Chapter 18

Direct-Reading Gas and Vapor Instruments

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Introduction

This chapter presents useful information about direct-reading instruments for analyzing airborne gases and vapors. The instrumentation that will be discussed is that which provides an on-site indication, in useful units (e.g., ppm, mg/m^3, etc.), of the presence of the contaminant(s) of interest. Frequently, these instruments are general, nonspecific detectors, but chemispecific detectors are also available. The instruments are commercially available.

Direct-reading instruments may be used for area, process, or personal monitoring, and it is convenient to describe three physical classifications for grouping these instruments: *personal* instruments are those instruments small enough to be worn by an individual; *portable* instruments are those easily carried by an individual; *transportable* instruments are those requiring a cart or other support for movement to or from the monitoring site. Ideally, these instruments operate from self-contained battery power, but many can also use, and some require, line current.

In this chapter, the reader will find information on operational, physical, and performance characteristics for each of the instruments described. The instruments are grouped into the following classifications: electrochemical instruments, spectrochemical instruments, thermochemical instruments, gas chromatographic

instruments, mass spectrometers, paramagnetic instruments, and an aerosol formation and detection instrument. In each section, there is a general definition of the instrumentation to be described, an explanation of the principle of detection, and a brief discussion of conditions of application for the instruments, including capabilities, restrictions, and limitations. At the end of the chapter is a suggested reading list for the reader who requires more in-depth information about a particular technique.

Regardless of the instrument chosen for use and the capabilities of that instrument, there is no substitute for knowledge of the capabilities and limitations of the instrument as well as effects of the conditions in the proposed monitoring situation. Then, the most appropriate instrument can be chosen for a given application, meaningful data can be obtained, and, if necessary, effective solutions for contaminant control can be implemented.

Electrochemical Instruments

Electrochemical techniques involve the measurement of electrical signals associated with chemical systems.[1] These chemical systems are typically incorporated into electrochemical cells. Electrochemical techniques include instruments that operate on the principles of conductivity, potentiometry, coulometry, and ionization.

Conductivity (1.1–1.4)

Instruments that measure conductivity rely on the fact that charged species (ions) conduct electricity. Equally significant is the fact that at low concentrations, such as those concentrations typically found when these species are measured as workplace contaminants, conductivity is proportional to concentration. The fundamental equation for conductivity is given by

$$G = \frac{\Lambda C}{1000 K} \tag{1}$$

where G = conductance in Siemens
Λ = equivalent conductance in Siemens per centimeter-equivalent
C = the concentration in equivalents per 1000 cm^3
K = a geometric term describing the electrochemical cell

A conductivity measurement depends on the space between, and area (size) of, a pair of electrodes and also on the volume of solution between them. Because conductance is the reciprocal of resistance, that is,

$$G = \frac{1}{R} \tag{2}$$

where R is resistance in ohms, the latter is sometimes measured because it is a more fundamental property. It should be noted that species monitored by conductivity need not be in an ionic form in the vapor phase but may be gases or vapors that form electrolytes, by chemical reaction, in solution.

Conductivity measurements are temperature dependent, having a temperature coefficient that can be on the order of 2% per °C. Instruments that control temperature may use thermostatted cabinets; those that compensate for temperature effects do so electronically.

A special case of conductivity instrumentation is one wherein a gold film is used to amalgamate mercury (Hg). In the mercury conductivity detector, the change in resistance of the solid film is measured.

Conductivity is, typically, a nonspecific technique in that any species ionizable under the given conditions will affect the measurement. The specific conductance, λ, of each ionizable species is important, for only when the conductivity of interfering electrolytes is either constant and/or negligible can the conductivity of the species of interest be measured.

There also are several solid-state devices that exploit electronic conductivity charges induced in metal oxide semiconductors.[2] Their principle of operation is based on the change in surface conductivity of a semiconductor, such as SnO_2, as a result of gas adsorption. The adsorbed gas may either directly affect the conductivity, or interact with the surface oxygen coverage, which, in turn, affects the conductivity. These instruments are relatively inexpensive, are easy to use, and can be used in oxygen-depleted atmospheres. They are typically used in screening applications and for hazard warning.

Conductivity instruments are primarily used for detection of corrosive gases, e.g., ammonia (NH_3), hydrogen sulfide (H_2S), and sulfur dioxide (SO_2). The conductivity analyzers are numbers 1.1 through 1.4 in the "Instrument Descriptions" section. They are most effectively used in isothermal environments at or near room temperature. Environments with few potential interferences are preferred. Chemical prescrubbers can be helpful.

Potentiometry (2.1–2.45)

Instruments that use a change in electrochemical potential as their principle of detection are most

commonly represented by the pH meter. Potentiometry is strictly defined as the measurement of the difference in potential between two electrodes in an electrochemical cell under the condition of zero current. Gases and vapors can react with reagents effecting an oxidation/reduction, the extent of which is proportional to the concentration of the reacting gas. The fundamental equation governing a potentiometric reaction is the Nernst equation:

$$E_{cell} = E^{o}_{cell} - \frac{RT}{nF} ln \frac{[C]^{c}[D]^{d}}{[A]^{a}[B]^{b}} \quad (3)$$

where: E_{cell} = cell potential
E^{o}_{cell} = standard cell potential
R = gas constant
T = temperature
n = number of electrons involved in the electrode reaction
F = Faraday constant

Although the letters in brackets strictly represent the chemical activities of the reacting species, when considering dilute solutions, it is reasonable to approximate the activity using the concentration. This equation is simplified at nominal room temperature (25°C) by converting to the base ten logarithm and substituting for the constants: $R = 8.314$ Joules mol^{-1} T^{-1}, $T = 298$ K, $F = 96{,}485$ Coulombs/mol. This results in the following equation:

$$E_{cell} = E^{o}_{cell} - \frac{0.0591}{n} \frac{\log [C]^{c}[D]^{d}}{[A]^{a}[B]^{b}} \quad (4)$$

The Nernst equation relates potential, E_{cell}, with temperature, the electronic state change of the species being oxidized or reduced, and the concentration of the species. When sampling with a potentiometer, the sampled analyte of interest would most likely be represented in this equation by one of the reactants, A or B.

Whereas potentiometry is basically a nonspecific technique, some degree of specificity may be obtained through the selection of the membrane through which the gaseous analyte must diffuse to enter the electrochemical cell, the selection of the reagent, the specific potential range, and the type of electrodes used.

Potentiometers are listed as numbers 2.1 through 2.45 in the "Instrument Descriptions" section. Some are diffusion monitors. They are used for the measurement of a variety of contaminants including carbon monoxide, chlorine, formaldehyde, hydrogen sulfide, oxides of nitrogen, oxides of sulfur, oxygen, and ozone. Preferable application is at, or near, room temperature for area samples, including confined space, and personal.

Coulometry (3.1–3.22)

Coulometric analyzers have as their principle of detection the determination of the quantity of electricity required to affect the complete electrolysis of the analyte of interest. The amount of electricity required is proportional to the amount of analyte present. This analyte may be the contaminant requiring monitoring, or it may be a chemical with which the contaminant quantitatively reacts. Regardless, the equation governing coulometry is Faraday's:

$$W = \frac{qM}{nF} \quad (5)$$

where: W = mass of substance that is electrolyzed
q = charge, in Coulombs, required to completely electrolyze the substance
M = formula weight
n = number of electrons per molecule required for electrolysis
F = Faraday's constant: 96,485 Coulombs/mol

The quantity that an instrument must measure is q. This may be done either directly, by determining the integral (controlled-potential coulometry), or indirectly, by measuring the time required for electrolysis under conditions of constant current (constant-current coulometry). Both approaches work because of the following relationship:

$$q = \int i \, dt \quad (6)$$

where: i = current in amperes
t = time

Coulometry is free of temperature dependencies. The technique, inherently very accurate, can be nonspecific. Judicious choice of filters, membranes, and electrolytes can be used to improve specificity. Coulometric analyzers are numbered 3.1 through 3.22 in the "Instrument Descriptions" section. The vast majority of these instruments are configured as oxygen or oxygen deficiency monitors, although coulometric analyzers are also available for carbon monoxide, chlorine, hydrogen cyanide, hydrogen sulfide, oxides of nitrogen, ozone, and sulfur dioxide. Coulometric detectors can be personal or area monitors, and pumped or diffusive samplers.

Ionization (4.1–4.15)

There are three types of ionization detectors: flame ionization (FID); photoionization (PID); and electron

capture (ECD). All rely on the ability of their respective energy source (flame, lamp, or radioactivity) to ionize the species of interest.

Flame Ionization

In an FID, a gaseous sample is pyrolyzed in a hydrogen/air flame.[3] Pyrolysis produces ions and electrons that are carried through the plasma to an electrode gap, decreasing the gap resistance and allowing current to flow in the external circuit. Reactions in flame ionization include:

$$CH_3COCH_3 \rightarrow CH_3 + CH_3CO \text{ (cracking)}$$
$$H + C_3H_8 \rightarrow C_3H_7 + H_2 \text{ (stripping)}$$

There can be matrix reactions that give energetic intermediates exampled by:

$$H + HO_2 \rightarrow OH^* + O_2$$

and it is possible to ionize one species using excited components from the matrix as in:

$$CH_2 + OH^* \rightarrow CH_2OH^+ + e^-$$

Figure 18-1 shows a schematic of a typical flame ionization detector. The FID has a wide linear range, on the order of 10^6 to 10^7, and is a very sensitive detector able to detect on the order of nanogram quantities of organic compounds. As a result, this detector is excellent in trace analysis. Flame ionization is a nonspecific detection mechanism ideal for the detection of most organic compounds. The detector does not respond to, or responds very little to, common constituents of air, including water vapor. The user should be aware that electronegative compounds such as chlorine and sulfur (in the vapor phase) will depress the response.

Flame ionization detectors work well as portable survey instruments. Because the technique involves a flame, this must be considered when assessing the atmosphere wherein flame ionization would be used.

Photoionization

Photoionization is a flameless ionization technique wherein the contaminant gas or vapor is carried into an ionization chamber where an ultraviolet lamp of known constant voltage causes the ionization of any species having an ionization potential less than the energy emitted by the lamp.[4] That is, photoionization occurs when a molecule absorbs a photon of sufficient energy to cause the molecule to lose an electron and become a positively charged ion:

$$RH + h\nu \rightarrow RH^+ + e^- \quad (7)$$

where: RH = molecule to be ionized
h = photon whose energy is greater than the ionization potential of RH
RH^+ = ionized molecule
e^- = electron lost in the process

The PID will have a high voltage positive bias electrode to repel the positively charged molecules accelerating them toward a negatively charged collector electrode. This, in turn, generates a signal at the collector which is proportional to the amount of ionized species. Figure 18-2 shows a schematic of a photoionization detector.

Photoionization is a nondestructive technique and somewhat selective through judicious selection of ultraviolet lamps of varying energies. Lamp energies are typically on the order of 10–11 eV, but others are available. PIDs are useful for detection of some permanent gases such as methane and ethane, but most light permanent gases (hydrogen, helium, nitrogen) have ionization energies higher than 10.6 eV and do not give a response. It is necessary to consider if water will interfere. PIDs have traditionally been area/survey instruments, but personal PIDs are now commercially available. While primarily

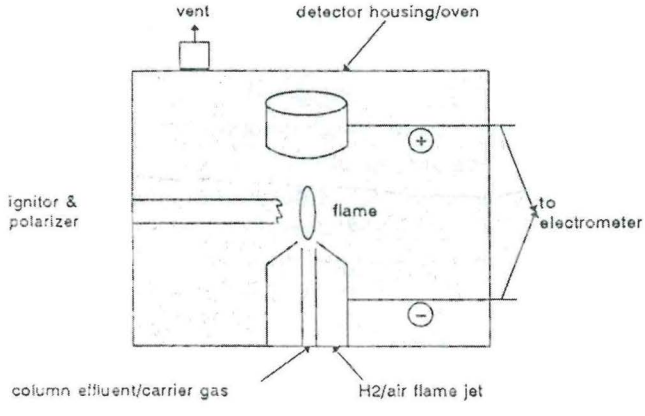

FIGURE 18-1. Schematic of Flame Ionization Detector.

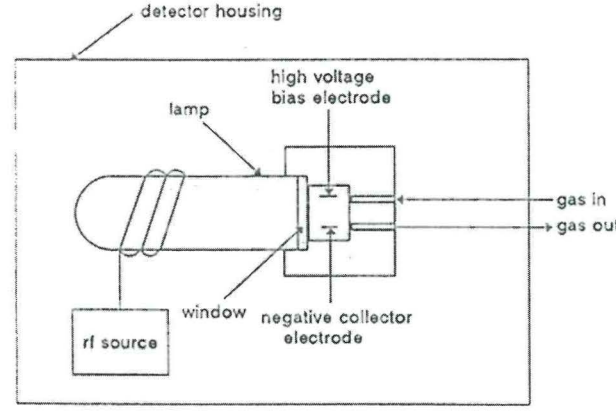

FIGURE 18-2. Schematic of a Photoionization Detector.

used for the detection of organic compounds, the PID has some utility for inorganic compounds such as nitric and sulfuric acids, hydrogen sulfide, arsine, and phosphine. Under optimum conditions, a PID can detect 5 pg of benzene and has a linear dynamic range on the order of 10^7.

Electron Capture

An ECD uses a radioactive source to generate the ions that are measured by this technique.[3] The radioactive source is usually H^3, Ni^{63}, or Kr^{85}. As the carrier gas, nitrogen, flows past the ion source, the nitrogen is ionized and slow electrons are formed that migrate to the anode, producing a steady current. Some molecules, said to have high electron affinity, have the ability to capture rapidly moving, free electrons from the radioactive source. When the molecules capture the electrons, they become stable, negative ions. This may happen by one of two mechanisms:

$$AB+e^- \rightarrow (AB)^- + energy \quad AB+e^- \rightarrow A^- + B \pm energy \tag{8}$$

where A and B = reactants

Figure 18-3 shows a schematic of an ECD. When samples with high electron affinity components are introduced into the chamber, the current flow, established through the ionization of the nitrogen, is reduced. Because the current reduction is a function of both the amount of sample present and its electron affinity, a calibration must be made separately for each sample component that is to be quantified.

An ECD is very selective, particularly for halogenated compounds, nitrates, conjugated carbonyls, and some organometallic compounds. It is useful for SF_6 and pesticide identification. This detector is very sensitive (as low as 0.1 pg) for the compounds it will detect, but its linear range is very low, about 10^2–10^3.

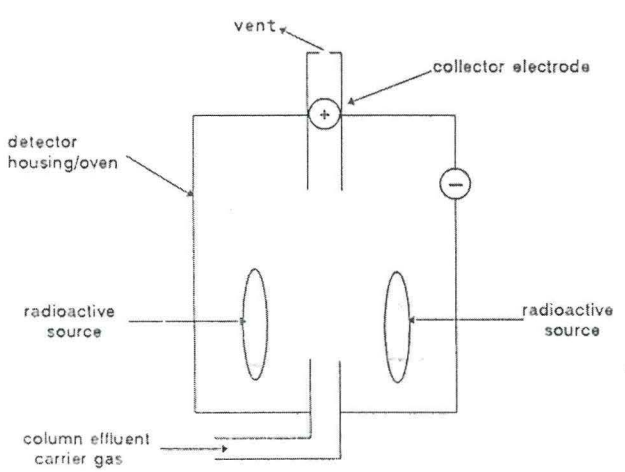

FIGURE 18-3. Schematic of an Electron Capture Detector.

Ionization detectors are numbers 4.1 through 4.15 in the "Instrument Descriptions" section. All three detectors are available in stand-alone instruments, as well as detectors for gas chromatographic systems, which will be discussed later in this chapter.

Spectrochemical Instruments

Instruments whose principle of detection is spectrochemical in nature include infrared analyzers, ultraviolet and visible light photometers, chemiluminescent detectors, and photometric analyzers.[5] Photometric analyzers include fluorescent and spectral intensity detectors. In general, spectrochemical analysis involves the use of a spectrum or some aspect of a spectrum to determine chemical species. A spectrum is a display of intensity of radiation that is emitted, absorbed, or scattered by a sample, versus wavelength. This radiation is related to photon energy via wavelength or frequency.

Infrared (5.1–5.16)

Infrared spectrometry (IR) involves the interaction of the infrared portion of the electromagnetic spectrum with matter. Specifically, that portion of the spectrum ranging in wavelength from 770 nm to 1000 μm, or 12,900 cm^{-1} to 10 cm^{-1} in wave number. The infrared portion of the spectrum is subdivided into three regions: the near-infrared (770 nm to 2.5 μm), the mid-infrared (2.5 to 50 μm), and the far-infrared (50 to 1000 μm). The terms "near," "mid," and "far" refer to proximity to the visible portion of the electromagnetic spectrum. Infrared radiation is not energetic enough to cause electronic transitions in molecules, but it does result in vibrational and rotational transitions. Nearly all molecules absorb infrared radiation, making the technique widely applicable. Because the IR spectrum of a given molecule is unique to that molecule, IR can be fairly specific and useful in compound identification. However, the possibility of overlapping peaks makes the use of any single wavelength IR measurement of an uncharacterized mixture risky.

Figure 18-4 shows a schematic of an infrared analyzer. These instruments consist primarily of six major sections: a source of infrared radiation; a wavelength selector; a sample cell; appropriate optics; a detector; and a signal processor/readout. Although Figure 18-4 shows the monochromator after the sample cell, wavelength selection can occur before the sample cell, after

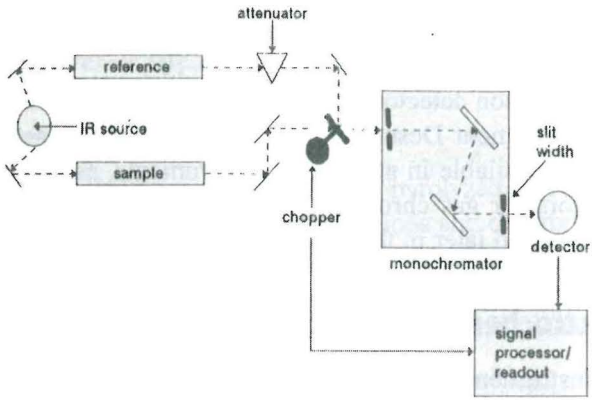

FIGURE 18-4. Schematic of Double Beam Infrared Analyzer.

the sample cell, or both. Infrared spectrometry may be either a nondispersive or a dispersive technique. A nondispersive IR is a filter photometer employing interference filters designed for the determination of a specific pollutant, whereas a dispersive IR uses prisms, gratings or interferometers to separate radiation into its component wavelengths to obtain a complete spectrum for qualitative identification.

Because it is an absorption technique, infrared spectrometry is governed by Beer's Law:

$$A = \varepsilon bc \tag{9}$$

where: A = absorbance
ε = molar absorptivity
b = path length
c = concentration

This equation shows the relationships between the amount of energy absorbed and the length of the path through the sample, and between the absorbed energy and the concentration of the species of interest. The dependency of absorbance on path length is significant in discussing parameters of interest because the longer the path length of the instrument, the more sensitive the instrument should be. In introducing Beer's Law, it is significant to note that the absorbance, A, is log P_o/P, where P_o is the original incident radiation, and P is the energy remaining after some is absorbed by the sample. The linear range of IR is limited at any set path length.

An additional instrument parameter of interest is the slit width. The slit width defines the window of energy seen either by the sample or by the detector. Figure 18-4 shows the slit width at the detector end of the instrument. The width of this slit is inversely proportional to selectivity and peak resolution.

The direct-reading infrared instruments are given in the "Instrument Descriptions" section as numbers 5.1 through 5.16. Primarily area monitors, the instruments balance modest precision with selectivity and high throughput. Some instruments are designed as fixed wavelength monitors whereas others are capable of scanning the infrared spectrum. Some of these instruments are designed as general detectors for organics and subgroups such as hydrocarbons; others are more specific monitors for compounds such as methane, ethylene, ethane, propane, butane, vehicle emissions, carbon monoxide, carbon dioxide, and several freons. The user needs to be aware that certain ubiquitous compounds, like water, absorb very strongly in the infrared, and care must be exercised to avoid making measurements at or near these absorbances.

Ultraviolet and Visible Light Photometers (6.1–6.10)

Both ultraviolet (UV) and visible (VIS) light photometers operate on the principle of absorption of electromagnetic radiation. The UV is that portion of the electromagnetic spectrum having wavelengths from 10 to 350 nm. The actual spectral range for direct-reading UV instruments is closer to 180B350 nm, which is termed the "near UV," in deference to its proximity to the visible spectrum. The corresponding energy range for the UV is 3.6–7 eV for the near UV and 7–124 eV for the far, or vacuum, UV. The visible spectrum has longer wavelengths than the UV (350–770 nm) and correspondingly lower energies (1.6–3.6 eV). Like their infrared counterparts, the operational principle (energy absorption) of the UV-VIS instruments is governed by Beer's Law, and the techniques have the same relationships between absorption and concentration and between absorption and path length. Although the relationship between absorbance and concentration is linear, the value typically measured in spectrophotometry is transmittance, T, whose relationship with absorbance is given by:

$$A = 2 - \log \%T \tag{10}$$

Transmittance is the ratio of the amount of energy passing through the sample (not absorbed) to the amount of incident energy.

Figure 18-5 shows a schematic of a typical UV-VIS photometer. The instruments operating on the principle of energy absorption in the UV-VIS region are given in the "Instrument Descriptions" section as numbers 6.1 through 6.10. Most of these instruments are designed to analyze gaseous samples such as ammonia, mercury vapor (which absorbs very strongly at 253.7 nm), oxides of nitrogen, ozone, and sulfur dioxide.

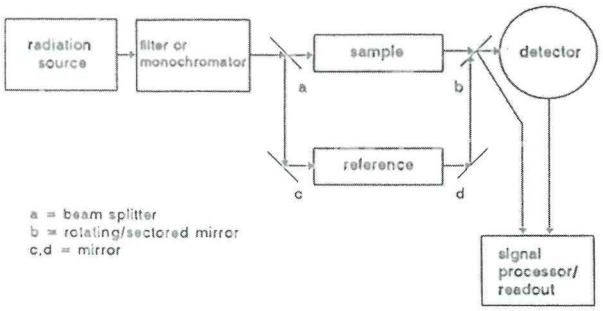

FIGURE 18-5. Schematic of a UV-VIS Spectrophotometer.

A special case of visible spectroscopy is colorimetry, wherein the sample is mixed with a reagent selected to react with the contaminant of interest, forming a colored product. The ability of this colored, liquid product to absorb light in the visible region is exploited. This type of instrument, governed by the same chemical principles, can be used as a continuous monitor for a variety of compounds. The UV-VIS instruments, primarily area monitors, are capable of detecting contaminants in the ppm range.

Chemiluminescence (7.1–7.6)

Chemiluminescence is a form of emission spectroscopy wherein spectral information is obtained from nonradiational activation processes.[6] In this case, the emitted energy results from species that are excited by chemical reactions and are returning to the lower energy state by emission of a photon. Chemiluminescence is based on the fact that in some chemical reactions, a significant fraction of the intermediates or products are produced in excited electronic states. The emission of photons from these excited electronic states is measured and, if the reaction conditions are arranged appropriately, is proportional to the concentration of the contaminant of interest. Two common chemiluminescence mechanisms are:

$$\begin{array}{lll} A+B \rightarrow I+I^* & & A+B \rightarrow P+P^* \\ \downarrow & + & \downarrow \\ I+h\nu \rightarrow P & & P \rightarrow h\nu \end{array} \qquad (11)$$

where: A and B = reactants
I = intermediate
P = product
$*$ = excited state
$h\nu$ = emitted energy

Three conditions must be met in order to have chemiluminescence take place. First, there needs to be enough energy to produce the excited state; second, there must be a favorable reaction pathway to produce the excited state; and, third, photon emission must be a favorable deactivation process.

The direct-reading chemiluminescent detectors are numbered 7.1 through 7.6 in the "Instrument Descriptions" section. They analyze gas phase samples and have been developed primarily for oxides of nitrogen and ozone. Because of the chemical reactions involved, the instruments have a high degree of specificity and have typical limits of detection on the order of 10 ppb.

Photometric Analyzers

This category includes fluorescence analyzers, flame photometric detectors, spectral intensity analyzers, and photometers, primarily reflectance. The first three techniques are all examples of emission spectroscopy wherein the excitation process is radiative in nature; the last category includes automated media advance samplers, branched sequential samplers, and paper tape stain development, all of which utilize photometric analysis.

Fluorescence (8.2, 8.3, 8.5)

Fluorescence is the emission of photons from molecules in excited states when the excited states are the result of the absorption of energy from some source of radiation. For most molecules, electrons are paired in the lowest energy or ground state. If a molecule absorbs energy from a sufficiently powerful radiation source, such as a mercury or xenon arc lamp, the molecule will become "excited," moving an electron to a higher energy state. When the electron returns to the lower, more stable energy condition, it releases the absorbed energy in photons. A significant characteristic of fluorescence is that the emitted radiation is of a longer wavelength (lower energy) than the exciting radiation. Figure 18-6 shows a block diagram of the components of a fluorescence instrument. An excitation wavelength selector is used to limit the energy to that which will cause fluorescence of the sample while excluding energy wavelengths that may interfere with the detection. The emission wavelength selector isolates the fluorescence peak. Detection is at right angles to allow measurement of the longer wavelength light emitted from the sample while avoiding detection of light from the source, which could cause large errors in measurement. A narrow band of excitation and emission wavelengths can make the instrument very selective and often specific.

