remove the probe from excessive temperature immediately: excessive heat can damage the sensor. Operating temperature limits can be found in [Appendix A, Specifications](#).

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# Appendix A

## Specifications

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Specifications are subject to change without notice.

### **Model 984 Low Concentration (ppb) VOC and Temperature**

Range 10 to 20,000 ppb,  
14 to 140°F (-10 to 60°C)  
Accuracy  $\pm 1.0^\circ\text{F}$  ( $\pm 0.5^\circ\text{C}$ )<sup>1</sup>  
Resolution Up to 10 ppb, 0.1°F (0.1°C)

### **Model 985 High Concentration (ppm) VOC and Temperature**

Range 1 to 2,000 ppm,  
14 to 140°F (-10 to 60°C)  
Accuracy  $\pm 1.0^\circ\text{F}$  ( $\pm 0.5^\circ\text{C}$ )<sup>1</sup>  
Resolution Up to 10 ppm, 0.1°F (0.1°C)

### **Model 986 Low Concentration (ppb) VOC, Temperature, CO<sub>2</sub>, and Humidity**

Range 10 to 20,000 ppb VOC, 0 to 5,000 ppm CO<sub>2</sub>  
14 to 140°F (-10 to 60°C), 5 to 95% RH  
Accuracy  $\pm 3\%$  of reading or 50 ppm CO<sub>2</sub><sup>2</sup>, whichever is greater  
 $\pm 1.0^\circ\text{F}$  ( $\pm 0.5^\circ\text{C}$ )<sup>1</sup>,  $\pm 3\%$  RH<sup>3</sup>  
Resolution Up to 10 ppb VOC, 0.1 ppm CO<sub>2</sub><sup>2</sup>,  
0.1°F (0.1°C), 0.1% RH

### **Model 987 High Concentration (ppm) VOC, Temperature, CO<sub>2</sub>, and Humidity**

Range 1 to 2,000 ppm VOC, 0 to 5,000 ppm CO<sub>2</sub>  
14 to 140°F (-10 to 60°C), 5 to 95% RH  
Accuracy  $\pm 3\%$  of reading or 50 ppm CO<sub>2</sub><sup>2</sup>, whichever is greater  
 $\pm 1.0^\circ\text{F}$  ( $\pm 0.5^\circ\text{C}$ )<sup>1</sup>,  $\pm 3\%$  RH<sup>3</sup>  
Resolution Up to 10 ppm VOC, 0.1 ppm CO<sub>2</sub>,  
0.1°F (0.1°C), 0.1% RH

### **Temperature Range:**

Operating (Electronics): 40 to 113°F (5 to 45°C)  
Operating (Probe): 14 to 140°F (-10 to 60°C)  
Storage: -4 to 140°F (-20 to 60°C)

## Probe Dimensions

|                    |                   |
|--------------------|-------------------|
| Length             | 7.0 in. (17.8 cm) |
| (excluding handle) |                   |
| Base Diameter      | 0.75 in. (1.9 cm) |
| Tip Diameter       | 1.0 in. (2.54 cm) |

Note: The 984 and 986 probes are designed to measure ppb concentrations of VOCs. The 10 to 20,000 ppb range corresponds to 0.01 to 20 ppm.

<sup>1</sup> Accuracy with instrument case at 77°F (25°C), add uncertainty of 0.05°F/°F (0.05°C/°C) for change in instrument temperature.

<sup>2</sup> Accuracy with probe at 77°F (25°C). Add uncertainty of  $\pm 0.2\%/^{\circ}\text{F}$  ( $\pm 0.36\%/^{\circ}\text{C}$ ) away from calibrated temperature

<sup>3</sup> Accuracy with probe at 77°F (25°C). Add uncertainty of 0.1% RH/°F (0.2% RH/°C) for change in probe temperature. Includes 1% hysteresis.

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