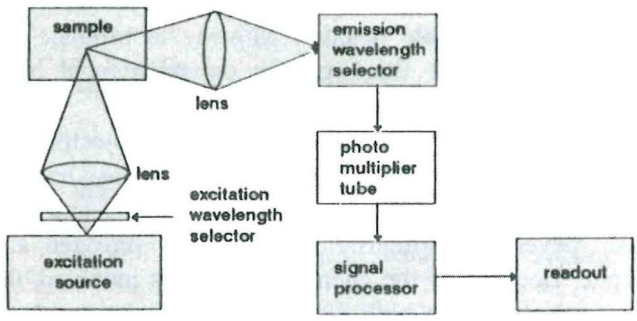

FIGURE 18-6. Schematic of a Fluorescence Spectrometer.

Fluorescence instruments are available for carbon monoxide and sulfur dioxide. They are numbers 8.2, 8.3, and 8.5 in the "Instrument Descriptions" section. Typical limits of detection are in the 5–10 ppb range.

Flame Photometric (8.4, 8.6, 8.14)

Flame photometric detectors can be adjusted to obtain selectivity for nanogram quantities of sulfur or phosphorous compounds. The detector works by measuring the emission of light from a hydrogen flame. Light from the flame impinges upon a mirror and is reflected to an optical filter that allows only light of either 526 μm (for phosphorous) or 394 μm (for sulfur) to pass through to the photomultiplier tube. Calibration with a flame photometric detector is critical because this detector exhibits little or no linearity. From the "Instrument Descriptions" section, numbers 8.4, 8.6, and 8.14 are flame photometric detectors. They have limits of detection in the low ppb range.

Spectral Intensity (8.8, 8.13)

Spectral intensity analyzers measure the radiant power of emission from an analyte due to nonradiational excitation. Two such instruments are available (numbers 8.8 and 8.13 in the "Instrument Descriptions" section). Both instruments are used for halide detection by measuring the increased spectral intensity of an AC arc (or spark) in the presence of halogenated hydrocarbons. The increased intensity can be related to the concentration of the halogenated compound by using a calibration curve based on the specific compound of interest, as each response curve for each halogenated compound will be different. These instruments have limits of detection in the tens of ppm range and have limited selectivity, i.e., they can differentiate halogenated compounds from nonhalogenated compounds, but cannot differentiate between halogenated compounds.

Photometers [Other](8.1, 8.7, 8.9, 8.12)

The remaining instruments in this category are simply referred to as photometers. The instruments, numbers 8.1, 8.7, and 8.9 through 8.12 in the "Instrument Descriptions" section, have unique sampling characteristics and detection principles relative to the other instruments in this category (spectrochemical techniques), but they operate on spectrochemical principles nonetheless. The majority of these instruments allow for unattended sampling through the use of automated sampling media advance (i.e., tape samplers, rotating drum samplers, rotating disc samplers, and turntable samplers measuring reflectance) or branched sequential sampling trains. These samplers typically involve a color change of the sampling medium and the analytic finish is measurement of the light reflected from the sampling medium. These instruments are useful for such toxic species as toluene diisocyanate, ammonia, phosgene, arsine, and hydrogen cyanide. The reflectance instruments can be quite specific through judicious selection of the chemistry for the sampler, and the ability to change the chemistry makes these instruments potentially useful for a wide variety of compounds.

Other instruments in this category include one designed for the determination of CO. This instrument actually measures mercury that is generated via reduction of solid-state mercury oxide. The amount of mercury generated is equal to the quantity of carbon monoxide oxidized in the sample. The mercury is measured using a UV filter photometer. The other three instruments rely on the development of a color stain, wherein the intensity change or the development of the intensity change is measured via a photoelectric cell. These last three instruments are useful primarily for hydrogen sulfide, although one will determine other analytes as a function of the chemically impregnated paper used for color development. All the photometers have limits of detection in the low ppm range and are very specific for the contaminant(s) of interest.

Thermochemical Instruments

Gases and vapors have certain thermal properties that can be exploited in their analysis.[7] Of the instruments available for industrial hygiene applications, one of two thermal properties, conductivity or heat of combustion, is measured.

Thermal Conductivity (9.1, 9.3)

Thermal conductivity detectors are relatively simple devices that operate on the principle that a hot body will

lose heat at a rate that depends on the composition of the surrounding gas. That is, the ability of the surrounding gas to conduct heat away from the hot body can be used as a measure of the composition of the gas. In actual practice, a thermal conductivity detector consists of an electrically heated element, or sensing device, whose temperature at constant electrical power depends on the thermal conductivity of the surrounding gas. The resistance of the sensing device is used as a measure of its temperature. Thermal conductivity detectors are universal detectors, responding to all compounds. They have large linear dynamic ranges, on the order of 10^5, and limits of detection on the order of 10^{-8} gram of solute per mL of carrier gas (10–100 ppm for most analytes). Thermal conductivity detectors require good temperature and flow control. They are numbered 9.1 through 9.3 in the "Instrument Descriptions" section.

Heat of Combustion (10.1–10.35)

Heat of combustion detectors, comprising the largest single class of direct-reading instruments for analyzing airborne gases and vapors, measure the heat released during combustion or reaction of the contaminant gas of interest. The released heat is a particular characteristic of combustible gases and may be used for quantitative detection. There are two main mechanisms for the operation of heat of combustion detectors. The first relies on heated filaments. Upon introduction of the contaminated air into the sample cell, the contaminant comes into contact with a heated source, igniting the contaminant. The resulting heat changes the resistance of the filament. The measured change in filament resistance is related to the gas concentration through the use of calibration standards.

The second mechanism used in heat of combustion instruments employs the use of catalysts via catalytically heated filaments or oxidation catalysts. This second mechanism may use one of two methods of detection: a measured resistance change, or temperature changes measured via thermocouples or thermistors.

Like thermal conductivity detectors, heat of combustion detectors are nonspecific, universal detectors. Some specificity can be introduced by manipulation of the temperature; that is, the combustion temperature may be controlled so that it is insufficient to combust interfering gases. From the second mechanism, some specificity may be introduced by careful selection of the oxidation catalyst.

As the category name implies, heat of combustion detectors are available as generic detectors for combustible gases. Some more specific heat of combustion detectors are available for carbon monoxide, ethylene oxide, hydrogen sulfide, methane, and oxygen deficiency. Most of these monitors read out in terms of percent of the lower explosive limit (LEL) or hundreds of ppm and the limits of detection are a function of the analyte of interest. These instruments are numbered 10.1 through 10.35 in the "Instrument Descriptions" section.

Gas Chromatographs (11.1–11.7)

In terms of detection of airborne gases and vapors, the detectors used in gas chromatographic analyzers have, for the most part, been discussed earlier in this chapter.[3,4] The most frequently used detectors in GCs designed for industrial hygiene applications are the FID and the PID. The reason gas chromatographs are being discussed separately is fourfold: there are several direct-reading gas chromatographs commercially available; they represent a distinct family of instruments in that they very specifically address the issue of separation (specificity), as well as detection, in industrial hygiene monitoring; they represent one area where a great deal of research and development is ongoing; and they most closely approximate the transfer of laboratory analytical techniques into the field.

Figure 18-7 shows a schematic of a GC. The sample is either injected into the GC using a gas-tight syringe or the instrument may be capable of obtaining its own sample via a built-in sampling pump. If the sample is a liquid, the instrument must be capable of vaporizing the sample (e.g., using a heated injection port).

The actual separation of the sample into its component parts takes place on the GC column.[8] Columns are typically long tubes made of metal, glass, Teflon®, or fused silica. Columns in portable, direct-reading GCs are of two kinds: packed and wall-coated. A packed column contains a granular material used as a solid support which is coated with a chemical chosen for its ability to interact with the components of the sample. This chosen chemical is referred to as the stationary phase. Packed columns are generally from 4 or 5 cm to 1 meter or more in length and have external diameters on the order of

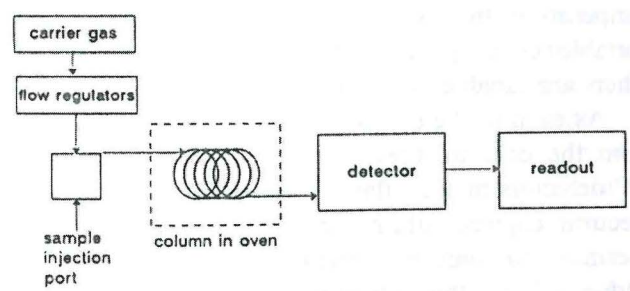

FIGURE 18-7. Schematic of a Gas Chromatograph.

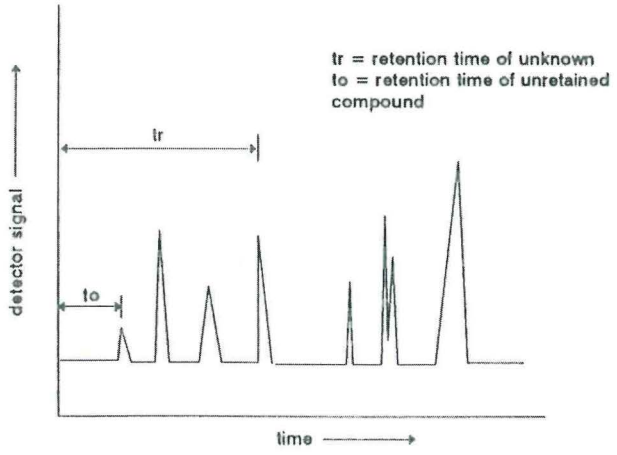

FIGURE 18-8. Schematic of a Typical Gas Chromatogram.

0.3 cm (1/8 in). A wall-coated column tends to be longer (5 cm to 3 m or more) and narrower (i.d. from 0.1 to 1 mm) than packed columns. In a wall-coated column, there is no granular solid support for the stationary phase. It is, as the name implies, coated directly on the inner walls of the column. The long, thinner columns (i.d.'s < 0.5 mm) are sometimes referred to as capillary columns.

The sample is carried through the column by an inert (relative to the sample) carrier gas, which, depending on the direct-reading GC, may be helium, hydrogen, nitrogen, argon, carbon dioxide, or air. The separation is governed by the degree of interaction of the sample with the stationary phase and the properties of the carrier gas. All components of a mixture spend the same amount of time in the carrier gas, so their different elution times is a function of the time partitioning between the stationary phase and the gas phase. The elapsed time from injection until the detector sees a component of a mixture is that component's retention time. The retention time is a function of the physical properties of a component in a sample, whereas the size of the peak is a function of the amount. Figure 18-8 shows the component parts of a typical chromatogram.

The degree of separation of two components, as well as their relative retention times, depends, in part, on the temperature at which the system operates; the higher the temperature the shorter the retention times. Some portable GCs operate only at ambient temperatures; others are capable of heating the column.

As each of the component parts of a mixture elutes from the column, they go into the detector. Portable GC detectors include flame ionization, photoionization, electron capture, ultraviolet, flame photometric, and thermal conductivity (which have already been addressed in this chapter), as well as nitrogen-phosphorous and argon ionization.

Because of their separation capabilities, GCs offer excellent selectivity combined with low limits of detection. The limits of detection are primarily a property of the individual detectors and are given in the detector discussions, but portable GCs generally have limits of detection at sub-ppm levels. Some limitations associated with portable GCs include the need for more user knowledge of the technique, the size, and cost. The portable GCs are numbers 11.1 through 11.7 in the "Instrument Descriptions" section.

Mass Spectrometers (12.1–12.2)

As the name implies, mass spectrometers determine mass of molecular fragments. Specifically, a mass spectrometer will determine the masses of individual fragments that have been converted into ions. A mass spectrometer determines mass by measuring the mass-to-charge ratio of ions formed from the molecule(s). After the ions are formed, they are separated in the mass analyzer according to their mass-to-charge ratio and collected by a detector wherein the ion flux is converted into an electrical signal proportional to the ion flux. [9] The components of a typical mass spectrometer are shown schematically in Figure 18.8.

Separation by, for example, gas chromatography of the components in a mixture prior to mass spectral analysis provides for unambiguous identification of mixture components. Mass spectrometry is the only technique currently available that will provide for such identification of compounds in the field.

Mass spectrometers are currently used only for area samples because of their size and power requirements and are primarily used for volatile organic compounds.

Summary

Many instruments are available for direct-reading analysis of gases and vapors. They operate on a variety of principles of detection and vary in performance characteristics such as linear range, specificity, and limits of detection. Direct-reading instruments represent a powerful tool in developing sampling strategies. That is, direct-reading instruments, when correctly used, can determine, in real or near-real time, those areas of high concentration, those workers at highest risk, and those processes with the highest emissions. Such information is useful in solving a variety of gas and vapor exposure problems. This information can guide the hygienist or safety professional in obtaining other more informative and useful samples requiring laboratory analyses. Used properly, direct-reading instruments can conserve resources, eliminating samples with results of "none detected."

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Instrument Descriptions

This section contains tables and short descriptions of the commercially available direct-reading instruments for gases and vapors. Not all instruments from each manufacturer are listed. Rather, representative instruments are included. The tables are designed to provide an overview of the instrument features, sizes, and capabilities, whereas the descriptions give more detailed information and photographs. Each description is numbered and is cross-referenced in the tables that appear at the end of the chapter. The descriptions are grouped by the operating principle upon which the measurement is based. The following instrument tables are included:

Table 18-I-1. Electrical Conductivity Analyzers
Table 18-I-2. Potentiometric Analyzers
Table 18-I-3. Coulometric Analyzers
Table 18-I-4. Ionization Detectors
Table 18-I-5. Infrared Photometers
Table 18-I-6. Ultraviolet and Visible Light Photometers
Table 18-I-7. Chemiluminescent Detectors
Table 18-I-8. Photometric Analyzers
Table 18-I-9. Thermal Conductivity Detectors
Table 18-I-10. Heat of Combustion Detectors
Table 18-I-11. Gas Chromatograph Analyzers
Table 18-I-12. Multi-Gas Monitors
Table 18-I-13. Portable Mass Spectrometers

These tables reference instrument manufacturers by code letters; complete names and addresses are given in Table 18-I-14.

18-1. Electrical Conductivity Analyzers

18-1-1. Jerome 431-X Mercury Vapor Analyzer

Arizona Instrument Corporation

The Model 431-X Mercury Vapor Analyzer is a portable instrument designed for mercury surveys in workplace environments. The Model 431-X uses a patented Gold Film microsensor as the basis of detection. The sensor absorbs and integrates the mercury present in the sample, registering this as a proportional change in electrical resistance. The sensor's selectivity to mercury eliminates many interferences common to atomic absorption, such as water vapor, SO_2, aromatic hydrocarbons, and particulates. The Model 431-X incorporates an internal pump and digital display with microprocessor control. Activating either the 10-second sample or the 1-second survey mode starts the pump that draws a precise volume of air over the Gold Film sensor. Mercury in the sample is adsorbed and integrated by the sensor. The microprocessor computes the concentration of mercury in mg/m^3 and displays the results on the digital meter until the next sample cycle is activated. Response time: sample mode, 13 seconds; survey mode, 4 seconds. Meter: LCD display. Construction: aluminum alloy. Flow rate: 0.75 L/min. Can be attached to a datalogger or PC for automatic sampling.

18-1-2. Jerome 631-X Hydrogen Sulfide Analyzer

Arizona Instrument Corp.

The new Jerome 631-X Hydrogen Sulfide Analyzer utilizes the same gold film technology in its proven mercury monitor to detect H_2S in the range of 0.001 to 50 ppm with the push of one button. The instrument works the same as for mercury where the H_2S is adsorbed onto the gold film. Potential interferences from SO_2, water vapor, CO, and CO_2 are eliminated. In the survey mode, response times are as quick as 3 s. The instrument can be connected to a PC for unattended operation. The unit is designed for use in leak detection, odor and corrosion control, and safety in industries such as wastewater treatment, oil and gas, and pulp and paper.

18-1-3. UltraGas-U3S Sulfur Dioxide Analyzers

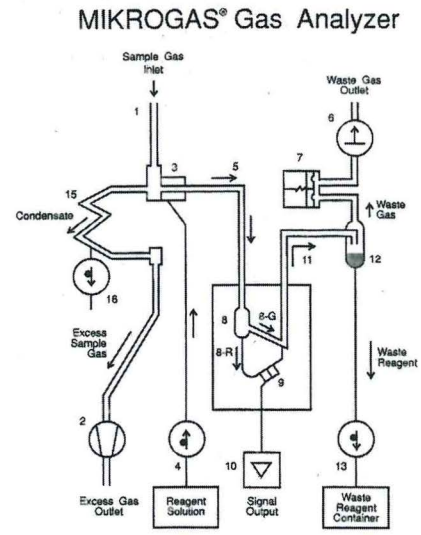
Calibrated Instruments, Inc.

The UltraGas-U3S is a sampling and analysis device for measuring the concentration of SO_2 in air by the conductivity method. Existing interference components can be eliminated in most cases through suitable absorption traps so that measurement is selective. In the instrument, a constant and continuous stream of air and reagent mix in a reaction chamber. The conductivity of the solution changes in proportion to the concentration of SO_2. The conductivity change is determined in the detector by two electrode sections. The conductivity of the reagent is measured first in one section, and after reaction with SO_2, the conductivity is measured in the second section. The difference in the two alternating currents flowing through the two electrode sections is selected electronically by the recorder. A temperature-dependent resistance compensates for temperature changes.

18-1-4. Mikrogas® Series Gas Analyzers

Calibrated Instruments, Inc.

Mikrogas® instruments continuously measure concentrations of SO_2, HCl, H_2S, NH_3, Cl_2, $COCl_2$, COS, CS_2, HCN, and other gases in ambient air, industrial process streams, standing tanks, waste treatment facilities, and stack and incineration emissions using the conductimetric measuring principle. Extremely accurate and precise streams of sample gas and a liquid reagent of measured conductivity are volumetrically forwarded to a wet sampling head where they are combined. Thoroughly mixed in a reaction line, the sample gas and chemically changed reagent are then again separated. The reacted conductivity level of the reagent solution is then monitored as it passes a temperature-compensated continuous measuring electrode. An electronic circuit determines the change in conductivity of the reagent solution. This change in conductivity is proportional to the concentration of gas being sampled. Operating temperature: 2 to 40°C.



INSTRUMENT 18-1-4. Mikrogas® Series Analyzers.

18-1-5. Ultragas® Series Gas Analyzers

Calibrated Instruments, Inc.

Utilizing the principle of conductivity measurement, Ultragas® instruments provide continuous or batch analysis for laboratory and closed chamber research, and environmental, industrial process, ambient air, and stack applications involving one or more of the following gases: CO, CO_2, CH_4, NH_3, H_2S, SO_2, HCl, $COCl_2$, COS, CS_2, HCN, and other hydrocarbons. High precision pumps continuously forward a liquid reagent and sample gas stream to a temperature-compensated reaction line where both are combined in a constant volumetric ratio and thoroughly mixed. The conductivity of the reagent changes in proportion to the concentration of the gas being sampled and is measured by an electrode. Operating temperature: 2 to 35°C.

18-2. Potentiometric Analyzers (see 18-12, Multi-Gas Monitors)

18-2-1. Canary® Single Gas Monitor

Bacharach, Inc.

The Canary is a compact, personal monitor which can be fitted to monitor for 10 different gases (O_2, CH_4, H_2S, CO, SO_2, Cl_2, NO_2, HCl, HCN, and NH_3). The range of applications is vast, including steel manufacturing, pulp and paper mills, oil and gas refineries, waste

and wastewater treatment, chemical plants, and offshore drilling. The unit weighs only 10 oz and includes visual and audible alarms, direct LED readout of gas concentration, a confidence light, single-button operation. Easy zeroing, calibration and sensor replacement. Powered by 4 AA alkaline or Ni-Cd batteries. Operating temperature: –10° to 50° C.

18-2-2. CO Sniffer® Multi-Purpose Detector

Bacharach, Inc.

Hand-held monitor continuously measures CO between 0 and 2000 ppm in less than one minute. Applications are for CO surveys and for breath analysis (with special module). Concentration is displayed via a highly visible LCD with backlight. The unit has an internal pump, a rugged design with case to match, weighs only 21 oz, and is operated by 4 C-size alkaline batteries.

18-2-3. Toxi Series of Single Gas Detectors

Biosystems, Inc.

The Toxi Series of gas detectors are small, rugged personal monitors for the detection of oxygen and toxic gases in applications where low cost, ease of use, and durability are prime considerations. Sensors are available for O_2, CO, H_2S, SO_2, Cl_2, NH_3, NO, NO_2, or the new dual-purpose "CO Plus" sensor for the simultaneous detection of both CO and H_2S. The Toxi units feature a microprocessor controller which allows choice of alarms (including optional vibrator alarm) for ceiling values, STELs, or TWAs; true one-button operation; choice of batteries; automatic calibration adjustment, and a variety of accessories. The unit also allows the downloading of data to a PC. All Toxi monitors are shipped complete with sensor, calibration adapter, belt clip, a lanyard, and an alligator clip. Toxi monitors are intrinsically safe for use in hazardous locations Class I, Groups A, B, C, and D.

18-2-4. TOXYCLIP AND TOXYCLIP2 Personal Gas Alarm

BW Technologies

The TOXYCLIP and now the TOXYCLIP2 offer a miniature personal gas alarm for carbon monoxide, oxygen and hydrogen sulfide. The TOXYCLIP2 offers 2 years of protection without any need for factory renewal (CO and H_2S). The units feature easy one-button operation, life remaining of sensor, self-test of batteries and sensor, LCD readout, two levels of visual and loud audible alarms, and impact-resistant case with RF shielding. Weighing just 2 ounces, the TOXYCLIP2 is one of smallest personal alarms available. Also available is the TOXYCLIP Test Station for easy calibration.

18-2-5. MINIMAX Personal Gas Monitor

BW Technologies

The MINIMAX offers a wide variety of options in a personal gas monitor. The Plug-in sensors are available for CO, H_2S, SO_2, Cl_2, HCN and NO. The unit features five year battery life, automatic self-test, auto zero calibration, intelligent alpha-numeric display, two user selectable alarm levels for TWA and instantaneous high level, hi-output visual and audible alarms, microprocessor controller, fast response time (3–9 s), and rugged and is light weight (5.8 ounces). Each time the unit is turned on, it will automatically execute a self-test and advise the current alarm setpoints. Calibration requires only one step and the zero is set automatically.

18-2-6. Gasman and Gas Baron Personal Gas Detectors

CEA Instruments, Inc.

The Gasman is a series of single gas, shirt-pocket-sized personal gas monitors for toxic gases, combustible gases, or O_2. All models have a large, front-mounted digital display with built-in back light. Visual and audible alarms are available for toxic gases to provide instantaneous and TWA warnings. The monitors are rugged and water resistant. They are radio frequency (RF) shielded and are powered by four AA or rechargeable batteries. Models are available for O_2, H_2S, CO, SO_2, Cl_2, NO_2, NO, HCl, HCN, NH_3, and combustibles. The Gas Baron is a palm-sized personal monitor for O_2, H_2S, CO, Cl_2, ClO_2, and HCN. It features field replaceable sensors, 6–12 month battery life, vibrating alarm, test button, UL and CSA intrinsic approvals.

18-2-7. Series U Toxic Gas Detectors

CEA Instruments, Inc.

The Series U instruments are dedicated gas detectors in portable, wall-mounted, or multipoint configurations for a variety of contaminants. All instruments in this series use electrochemical-type or catalytic sensors and are available for H_2S, CO, SO_2, NH_3, hydrocarbons, H_2, combustibles, freons, EtO, alcohols, and diesel/gasoline vapors. The diffusion-type sensors are guaranteed for 2 years, provide rapid response, are solid-state, and are UL approved. Other features include low battery warning lights; built-in battery charger; high poison resistance to sulfur, lead, silicon, and halogenated compounds; and rugged, compact, leather carrying case. Operating temperature: –20 to +65°C.

18-2-8. TG-KA Series Portable Toxic Gas Analyzers

CEA Instruments, Inc.

The TG-KA Series Analyzers are available for formaldehyde, phosgene, ozone, hydrogen fluoride, and hydrides. The portable units can be used with AC/DC operation for continuous monitoring. Other features include a rechargeable battery for 30 hrs of operation, remote refillable sensor for spot checking, digital read-out, recorder output, user adjustable audible and visual alarms, light weight (10 oz).

18-2-9. Gasman II Personal Gas Monitor

Crowcon Detection Instruments

The Gasman II is a lightweight personal monitor housed in a rugged orange NEMA 4X rated housing. The unit has a large LCD display with a back lighting button, audible and visual alarms, up to 4 month operation from one set of AA batteries, and operates over a wide range of temperatures (–10 to 50°C) and humidity (0–95% non-condensing). Sensors are available for combustibles, CH_4, CO, H_2S, O_2, Cl_2, HCl, HCN, NH_3, O_3, SO_2, and NO. Other features include RFI shielding, intrinsically safe (UL Class I, Division I, Groups A, B, C, and D), and an operation light.

18-2-10. MONOGARD and dynaMite Personal Monitors

Dynamation, Inc.

The MONOGARD and dynaMite Series of pocket-sized instruments combine digital LCD and diffusion chemical cell sensing for CO, H_2S, O_2, SO_2, and NO. The units feature an audible, pulsating alarm and a visual flashing light when unsafe atmospheres are encountered. Each unit has a low battery alarm, test switch, and illuminated display switch for reading in dark areas. All alarm points are factory set and customer adjustable. MONOGARDs are enclosed in rugged aluminum cases with leatherette carrying cases. The dynaMite gives more than 250 hrs of continuous operation from its replaceable lithium battery. Operating temperature for the monitors ranges from 0 to 41°C or to 52°C. Response time is 90% of full reading in 30 seconds. Monitors warm up in less than 10 seconds. The expected sensor life is 1.5 years (6-month warranty).

18-2-11. SPECTRUM Series Pocket-Size Gas Detectors

ENMET Corp.

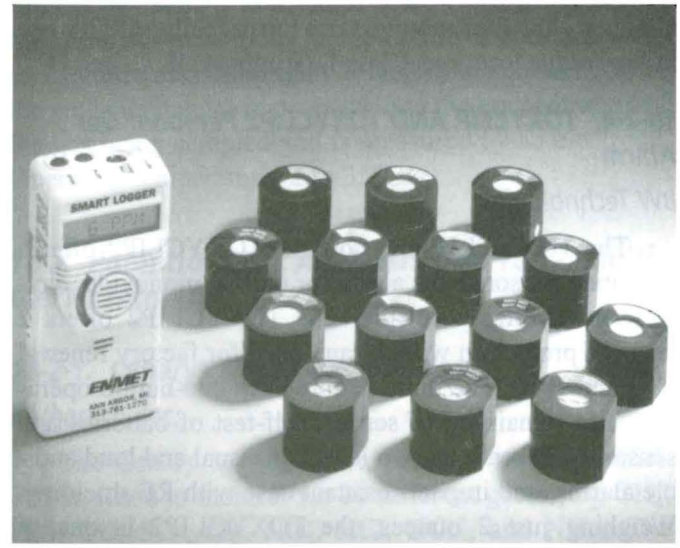
The new SPECTRUM Series are inexpensive, high performance, microprocessor-based personal gas monitors. These unique gas detectors feature simple operation, large easy-to-read continuous digital display, and a new generation of electrochemical toxic sensors in a small, durable package. Instruments are available to monitor CO, H_2S, Cl_2, HCN, SO_2, NH_3, or O_2. These instruments have been designed for use by firefighters and rescue personnel as well as for industrial applications. The instruments also feature maximum/minimum value tracking, "Intelli-Cal" calibration procedure, dual-level audio and visual alarms, password protected maintenance functions, low battery alarm and temperature display.

INSTRUMENT 18-2-11. Spectrum Series Gas Detector.

18-2-12. Smart Logger Series

ENMET Corp.

The SMART LOGGER series personal pocket-size gas detector features interchangeable, precalibrated



INSTRUMENT 18-2-12. Smart Logger Series.

SMART BLOCK sensors. This modular design enables the user to simply and easily convert one unit for the detection of many different gases. SMART BLOCK modules are available for : H_2, CO, Cl_2, HCN, H_2S, HCl, NO, NO_2, NH_3, O_3, ClO_2, ETO, and O_2. As your requirements for monitoring a specific gas change all you do is to plug in a different precalibrated SMART BLOCK module that meets your current needs. Instrument provides continuous datalogging for industrial hygiene applications. It stores up to 120 hours of exposure and event information which can be downloaded to a serial printer or an IBM-compatible personal computer. Instrument also features on-board datalogging, TWA and STEL alarms, and continuous digital readout.

18-2-13. Formaldehyde, Glutaraldehyde, and Ethylene Oxide Monitors

Environmental Sensors Co.

The ESC line of electrochemical sensors include the MVN-100A & B for ethylene oxide, the MVN-200D for glutaraldehyde, and the MVN-300 for formaldehyde. These units read ppm concentrations for these specialty gases. Applications include in hospitals, clinics, laboratories, sterilization facilities, chemical processing plants, and in the construction industry. The units are compact and lightweight, have audible and visual alarms, continuous LCD display, instant data output, long life sensors, and are easy to operate and affordable. Datalogging is optional.

18-2-14. GT and GTD Series Multi-Gas Monitors

GasTech, Inc.

The GT Series multi-gas monitor is ideal for pretesting of confined spaces in refineries, wastewater treatment plants, fire departments, off shore oil wells, fish processing, utilities, tanneries and other applications. This unit can be configured to monitor up to four gases in several different combinations for the detection of combustibles in the LEL and ppm range, oxygen content and a choice of one or two toxics. A built-in internal sampling pump will draw gas samples from up to 100 feet. The GT Series features include built-in datalogger, TWA/STEL alarms, and exclusive LIP (Liquid Inhibiting Probe). This unit is UL classified and CSA certified with a one year warranty.

INSTRUMENT 18-2-14a. GT402 Multi-Gas Monitor.

INSTRUMENT 18-2-14b. GTD Multi-Gas Monitor.

The GTD Series diffusion version of the GT multi-gas monitor is ideal for pre-testing of confined spaces and use in applications such as railcars, tanneries, refineries, off shore oil wells, and utilities areas where extreme conditions such as moisture, dust or contamination exist. This unit can be configured to monitor up to four gases in several different combinations for the detection of combustibles in the LEL and ppm range, oxygen content and a choice of one or two toxics. The GTD provides real-time response to gas by lowering the sensor module in confined space by the optional 20- to 50-ft extender cable. Features built-in datalogger, and LCD display.

18-2-15. GT-2400 Multi-Gas Monitor

GasTech, Inc.

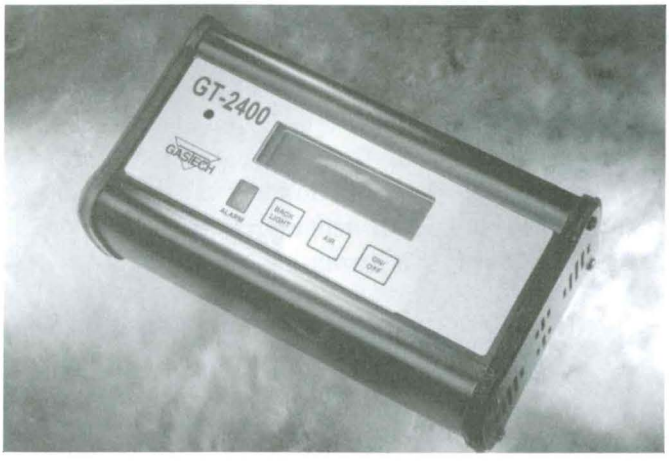
The GT-2400 **low cost multi-gas monitor** is a complete monitoring instrument for multiple applications, such as municipalities, electric and gas utilities, breweries, petrochemical, and a host of other applications. This personal portable instrument can detect up to four gases; combustible, oxygen content and a choice of one or two toxics. The standard sampling method is 'diffusion' or use the optional sample-draw pump. The GT-2400 features include visual and audible alarms, simple operation and calibration, and peak hold mode. This unit is UL classified and CSA certified with a one year warranty.

18-2-16. STM 2100 Multi-Gas Monitor

GasTech, Inc.

The STM 2100 **multi-gas monitor** is designed to protect workers from hazardous gases in confined spaces and other industrial work sites. This monitor can detect up to four gases, combustibles in the % LEL range (ppm and %VOL range when using the sample-draw pump), oxygen content and a choice of one or two toxics. The standard sampling method is 'diffusion' or use the optional sample-draw pump. The STM 2100 features built-in datalogger, TWA/STEL alarms, simple two button operation, toxic sensor recognition and adjustable calibration reminder. This unit is UL classified and CSA certified with a one year warranty.

INSTRUMENT 18-2-16. STM 2100 Multi-Gas Monitor.



INSTRUMENT 18-2-15. GT-2400 Multi-Gas Monitor.

18-2-17. 95 Series Single Gas Monitor

GasTech, Inc.

The 95 Series **single gas monitor** is ideal for personal protection from hazardous gases. These low cost microprocessor controlled instruments are available in models that detect carbon monoxide, hydrogen sulfide or oxygen content. A top-mounted LCD (liquid crystal display) shows readings of the gas being measured, a built-in audible and visual alarm light to warn users of hazardous conditions. The 95 Series instruments can operate up to 3000 hours of operation, and an integrated pocket/belt clip provides hands-free monitoring. This unit is UL classified and CSA certified and comes with a one year warranty.

INSTRUMENT 18-2-17. 95 Series Single Gas Monitor.

INSTRUMENT 18-2-21. STX Single Gas Monitor.

18-2-18. Portable, Personal Monitors for Toxic Gases

GC Industries

GCI offers a complete range of small, portable monitors/alarms for the detection of O_2, CO, H_2S, SO_2, NO, and NO_x. Monitors are designed as personal monitors for field use, providing continuous monitoring and alarm of a particular gas. Pocket-sized monitors feature LCD display, audible and visual alarms, 9 V power supply, and a patented electrochemical sensor. Units have a 90% response time of 20 seconds, sensor life of 1 year, easy field replacement of sensors, and operates at temperatures of 0–40° C.

18-2-19. G3000 MicroTox® Series

GfG dynamation

The G3000 Series toxic monitors are hand-held, lightweight monitors available for CO (Microco®) and H_2S (Microtox®). Both the Microco and Microtox utilize diffusion input electrochemical cells. The cells are designed to last 1–2 years with little maintenance. A steel mesh diffusion screen and a Teflon membrane protect the unit from dust and splash water. The rechargeable, sintered metal Ni-Cd battery pack powers the unit for over 100 hrs of continuous operation on one charge. Both units use a three-chamber, 8-mm, high digital display. Operating temperature for both units is 0 to 53°C; response time is 15 seconds (T_{90}).

18-2-20. G111 Toxitector®-CO

GfG dynamation

The Toxitector® is a very small detector used to continuously monitor for CO concentrations releasing audible and visual alarms. The units provide three alarm thresholds: 30, 60 and 300 ppm. Applications include in the steel industry, power stations, chemical industry, mining industry and various authorities. The battery operated units run for 150 hours between charges. The very small units are rugged and feature true pocket size, a stainless steel body, and a >2 years sensor life. The units operate in temperatures of –15 to +50° C and humidities of 5–95% RH.

18-2-21. STX Single Gas Monitor

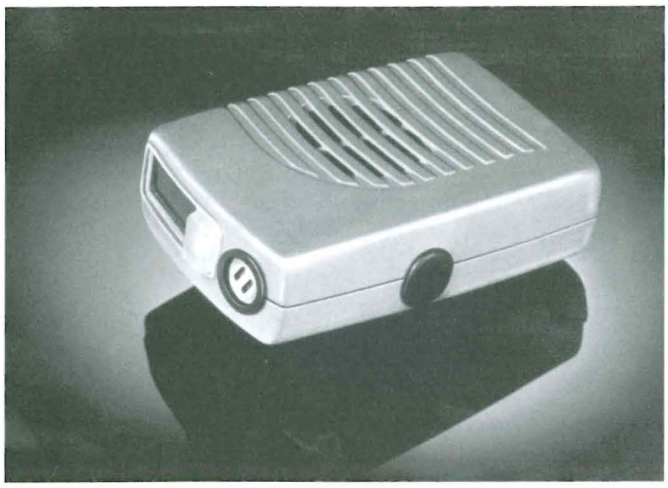
Industrial Scientific Corp.

The STX70 continuously monitors oxygen or any of eight toxic gases. Available sensors include NH_3, CO, Cl_2, HCN, H_2S, NO, NO_2, and SO_2. The instrument is available in three distinct configurations. A Non-display version operates in "alarm-only" mode, while the Display version provides digital readout of toxic gases in ppm and oxygen in percent of volume. Also available is a Datalogging/Industrial Hygiene version (display or non-display) that provides 60 hours of data storage logged at one minute intervals. Additional features include RFI protection, audible and visual alarms and an easy to read top mounted LCD display.

18-2-22. T80 Single Gas Monitor

Industrial Scientific Corp.

The T80 monitors any one of eight gases with electrochemical smart sensors including CO, Cl_2, HCN, H_2S, NO_2, O_2 and SO_2. The T80 recognizes each installed sensor and an LCD display provides continuous gas concentration readings. The audible alarm is rated at 90 dB at three feet, and an optional internal vibrating alarm is available. Features include one-button auto calibration, built-in STEL and TWA readings and peak/hold memory. The high impact, RFI resistant case adds durability for almost any environment. A 9-volt alkaline battery provides continuous operation for up to 2600 hours or 4400 hours with a 9-volt lithium battery.



INSTRUMENT 18-2-22. T80 Single Gas Monitor.

18-2-23. GasBadge Single Gas Monitor

Industrial Scientific Corp.

GasBadge delivers continuous non-display monitoring for potentially hazardous levels of CO, H_2S, or O_2 with audible and visual alarms. After the unit is activated it will run continuously for one full year. At the conclusion of each year, the unit shuts down and can then be cost-effectively renewed for another year of usage. With the exception of daily battery testing and periodic gas bump testing, GasBadge requires no additional maintenance. Weighing less than three ounces, the instrument is extremely durable and offers outstanding RFI protection. The instrument does not require any calibration, though an optional automatic calibrator is available for users requiring periodic calibration.

18-2-24. Portable Gas Analyzers, Series 1000/4000/7000

Interscan Corp.

Interscan's field proven portable analyzers are available for CO, Cl_2, ClO_2, ethylene oxide, formaldehyde, hydrazine, HCl, HCN, H_2S, NO, NO_2, and SO_2. The 1000 Series is the original workhorse unit while the 4000 is a smaller version providing most of the same features. The 7000 in addition includes an internal datalogging capability. The units are 178 × 102 × 225 mm, and weigh 2 kg. Accuracy is rated 2% of full scale, while zero and span drift are less than 2% of full scale (24 hour). All the units are calibrated against a known standard.

18-2-25. LD Series Continuous Monitoring Systems

Interscan Corp.

Interscan's LD Series Continuous Monitoring Systems are available for CO, Cl_2, ClO_2, ethylene oxide, formaldehyde, hydrazine, HCl, HCN, H_2S, NO, NO_2, and SO_2. Industrially hardened, the systems can be provided with a variety of alarm and packaging features. Integral datalogging is also available. Dimensions are 356 × 508 × 222 mm, exclusive of alarm strobe light. Weight is 10.4 kg. Various multipoint versions of the LD Series provided with full SCADA features are available.

18-2-26. RM Series Continuous Monitoring Systems

Interscan Corp.

Interscan's RM Series rack mountable analyzers are available for CO, Cl_2, ClO_2, ethylene oxide, formaldehyde, hydrazine, HCl, HCN, H_2S, NO, NO_2, and SO_2. They are intended to either be used in laboratory applications, or to be installed as part of a larger instrument system. Continuously adjustable alarm relays, and 4–20 mA analog output are provided. The dimensions are 178 × 483 × 305 mm, and the weight is 5.2 kg, when provided with a pump and rotameter.

INSTRUMENT 18-2-23. GasBadge Single Gas Monitor.

18-2-27. ToxiBEE and GasBUG Series Personal Monitors

Luminor Safety Products

The ToxiBEE and GasBUG Series are small, lightweight personal warning monitors for toxic gases. The ToxiBEE weighs 2 oz, is less than an inch thick, and is available for CO and H_2S. The units have loud audible and bright visual alarms and are intrinsically safe (UL Class I, Division I, Groups A, B, C, and D). The units feature quick response (3–5 sec), easy calibration, 2-yr warranty, and low battery indicators.

18-2-28. UniMAX Personal Single Gas Detector

Lumidor Safety Products

The new UniMAX is a UL classified compact, pocket-sized, microprocessor controlled single gas monitor. The UniMAX continuously detects and displays gas concentration and instrument status on a large, easy to read digital display. The UniMAX can be configured to monitor O_2, CO, NH_3, PH_3, SO_2, H_2S, NO_2 Cl_2, and ClO_2. The UniMAX utilizes state of the art electrochemical interchangeable plug-in sensors, with smart sensor technology, offering easy adaptability and versatility for monitoring a wide variety of areas and to ensure both worker safety and simple operation. The UniMAX is housed in a rugged, water-resistant, ergonomic case with a strong, durable belt clip. It is suitable for potentially hazardous environments in pulp/paper mills, utilities, waste water treatment facilities, chemical, construction, manufacturing, mining, and petroleum industries. The unit has multiple alarms to alert the user to a dangerous situation which include a horn, bright flashing LEDs and an optional internal vibrator for noisy environments.

INSTRUMENT 18-2-28. UniMAX Personal Single Gas Detector.

18-2-29. Series PM-7700 Personal Toxic Gas Monitors

Metrosonics, Inc.

The PM-7700 uses interchangeable electrochemical sensors to detect CO, H_2S, SO_2, Cl_2, NO_2, NO, O_2, ETO, O_3, HCN, NH_3, H_2, and HCl for personal protection. The sensors utilize capillary diffusion barrier technology, which results in a direct response to volume concentration. The sensors are also cable mounted and can be clipped to clothing for readings taken in the breathing zone. Visual and ear piece audible alarms can be set for two user-selected gas concentrations. The PM-7700 can operate 720 hrs on a 9V alkaline battery. Operating temperature: –5 to 40°C. Response to 90% of final reading ranges from 30 to 90 seconds, depending on gas.

18-2-30. MiniCO® Responder Carbon Monoxide Indicators

Mine Safety Appliances Company

The MSA MiniCO® Responder provides fast, accurate sampling of CO concentrations from 0–99 ppm in a pocket-sized device. They operate on the principle of an electrochemical sensor cell. The MiniCO Responder features simple three-button control for easy operation, even with heavy gloves. With the press of a button, the instrument's back-lit display provides readings in low-light conditions for 30 s. The rugged case provides impact protection and RF shielding. A Goretex® filter over the inlet provides exceptional water resistance. This unit was designed for use by firefighters. An adapter with aspirator bulb, using standard MSA sampling lines, is available for remote sampling. The units are battery powered. The alarm set point is adjustable over the range of 25 to 500 ppm. All models have ±2% precision and accuracy, 90% response time in 30 seconds, a span drift less than 2% full scale/day, and zero drift less than 1% full scale/day. MiniCO indicators can be field-calibrated using the MSA Calibration Check Kit, Model R. Common interferents include SO_2, H_2S, NO_2, ethyl alcohol, and H_2.

18-2-31. Cricket® Personal Alarms

Mine Safety Appliances Co.

The Cricket® Personal Alarms are very lightweight, weighing less than 3 oz and can be worn clipped to a pocket, belt, lapel, or hard hat for hands-free operation. The instrument is only 1.25 × 3 × 2 in. in size. The Cricket series of personal alarms are miniature, battery-powered instruments designed to provide users with an inexpensive yet dependable way to monitor for O_2 deficiency, CO, or H_2S. The instruments operate continuously and sound an

INSTRUMENT 18-2-32. MSTox 8600 Personal Toxic Gas Monitor.

alarm if levels in the environment exceed preset levels (for CO and H_2S) or fall below a preset level (for O_2).

18-2-32. MSTox 8600 Personal Toxic Gas Monitor

MST Measurement Systems, Inc.

The MSTox is an intrinsically safe personal toxic gas monitor. The unit can detect a wide range of gases including exotic gases used in semiconductor manufacturing. The MSTox is compact and lightweight. It has a rugged, high impact exterior that stands up to demanding use. The MSTox can be used in a variety of applications. Features include field settable, dual level concentration alarms, easy to read digital display, earphone jack and audio and visual alarm indications. CSA approved for Class 1, Division 1 and 2, Groups A, B, C and D.

18-2-33. Satellite

MST Measurement Systems, Inc.

The Satellite is a microprocessor based monitoring system for the detection of toxic, combustible and pyrophoric gases. It has a local, graphical LCD display that shows gas type, concentration and alarm status.

INSTRUMENT 18-2-33. Satellite.

Features include continuous sensor self test, user settable dual alarm and the ability to change gas types by simply plugging in a new sensor.

The Satellite is offered in both analog and digital versions. The analog version utilizes a 4–20 mA signal designed to interface with a controller, PLC or DCS system. The Digital version utilizes LonWorks™ technology, addressable input/output modules and MST's Wonderware based visualization software. UL listed for Class 1, Division 2, Groups A, B, C, and D.

18-2-34. Pac III Personal Monitor

National Draeger, Inc.

The Pac III is a single gas monitor which features Draeger's intelligent electrochemical sensors, loud (95 dBA at 1 ft) and bright alarms, large backlit displays, RFI shielding, and a rugged ABS/polycarbonate housing. The sensors come equipped with their own electronics which allows for interchangeability of sensors, increased temperature range stability, minimum cross sensitivities to other gases, and constant sensor validation of status and performance. Sensors are available for CO, O_2, CO_2, Cl_2, HCN, NH_3, H_2S, NO, NO_2, hydrides (PH_3, AsH_3, and B_2H_6) and SO_2. The unit operates from a 9V battery and over a temperature range of –20 to 50°C.

18-2-35. MicroPac Personal Gas Instrument

National Draeger, Inc.

The MicroPac is a compact gas warning instrument available for CO, H_2S and O_2. Uses include in the ambient air in industry, during the transport of dangerous goods and at other workplaces exposed to gas hazards. The instrument features very long operating periods, pocket size, infrared interface for data transmission, wide temperature and humidity range, small robust housing, different display variants, optimized electrochemical Drägersensors®, and international approvals for intrinsic safety.

18-2-36. Neotox® XL Pocket-Size Single Gas Monitors

Neotronics

The Neotox® XL monitors offer individual, lightweight, pocket-sized protection against the hazards of O_2 deficiency and enrichment, flammable gas (volume or LEL),CO, H_2S, Cl_2, SO_2, and NO_2. The monitor incorporates a top mounted backlit LCD display, one button operation, three levels of alarm, and audible and visual alarms. Applications include oil field monitoring, chemical laboratories, open air plan measuring, silos, food processing, steel processing, residential monitoring, underground parking garages, and handling bulk

chlorine. Other features include small lightweight design, watchdog beep for unit function, "Lock On" and real time alarms, color coded, peak reading, optional use of rechargeable or alkaline batteries, auto-zero, optional datalogging, and a rubber boot for protection. The Firetox® CO unit is designed specifically to assist firefighters in locating CO leaks.

18-2-37. Solotox® Disposable Monitor

Neotronics

The Solotox is a disposable, personal, portable single gas detector. This unit requires zero maintenance (no battery replacement or calibration). This device is an inexpensive way to provide personal safety when hazardous levels of either hydrogen sulfide or carbon monoxide are present. The Solotox is sealed for life and has a preset alarm which will sound for the length of time the gas concentration exceeds the set point or until the battery is exhausted. The unit features a simple go/no go design, two year maintenance free life, visual and audible alarms, low life battery indicator, UL certified intrinsically safe, and a compact rugged design.

18-2-38. Sulfur Dioxide Analyzer/Recorder

Process Analyzers, Inc.

The Titrilog II is an automatic instrument for the determination of oxidizable sulfur compounds such as H_2S, SO_2, mercaptans, thiophene, and organic sulfides and disulfides. This instrument can be used for measurement in the atmosphere, in gas streams, and in stack gases. The measurement cell consists of an electrolyte containing potassium bromide from which free bromine is being generated electrolytically. In addition to the generating electrodes, there is a set of electrodes sensitive to free bromine. The potential of these electrodes varies with the concentration of free bromine in the solution. To distinguish between some of the different sulfur compounds, liquid absorptive filters are furnished as an accessory. These filters absorb one or more of the compounds of interest, enabling their concentration to be determined by difference. A programming system will route the sample through either of the filters, bypass the filters, and establish a zero level on an automatic repetitive cycle.

18-2-39. ToxiRAE Personal Gas Monitors

RAE Systems, Inc.

The ToxiRAE Series of Personal Gas Monitors features small, lightweight pocket-sized units available for a variety of toxic gases including O_2, combustibles, VOCs, CO, H_2S, SO_2, NO, NO_2, Cl_2, HCN, NH_3, and PH_3. The units feature a rugged, weatherproof composite case, a large digital display with backlight, loud audio and flashing visual alarms, a vibrating alarm, RF protection, plug-in interchangeable sensors, datalogging (PGM-30D), and STEL, TWA and Peak information.

18-2-40. Series 94 Personal Gas Monitor

RKI Instruments, Inc.

These pocket sized, personal monitors are available for the detection of oxygen deficiency, carbon monoxide, and hydrogen sulfide. These units are intrinsically safe, compact, accurate, and have microprocessor controlled functions in a slim and light package. They can easily fit in your shirt pocket. The units feature digital readout, visual and audible alarms (buzzer) for high concentrations and low battery, peak value function, TWA and STEL values for toxics, and touch operated controls.

18-2-41. Model SC-90 Portable Toxic Gas Monitor

RKI Instruments, Inc.

The Model SC-90 is a survey electrochemical monitor which will react to over 17 different gases in the ppm range. This monitor is useful as a personal safety monitor for detecting dangerous levels of toxic gases in semiconductor and other industries. The unit continuously reads gas concentrations until a preset alarm level is triggered, and audible and visual alarms are activated. The unit averages gas readings over time and has a peak reading function. The unit uses replaceable alkaline batteries which will run the monitor for up to 20 hours. Other features include a dot matrix self-illuminated display, microprocessor controller, 30 sec response times, and various carrying options.

18-2-42. S100 Series Portable Gas Indicators

Scott Aviation

The S100 Series are intrinsically safe, portable instruments that can be applied to area monitoring, confined space entry, or personal monitoring. Instruments are available that can monitor for one, two, or three of the following: combustible gas, O_2, H_2S, and CO. Features of the S100 Series include dual low-battery alarms, liquid crystal display that illuminates for low ambient light conditions, and audible alarms for each measured variable. The S100 Series has memory capability to store the highest combustible gas concentration, peak CO or H_2S concentration, or the lowest O_2 measurement. Response time to 63% change: 10 seconds to LEL, 20 seconds for O_2, 45 seconds for H_2S, and 25 seconds for CO. Operating temperature ranges are –10 to 60°C for LEL and 0 to 40°C for the others.

18-2-43. Portable Gas Monitors

Sensidyne, Inc.

Sensidyne markets a wide range of pocket-sized personal monitors (Mini Monitors), portable survey monitors (Series SS2000 and SS4000 for semiconductor gases), and a variety of fixed gas detection systems. The Mini Monitors and Series SS2000 monitors utilize diffusion electrochemical cells specifically designed for each gas to be detected. The lightweight (7 oz), pocket-sized Mini Monitors feature a continuous LED light-illuminated digital display, dual alarm set points, intrinsically safe design, replaceable batteries, RFI/EMI protection, and easy calibration. Additional features on the hand-held Series SS2000 include long-life sensors (3 years expected life), rechargeable batteries, optional continuous operation from AC power, triple alarm system, and ability to withstand temperature extremes. Response time: <20 seconds for Mini Monitors, 10–15 seconds for SS2000, <30 seconds for SS4000. Battery life: over 100 hrs for Mini Monitors, 20 hrs for SS2000, 35 hrs for SS4000. Humidity range: 5% to 95% for Mini Monitors and SS2000; 20% to 90% for SS4000. Temperature range: 0 to 40°C for all monitors.

18-2-44. Portable Flue Gas Analyzer

Teledyne Analytical Instruments

The Model 990 is a completely portable, battery-powered flue gas analyzer designed to rapidly monitor the O_2 and CO content of a combustion process. When these two measurements are combined for the purpose of maximizing fuel-burning efficiencies, boilers and heaters can be fine-tuned for optimum air/fuel ratios.

The CO trace measurement is accomplished by an electrochemical sensor (6-month warranty). The sensor output is directly proportional to the CO concentration. Zero and span drifts are less than 2% in 24 hrs. A 90% of full-scale response is attained in 30 seconds or less. Operating temperature: 0 to 50°C. O_2 analysis is accomplished with Teledyne's Micro-Fuel Cell (1-year warranty), which produces an electrical signal that is directly proportional and specific to the O_2 concentration in the flue gas. A 90% of full-scale response is attained in 13 seconds or less.

18-2-45. MDA Scientific Lifeline Gas Monitors

Zellweger Analytics

Designed to eliminate many of the shortcomings of traditional cell-based technologies, the new MDA Scientific LIFELINE product line features quick installation, minimal maintenance, and "smart" sensors which provide early warning diagnostics of a sensor's condition and effective life cycle. Four versions of LIFELINE monitors cover virtually all semiconductor applications, as well as many other industrial applications requiring a rugged toxic gas detection system. A passive, diffusion-type system and a remote system capable of locating sensors up to 50 feet from the transmitter feature an intrinsically safe design. Extractive and pyrolyzing models are capable of regulating samples and drawing air from streams up to 50 feet away. Each version has a compact footprint and features easy maintenance. Gases monitored include AsH_3 , PH_3, B_2H_6, SiH_4, HCl, HBr, HF, NF_3, CO, TEOS, NH_3, H_2, Cl_2 and others. All units use smart, digital sensors that monitor cell performance and advise of recalibration requirements. Electro-chemical cell-based sensors are easily exchanged at six-month intervals through a sensor exchange program. Complete diagnostics are reported locally on unit's LCD display and transmitted via 4–20 mA outputs. There is also a LonWorks compatible version available.

18-3: Coulometric Analyzers (see 18-12, Multi-Gas Monitors)

18-3-1. Model OX630 Oxygen Analyzer

Engineering Systems and Designs

The OX630 is a portable unit that utilizes a maintenance-free galvanic electrode to measure atmospheric oxygen levels from 0% to 100%. The electrode has an expected life of 3–5 years at 25°C, 1 atmosphere pressure, and a concentration of 20.9% O_2. The OX630 is sold in a kit containing the meter, an electrode on a 5-ft cable, screwdriver for calibration, and a carrying case. Electrodes up to 100 ft can be manufactured upon request. Operating temperature range: 0 to 40°C. Response time: 95% of final reading in 30 seconds. Power: 9V battery. Calibration: 20.9% in air.

18-3-2. Oxytector® Oxygen Warning Device

GfG dynamation

The Oxytector® is an ultra-compact, easy to use, battery powered instrument for continuous oxygen monitoring. The main application is monitoring oxygen content in air when going into manholes, canals, tank vessels and other narrow areas with the danger of reduced oxygen concentration. Applications include water supplies, municipal service, fire brigades, civil engineering power stations, mining industry, and various authorities. The unit features variable warning optical and acoustic alarms, 150 hours of operation between charges, a battery function check, a stainless steel body, and 3 alarm thresholds (17, 19, 22%).

18-3-3. Models 8060/8061 Oxygen Deficiency Monitors

Matheson Gas Products

Models 8060/8061 Oxygen Deficiency Monitors are portable personal monitors or guarding against oxygen deficient exposure. Using an electrochemical sensor, the instruments each provide a large digital concentration readout, and an audible alarm when the level drops below 19.5%. The model 8060 uses a short 3 foot coiled cable connecting the sensor to the instrument. The 8061 uses a 16-ft cable on a spool making it ideal for lowering into confined spaces.

18-3-4. NGA 2000 Trace Oxygen Analyzer Module (TO2)

Rosemount Analytical, Inc.

The TO2 is designed for applications like analyzing trace impurities in pure gases, controlling inert atmospheres in heat treat application, and monitoring inerting operations where the presence of oxygen is undesirable. At the heart of the TO2 Analyzer Module is a one-depleting electrode sensor which provides accurate oxygen measurements in the ppm oxygen range. With sensitivity to less than 10 ppb, the sensor is truly designed to provide precision trace oxygen measurement with superior performance. The TO2 module is a self contained unit complete with detector and microprocessor-based electronics. It is ideal for air separation plants, heat treat applications and inerting operations.

18-3-5. Model 55 Oxygen Deficiency Monitor

Sierra Monitor Corp.

The Model 55 is a hand-held oxygen monitor with digital display to measure oxygen depletion in confined spaces. This monitor is accurate, rugged and simple to use and includes a digital display and audible alarm that sounds at 19.5% oxygen. An external senor with a 20-foot extension is optional.

18-4: Flame Ionization Detectors

18-4-1. Total Hydrocarbon Analyzer

Columbia Scientific Corporation, a division of Forney Corporation

The Model HC500-2D performs real time and continuous dry analysis of hydrocarbon gases utilizing a flame ionization detector (FID). Emphasis is focused in stable and reliable performance without a requirement for clean hydrocarbon-free combustion air. The temperature of the sample air, hydrogen, and exhaust gas is controlled within ± 1% over 10 to 40 C. The HC500-2D closely approximates ppm hydrocarbon molecules rather than approximate methane equivalents as provided by FIDs operating in the gas chromatograph (GC) mode. The Model HC500-2C is available to differentiate methane and non-methane hydrocarbons. Outputs are available as 0–100 mV, 0–1 V (other outputs optional). Ranges: 0 to 10, 50, 100, 500, 1000 ppm. Minimum Detectable Sensitivity: 0.1 ppm CH_4. Noise: ±0.05 ppm CH_4. Lag time: <15 seconds. Rise Time/Fall Time to 90%: <30 seconds. Zero Drift/Span Drift: ±2 % Full Scale (FS)/day; ±3.0 % FS/3 days. Linearity: ±1.0 % FS. Selectable time constant: 1 second or 10 seconds. Operational specifications: unattended operation (no adjustment of flow or electrical systems), 7 days. Sample flow rate: 200 ml/min; hydrogen flow rate: 140 ml/min.

18-4-2. Century TVA-1000 Toxic Vapor Analyzer

Foxboro Company

The TVA-1000 is an over-the-shoulder portable vapor analyzer which offers both flame ionization and photoionization. An optional Enhanced Probe is available which allows single hand operation. The power and fuel supplies the unit for eight hours of operation in a fully certified intrinsically safe package. Other features include on-board datalogging, multipoint calibration, multiple calibration, menu driven operation, easy-to-read LCD displays, large keypad, datalogging thumb switch on hand-held probe, automatic autoranging, internal diagnostics, and an optional flame re-ignite function.

18-4-3. Models PI-101, IS-101, DL-101 Portable Photoionizers

HNU Systems, Inc.

The PI-101 is the original photoionization analyzer developed in 1974. The units are portable analyzers used for the measurement of gases in industrial atmospheres. The IS-101 in an intrinsically safe unit for explosive conditions. The new DL-101 is a microprocessor-controlled unit equipped with datalogging and four operating modes. The basic sensor consists of a sealed UV light source that emits photons which are energetic enough to ionize many trace species (particularly organics) but do not ionize the major components of air such as O_2, N_2, CO, CO_2, or H_2O. The field created on an electrode drives any ions formed by adsorption of the UV light to the collector electrode where the current (proportional to concentration) is measured.

This instrument consists of two separate units: a sensor and a readout, connected by a 3-ft, shielded, multiconductor cable with electrical connector. The case for the readout module is constructed of drawn aluminum. The sensor's outer body is of aluminum and engineering thermoplastic. The DL-101-2 has two automatic modes: survey and hazardous waste. The DL-101-4 has two additional modes of operation which include industrial hygiene and leak detection.

18-4-4. Passport® PID II Monitor

Mine Safety Appliances Co.

The Passport PID II Organic Vapor Monitor is a convenient, portable instrument for detecting low concentrations of VOCs. Applications include soil remediation in connection with hazardous material spills and underground tank leakage, arson investigation, industrial hygiene applications, emissions monitoring and general leak detection. The unit is ideal for Method 21 analysis since it can directly measure 0.1–10,000 ppm VOCs. Features include humidity insensitivity, autoranging capability, 69 pre-programmed plus 10 user-defined response factors, three buttons for simplified operation, graphic and numeric display, peak, STEL, and TWA measurements, simple fresh air setup, and labeling features. The unit has certification for various Class I, II, and III instrinsically safe operations.

18-4-5. Model 2020 Miniature Photoionization Monitor

PE Photovac

The PE Photovac Model 2020 is a hand-held Photoionization Detector System for use in the monitoring of ambient air for the presence of organic vapors. Virtually any non-methane organic volatile can be observed and measured to levels as low as 0.5 ppm. The 2020 is easily used in the field for hours using its rechargeable battery. Internal datalogging allows the operator to record hundreds of sampling points that can be downloaded to a computer for recordkeeping. The 2020 can also be pre-set to sample at intervals for tracking of VOC levels over time, or for calculation of 8 hour exposure levels. The 10.6 ev lamp is guaranteed for one year, and is easily cleaned and replaced by the user. An optional 11.7 ev lamp can be used where the ionization potential of the compound(s) of interest is (are) higher than optimal with the standard lamp. Applications included confined space pre-entry, fugitive emissions, plume characterization, leak detection, workplace monitoring, storage vessels, site characterization, and SVE system monitoring.

18-4-6. MicroFID™ Flame Ionization Detector

PE Photovac

The MicroFID is a battery-powered, hand-held flame ionization detector (FID). It is designed to detect and measure total hydrocarbons, or total VOCs in the range of 0.1 to 50,000 ppm. The MicroFID is completely self-contained and is intrinsically safe for use in potentially hazardous environments. The MicroFID is the world's lightest weight direct-reading FID. Its ergonomic design includes a built-in handle, and a rubberized keyboard that can be used while wearing protective equipment. Up to 750 sample points can be recorded with date, time and instrument status at selectable intervals or in Method 21 Format. The data can be downloaded to any PC for data management. PE Photovac Star 21 Software is designed to address the requirements of Method 21 data reporting and sample scheduling. Using Star 21, monitoring schedules can be uploaded to the MicroFID datalogger. The MicroFID has a wide linear range, responds to almost all organic compounds, is quite stable, and is virtually immune to possible interferences such as water vapor. The sample air serves as the source of oxygen to support the flame. A glow plug starts the flame automatically. After the sample passes through the detector, it is vented through a flame arrestor, preventing the ignition of any flammable gases surround the sampling location. The rugged design of the MicroFID combines with small size, light weight, and ease of operation, to make it an ideal choice for use in the field.

18-4-7. MiniRAE 2000, MiniRAE PLUS, and UltraRAE Portable VOC Monitors

RAE Systems, Inc.

The MiniRAE 2000 is the newest member of the RAE family of portable photo-ionization monitors. It is advertised as the smallest handheld VOC monitor available. The MiniRAE PLUS is a hand-held PID monitor useful for leak testing, fugitive emissions testing, etc. The UltraRAE is a quick, spot check Monitor used with a colorimetric tube to get readings for total hydrocarbons or classes of hydrocarbons for pre-screening during tank entry, hazardous material response, and refinery downstream monitoring. The MiniRAE 2000 features the new RAE 3-D sensor, provides easy access to the lamp and sensor, reduces moisture interference, has improved linearity and sensitivity, and has an extended range of 0–10,000 ppm. Other features include a built-in sample pump, external NMH batteries, automotive charger available, large keys operable with gloves, back lit display which is alarm- or darkness-activated, and preset

alarms for STEL, TWA, low, and high peak values. There are many other features for all models.

18-4-8. NGA 2000 McFID

Rosemount Analytical, Inc.

The NGA 200 McFID is an advanced, high sensitivity Flame Ionization Detection system. The McFID utilizes state of the art "variable pressure" chromatographic separation of methane and non-methane hydrocarbons to provide a fast and accurate analysis of these constituents. Four standard measured variables corresponding to CH_4, non-CH_4, Total Hydrocarbons and real-time chromatogram plot. Exclusive split electronic-pneumatic bench design provides intrinsically safe operation, no continuous dilution purge required. Meets or exceeds U.S. EPA requirements CFR 40 pt. 60, App. A Method 25 (process) and CFR 40 pt. 86, (light duty automotive) hydrocarbon monitoring requirements.

18-4-9. Sensidyne Intrinsically Safe Portable FID

Sensidyne, Inc.

Sensidyne's Portable Flame Ionization Detector (FID) allows one to measure low levels of volatile organic compounds (VOCs) in virtually any hazardous environment since it is intrinsically safe (Class I, Division I, Groups A, B, C, and D). The FID is rugged, portable (3.9 kg), and has quick responses (<10 sec). It can measure VOCs over the range of 0.1 to 10,000 ppm (0.05 ppm minimum limit of detection for methane) and has up to 29 hrs of continuous operation. An optional datalogger allows for storage of measurements with easy downloading to a serial printer or IBM PC. Temperature range: 0 to 40°C. Humidity Range: 10-95% continuous, non-condensing. Other features include a multi-purpose sampling probe, a gas chromatograph version for GC separation of VOCs, a choice of hydrogen bottles, audible and visual alarms, back lit display, FID range extenders (up to 10x), Integraph software to interpret GC results, and low battery indicator.

18-4-10. Models 580EZ Portable PID and Models 55C Direct Methane, Non-Methane, 51 Total Hydrocarbon FID Analyzers

Thermo Environmental Instruments

The 580EZ is a portable PID monitor for VOC analysis. It features datalogging, microprocessor control, graphic LCD display, three button operation, weatherproof cases and keys, backlit display, and Smart Battery indication of battery status. Models 55C and 51 use FID for Total Hydrocarbon Analysis. Model 55C allows differentiation of methane, non-methane hydrocarbons while Model 51 is a heated FID for determining total hydrocarbons (THC). The units each have individual features and specifications for their specific applications.

18-5: Infrared Photometers

18-5-1. Model 1301 Gas Analyzer

Bruel and Kjaer Instruments, Inc.

The Model 1301 Gas Analyzer is a fully self-contained, transportable Fourier Transform Infrared (FTIR) spectometer that utilizes photoacoustic detection and is designed for field use. The unit can be used as both an analyzer to determine what gases are present and as a monitor for concentration measurements. Any gas or vapor that has an infrared absorbance between 4000/cm and 650/cm can be detected. Detection limits are typically in the range from 0.1 to 10 ppm. The dynamic range is 4 orders of magnitude. The unit has extensive internal data handling and data storage capabilities, along with a built-in disk drive and graphics screen. Serial and parallel interfaces allow for the transfer of data to various peripherals and computers. Zero drift: detection limit over 3 months. Span drift: 5% of reading over 3 months.

18-5-2. Toxic Gas Monitor Type 1302

Bruel & Kjaer Instruments, Inc.

The Toxic Gas Monitor Type 1302 is designed for the continuous measurement of various toxic gases. Typical applications are area monitoring for process emissions and perimeter monitoring for accidental releases. The monitor can operate unattended for months at a time. The Multi-gas Monitor 1302 is a portable unit that has typical applications for occupational exposure, tracer gas analysis, and indoor air quality assessment. The measurement technique used in both instruments is based on infrared photoacoustic spectroscopy. This method is based on the fact that when a gas absorbs modulated light, it emits sound proportional to the concentration of the gas. During operation, air is pumped into the measurement chamber. The chamber is sealed and irradiated with modulated, narrow band, infrared light. If the toxic gas of interest is in the air sample, sound is emitted and measured with a microphone. The signal is processed and the result is transmitted to the controlling computer. Selectivity is controlled by fitting the monitor with the appropriate optical filter for the gas of interest. A wide range of filters is available, covering the useful region of the infrared spectrum.

The Toxic Gas Monitor is remotely controlled from a personal computer that can be positioned a considerable distance from the monitor. The monitoring system can incorporate from 1 to 254 monitors connected to one computer. The Model 1302 has 32 KB of memory and an

80-character display. It has a measurement time of 30 seconds for one gas and up to 100 seconds for five gases. Span drift: 2.5% of reading in 3 months. Zero drift: detection threshold concentration in 3 months.

18-5-3. Models CEA 266 & 104 Wall Mounted CO_2; CEA 105, GD-444 and GD-344 Portable and Personal CO_2 Monitors

CEA Instruments, Inc.

Models CEA 266 and 144 are wall mounted analyzers for CO_2. The units feature digital display, internal pumps, linear 4–20 mA outputs, low maintenance and water resistant housing. These units are designed for continuous area monitoring of CO_2 concentrations. Models CEA 105 and GD-444 are portable CO_2 analyzers for continuous or spot check analysis of CO_2. The CEA-105 is a hand-held unit with audible and visual alarms, AC/DC operation, 0–2000 ppm display, and has optional temperature and RH probes. The GD-444 is pocket-sized, autoranging unit with a built-in pump, optional datalogger, large backlit display, and push button operation. The GD-344 is a lightweight (9 oz) personal CO_2 monitor which monitors 400–15,000 ppm and is easy to operate, weather and dust resistant, has a long-life battery, and digital display with audio and visual alarms.

18-5-4. Fourier Transform Infrared Analyzer (FTIR)

Columbia Scientific Corporation, a division of Forney Corporation

The Quantum 7000 FTIR Gas Analyzer is a transportable gas analyzer with the latest monitoring hardware and software technology to provide a complete, high-speed gas analysis system. The Quantum 7000 uses a patented interferometer with cube corner reflectors. The advantage of this design is that it is significantly less sensitive to temperature variations and to vibration. The Quantum 7000 utilizes a Fourier Transform Infrared (FTIR) spectrometer to analyze the entire IR spectrum of the gas sample and allows for detection, identification, and quantification of up to 32 different components of a gas sample. Sample cell: various configurations available. Data System: internal 486 computer, DOS operating system, CALCWARE analysis software, RS-232 Centronics port. Analyzer Performance: up to 12 measurements a second. Lowest detection limits: typically 10–100 ppb.

18-5-5. Miran SapphIRe Gas Analyzers

Foxboro Environmental Company

The Miran SapphIRe is the new line of NDIR gas analyzers from Foxboro which replaces the old 101, 1A, 1B, 1B2, etc. line of portable IR analyzers. The SapphIRe units are lightweight and portable, ergonomically designed, has an eight-line 40-character display that prompts user through each step, has interference compensation which helps eliminate the additive effects of other gases, and are easily upgraded. The SapphIRe-1 is dedicated to specific gases requested by the user, which can be tuned to virtually any wavelength or pathlength needed. The SapphIRe-5 is dedicated to measure a multicomponent application defined by the user. Up to 5 components can be measured and displayed, plus up to 5 components can be defined that are to be factored out of the analysis. The SapphIRe-30 and 30E are calibrated for 30 single gas applications. In addition, the unit is calibrated for one multi-component application per user specifications. The SapphIRe-100 and 100E analyzers employ factory calibrated multicomponent interference capabilities for the user's specific application. The instrument has the ability to "dial up" any of over 100 factory calibrated single gas applications from the fixed library.

18-5-6. APBA-250E Indoor Air CO_2 Monitor

Horiba Instrument Corp.

The APBA-250E Indoor CO_2 Monitor is designed for convenient monitoring and control of atmospheric carbon dioxide content and is ideal for greenhouses, food storage facilities and confined indoor spaces. This wall mounted unit uses NDIR to monitor CO_2 over the ranges of 0–3000 ppm, 0–1%, and 0–5%. The unit features a visual alarm, recorder output, and LED readout.

18-5-7. APMA-360 Ambient CO Monitor

Horiba Instrument Corp.

The APMA-360 is designed for continuous ambient air monitoring of CO using cross flow modulation, NDIR. This instrument features excellent long-term stability with low zero drift. The unit features ranges from 0 to 10 up to 100 ppm CO, various alarms, four language on-screen messages, variable input/output ranges, and excellent performance.

18-5-8. CDU440/MDU420 Infrared Single Gas Monitors

Industrial Scientific Corp.

Both the CDU440 and MDU420 feature Industrial Scientific's patented infrared sensor technology and internal sampling pumps. The CDU440 provides continuous auto-ranging detection of carbon dioxide levels as low as 10 ppm to 6% by volume (60,000 ppm). The MD420 detects both low and high levels of methane gas, from 0 to 100% LEL and auto ranging to 100% of volume. Both instruments feature a five-year infrared

INSTRUMENT 18-5-8. CDU440/MDU420 Infrared Single Gas Monitor.

sensor warranty, peak hold memory and interchangeable Ni-Cd or lithium battery packs.

18-5-9. Aq-511 CO_2 Monitor

Metrosonics, Inc.

The Model Aq-511 is designed to monitor and display CO_2 concentrations in indoor environments. It features a built-in pump for continuous monitoring. Other models (Aq-501, 502, 512, 513) will also monitor temperature, humidity, air velocity, light, VOCs, particulates, noise and other gas levels (see 18-12-27).

18-5-10. Lira® Nondispersive Infrared Analyzer

Mine Safety Appliances Company

The Lira® NDIR Analyzer is designed for fixed station use in the detection of a single gas or vapor in chemical process streams. Lira Analyzers are commonly used to measure CO, CO_2, SO_2, ammonia and virtually all hydrocarbons and chlorinated hydrocarbons. The Model 202X Lira Analyzer monitors many hazardous gases in the ppm range and is suited to CO in the range of 0–50 ppm and organic compounds at their TLV levels. The Model 3000 Lira offers somewhat lower sensitivity and is available in both digital and analog versions. All models provide signals for activating alarms, records, and process control or automatic shutdown equipment.

18-5-11. ML®9830B Carbon Monoxide Analyzer

Monitor Labs, Inc.

The ML®9830B CO Analyzer uses a combination of non-dispersive infrared and gas filter correlation (GFC) techniques. The GFC minimizes the sensitivity to potentially interfering gases such as H_2O and CO_2. IR radiation is emitted from a long life electrically heated element and projected through a rotating filter wheel which is heated and contains one glass cell of CO and another filled with nitrogen. As the wheel rotates, the reference beam is detected when the cell with the CO is in the light beam, and a measurement of the unknown gas is detected when the cell with nitrogen is in the light beam. The unit features a heated measurement cell to minimize maintenance, automatic zero background correction for minimum zero drift, temperature stabilized filter and gas filter wheel to minimize span drift, and automatic zero/span check with internal zero source and external span gas.

18-5-12. Riken RI-411A Portable Infrared CO_2 Monitor

RKI Instruments, Inc.

The Riken RI-411A is a lightweight CO_2 infrared gas monitor with digital readout and audible alarm. The unit is applicable to food-related industries, brewers, mushroom growers, greenhouse horticulture, welding, office ventilation systems, cooling systems, hazardous environments, laboratory and research projects, etc. The Riken RI-411A utilizes NDIR absorption to measure CO_2 in air. The unit is Ni-Cd battery operated and microprocessor controlled. The readings of CO_2 concentrations can be continuous or averaged over 1, 3, or 15 min. Averaged readings are held on the display until needed by the user. The RI-411A has a solid-state detector, an illuminated dot-matrix digital display, and a recorder output and can operate on AC using an optional DC power supply. Audible alarms: high CO_2, 5000 ppm (short pulse, optional 25%), averaging period (long tone), and low battery (continuous tone). Response time: 10 seconds to 90% indication. Calibration: zero, calibration using nitrogen or air cylinder (zero gas); span, calibration using cylinder of CO_2 in air. Ambient temperature range: –10 to 40°C. Ambient humidity range: 10% to 90% RH. Recorder output: 0- to 10-mv DC (linear). Auxiliary charger available for charging or continuous operation on 115-VAC adaptor. Operating hrs: about 6 hrs continuous.

18-5-13. Riken RI-413A Portable Halocarbon Indicator

RKI Instruments, Inc.

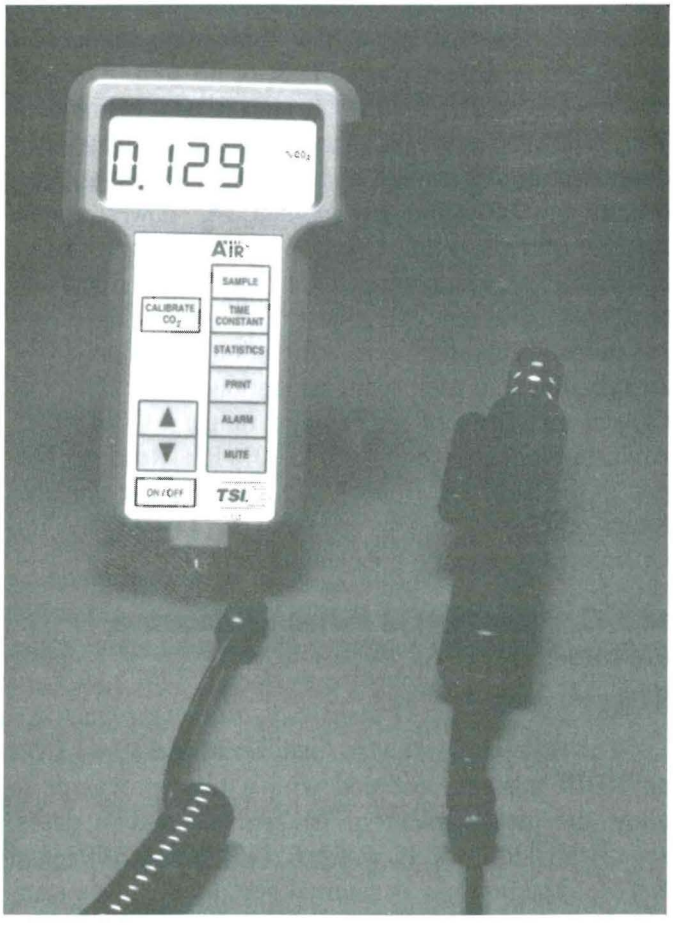
The Riken Infrared Gas Analyzer Model RI-413A is an NDIR analyzer coupled with a microprocessor to allow the measurement of halogenated carbon gases, specifically, R-11, R-12, R-22, R-113, R-114, R502, and R-134a. The unit has an internal pump that pulls a sample through a probe and into the infrared source. The source emits a broad band of energy which is focused on

a solid state detector through a narrow band filter selected to transmit only a certain range of frequencies which are selectively absorbed by halogenated carbon gas. The unit features three options for battery use (alkaline, Ni-Cd, carbon-zinc), continuous readout and averaging concentration display, audible alarm for continuous display or averaging display plus low battery indicator, and a recorder output.

18-5-14. Sieger Searchline Excel Open Path Infrared Gas Detector

Sieger Instruments

The Searchline Excel is a state-of-the-art open path infrared gas detection system. It would be mounted in a potentially hazardous environment to detect the presence and build up of potentially explosive concentrations of hydrocarbon gas clouds. The receiver unit produces an analogue or digital output signal proportional to actual gas concentrations within the volume of air located between a transmitter and receiver. The signal indicates the level of potential hazard in units of LEL. Applications range from offshore platforms and vessels, downstream chemical processing plants, gas transport and pipelines. Features: Totally solar immune using a uniquely modulated high-intensity lamp source (Eye-safe), smart heated optical windows, patented fog filter, early warning dirty optics, instrument assisted alignment, T90 response time of less that 3 seconds, operating distances range from 15 to 650 feet, operating temperature range between –40 and +150 EF.



INSTRUMENT 18-5-15. InspectAir™ Model 8560.

18-5-15. InspectAir™ Model 8560

TSI, Inc.

The Model 8560 Carbon Dioxide Monitor is a portable, hand-held instrument for measuring high levels of carbon dioxide. The NDIR sensor has very fast response to changes making it an ideal survey type instrument. It also has two alarm levels that enable it to be used as an area monitor. Statistics for a measurement period are also available. It is typically battery powered but can be run extended times with an AC adapter. The instrument is designed for concentrations of carbon dioxide up to 5% in air. This same CO_2 sensor is available in the Q-TRAK™, which also measures temperature, % RH and CO.

18-6: Ultraviolet (UV) and Visible Light Photometers

18-6-1. Model TGM555 Portable Toxic Gas Monitor

CEA Instruments, Inc.

The TGM555 is a portable, ambient air monitor that can be used for continuous colorimetric analysis of numerous compounds. The TGM555 contains a rechargeable DC power source and a constant-volume adjustable air pump. An air sample is continuously drawn into the unit and scrubbed with an absorbing reagent that removes a trace pollutant from the air stream and transfers it into the liquid reagent system. The subsequent color formation is read by a colorimeter and displayed on a built-in meter or on the optional digital readout. A recorder output is also provided.

Operating period: 20 hrs, fully charged internal batteries. Signal output: 0–1.0 V at 0–2.0 mA. Calibration: <1% drift/72 hrs. Sensitivity: 1% of full scale. Nonlinearity: <2%. Zero and span drive: <2%/72 hrs. Air flow drift: <1%/72 hours. Noise: 0.75% of full scale. Lag time: 4 min. Rise time to 90%: 4 min. Fall time 90%: 2.5 min. Temperature range: 4.5 to 49°C. Temperature drift: at laboratory conditions ±3°C, ±1%; from 15 to 30°C, ±2%; from 30 to 50°C, ±4%; from 14 to 50°C, ±8%. Relative humidity range: 5% to 95%.

Reagent requirements: SO_2, 3.4 L/week modified West and Gaeke; 3.4 L/week demineralized water; NO_2, 3.4 L/week modified Saltzman (Lyshkow).

18-6-2. Ultraviolet Photometric Ozone Analyzer

Columbia Scientific Corporation, a division of Forney Corporation

The Photomet™ 3100 Analysis method, which measures ozone directly, is based on the absorption of UV radiation by ozone at the 254 nm band using the Beer-Lambert Law to arrive at the exact concentration. Ozone concentration is displayed digitally in ppm or mg/m^3 and can be corrected automatically for temperature and pressure. Ranges of 0.5 and 1.0 ppm are the EPA designated ranges for this equivalent method. Potential instrument drift is compensated for by continuous alternating measurements of zero air and ozone air. Ranges: .05 to 1.0 ppm. Lower Detectable Limit: 2.0 ppb. Noise: <± 1 ppb. Lag Time: < 20 seconds. Rise Time/Fall Time: 15 seconds. Zero/Span Drift: < 2 ppb/24 hours. Precision: ± 2 ppb. Linearity: ± 0.2%. Cycle time: Updated results every 10 seconds. Operational Specifications: Sample flow rate: 2.5 ± 0.5 lpm. Outputs: display, 0–1 V (other voltages available), RS-232 (optional). Optional internal ozone generator for span checks requires 5 lpm of clean dry air.

18-6-3. Model 1003 Ozone Monitor

Dasibi Environmental Corporation

The Model 1003 Ozone Monitor continuously monitors the concentration of ozone in the air in ppm. An analog output is available for continuous strip-chart recording, and a binary-coded decimal (BCD) output enables direct interfacing with a computer or a printer. Ozone concentration is measured by detecting the absorption level of UV light within a sample volume of air. Accuracy: ±3%. Scale factor: adjustable to any standard. Drift: <0.001 ppm/week noncumulative. Zero span: ±0.4%/°C, corresponding to much less than 0.001 ppm. Interval: 8 or 30 seconds. Flow rate: 7 L/min at 8-second intervals; 1.0 L/min at 30-second intervals. Zero return: 1 interval from 1.0 ppm. Temperature: 0 to 49°C. Meets vibration and shock constraints typically encountered in shipping, aircraft, and mobile vans; maintenance, 1000-hr mean time between maintenance under typical conditions.

18-6-4. ML®9810B Ozone Analyzer

Monitor Labs, Inc.

The ML®9810B utilizes ultraviolet photometric measurement to quantify ozone concentrations. The unit is designed to be a cost-efficient solution for ambient air quality monitoring systems (AQMS) and continuous emission monitoring systems (CEMS). The units include sample pumps and particulate filters. UV light is generated by a temperature controlled mercury arc lamp and is filtered to select the wavelength of interest, collimated, and directed through a single glass measurement cell to the detector. The unit features easy to maintain single-cell construction, classical narrow band UV measurement, programmable automatic zero/span calibration checks, optional internal UV driven ozone generator for automatic span checks, and exceptional stability.

18-6-5. ML®9850B (MB) Sulfur Dioxide Analyzer

Monitor Labs, Inc.

The ML®9850B and ML®9850MB are based on detection of the UV excited fluorescence of the SO_2 molecules. When the unknown gas sample is exposed to specific wavelengths of UV light, the SO_2 molecules are excited and emit a photon when they relax to their normal energy state. The excitation intensity is sensed by a reference detector so that the measurement can be processed using a ratiometric technique. The units are designed for AQMS and CEMS monitoring. The units feature rugged reliable measurements, internal scrubbers to remove potential interfering hydrocarbons, programmable automatic zero/span, long life UV lamp, and no continuously moving parts.

18-6-6. Instantaneous Vapor Detector

Sunshine Scientific Instruments

The Instantaneous Vapor Detector is intended primarily for the detection of mercury vapor but can be used for the detection of other vapors in specified ranges of concentration. Applications include the manufacture of electrical apparatus, instruments, bulbs, glassware, fur, and salt; use in the chemical, metal mining, and smelting industries; and use by insurance companies and laboratories. Operation of the detector is based on UV light absorption by mercury vapor. This same principle is also used for the detection of certain other vapors that have selective absorption characteristics for UV radiation. For this reason, the identity of the vapor under test must be known and the vapor must be free from other substances which will absorb or obstruct UV light. In addition, the vapor should be relatively uncontaminated by extraneous substances such as fog, dust, or smoke. Features: warm-up time <15 minutes; <1% change in reading for 10% line voltage variation. Low power consumption permits operation from a battery-powered inverter for complete portability. Special options include explosion-resistant Model 38E, recorder output, single-

or dual-set point meter (Model 38F), panel or rack mounting, audible/visible alarms, and systems for monitoring multiple locations.

18-7: Chemiluminescence

18-7-1. Chemiluminescent Nitrogen Oxides Analyzer

Columbia Scientific Corporation, a division of Forney Corporation

The Model 5600 NO_X Analyzer performs specific, real-time and continuous dry analysis of ambient level nitric oxide and nitrogen dioxide in gas mixtures by detecting chemiluminescence resulting from the nitric oxide/ozone reaction. The reaction chamber and photomultiplier tube are thermally stabilized to ensure accurate readings over widely varying ambient temperatures without the need for moving parts such as a chopper. An exclusive photon counting technique filters photomultiplier noise far more effectively then conventional techniques. The logical menu-driven operation is extremely user-friendly and features a liquid crystal display. Range: 0 to 50,000 ppb. Noise: 0.05 ppb. Linearity (0 to 50,000 ppb): NO and NO_X 1% Full Scale (FS), NO_2 1.5 % FS. Lower Detection Limit: 0.1 ppb. Zero Drift: < 1ppb/day. Span Drift: < ± 1 %/day. Precision: ± 3 ppb. Rise Time: 120 seconds. Lag Time: 8 seconds. Interference Equivalent: < 20 ppb. Operational Specifications: Sample flow rate: 500 mL/min. Ozone generator flow rate: 125 mL/min. Temperature Range: 10 to 35 C. Humidity Range: 0 to 95% RH non-condensing. Output: Display, RS-232 (other outputs available).

18-7-2.Chemiluminescent Ozone Analyzer

Columbia Scientific Corporation, a division of Forney Corporation

EPA-designated Model OA325-2R/OA350-2R detects chemiluminescence from the reaction between excess ethylene and ozone in ambient air. Unlike the UV photometric, its chemiluminescent measurement is free from interferences of other gases. The Model OA325-2R provides cost-effective ozone monitoring while the Model OA350-2R incorporates internal calibration capability. Temperature control of the photomultiplier tube and flow controllers ensure repeatable results. Range: 0 to 0.01, 0.1, 0.5, 1.0, 5.0, and 10.0 ppm. Noise: 0.0005 ppm at 20% URL: 0.002 ppm at 80% URL. Lower Detectable Limit: 0.001. Zero Drift : ± 0.002 ppm/day. Span Drift: ± 1.5 % at 20% URL, ± 2.5 % at 80 % URL. Lag Time: 1.0 min. Rise Time/Fall Time: 0.5 min. Precision: 0.001 at 20% URL, 80% URL. Linearity: + 1% Full Scale.

18-7-3. NGA 2000 Heated NO/NOx Analyzer Module (WCLD)

Rosemount Analytical, Inc.

The NGA 2000, Wet Chemiluminescence Detection Analyzer Module (WCLD) is the industry's first modular analyzer designed to meet environmental regulations on NO_x emissions. It's heated sample handling module for hot/wet gas samples eliminates loss of NO_2 in sample condensate. A built-in Peltier Cooler removes moisture after NO_2 conversion. Applications such as internal combustion engine emissions (ICEE), continuous emissions monitoring systems (CEMS), and NO_x scrubber efficiency monitoring can all benefit from increased accuracy and simplified sample handling requirements associated with the WCLD.

18-7-4. NGA 2000 CLD NO/NOx Analyzer Module

Rosemount Analytical, Inc.

The NGA 2000 Chemiluminescence Detector (CLD) NO/NO_x Analyzer module provides quick and accurate measurement of oxides of nitrogen (NO/NO_x) over a wide dynamic range from 0 to 10 ppm through 0 to 10,000 ppm. It's thermoelectrically cooled solid-state detector insures high stability. Designed for such varied applications as continuous emissions monitoring systems (CEMS), process gas analysis, and internal combustion engine emissions (ICEE), the CLD may be a stand alone analysis instrument with the addition of the Input/Output (I/O) Module and Platform or it can be integrated into a sophisticated multi-component analysis network. It is an efficient, interferent free vitreous carbon NO_2 Converter.

18-8: Photometric Analyzers

18-8-1. AutoStep Plus Portable Toxic Gas Monitor

Bacharach, Inc.

The AutoStep Plus is a microprocessor-controlled portable paper tape toxic gas detector. The AutoStep Plus utilizes a removable, gas-specific ranging or gas-type module to monitor for TDI, MDI, hydrazines, Phosgene "A," Phosgene "B," or acid gas. Multi-gas modules are available to monitor for TDI, MDI, and HDI or chlorine, hydrides, and acid gas. The detection principle is colorimetric paper tape and reflected light, level measurement controlled by the microprocessor. Other features of the Autostep Plus include 2,000-point datalogging capability, built-in audible alarm, and external battery and data connectors. The precision depends on gas and model: 15% of reading or 1 ppb/0.1 ppm, whichever is greater.

The AutoStep Plus can operate from –10 to 40°C and in 5% to 95% relative humidity, non-condensing.

18-8-2. Sure-Spot Test Kit, GMD Systems

Bacharach, Inc.

The Sure-Spot Test Kit is a portable, colorimetric paper tape test system for a variety of toxic gases, such as MDI, TDI, HDI or NDI. Air is drawn through a test card with a pre-calibrated pump and a colored stain is developed based on the reaction with the toxic material of interest. The intensity of the color stain is directly proportional to the concentration of gas present. Can detect isocyanates down to the 1 ppb with an accuracy of +/– 25%. The unit is easily carried by a worker and can operate at temperatures of 10° to 40° C, and 20–85% RH.

18-8-3. Remote Intelligent Sensor (RIS)

Bacharach, Inc.

The Remote Intelligent Sensor (RIS) is housed in an environmentally sealed (NEMA 4), tamper resistant enclosure and operates from an external 12 VDC power supply. The unit utilizes colorimetric paper tape with reflected light level measurement as the detection principle, in a datalogging, remote housing. Paper tape units are available for TDI, MDI, HDI, PPDI, hydrazine, MM hydrazine, phosgene (A and B), chlorine, arsine, acid gases, and HCl. The data can be sent to a printer on a regular basis or will store data up to 8–10 hrs. Large LCD readout display. Unit detects gases in the ppb ranges with accuracy of +/– 15% (+/– 1 ppb). Operates over the temperature range of –40° to 80°C, 40–90% RH (non-condensing).

18-8-4. Flame Photometric Total Sulfur Detector

Columbia Scientific Corporation, a division of Forney Corporation

The continuous, dry optical principle of the Flame Photometric Detector (FPD) is used in the Model SA285 to measure total sulfur. The Model SA285 incorporates continuous performance reliability, high sensitivity, speed of response, and level of precision needed for area monitoring and for basic research. Model SA285E and Model SA285H are available for specific applications to measure sulfur dioxide and hydrogen sulfide respectively. Four linear ranges : 0 to 50 ppb, 100 ppb, 500 ppb, 1 ppm. Noise at 80% URL: ± 2.5 ppb. Lower Detectable Limit: 1.0 ppb. Zero Drift: ± 2 ppb. Span Drift: ± 10 % at 20%URL, ± 3 % at 80% URL. Lag Time: 5 seconds. Rise Time/Fall Time to 95%: 0.5 to 5 ppb. Precision: 1.0 at 20% URL, 4.0 at 80% URL. Linearity: ± 1.0 %. Temperature Range: 10 to 40°C. Unattended Operation: 14 to 28 days. The Model SA260 is also available for flame photometric detection of sulfur up to 10 ppm.

18-8-5. Ultraviolet Fluorescence Sulfur Dioxide Analyzer

Columbia Scientific Corporation, a division of Forney Corporation

The Model 5700 SO_2 Analyzer performs specific, real-time and continuous dry analysis of ambient level sulfur dioxide in gas mixtures by detecting fluorescence resulting from illumination with ultraviolet light. The reaction chamber and photomultiplier tube are thermally stabilized to ensure accurate readings over widely varying ambient temperatures without the need for moving parts such as a chopper. An exclusive photon counting technique filters photomultiplier noise far more effectively then conventional techniques. Range: 0 to 20,000 ppb. Noise: 0.2 ppb. Minimum Detectable Sensitivity: 0.4 ppb. Interference Equivalent: < 20 ppb. Zero Drift (24 hour): ± 1ppb. Span drift (24 hour): ± 1 %. Precision: 1 ppb at 200 ppb, < 1% above 1000 ppb. Lag Time: 20 seconds. Rise Time: 140 seconds. Linearity: ± 1 %. Temperature Range: 0 to 35°C. Humidity Range: 0 to 95% RH non-condensing.

18-8-6. Flame Photometric Phosphorous Gas Analyzer

Columbia Scientific Corporation, a division of Forney Corporation

The operating principle of the Model PA260 utilizes the photometric detection of the 526 millimicron band emitted by compounds which contain phosphorous in a hydrogen rich air flame. The specificity of the measurement results from the geometric arrangement which optically shields the photomultiplier tube from the primary flame and from the employment of a narrow bandpass interference filter. Selectable current ranges on a log scale for concentrations of 0.005 to 1 ppm may be used with good quantitative results to a maximum of 10 ppm. Minimum Detectable Sensitivity: 0.5 ppb. Noise: ± 0.5 ppb. with 1 to 10 sec time constant. Lag Time: < 15 seconds. Rise Time/Fall Time: < 30 seconds. Precision: + 1.0 ppb. Zero Drift: + 0.5 ppb/ day. Span drift: ± 2% of reading per day. Operational specifications: (7) days unattended operation. Sample flow rate is approximately 240 ml/min. Hydrogen flow rate is approximately 125 ml/min. Relative Humidity: 0 to 99% non-condensing. Ambient temperature range: 10 to 40°C. Model SA260 is also available for flame photometric detection of sulfur up to 10 ppm.

18-8-7. Model 722R H_2S Gas Analyzer

Houston Atlas, Inc.

The 722R can be used either as a stand alone hydrogen sulfide analyzer or coupled with any of the range extension, sample conditioning or hydrogenation systems to measure ppb, ppm or percent levels. The Model 722R operates continuously and automatically with no interferences. Conforms with ASTM methods D 4084, D 4323, and D 4468. Applications include environmental monitoring, trace H_2S measurements, reformer cycle gas, sweeting plants, personnel protection, amine and caustic treaters, stack monitoring, and fuel gas boilers.

18-8-8. Dräger CMS Portable Gas Monitor

National Draeger, Inc.

The Drager Chip Measurement System (CMS) utilizes a chip containing 10 capillaries filled with specific reagents which react with the gas of interest, producing a color reaction. The color change is read optically and is displayed in a digital readout. The monitor itself is a hand-held unit with push button operation and any of 15 different chips can be inserted for different gases. Currently available chips include benzene, NH_3, CO_2, CO, Cl_2, HCl, HCN, H_2S, NO_x, NO_2, SO_2, and perchloroethylene. Features include a constant mass flow unaffected by atmospheric fluctuations, predetermined temperature and humidity effects, and is intrinsically safe (UL Class I, Division I, Group A, B, C, and D).

18-8-9. Rotorod H_2S Gas Sampler, Model 721

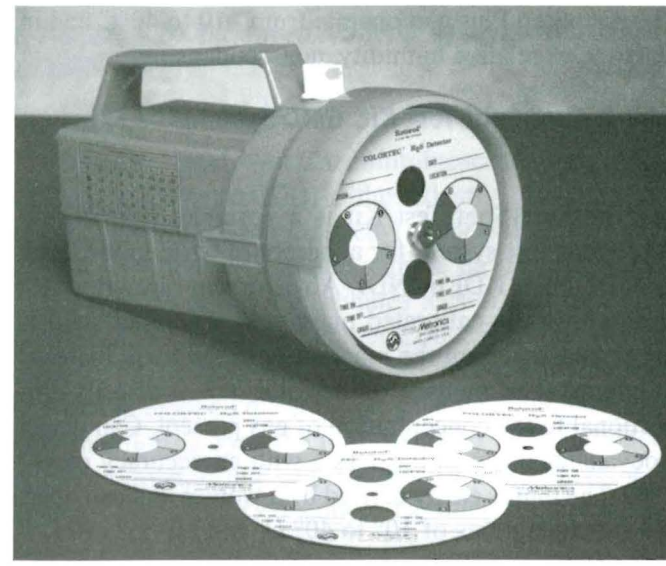
VICI Metronics, Inc.

The Model 721 H_2S Gas Sampler provides a fast, simple and economical way to measure low concentrations of H_2S. Detector discs contain a chemically treated pad that develops a dark color in the presence of H_2S. The spinning disc samples a high volume of air to give a sensitivity in the ppb range in less than 3 minutes. Color reference standards printed on each disc allow instant dosage evaluation. The detector is also used to monitor ambient levels of H_2S by mounting the tag in a simple tubular shelter.

18-8-10. MDA Scientific Model CM4 Continuous Gas Monitor

Zellweger Analytics, Inc.

The MDA Scientific Model CM4 continuously monitors ambient air and ventilation systems for toxic, corrosive, and pyrophoric gas levels. The instrument simultaneously analyzes up to four locations, 300 feet (90 meters) or more from the monitor. The Model CM4 uses the Chemcassette® colorimetric detection method, measuring down to ppb levels with virtually no interference from other common gases. Chemcassette technology provides physical evidence of the presence of the target gas. Model CM4 provides hazardous gas detection and monitoring protection for the semiconductor, pharmaceutical, and chemical industries. Several communications configurations are available, including LonWorks®, Wonderware In Touch®, Intellutions Fix 32®, and Profibus® to link multiple instruments and provide hundreds of monitoring points. Calibrations are available for more than 25 toxic and corrosive gases,



INSTRUMENT 18-8-9. Rotorod H_2S Gas Sampler, Model 721.

INSTRUMENT 18-8-10. MDA Scientific Model CM4 Continuous Gas Monitor.

including ammonia, oxidizers, hydrides, mineral acids, hydrogen cyanide, hydrogen sulfide, PFCs, phosgene, and others. Nitrogen trifluoride (NF_3) can be detected by the Model CM4-P, a pyrolyzer version, which converts NF_3 to hydrogen fluoride via pyrolysis.

18-8-11. MDA Scientific ChemKey TLD Gas Monitor

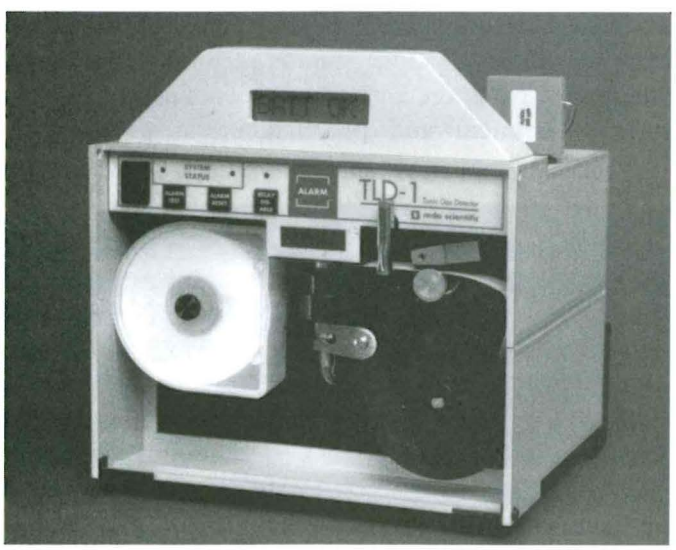
Zellweger Analytics, Inc.

The MDA Scientific ChemKey TLD gas monitor is a portable, direct-reading instrument capable of detecting and measuring over 40 different toxic, corrosive or pyrophoric gases. The unit is ideal for use by emergency response teams, industrial hygienists, or anyone who needs to monitor for different hazardous gases. The instrument features a unique ChemKey Gas Selection System, a programmed key which, when installed, allows operators to switch monitoring modes from one gas to another. All that is required is a simple change of key and a Chemcassette colorimetric tape. The exclusive Chemcasstte tape technology provides physical evidence of the presence of the target gas. Gases detected by the ChemKey TLD include ammonia, arsine, chlorine, diborane, diisocyanates, hydrazines, hydrogen fluoride, hydrogen chloride, hydrogen cyanide, hydrogen sulfide, phosgene, phosphine, silane, and many other hazardous gases. It features built-in audio/visual alarms, 4–20 mA output, and mechanical alarm relays.

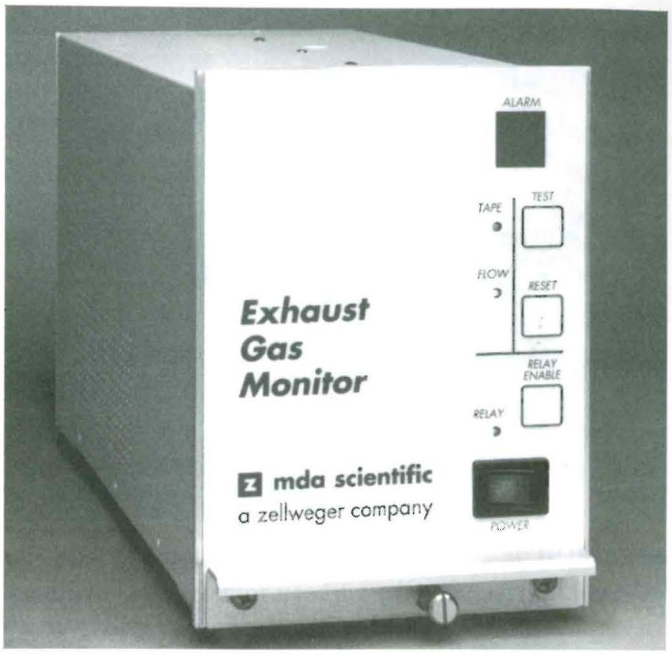
18-8-12. MDA Scientific Model EGM Exhaust Gas Monitor

Zellweger Analytics, Inc.

The MDA Scientific Model EGM Exhaust Gas Monitor is a compact, simple to operate, low-maintenance gas monitor designed to continuously monitor for toxic gases in gas cabinet ventilation, laboratory vent hoods, and other pre- and post-process exhaust streams. The unit is considered ideal for meeting environmental regulations, process control and safety concerns. Model EGM offers low level gas detection in the parts-per-billion and higher levels using the exclusive Chemcassette colorimetric detection system. The instrument features low maintenance, ease of use, and a compact, panel mountable enclosure. Gases monitored include aliphatic amines, chlorine/oxidizers, hydrides, hydrogen cyanide, hydrogen peroxide, hydrogen sulfide, mineral acids, ozone, phosgene, and sulfur dioxide.



INSTRUMENT 18-8-11. MDA Scientific ChemKey TLD Gas Monitor.

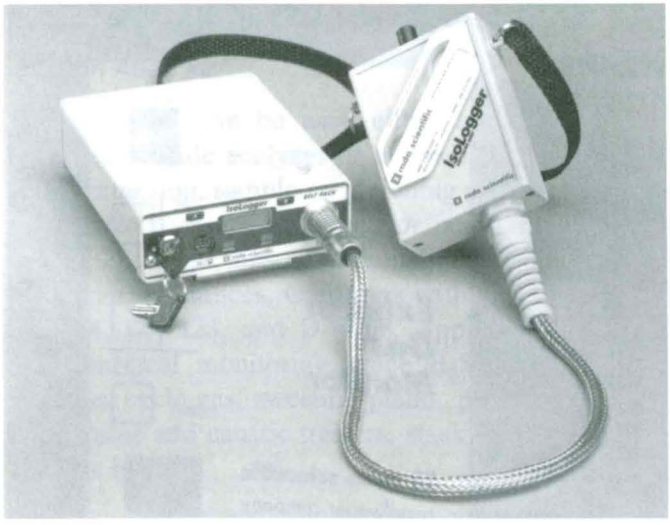


INSTRUMENT 18-8-12. MDA Scientific Model EGM Exhaust Gas Monitor.

18-8-13. MDA Scientific IsoLogger® Personal Gas Detection System

Zellweger Analytics, Inc.

The MDA Scientific Isologger is a compact personal gas monitoring system for datalogging and reporting exposures to isocyanate gases such as those found in urethanes, chemical, and petrochemical production. The unit may also be used as an area monitor for survey and temporary monitoring. The system uses the well-proven Chemcassette colorimetric method of detection for part-per-billion sensitivity, provides excellent selectivity without interference and requires no gas calibration. User-selectable audio and visual alarms are provided as well as a real-time display. A Windows-based datalogging software package is provided for tabular and



INSTRUMENT 18-8-13. MDA Scientific IsoLogger® Personal Gas Detection System.

graphic reporting of data. Detectable gases include HDI, IPDI, MDI, TDI, AsH_3, HCl, $COCl_2$.

18-8-14. MDA Scientific Model SPM Gas Monitor

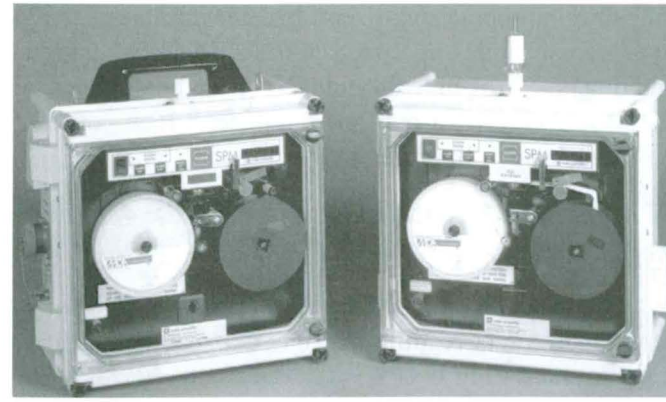
Zellweger Analytics, Inc.

MDA Scientific Model SPM single point monitor provides a rugged, portable, fast response gas detector. The unit can be used as a fixed point monitor or a portable instrument for surveying, and is designed for harsh industrial applications, including chemical, petrochemical, and urethanes production environments. Model SPM detects specific target gases with sensitivity at ppb levels, and utilizes exclusive Chemcassette colorimetric technology to provide physical evidence of gas detection. Over 50 toxic, corrosive, or pyrophoric gases calibrations are available. The list of gases and gas families includes: amines, ammonia, bromine, chlorine, chlorine dioxide, diisocyanates, hydrazines, hydrides, hydrogen cyanide, hydrogen peroxide, hydrogen sulfide, mineral acids, nitrogen dioxide, ozone, phosgene, and sulfur dioxide.

18-8-15. MDA Scientific Series 7100 Gas Monitor

Zellweger Analytics, Inc.

The MDA Scientific Series 7100 continuous gas monitor responds instantly to hazardous gas leaks and pinpoints concentrations as low as 1 ppb with full documentation and self-diagnostics. It is considered ideal for applications where a quick starting, fast response, user-friendly gas detection and monitoring instrument is needed. These applications include monitoring gas storage areas, gas cylinder changes, bulk chemical transfers, equipment repairs, survey work, spill clean-ups, and emergency response situations. The instrument ignores non-target gases which can trigger false alarms in other detection systems. Exclusive Chemcassette colorimetric technology provides physical evidence of the target gas, even at ppb levels. The Chemcassette tape is continually advanced during monitoring which prevents the tape sensor media from "falling asleep" or becoming permanently poisoned. Series 7100 instruments detect and monitor over 50 toxic and corrosive gases, including amines, diisocyanates, hydrazines, hydrides, mineral acids, and oxidizers.

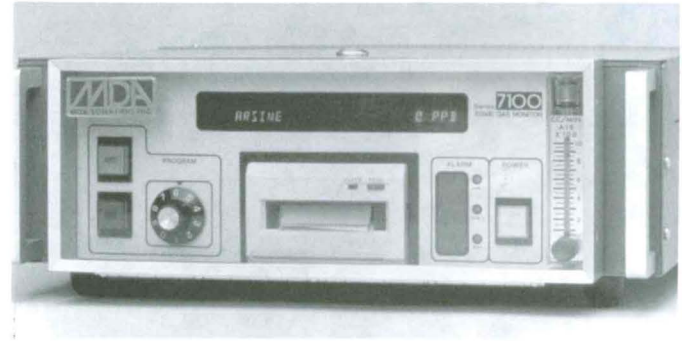


INSTRUMENT 18-8-14. MDA Scientific Model SPM Gas Monitor.

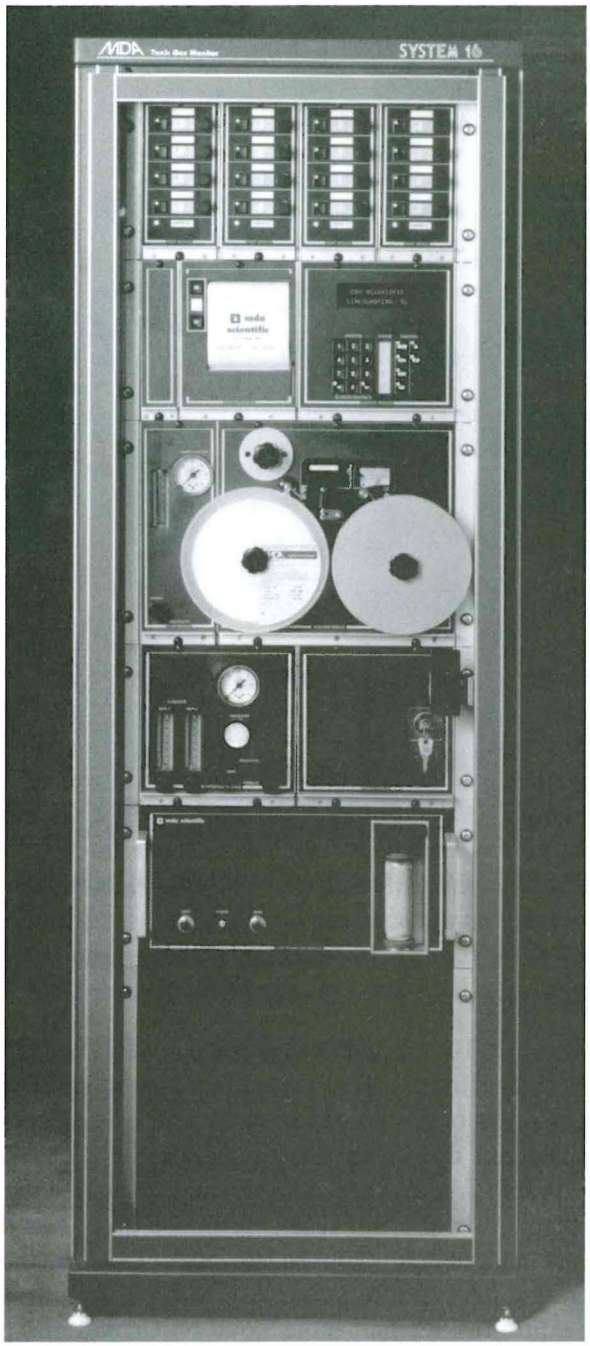
18-8-16. MDA Scientific Series 16 Gas Monitor

Zellweger Analytics, Inc.

The MDA Scientific System 16 is a modular toxic gas monitoring system designed for simple in-field expansion and is capable detecting and monitoring one or two different toxic, corrosive, or pyrophoric gases or gas families at 4 to 16 individual locations (points). A System 16 modular multipoint monitor provides extremely cost-effective surveillance of work areas and chemical storage areas in semiconductor manufacturing, chemical and pharmaceutical production.



INSTRUMENT 18-8-15. MDA Scientific Series 7100 Gas Monitor.



INSTRUMENT 18-8-16. MDA Scientific Series 16 Gas Monitor.

System 16 uses the exclusive Chemcassette colorimetric detection system for specific, low-level gas detection. The instrument can be expanded by simply plugging the appropriate sampling or detection module into the chassis. Additional monitoring points are brought under surveillance by adding a sample module; the number of gases monitored is increased by adding a detection/analyzer module. Up to three 4-point sampling modules and one additional analyzer module may be added to the each system. The instrument also features a built-in printer, local digital display, alarm relays and complete self-diagnostics. System 16 offers calibrations for more than 25 toxic gases including ammonia, oxidizers, hydrides, mineral acids, hydrogen cyanide, hydrogen sulfide, PFCs, and phosgene. System 16 is available for the detection and measurement of dozens of gases including ammonia, chlorine, arsine, diborane, phosphine, silane, HCN, HCl, HF, phosgene and nitrogen trifluoride.

18-9: Thermal Conductivity Detectors (also see 18-12 Multi-Gas Monitors)

18-9-1. Leak Hunter Plus Model 8066

Matheson Gas Products

The Model 8066 Leak Hunter *Plus* is a portable handheld leak detector used for pinpointing gas leaks in gas handling systems. Using a thermal conductivity sensor and ambient air as its reference, the Leak Hunter *Plus* can be used for detecting helium, hydrogen, carbon dioxide, argon, sulfur hexafluoride and halocarbons. With a response time of less than one second, the unit provides both audible and visual readouts indicating positive leak location and leak size. The instrument's probe attaches to the body for single handed operation, or can be detached allowing access to tighter spaces. Memory resident calibration data, user selectable measurement units and a peak hold function facilitate the measurement of leak size.

18-10: Heat of Combustion Detectors (see also 18-12, Multi-Gas Monitors)

18-10-1. Leakator™ 10

Bacharach, Inc.

The Leakator™ is a battery operated, hand-held, combustible and toxic gas leak detector. Ten bright LEDs show level of gas presence while 3 separate LEDs indicate sensor status, power levels and power on. The instrument is inexpensive, has a longer probe for small area testing, earphone, and 20 hours of battery operation.

18-10-2. TLV SNIFFER®

Bacharach, Inc.

This instrument operates on the principle of catalytic combustion (a process of oxidizing a combustible gas/air mixture on the surface of a heated catalytic bead element). Designed for low level combustible gas detection (0–100 ppm scale) for use as a leak detector,

assessment of contaminant conditions, or arson investigations. Eight-hour continuous operation is possible with six size D, Ni-Cd batteries or approximately 3 hrs with six size D, carbon-zinc batteries. Sampling rate: 1.65 L/min, nominal. Readout mode: meter, audible alarm, earphone output, and recorder output. Response time: initial response within 12 seconds of exposure. Its stability is in keeping with instruments of similar sensitivity and construction.

18-10-3. Sniffer® 300 Series

Bacharach, Inc.

The Sniffer Series 300 gas indicators are designed for intermittent measurement of combustible gases and oxygen deficiency. The internal pump allows sampling up to 100 feet away. The rugged instruments are in ergonomically designed, rugged, weatherproof cases with a built-in handle with locking trigger-style switch and a shoulder harness. Applications include general industry and government, plant and welding surveys, leak detection and confined space entry. Units are powered by four size D batteries (alkaline, C-Zn, or Ni-Cd); operate in temperature ranges from –20 to 50°C (limited by battery specifications), and have non-latching visual and audible alarms.

18-10-4. ABL-50, 741 and 4021 Series Respiratory Air Monitors

GfG dynamation

The Model ABL-50 is a CO monitor/alarm specifically designed for respiratory airline breathing applications. It will continuously indicate the level of CO in ppm on its built-in meter and activate external alarms if the concentration exceeds the preset alarm threshold. The Models ABL-741 and 4021 also monitor for oxygen levels and organic vapors. The Model ABL-50 is connected to a tee fitting in the airline that bleeds off a small, continuous sample of air flowing between the compressor and the user. This sample is filtered for particulate matter, has the oil mist removed, and is regulated to 10 psig before passing over the solid-state, catalytic semiconductor sensor. Enclosure: polyester fiberglass NEMA 4 with cover latch. Controls: calibration and alarm threshold internal. Meter size: 2.5 in. Response: 90% of maximum reading within 2 min with 20 ppm CO concentration; faster at higher concentrations. Alarm adjustment range: 2–50 ppm CO. Recorder output: 0–1 mA. Interferences: other types of organic vapors will be detected if present in high concentrations or at their TLV. Sensor purge period: 1 min nominal. Sensor stabilization period: 10 min nominal.

INSTRUMENT 18-10-5. Model EX-10 Personal Gas Detector.

18-10-5. Model EX-10 Personal Gas Detector

ENMET Corp.

The EX-10 is a pocket-sized combustible gas detector designed for personal protection of workers in hazardous areas or for confined space entry. The catalytic sensor in this instrument has a typical life expectancy of 3–5 years. Alarms are audible and visual, and are adjustable over the full scale. Response time: less than 10 seconds when exposed to 50% LEL methane. Operating temperature range: –10 to 55°C for intermittent exposures. Rechargeable 3.6-V Ni-Cd batteries provide 45 hrs of continuous operation.

18-10-6. Macurco Gas Detectors

Macurco, Inc.

Macurco offers a wide range of stationary monitors for CO, combustible gases, ammonia refrigerants, various toxics, and hydrogen. These units cover a wide range of applications including use in homes, offices, warehouses, commercial buildings, maintenance facilities, parking garages, bathrooms, conference rooms, chillers, coolers, poultry operations, etc. The units may be plugged into 120 VAC for continuous use or operated on 12 VDC and use low maintenance, long-life (7–10 years)

solid-state semiconductor sensors. Dozens of different units are available depending on the applications, size, power requirements, etc. A variety of alarm and output options are available.

18-10-7. Model 8057 Hazardous Gas Leak Detector

Matheson Gas Products

The Model 8057 General Purpose Leak Detector is a portable handheld leak detector ideal for pinpointing leaks of a variety of hazardous gases including ammonia, chlorine, hydrogen sulfide, sulfur dioxide, and hydrides. Its general purpose sensor enables detection for a wide variety of gases and vapor without requiring individual sensors, making it an extremely versatile leak detector.

18-10-8. D-Series Combustible Gas Systems

Scott Aviation

The D-Series line of portable instruments detects most combustible gases or vapors in air measured in ppm or LFL. The unit is used to safeguard lives and property. Applications include in petroleum refineries, petrochemical plants, steel mills, on gas transmission and distribution pipe lines, off shore, in the fire and police service, occupational hazard surveys, in the maritime industry, the military, telephone and radio communications, or mines. Scott portables detect hazardous conditions in virtually any industry, commercial or even residential environment.

18-10-9. Pocket Ozone Detector

Spectrex Corporation

The Spectrex Model A-20ZX Ozone Detector utilizes a semiconductor sensor to reliably and simply check ozone concentrations. Application include around water purifiers, ozone generators, air purifiers, laser printers and copiers, pulp bleaching, power generators and specialty manufacturing. The unit can detect down to 0.01 ppm of ozone over the range of 0-1 ppm. Weighs only 142 gm, and fits easily into a shirt pocket. Other features include a carrying case and rechargeable batteries. The Model C-30Z is a continuous, fixed monitor for ozone that displays concentration with a series of color bars. The unit comes with various warning displays and audible alarms.

18-10-10. Model SXC-20 VOC Monitor

Spectrex Corporation

The Model SXC-20 is a portable VOC monitor that utilizes a semiconductor sensor. The unit can detect over 100 VOCs and the response is indicated in a color bar display. The unit will run for up to 8 hours and has a built-in datalogger. The SXC-20 features an internal sampling pump to provide active sampling and faster response and the ability to connect a VOC sampling tube which automatically turns the sample on when a preset VOC level is detected.

18-11: Gas Chromatographic (GC) Analyzers

18-11-1. Crowcon ISFID-ISFIDGC Portable Gas Chromatograph

Crowcon Detection Instruments

The Crowcon ISFID unit can be used as a direct-reading flame ionization detector, or the ISFIDGC allow for chromatographic separation. The ISFID has a sampling pump that draws air through a hand held probe and passes it to the FID. The unit weighs 8 pounds, 11 for the GC, and provides a visual and audible output within 2 seconds. The magnitude of the signal is linear and proportional to the concentration of the organic sample. The unit has flame arrestors on every entry and is FM approved for use in Class I, Division I, Groups, A, B, C, and D. The unit has automatic ignition and warms up to use in just 2 minutes. An LED status light assures flow conditions are constantly maintained. The meter is backlit for use in low light applications, and the cylinder will last up to 50 hours. Battery life is 45 hours based on 6 alkaline cells. The GC offers a large selection of interchangeable columns and the unit has datalogging capabilities.

18-11-2. CENTURY TVA-1000 Toxic Vapor Analyzer (see Instrument 18-4-2)

Foxboro Company

18-11-3. Model 311D Portable Gas Chromatograph

HNU Systems, Inc.

The 311D gas chromatograph offer a range of compact versatility for environmental analysis of organic compounds. Four different detectors are available, including two detectors operational at once. Packed or capillary columns can be used, as well as a a wide range of isothermal or programmed temperatures, including temperature ramping. The units feature all the extras of a laboratory gas chromatograph, but in a rugged, compact package. Other features include Peakworks® software for data handling and report generation, and a concentrator to go down to parts per trillion levels.

18-11-4. Voyager™ Portable Gas Chromatograph

PE Photovac

Weighing just 15 pounds, the PE Voyager gas chromatograph (GC) is a truly portable, battery operated,

point-and-press instrument ergonomically designed for Environmental Site Characterization and Occupational Safety and Health monitoring. The Voyager uses gas chromatography to isolate and measure the compounds of interest. For users who need to monitor for specific VOCs in the presence of other compounds, this is the best way to eliminate interferences. Typical examples are BTEX in gasoline environments and 1,3-butadiene in C4 isomeric hydrocarbon backgrounds. With its on-board carrier gas and rechargeable battery, the Voyager can operate independently on-site for up to 8 hours. Users can view chromatograms and/or tabular results using the built-in backlit LCD. If desired, results can be uploaded to a computer in the field, or back at the lab or office. The unique Voyager Analytical Engine includes a smart selection of three columns, preinstalled, and selectable just by pressing a key. The three columns offer overlapping selectivity and confirmational analysis of "light," "medium," and "heavy" compounds of interest within complex environments. There is no need to worry about changing columns. Each Voyager is delivered with the user's choice of one or more Applications Assays. Each Assay automates the setup of all the instrument operating conditions and all of the data reduction parameters pertinent to a predefined set of compounds. Running the application is as simple as press and go.

18-11-5. Scentograph "Plus II" and Scentoscreen Portable Gas Chromatographs

Sentex Systems, Inc.

The Scentograph is a portable gas chromatograph designed to provide onsite field analysis with laboratory gas chromatographic quality. Five detector options are available, along with a choice of commercially available columns, either capillary or packed. The units can be heated isothermally or ramped to temperatures up to 180°C. The unit has an internal battery and gas supply for total portability or can be connected to AC power for prolonged use. A detachable laptop PC with applicable software controls the system and conducts the sample analysis, storing the results on disk for future recall.

18-12: Multi-Gas Monitors

These instruments contain detectors utilizing more than one operating principle. The most common example of this instrument is the confined space monitor which has a sensor for oxygen (coulometric analyzers), combustible gases (heat of combustion detectors), and various toxic gases, commonly CO and H_2S (potentiometric analyzers). Similar instruments for Indoor Air Quality applications are listed in the ACGIH publication, *Air Sampling Instrument Selection Guide: Indoor Air Quality*.

18-12-1. Series 200 and 300 Gas Detectors

AIM USA

The Series 200 and 300 Gas Detectors are designed to detect combustible gases, oxygen, and toxic gases. Applications include: confined space entry survey work, industrial safety and hygiene, fugitive emissions and leak detection. Instruments in the 200 and 300 Series are available to detect one, two, or three separate gases. Three datalogging formats are available: alarm incident, time-interval sampling, and location-survey testing. Sensors are chemical-specific electrochemical for toxic gases and O_2, and nonspecific metal oxide for combustible gases. The metal oxide sensor comes standard with the one sensor version and is optional in the two or three sensor versions.

18-12-2. Series 500 Gas Detectors

AIM USA

The Series 500 Gas Detectors are designed to monitor for combustibles, O_2, H_2S, and CO in confined space entry applications. These instruments use metal oxide or Pellister sensors to detect combustibles and electrochemical sensors to detect O_2, H_2S, and CO.

Features of the 500 Series include audible and visual alarms, shock resistance case, and datalogging capabilities for 1300 preset time intervals. Accessories included with the instruments include: power supply, manual, quick start card, confined space booklet, calibration hood, carrying case, QC sheet, and tool kit. Operating temperature range: –20 to 50°C. Operating relative humidity range: 5% to 99%, noncondensing.

18-12-3. Bodyguard® Personal Gas Monitor

Bacharach, Inc.

A personal monitor designed as a one-, two- or three-gas monitor (oxygen, combustibles, and toxics). A simple, rugged instrument design is perfect for daily field use in confined space entry, oil and gas refining, waste water treatment, coal mines and general industry. Uses alkaline or Ni-Cd batteries, has a water-resistant case, and visual and audible alarms. Other features include, one-step zeroing, alternating tone alarms, built-in diagnostics, a confidence light (to show it is on), automatic calibration and easy sensor replacement.

18-12-4. GasPointer® II Combustible Gas Detectors

Bacharach, Inc.

The GasPointer® II detectors are intrinsically safe, battery-powered portable instruments designed to measure concentrations of methane (or propane) and carbon monoxide and/or oxygen in ambient air and flue gas. The instrument is particularly designed for locating natural gas or propane leaks around pipes, fittings and appliances; for measuring excessive levels of carbon monoxide in heating and ventilation systems; and sampling for confined space entry. Available as a one-, two- or three-gas detector, it has a high visibility LCD display which automatically ranges from % LEL to % gas, or % gas by volume (oxygen), or 1–2000 ppm CO. Options include audible and visual alarms, three types of charges, probe assembly with holster, flexible SS probe and calibration equipment and gases. The GasPointer® II can operate in a temperature range of –15 to 50°C and a relative humidity range of 5% to 99%, non-condensing.

18-12-5. Sentinel® 44T Personal Multi-Gas Monitor

Bacharach, Inc.

The Sentinel® 44T is designed to measure O_2, combustible gases, CO, and H_2S in confined-space entry applications. The Sentinel® is equipped with audible and visual alarms that are activated when preset instantaneous levels, short-term exposure limits (STELs), or time-weighted averages (TWAs) are exceeded. Other features include: multi-gas LCD display, radio frequency interference (RFI) protection, datalogging capabilities, optional 44Talk software to download to a computer or printer, and removable battery packs. Accessories include: hand aspirator or motorized pump, 10-in. or 36-in. probes, calibration kits and gases, remote earphone or pocket alarms. Rechargeable lead acid gel cells can operate the instrument for 8–10 hrs per charge. The Sentinel® can operate in a temperature range of –20 to 50°C and a relative humidity range of 05% to 99%, non-condensing.

18-12-6. SNIFFER® 500 Series Portable Area Monitors

Bacharach, Inc.

The SNIFFER® 500 Series Portable Area Monitors are instruments designed to alert personnel to the hazards of O_2 deficiency and the presence of dangerous concentrations of combustible gases, CO, or H_2S. The SNIFFER 500 Series combines sensors for two or three different contaminants. The sensors include a heated catalytic bead for combustible gases and electrochemical cells for O_2, H_2S, and CO. Any combination of these contaminants, up to three, is available. Various visual (steady or pulsing LEDs) and audible alarms (using steady, alternating, or pulsed tones) are used for different instruments. In addition to the various alarm options, the 500 Series includes an integral sampling pump, a variety of concentration ranges for combustibles, analog displays, low flow and battery alarms, and use in hazardous areas. Operating temperature: –20 to 50°C. Response time: variable from 5 seconds to 60 seconds (90% response). Operating time: 10 hrs.

18-12-7. PhD Series and Cannonball® Multi-Gas Monitors

Biosytems, Inc.

The Biosystems PhD5 monitors up to five atmospheric hazards simultaneously: oxygen, combustible gas, and up to three channels of toxic gas detection. Choose from a wide variety of toxic sensors; including Biosystems' innovative new "Duo-Tox" two-channel CO/H_2S sensor to measure both carbon monoxide and hydrogen sulfide when both hazards are present without cross interference.

Biosystems' PhD Lite monitors up to four atmospheric hazards simultaneously: oxygen, combustible gas, carbon monoxide, and hydrogen sulfide. The PhD Lite allows you to choose specific sensors for the detection of CO or H_2S when you have only one toxic hazard to deal with; or choose Biosystems' innovative new dual channel CO/H_2S sensor to measure both carbon monoxide and hydrogen sulfide when both hazards are simultaneously present.

The Biosystems PhD Plus is an economical, confined space gas detector which measures oxygen, combustibles, and up to two additional toxic gases. All normal procedures automatic calibration adjustment are controlled through the single On/Off Mode button. The Biosystems PhD Plus is housed in a rugged, compact case with choice of snap-in NiCad or alkaline battery packs.

The Biosystems PhD Ultra datalogging confined space gas detector measures oxygen, combustibles, and up to two toxic gases. All normal procedures including automatic calibration adjustment are controlled with a single button. The instrument automatically logs gas readings, user and location ID and other important information. The PhD Ultra is housed in a rugged, compact case with choice of snap-in NiCad or alkaline battery packs.

The Biosystems Cannonball2 portable gas detector is also designed to measure oxygen, combustible gas and

up to two toxic gases. It offers the ease of use and dependability of our other gas detection products with the additional advantage of being housed in a gasketed, waterproof case designed to take on the roughest industrial environments and survive.

The Biosystems PhD2 gas detector measures oxygen, combustibles, and up to two additional toxic gases. The PhD2 offers the widest range of toxic sensor choices including CO, H_2S, SO_2, Cl_2, NH_3, NO, NO_2, HCl and HCN. The instrument automatically logs gas readings and other important information.

18-12-8. DEFENDER and MULTIMAX Multi-Gas Detector

BW Technologies

The DEFENDER is designed as a confined space monitor for the detection of combustibles, oxygen, carbon monoxide, and hydrogen sulfide. The unit features a compact and lightweight design, nonintrusive battery/sensor replacement and calibration, two alarm levels per sensor, auto zero and auto span functions, automatic self-test, one button operation, password security, use of Black and Decker VersaPak Ni-Cd batteries, and a rugged ergonomic design. The MULTIMAX offers 2, 3 or 4 gas detectors. In addition to O_2 and combustibles, detectors are available for CO, H_2S, SO_2, Cl_2, ClO_2, HCN, and NO_2. It features an optional sampling pump, data hold, radio linked remote alarm, multiple audible and visual alarms, one switch operation, up to 160 hr of operation on one set of alkaline batteries, intrinsically safe approval and all in a rugged case.

18-12-9. LMS-40 and Personal Surveyor Multi-Gas Monitors

CEA Instruments, Inc.

The LMS-40 is equipped with methane and carbon dioxide infrared measurements, oxygen cell measurements, and temperature and pressure measurements. It is also available for numerous other toxic gases. The LMS-40 has a built-in sample pump with long battery life, an internal datalogger that stores all measurements, time, date, locations, and is user adaptable, has built in 'help' function keys and built-in status checks to avoid erroneous readings. The unit has excellent accuracy and stability in a water resistant lightweight housing plus a serial interface to a computer or directly to a printer.

The Personal Surveyor simultaneously monitors and displays: O_2, Combustibles (%LEL), CO, and H_2S in any one to four gas configurations. The unit is: extremely rugged, has easy one button operation, long life rechargeable and/or alkaline battery packs that easily slide on and off, push button calibration and electronic zeroing, UL, CSA and other intrinsic safety approvals, an internal datalogger with built-in memory back up battery, optional miniature air pump, water resistant and RF shielded, and with a high contrast display with bright backlight.

18-12-10. Custodian, Triple Plus, and Detective Multi-Gas Monitors

Crowcon Detection Instruments

The Triple Plus is a 2-, 3-, or 4-gas monitor, the Custodian and Detective are 3- or 4-gas units. All units feature rugged design in NEMA 4X rated housings and are UL approved for use in hazardous atmospheres. All contain audible and visual alarms, simple controls, datalogging, downloading to printers or personal computers, backlit digital displays, temperature ranges of –10 to 50°C, humidity of 0–95% non-condensing (Triple Plus will float if dropped in water), wide range of sensors, and RFI shielding. Units for combustibles can be made to auto-range which utilizes both a pellistor and a thermal conductivity sensor. In addition to the %LEL and % by volume combustible and O_2 sensors, toxic sensors are available for CO, H_2S, SO_2, Cl_2, HCN, and O_3. The Detective is a transportable multi-gas monitor which can be set up in a hazardous location within minutes and provide area warnings of gas clouds. The unit is mounted on a tripod frame and features an omni-directional sounder and 4 red LED clusters on top. Multiple units can be connected via 30-ft cables to provide a broader warning area.

18-12-11. EXPLORER™ Multi-Gas Monitor

CSE Corp.

The EXPLORER™ is a one-button, three gas, handheld gas monitor. The unit toggles to read each individual gas when the button is pushed. Audible and visual alarms sound if one or more of the gases exceeds a preset limit. The unit can be configured to monitor any of 12 combinations of gases including combustibles, O_2, CO, CH_4, or H_2S. Features include EasyCal 100 calibration unit, backlit LCD display, fast rechargeable Ni-metal hydride batteries, remote sampling pump and probe, and is intrinsically safe.

18-12-12. Multiwarn II

Draeger Safety

The Multiwarn II is a versatile measuring instrument for: 1 to 4 Gases (without infrared sensor) or 1 to 5 gases (with infrared sensor). It is available in two models: basic easy-to-use, or extended with advanced operating software. Sensors available include one or two infrared

INSTRUMENT 18-12-13. BLAQ Box 1300 Series Indoor Air Quality System.

INSTRUMENT 18-12-14. Telaire 7001 Carbon Dioxide and Temperature Measurement Monitor.

sensors, a plug-in catalytic Ex-sensor (for all explosive gases and vapors), or choose from a selection of 13 plug-in, intelligent, interchangeable electrochemical sensors for the measurement of more than 35 different gases. Equipment options include an integrated pump and 50-hour datalogger and versatile operating software.

18-12-13. BLAQ Box 1300 Series Indoor Air Quality System

Engelhard Sensor Technologies

The BLAQ Box is designed for monitoring indoor air quality and ventilation rates over extended periods of time. The unit is enclosed in a rugged, theft and tamper resistant carrying case and includes a cable and padlock. The streamlined push-button interface panel and LCD display give real time readings of carbon dioxide, temperature, relative humidity and carbon monoxide (optional). Data is recorded and can be graphed on a PC or laptop using Windows-based VG Graphing software (included). The CO_2 sensor uses a non-dispersive infrared detector and has a range of 0-5,000 ppm. The electrochemical CO sensor has a range of 0–300 ppm. RH measurements range is 20–95%. Temperature measurement is 0–40°C or 32–112°F. The built-in datalogger has a storage capacity of 14,000 data points and has user selectable sampling intervals.

18-12-14. Telaire 7001 Carbon Dioxide and Temperature Measurement Monitor

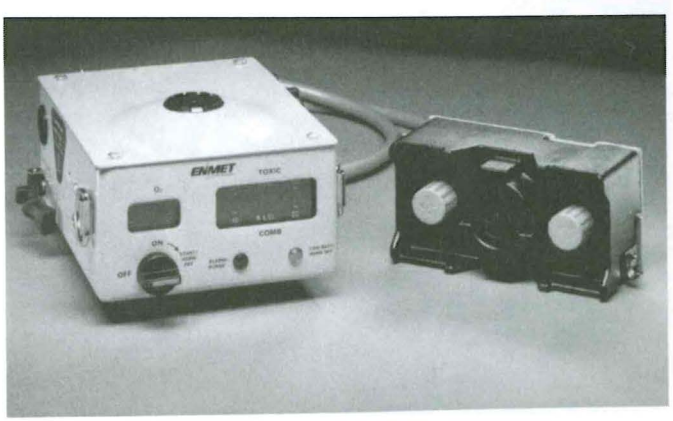
Engelhard Sensor Technologies

This hand-held CO_2 and Temperature monitor was designed to check ventilation rates in commercial or residential applications. The 7001 is equipped with Engelhard's patented dual beam Absorption Infrared technology and has a range of 0–10,000 ppm. The 7001 has the ability to display CO_2 in less than 30 seconds, and is an ideal tool for identifying energy savings opportunities in over-ventilated spaces, determining if air quality complaints are due to insufficient ventilation, or locating the presence of combustion fumes generated from vehicles and appliances. This unit is also equipped with an output for recording data via accessory cable and datalogger. The 7001 comes with an AC adapter or runs on 4 AA batteries for 70 hours.

18-12-15. CGS-90R Portable Gas Detectors; Omni-4000 and Quadrant Multi-Gas Monitors

ENMET Corp.

The CGS-90R portable gas detector for confined space entry features "broad range" toxic and com-



INSTRUMENT 18-12-15. CGS-90R Portable Gas Detectors.

INSTRUMENT 18-12-16. Omni-4000 Portable Programmable Gas Detector.

bustible sensors as referenced in the May 19, 1994 Amendment to the Federal OSHA CFR 1910.146 confined space rule. The instrument also includes a detachable sensor head with 20 foot sensor cable for remote pre-entry testing, separate toxic and combustible bar graphs, and separate digital oxygen display.

The Quadrant is set up to monitor four gases: O_2, combustibles, CO, and H_2S. The Omni 4000 can monitor multi-gases including NH_3, CO, Cl_2, HCN, HCl, H_2S, NO, NO_2, and SO_2, ClO_2, ETO, O_2, and combustibles.

18-12-16. Omni-4000 Portable Programmable Gas Detector

ENMET Corporation

The OMNI-4000 features interchangeable, precalibrated SMART BLOCK sensors, and monitors four gases simultaneously. This unique modular design enables the user to simply and easily convert the instrument for the detection of many different gases. SMART BLOCK modules are available for H_2, CO, H_2S, Cl_2, HCN, HCl, NO, NO_2, NH_3, O_3, ClO_2, ETO, and O_2. Another unique feature allows the user to select the combustible gas they wish to monitor from the instrument's internal memory of 25 preprogrammed combustible gases/vapors. As your requirements for monitoring a specific gas change, all you have to do is plug in a different precalibrated SMART BLOCK module or choose a different combustible gas that meets your current needs. The OMNI-4000 provides TWA and STEL alarms, and continuous datalogging for industrial hygiene applications. It stores up to 48 hours of exposure and event information which can be downloaded to a serial printer or an IBM compatible personal computer.

INSTRUMENT 18-12-17. Quadrant Four-Gas Monitor.

18-12-17. QUADRANT Four-Gas Monitor

ENMET Corporation

The QUADRANT portable gas detector is a very small, light-weight four gas instrument. Compact design with surface-mount electronics provides a truly pocket-size, four-function gas detector. Flexibility in sensor combination (CO, H_2S, O_2, and a programmable combustible sensor) enables the user to customize the instrument to meet their needs. This compact unit can be used with a chest/shoulder harness or belt clip. QUADRANT can be used as a simple warning device or as a sophisticated instrument providing TWA/STEL alarms and datalogging. It was specifically designed with the budget customer in mind.

18-12-18. STM2100 Portable Gas Monitor

GasTech, Inc.

GasTech's STM2100 personal portable gas monitor is designed to protect workers from hazardous gases in confined spaces and other industrial sites. This portable unit can detect up to four gases: oxygen content, combustibles (%Vol, LEL or ppm), and up to two toxics (NH_3, CO, Cl_2, HCN, H_2S, NO, NO_2, or SO_2). The unit features, simultaneous display of all four gases simultaneously, one button operation, two UL listed NiMH battery packs or alkaline batteries, programmable ID locations, fail detection sensor circuitry, high stability and low ppm sensitivity for hydrocarbon monitoring, built-in datalogger with XPRESS CAL software, backlit LCD display, and UL classified.

18-12-19. G750 Polytector II

GfG dynamation

The G750 offers the choice of up to six "smart" sensors at one time, including IR detection of CO_2. Sensors available include O_2, LEL, percent volume and

INSTRUMENT 18-12-21. Multi-Gas Monitors.

INSTRUMENT 18-12-22. LTX310 Multi-Gas Monitor.

infrared CO_2, and two toxics (CO, H_2S, SO_2). The G750 automatically sets sensor parameters, allowing the flexibility to interchange sensors in the field. Applications include confined space or industrial hygiene monitoring. Features include AutoCal easy calibration; datalogging with software; visual, vibrating, and audible alarms; large graphic numeric display; and a sturdy polyamide case.

18-12-20. CGM II 900 AutoCal® Series Multi-Gas Monitor

GfG dynamation

The CGM combines smart sensor technology to provide four gas monitors plus a ToxAlert™ broad range sensor to detect hundreds of unknown toxic gases. The unit has the AutoCal features which provides simplified calibration. Sensors are available for combustibles (LEL), O_2, CO, H_2S, and ToxAlert. The unit features a power take off port for datalogging, an optional mini-pump, remote alarms, visual and audible (buzzer) alarms, and RF resistant casing.

18-12-21. ATX612 and 620 Multi-Gas Monitors

Industrial Scientific Corp.

The ATX612 and ATX620 can be configured for up to four gas monitoring, allowing for continuous detection of combustible gases (%LEL, methane 0–5% of volume and ppm hydrocarbons), O_2 and two toxic gases (including CO, Cl_2, H_2S, NO_2, and SO_2). The internal constant flow pump will draw samples from up to 100 feet in the ATX612. The ATX612 and 620 feature one button auto calibration, an ultra-bright light bar and 90 dB audible alarm. The instruments are available with optional datalogging for up to 100 hours of data storage and industrial hygiene functions. The ATX612 and 620 are available with Ni-Cd batteries and built-in charger or replaceable alkaline batteries.

18-12-22. LTX310 Multi-Gas Monitor

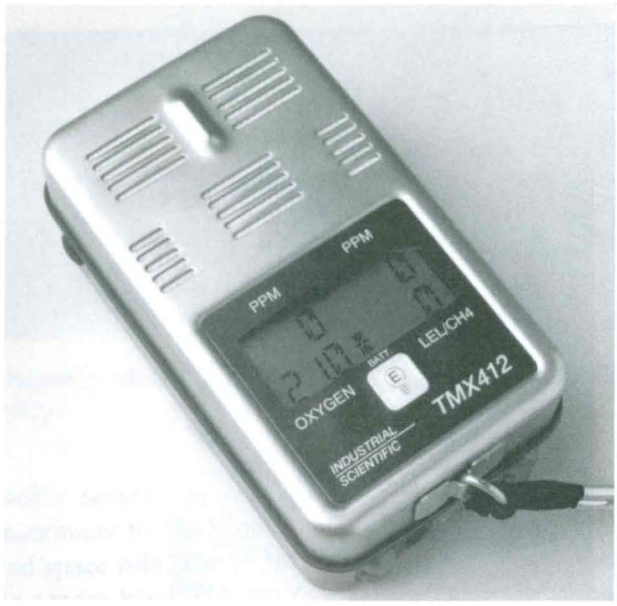
Industrial Scientific Corp.

The LTX simultaneously monitors up to three gases: combustible gases (% LEL or methane % by volume), O_2 and any one of eight toxic gases (NH_3, CO, Cl_2, HCN, H_2S, NO, NO_2, and SO_2). The LTX310 automatically recognizes and identifies the installed sensors and adjusts alarm and calibration parameters accordingly. Additional features include one-button auto calibration, combustible sensor over-range protection, plug-in sensors, RFI protection, audible and visual alarms and peak hold readings. User selectable override features include latching alarm, alarm set points and calibration settings.

18-12-23. TMX-412 Multi-Gas Monitor

Industrial Scientific Corp.

The TMX-412 simultaneously monitors up to four gases: combustible gases (% LEL or methane % of volume), O_2, and one or two toxic gases (CO, Cl_2, H_2S, NO_2, or SO_2). The instrument automatically recognizes all installed sensors and displays instantaneous readings on the LCD display. The TMX412 is available with an optional datalogging board with real-time clock that



INSTRUMENT 18-12-23. TMX-412 Multi-Gas Monitor.

calculates and records STEL and TWA readings (up to 110 hours of data stored). Additional features include one-button auto calibration, combustible sensor over-range protection, plug in sensors, RFI protection, audible and visual alarms and peak hold readings.

18-12-24. MicroMAX Multi-Gas Monitor

Lumidor Safety Products

The MicroMAX series is a UL classified and CSA certified small, lightweight, microprocessor controlled multi-gas monitor (1-5) with an internal sampling pump to provide very short response times. Weighing under one-pound, the MicroMAX simultaneously monitors concentrations of O_2, combustibles and up to three toxic gases (NH_3, CO, Cl_2, HCN, ClO_2 , H_2S, SO_2, PH_3). The MicroMAX is compact, fast responding, and easy to use with one button operation. The MicroMAX features interchangeable sensors, datalogging port, interchangeable batteries (Ni-Cd or alkaline), automatic backlit display, RFI resistance, and easy calibration. The MicroMAX is ideal for use in and around electrical, water or gas utility manholes, water and wastewater treatment plants, landfill operations, silos, tunnels, oil fields, gas pipelines, petrochemical facilities, pulp and paper mills and in confined areas in virtually any municipal or industrial environment. The unit has an optional datalogging feature which allows downloading of data to a PC, providing the ability to record readings to comply with record keeping and analysis requirements.

INSTRUMENT 18-12-24. MicroMax Multi-Gas Monitor.

18-12-25. Model IQ 1000 MEGA-Channel Gas Detector

Matheson Gas Products

The Model IQ 1000 MEGA-Channel Gas Detector System, equipped with the MEGA-Gas sensor, can detect over 100 different gases and vapors. The IQ 1000 is ideal for Haz Mat or emergency response operations, where the substance to be detected is an unknown, or if the substance to be detected can be different each time out.

18-12-26. Gasport®, Passport®, Passport® Personal, and Watchman® Multi-Gas Monitors

Mine Safety Appliances Co.

The Gasport Gas Tester is a handheld instrument that can be used by gas utility workers to simultaneously test for the presence of combustible methane (CH_4), carbon monoxide (CO), hydrogen sulfide (H_2S), and Oxygen (O_2) enrichment or deficiency. Depending on the user's needs, gases can be monitored across seven different ranges, including: 0–5000 ppm CH_4; 0–100% LEL (Lower Explosive Limit) CH_4 or 0–5% by volume CH_4; 0–100% by volume CH_4, 0–25% O2; 0–50 ppm (parts per million) H_2S; and 0–1000 ppm CO.

The Passport FiveStar Alarm is compact,weighing less than 17.3 ounces (500 grams). Designed with MSA's Plug-and-Play Sensor Memory System, the Passport FiveStar Alarm allows you to install the best combinations of sensors to match the task at hand. As many as five sensors can be used at one time. If you require data downloading, the instrument will soon be available with an infrared IrDA-compatible link for easy data communications.

The Passport Personal Alarm is a very compact instrument used to monitor combustible gases, oxygen and toxic gases in workplace atmospheres, especially in confined spaces such as manholes, storage tanks, tank cars, vaults, mines and sewers. The face of the instrument simultaneously displays the readings of all gases

monitored. The instrument's metal-filled polycarbonate case provides protection from electromagnetic interference (EMI) and radio frequency interference (RFI).

The Watchman Multi-Gas Monitor is a hand-held instrument used to detect and monitor combustible gases, oxygen and toxic gases in workplace atmospheres, especially in confined spaces such as manholes, storage tanks, tank cars, vaults, mines and sewers. Designed for rugged handling, the monitor incorporates the state-of-the-art technology of the Passport Personal Alarm in the strong, aluminum housing of the Portable Indicator and Alarm, Model 360. The Watchman Monitor also is easy to operate. The face of the instrument simultaneously displays the readings of all gases monitored. Microprocessor-based, the instrument is menu-driven for ease of operation. The user can "page through" various menu activities for calibration and display options.

18-12-27. Model pm-7400 and pm-7440 Multi-Gas Monitors

Metrosonics, Inc.

The pm-7400 monitors up to four gases simultaneously: O_2, LEL, NH_3, CO, Cl_2, HCN, ClO_2, H_2S, SO_2, PH_3, NO, NO_2, ETO. The hand-held unit provides alarms, 1 button operation and calibrates up to 12 sensors with unique calibration setup. The pm-7440 is a desktop unit that monitors up to 4 gases simultaneously (same gases as above plus O_3, H_2, and HCl) and prints instantaneous gas levels and reports. Both units can use available Metrosonics Software for Data Analysis.

18-12-28. Dräger MiniWarn Multi-Gas Personal Monitor

National Draeger, Inc.

The Dräger MiniWarn is a hand-held personal monitor for 4 gases (choice of 20 sensors including combustibles, CO, O_2, and H_2S). A simple 3-button keypad makes for ease of operation with datalogging capabilities. The unit features the new DrägerSensors® XS intelligent sensors with up to a 3-yr warranty (for selected gases). The unit features a loud audible and very bright visual alarms and an attachable pump for remote sampling.

18-12-29. MultiRAE PLUS and VRAE Hand-Held Multi-Gas Monitors

RAE Systems, Inc.

Both units from RAE are 1–5 gas monitoring units with electrochemical sensors and also features the very small RAE PID sensor for VOCs (MultiRAE PLUS only). The gases available include oxygen, combustibles, VOCs, CO, H_2S, SO_2, NO, NO_2, Cl_2, HCN, NH_3, and PH_3. Other features include large backlit LCD display, multiple audio and visual alarms, 10–12 hours of run time, 16,000 data point datalogging download to PC, built-in pump, runs on a variety of battery packs, and has a rigid sampling probe. Applications include refineries and petro chemical plants (confined space, hot work permits), utilities (cable vaults and transformer stations), waste water treatment plants, marine and off shore wells, landfill operations, and food processing. The units both have fast response times, are intrinsically safe, and work over large temperature and humidity extremes.

18-12-30. RKI Multiple Gas Monitors, Models GX-82, 86, 86A, and 94

RKI Instruments, Inc.

RKI offers a wide range of three or four gas personal monitors for use in confined spaces.

The units offer detection of oxygen, combustibles, and one or two toxics (CO, H_2S, and SO_2). Applications include sewage treatment plants, utility manholes, chemical plants, hazardous waste sites, sulfur plants, nuclear plants, logging operations, mines, refineries, tunnels, paper mills, drilling rigs, storage tanks, and pipelines. The units have many features including datalogging, microprocessor control, continuous monitor and readout, variable audible and visual alarms with multiple set points, intrinsically safe, touch control panel, rugged dot matrix LCD readout with back lighting, user replaceable batteries, and many carrying options.

18-12-31. RKI EAGLE® Portable Gas Detector

RKI Instruments

The RKI EAGLE offers an ergonomically designed package to monitor up to 4 different gases with a powerful internal pump. Sensors available include hydrocarbons (in LEL or ppm), O_2, CO, H_2S, NH_3, AsH_3, Cl_2, F_2, HF, HCl, NO_2, O_3, PH_3, SlH_4, and SO_2. Other features include the ability to draw a sample through 75 feet of tubing, large LCD display with backlighting, 2 alarms per channel plus TWA and STEL, audible and visual alarms, autocalibration and demand zero, 30 hr of operation on one set of batteries, intrinsically safe approval, internal dust and hydrophobic filters, methane elimination for hydrocarbon analysis, status indicator, and compliance with EPA Method 21 protocol for fugative emissions testing.

18-12-32. GMP 1000M Monitor

Rosemount Analytical, Inc.

The GPM 1000M is a packaged approach to measuring up to five gases plus opacity. The measurement

options include: CO, CO_2, SO_2, NO, NO_x, O_2, THC and Opacity. The GPM 1000M is manufactured under ISO 9001 certified quality standards. Temperature controllers for both probe and heated sample line are included. Non-freon thermoelectric sample conditioner containing integral pre-cooler, sample pump, condensate removal system, and water intrusion monitor for sample pump shutdown in the unlikely event of a conditioner failure; provides unsurpassed analyzer protection. Local/remote calibration capability for diagnostic testing of analyzers, and compliance with the EPA's 40 CFR 60, Appendix F, and 40 CFR 75.

18-12-33. Scott SA2000 Portable Gas Detector

Scott Aviation

The SA2000 four-gas portable instrument detects the following gases: CO, H_2S, LEL, O_2. Scott's SA200 is available in one, two, three-gas options, in addition to the standard four-gas detection system. For users needing one gas monitoring, SA2000 Single Series offers any choice of the four gases listed above. The Dual Series SA2000 offers O_2 and combustible gas detection. For more complex monitoring needs, choose the SA2000 Triple Series. The Triple Series is upgradable to the standard four-gas SA2000 model allowing maximum flexibility in an expanding gas monitoring program. All SA2000 Series instruments are available in either alkaline or nicad battery configurations.

18-12-34. ProtectAir™ Model 8570

TSI, Inc.

Model 8570, Personal Multi-gas monitor is a small, portable and intrinsically safe instrument primarily designed for confined space entry applications. Housed in a rugged stainless steel case, it has exceptional durability and RFI protection. The standard instrument has two sensors, oxygen (O_2) and combustibles (CH_4). The measurement can be expanded to include two additional toxic gases. It will accept either a rechargeable (NiMH) battery pack or six AA alkaline batteries to provide long duty cycles. The instrument will log data for 40+ hours and is compatible with TRAKPRO software. The instrument has many options to customize a package for unique situations. Among the popular options are a hand-aspirated pump, a powered pump, a miniature remote alarm, calibration kits, and protective carrying cases.

18-12-35. Q-Trak® Model 8551

TSI, Inc.

Models 8550 and 8551, Indoor Air Quality Monitors are available in two versions. Both versions measure and record 3 parameters: CO_2, temperature and humidity. Model 8551 adds carbon monoxide as a 4th measurement parameter. All sensors, including the NDIR CO_2 sensor, are located in the detachable probe. Both models will log all parameters for 3+ weeks at a 1-minute interval, longer at extended intervals. The instrument can download data to the TRAKPRO data analysis software. They are battery operated for ease of portability or can operate on AC for extended monitoring

INSTRUMENT 18-12-34. ProtectAir™ Model 8570.

INSTRUMENT 18-12-35. Q-Trak® Model 8551.

requirements. The new IAQ-CALC™ will monitor the same parameters, but new software allows calculation of % outside air.

18-12-36. Minigas-XL

Zellweger Analytics, Inc.

The MiniGas-XL can be configured to monitor and datalog up to four gases—oxygen, flammable, and two toxics (CO, H_2S, Cl_2, and SO_2). The pocket-sized unit helps ensure safe work conditions required for confined space and hazardous area working. Applications include water and sewage treatment, telecommunications, construction, oil and gas, chemical, transport, process and mining. Features include a tough die-cast metal case; protective rubber boot; instantaneous, STEL and TWA dual tone audible alarms and visual red alarms; either dry cell or NiMH batteries, EasyCal calibration and calibration reminder; field settable alarms; optional sample pump or aspiration pump; earphones; and comprehensive datalogging software.

18-13: Portable Mass Spectrometers

There are many brands of laboratory-housed mass spectrometers which we will not duplicate here. Of interest to our readers is the class of portable analytical instruments (see also gas chromatographs, 18-11).

18-13-1. MG2100 Portable Mass Spectrometers

Industrial Scientific Corp.

The MG2100 Portable Mass Spectrometer delivers full mass spectrometry in a package that weighs less than 35 pounds. The unit operates over the range of 10-200 amu (higher levels are available) and is a completely self-contained system, housing an electron impact (EI) ionizer, mass analyzer, detector, 386X microprocessor, analytical software, vacuum pump, controller electronics, a handle for easy transportation, sampling inlets and a digital readout. The unit can be interfaced through an RS232 port to a PC for expanded capabilities.

TABLE 18-I-1. Electrical Conductivity Analyzers

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-1-1	AIC	431-X	Hg	0.001–2	0.001	5%	5.1	2.4	1.6	2.3	110 VAC	–	–	A
18-1-2	AIC	631-X	H_2S	0–50	–	–	5.1	2.4	1.6	2.3	115 VAC	–	–	A
18-1-3	CAL	U3S	SO_2	–	0.005	–	6.3	5.5	8.3	–	115 VAC	–	–	B, C
18-1-4	CAL	Mikrogas®	SO_2, H_2S, HCl, Cl_2, $COCl_2$, NH_3, COS, CS_2, HCN	variable	variable	–	–	–	–	–	115 VAC	–	–	D
18-1-5	CAL	Ultragas®	same as above	variable	variable	–	–	–	–	–	115 VAC	–	–	D

* Manufacturer codes given in Table 18-I-14.

A. Collects a 1- or 10-second sample on a gold film sensor.

B. Absorbs sample in acidified H_2O_2.

C. Converts SO_2 to H_2SO_4.

D. For process operation.

TABLE 18-I-2. Potentiometric Analyzers

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-2-1	BAC	Canary®	O_2, CO, H_2S, SO_2, NH_3, NO_2, Cl_2, HCN, HCl, CH_4	variable	variable	variable	6.4	3.8	11.4	0.3	4-AA	X	X	A, B, C
18-2-2	BAC	CO Sniffer®	CO in air or in breath	0–2000	–	5%	22	9	7.4	0.6	4-C cells	–	–	A
18-2-3	BI2	Toxi	O_2, CO, H_2S, SO_2, NH_3, NO, NO_2, Cl_2	variable	variable	–	1.1	5.2	2.8	0.13–1.1	3-AAA cells	X	X	A, B, C
18-2-4	BWT	Toxiclip	O_2, CO, H_2S	0–100, 300	1-CO 0.3-H_2S	–	7.2	3.8	2	0.056	–	X	X	A, B, C
18-2-5	BWT	MiniMax	SO_2, H_2S, Cl_2, CO, HCN, NO	variable	0.1–1.0	–	8.7	7	2.7	0.16	5-yr battery	X	X	A, B, C
18-2-6	CEA	Gasman	CO, CO_2, CH_4, NH_3, H_2S, SO_2, HCl, $COCl_2$, COS, CS_2, HCN	variable	0.1	3% FS	–	–	–	–	4-AA cells	X	X	A, B, C
18-2-7	CEA	Series U	O_2, H_2S, CO, SO_2, Cl_2, NO_2, NO, HCl, HCN, NH_3, %LEL	0–250, 500, 100 or %LEL	variable	1% FS	11.5	6.6	3.9	0.3	4-AA cells	X	X	A, D
18-2-8	CEA	TG-KA Series	HCHO, phosgene, ozone, HF, hydrides	variable	variable	–	1.7	2.9	1.1	0.09	AC/DC	X	X	A
18-2-9	CDI	Gasman II	O_2, H_2S, CO, SO_2, Cl_2, NO_2, NO, HCl, HCN, NH_3, O_2, CH_4, NO	variable	variable	–	11	6.6	4	0.27	4-AA	X	X	A, B, C
18-2-10	DYN	Monogard	CO, H_2S, O_2 SO_2, NO	–	–	–	–	–	–	–	Lithium battery	X	X	B
18-2-11	ENM	Spectrum	CO, H_2S, Cl_2, HCN, SO_2, NH_3, O_2	–	–	–	–	–	–	–	–	X	X	B

TABLE 18-I-2. (cont.). Potentiometric Analyzers

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-2-12	ENM	Smart Logger	H_2, CO, Cl_2, HCN, H_2S, HCl, NO, NO_2, NH_3, O_3, ClO_2, ETO, O_2	varies by analyte	–	1%	1.3	6.3	2.8	0.2	9V	X	X	A, B, E
18-2-13	ENS	MVN-100A	ETO, formaldehyde, glutaraldehyde	0.5-100 ETO	1.0	–	11	6	2.5	0.11	9V	X	–	A, B
18-2-14	GAT	GT, GTD	CH_4, O_2, CO, H_2S	variable	variable	–	25.4	15	13	2.25	4-D cells	X	X	A, E
18-2-15	GAT	GT-2400	CO, NH_3, Cl_2, HCN, H_2S, NO, NO_2, SO_2, O_2, CH_4	variable	variable	0.2–10	15	9	5.6	0.7	2-C cells	X	X	A, C
18-2-16	GAT	STM2100	NH_3, CO, Cl_2, HCN, H_2S, NO, NO_2, SO_2, O_2, CH_4	variable	variable	0.2–10	–	–	–	0.7	alkaline and NiCd	X	X	A, B, C, E
18-2-17	GAT	95 Series	CO, H_2S, O_2	0–500 0–100 0–30%	variable	±10%	11.4	6.4	2.5	0.2	9V	X	X	A, B, C
18-2-18	GCI	701	H_2S, CO, SO_2, NO_x, NO	0–100 variable	3	±3ppm	13.3	6.3	3.2	0.2	9V	X	X	A, B
18-2-19	DYN	G 3000	CO, H_2S	0–700/50	–	2–3%	1.5	0.9	0.6	0.2	NiCd	X	X	A, B
18-2-20	DYN	Toxitector®	CO	0–1000	30	–	9.2	3.4	–	0.15	NiCd	X	X	A, B
18-2-21	ISC	STX	CO, NH_3, Cl_2, HCN, H_2S, NO, NO_2, SO_2	variable	variable	–	10.2	6.4	3.0	0.2	Lithium	X	X	A, B
18-2-22	ISC	T80	CO, Cl_2, HCN, H_2S, NO_2, O_2, SO_2	variable	variable	–	10.2	6.8	3.4	0.2	9V	X	X	A, B, C, E
18-2-23	ISC	GasBadge	CO, H_2S, O_2	variable	variable	–	7.6	4.3	3.2	0.08	6V Li	X	X	A, B, C
18-2-24	ITS	Series 1000, 4000, 7000	CO, SO_2, H_2S, Cl_2, NO, NO_2, hydrazines, ClO_2, HCN, ETO, HCHO	0.1–10 times TLV	2% FS	1%FS	2.9	2.4	4.5	3.6	NiCd	X	X	A, C, E

TABLE 18-I-2. (cont.). Potentiometric Analyzers

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-2-25	ITS	LD Series	same as above	variable	variable	–	35.6	50.8	22	10.4	110 VAC	X	X	A, E, F
18-2-26	ITS	RM Series	CO, Cl_2, ClO_2, ETO, HCHO, hydrazines, HCl, HCN, H_2S, NO, NO_2, SO_2	variable	variable	±2%FS	17.8	48	30.5	5.2	110 VAC	X	X	A, F
18-2-27	LSP	ToxiBEE GasBUG	CO, H_2S, O_2	35, 10 .95%	variable	±5%	7.6	6.4	4	0.085	–	X	X	A, B, C
18-2-28	LSP	UniMAX	O_2, CO, NH_3, PH_3, SO_2, H_2S, NO_2, Cl_2, ClO_2	variable	variable	±2%	10.4	6.4	2.8	0.14	3-AAA NiMH	X	X	A, B, C
18-2-29	MET	PM-7700	CO, H_2S, SO_2, Cl_2, NO_2, NO, O_2, ETO, HCN, NH_3, H_2, HCl	variable	variable	1%	7.6	10.2	2.3	0.3	9V	X	X	A, E, F
18-2-30	MSA	MiniCo® Responder	CO	0–999	2	2%	–	–	–	–	9V	X	X	A, B
18-2-31	MSA	Cricket®	CO, H_2S, O_2	variable	variable	–	–	–	–	–	3V Li	X	X	A, B
18-2-32	MST	MSTox 8600	18+ gases	variable	variable	–	9.3	4.7	2.1	0.09	Recharge or Dispos-able	X	X	A, B, C
18-2-33	MST	Satellite	CO, H_2S, O_2	variable	variable	–	11.4	4.4	3.2	0.08	Li	X	X	A, B, C
18-2-34	NDR	Pac III	CO, NH_3, CO_2, Cl_2, ETO, PH_3, HCN, H_2S, NO_2, NO, O_2, LEL	variable	variable	–	6.7	11.6	3.2	0.2	Alk, Li, or NiCd	X	X	A, B, C, E
18-2-35	NDR	MicroPac	CO, H_2S, O_2	0–400 0–100 0–25%	–	–	5.4	8.4	3.2	0.1	–	X	X	A, B, C
18-2-36	NEO	Neotox® XL	CO, H_2S, Cl_2, SO_2, NO_2, O_2, LEL	0–100 0–500 0–35%	0.1-1	1-5%	4.9	6.5	11.3	0.203	3-AA NiCd	X	X	A, B, C
18-2-37	NEO	Solotox®	CO H_2S	0–500 0–100	1.8 7.5	–	7.5	6.4	4.1	0.08	2 yr. disposable	X	X	A, B, C

TABLE 18-I-2. (cont.). Potentiometric Analyzers

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-2-38	PRA	Titrilog II	H_2S, SO_2	–	0.01–0.02	–	5.6	5.6	8.3	30	115 VAC	–	–	G, H
18-2-39	RAE	ToxiRAE	O_2, LEL, VOCS, CO, H_2S, SO_2, NO, NO_2, Cl_2, HCN, NH_3, PH_3	variable	0.1–1	–	15.2	4.4	2.5	0.13	2-AAA	X	X	A, B, C
18-2-40	RKI	Series 94	O_2, CO, H_2S	0–40% 0–500 0–99	–	5–10%FS	14.5	4.4	2.5	0.12	2-AAA	X	X	A, B, C
18-2-41	RKI	SC-90	17+ gases	variable	variable	10%FS	20	8	14	1.9	Alkaline or NiCd	X	X	A
18-2-42	SCA	S100	O_2, H_2S, CO	variable	variable	–	3	2.5	3	1.8	battery	–	X	A
18-2-43	SEN	SS2000 SS4000	Br_2, Cl_2, CO_2, F_2, H_2, HCl, HCN, HF, NH_3, SO_2, PH_3, AsH_3	variable	variable	10%	21.6	11	17	1.5	NiCd	X	X	A, C
18-2-44	TEL	990	O_2, CO in combustion products	0–5, 10% 0–100, 500	2%	5%	4.8	5.1	2.7	5	NiCd	X	X	A, I, J
18-2-45	ZEL	Lifeline	AsH_3, PH_3, Br_2H_6, SiH_4, HCl, HBr, HF, CO, NH_3	variable	variable	–	12.5	8	5.7	1.4	NiCd	X	X	A, B, C

* Manufacturer codes given in Table 18-I-14.

A. Electrochemical sensor
B. Diffusion sampling.
C. Intrinsically safe.
D. Explosion proof units available.
E. Datalogger capabilities.
F. Available in a variety of fixed units.
G. Cell reagent is KBr, where Br_2 is generated.
H. Liquid prefilters are required for some analytes.
I. Designed for combustion process measurements.
J. Separate sensors for CO and O_2.

TABLE 18-I-3. Coulometric Analyzers

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (%)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-3-1	ESD	OX630	O_2	0–100	–	1%FS	15.3	8.9	3.8	–	9V	–	–	A, B
18-3-2	GFG	Oxytector®	O_2	0–25	0.1	0.5%	3.4	9.2		0.15	NiCd	X	X	A, B
18-3-3	MGP	8060, 8061	O_2	0–40	–	3%	12	6.6	2.9	0.3	2-AA NiCd	X	–	A
18-3-4	RAI	NGA 2000 TO2	O_2	0–100	10 ppb	–	rack mounted			–	110 VAC	X	X	C
18-3-5	SMC	55	O_2	0–25	–	–	hand-held			–	–	X	–	A, B

* Manufacturer codes given in Table 18-I-14.
A. Electrolytic cell for oxygen.
B. Diffusion sensor.
C. Electrode sensor.

TABLE 18-I-4. Ionization Detectors

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-4-1	FRC	HC500-2D	hydrocarbons	0–10 0–1000	0.1 CH_4	0.1ppm CH_4	4.8	7.5	7.9	18.2	110 VAC	–	–	A, C
18-4-2	FOX	TVA-1000	organic and toxic compounds	0–2000PID 0–50000FID	0.1 benzene 0.3 hexane	1%	34.3	26.3	8.1	5.6	NiCd	X	X	A or B D, E, F
18-4-3	HNU	PI-101, IS-101, DL-101	organic and toxic compounds	0–20 0–2000	0.2 benzene	1%FS	10.9	5.3	8.1	4.1	NiCd 12V DC	X	X	B, D, F
18-4-4	MSA	Passport® PID II	organic and toxic compounds	0–10000	0.1	–	–	–	–	–	NiCd	–	–	B, D, F
18-4-5	PEC	2020	organic compounds	0.5–2000	0.5	–	hand-held			0.79	–	–	–	B, D, E, F
18-4-6	PEC	MicroFID®	organic compounds	0.1–50000	0.1	–	hand-held			3.7	–	–	–	A, D, E, F
18-4-7	RAE	MiniRAE 2000, Plus	VOCs	0–10000	0.1	10%	21.8	7.6	5.8	0.55	NiCd, NiMH Alk 4-AA	X	X	B, D, E, F
18-4-8	RAI	NGA 2000 McFID	hydrocarbons	–	–	–	rack mounted			–	110 VAC	–	–	A, F
18-4-9	SEN	Portable FID	VOCs	0.1–10000	0.05 CH_4	10%	–	–	–	3.9	NiCd Alk	X	–	A, D, E, F
18-4-10	THE	580EZ, 55C, 51	VOCs	0.1–2000	0.1	10%	17.1	14.6	25	2.7	NiCd	X	–	B, D, E

* Manufacturer codes given in Table 18-I-14.

A. Flame Ionization Detector.
B. Photoionization Detector.
C. Microprocessor controlled.
D. Portable, self-contained instrument.
E. Datalogging capabilities.
F. Intrinsically safe.

TABLE 18-I-5. Infrared Photometers

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-5-1	BKJ	1301	IR absorbing gases	4 orders of magnitude	0.01–1	1%FS	70.5	43	15	18	115 VAC	–	–	A
18-5-2	BKJ	1302	IR absorbing gases	5 orders of magnitude	0.01–1	1%FS	17.5	39.5	30	9	VAC or 12V	X	X	A, B
18-5-3	CEA	GD 444	CO_2	0–10,000	20	1%	13	8	4.4	0.43	MHz	X	X	D
18-5-4	CSC	Quantum 7000	IR absorbing gases	–	10–100ppb	–	–	–	–	–	–	–	–	–
18-5-5	FOX	Sapphire	>100 IR absorbing gases	varies by gas	tp 50 ppb	varies	36.6	55	19.3	10	120 VAC	X	X	D, C
18-5-6	HOR	APBA-250	CO_2	0–3000, 1%, 5%	–	1.5%	26	22	8.5	2.7	VAC	X	–	–
18-5-7	HOR	APMA-360	Ambient CO	0–10,000	0.05	1%FS	43	22	55	20	115 VAC	X	X	F
18-5-8	ISC	CDU 440	CO_2, CH_4	0–60,000	100	–	12	7	5	0.85	NiCd	–	–	C, D, G
18-5-9	MET	Aq-511	CO_2	0–2,000, 20,000	100	3%	9.1	18	3.3	0.83	NiCd Alk	–	–	D, G
18-5-10	MSA	Liva®	CO, CO_2, SO_2, or other hydrocarbons	0–50	1	1%	–	–	–	–	VAC	X	X	–
18-5-11	MLI	ML® 9830B	CO, SO_2, NO_x	0–200	0.01	0.1	43.2	17.8	64.8	20.9	VAC	–	–	H
18-5-12	RKI	RI-411A	CO_2	0–5,000	25	10%	25	19	11.3	2.4	Alk, CZn,	X	X	D
18-5-13		RI-413A		0–10,000 0–20%							NiCd			
18-5-14	ZEL	Searchline Excel	hydrocarbons	variable	variable	variable	rack mounted			–	VAC	–	–	–
18-5-15	TSI	InspectAir™ 8560	CO_2	0–50,000	10	3%	9.9	16.8	3.8	0.6	4-AA	X	–	D

* Manufacturer codes given in Table 18-I-14.

A. Utilizes FTIR photo-acoustic spectroscopy.
B. Measures up to 5 gases simultaneously.
C. Intrinsically safe.
D. Portable, self-contained instrument.
E. Uses FTIR.
F. Utilizes cross flow modulation NDIR.
G. Datalogger.
H. Utilizes gas filter correlation NDIR.

TABLE 18-I-6. Ultraviolet and Visible Light Photometers

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-6-1	CEA	TGM555	SO_2, NO_2, NO_x, NH_3, Cl_2, TDI, HCHO, HCN, halides	variable	0.025%	1%	4.7	7.9	2.2	11.4	12VDC	–	–	A, C
18-6-2	CSI	Photomet™ 3100	O_3	0–1.0	0.002	2 ppb	14	48	56	16	VAC	–	–	B
18-6-3	DEZ	1003	O_3	0.01–9.99	0.01	2%	5	15	18.5	20.5	VAC	–	–	B
18-6-4	MLI	ML® 9810B	O_3	0–20	0.001	1%	43.2	17.8	64.8	16	VAC	–	–	B
18-6-5	MLI	ML® 9850B	SO_2	0–20	0.001	1%	–	–	–	25	VAC	–	–	D
18-6-6	SSI	Instanta-neous vapor detector	O_3	0–1.0	0.002	2 ppb	14	48	56	16	VAC	–	–	B

* Manufacturer codes given in Table 18-I-14.

A. Liquid reagents required.
B. UV absorption.
C. Visible light absorption.
D. UV fluorescence.
E. Dual Beam.

TABLE 18–I-7. Chemiluminescent Detectors

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-7-1	CSI	5600 NO_x	NO, NO_2, NO_x	0–50	0.0001	0.002 ppm	43	22	57	18.6	VAC	–	–	A, C, D
18-7-2	CSI	OA325-2R OA350-2R	O_3	0–10	0.001	0.001 ppm	31	43	51	18.2	VAC	–	–	A, B
18-7-3	RAI	NGA 2000 WCLD	NO, NO_x	0–250	–	–	–	–	–	–	VAC	–	–	A, C, D, E
18-7-4	RAI	NGA 2000 CLD	NO, NO_x	0–250	–	–	–	–	–	–	VAC	–	–	A, C, D

* Manufacturer codes given in Table 18-I-14.

A. Intended for unattended operation.
B. Uses chemiluminescent reactions of O_3 with ethylene.
C. Uses chemiluminescent reaction of NO with ozone as basis for detection.
D. NO_2 converted to NO for analysis.
E. Handles wet samples.

TABLE 18-I-8. Photometric Analyzers

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-8-1	BAC	AutoStep	TDI, MDI, hydrazines, phosgene acid gas	0–0.2 0–5 0–1	0.001–0.01	15%	24.4	21.7	9.8	2.2	Pb-acid	X	–	A, B, C
18-8-2	BAC	SureSpot	MDI, TDI, HDI, NDI	0–10	0.001	25%	16.2	9.5	6	0.8	Pb-acid	–	–	A, E
18-8-3	BAC	RIS	TDI, MDI, IPDI, HDI, hydrazine, phosgene, acid gas	0–0.2, 1.0, 5.0	0.001–0.01	15%	30	20	17.8	5.2	VAC 12VDC	X	X	A, D
18-8-4	CSI	SA 285	SO_2, H_2S, total sulphur	0–1000 ppb	0.0004	1%FS	12	17	20	22.7	VAC	X	X	D
18-8-5	CSI	5700	SO_2	0–20	0.0004	0.001	43	22	57	24	VAC	–	–	D, F
18-8-6	CSI	PA260	phosphorous gas	0–10	0.001	19	7.5	4.8	7.9	18.2	VAC	–	–	C, D
18-8-7	HAI	722R	H_2S	0–100	1	3%	8.3	5.1	5.1	27.3	VAC	X	–	A
18-8-8	NDR	CMS	NH_3, C_6H_6, CO_2, CO, Cl_2, HCl, HCN, H_2S, NO_2, NO_x, SO_2	variable	0.2–10	–	20.5	9.2	4.5	0.73	4-AA	–	–	B, C
18-8-9	VIC	721	H_2S	–	ppb	25%	–	–	–	–	battery	–	–	A, B, E
18-8-10	ZEL	CM4	25 toxic gases, NH_3, HCN, H_2S, phosgene	variable	ppb	15%	rack mounted			25	VAC	X	X	A, D
18-8-11	ZEL	ChemKey TLD	>40 gases, TDI, MDI, NH_3, AsH_3, Cl_2, H_2S, etc.	variable	ppb	15%	16.5	21.2	17.7	4.1	Pb-acid VAC	X	X	A, B, C, D
18-8-12	ZEL	EGM	exhaust gases, e.g., aliphatic amines, HCN, H_2S, O_3, SO_2	variable	ppb	15%	10.8	14.4	27	3.4	VAC	X	X	A, D
18-8-13	ZEL	IsoLogger® $COCl_2$	HDI, TDI, MDI, IPDI, AsH_3, HCL,	variable	ppb	15%	7	9.5	2.9	0.2	NiCd	X	X	A, B

TABLE 18-I-8. Photometric Analyzers (Continued)

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-8-14	ZEL	SPM	>50 gases, isocyanates and gases	variable	ppb	15%	30.5	30.5	17.3	6.6	VAC battery operated	X	X	A, B, D
18-8-15	ZEL	7100	>50 gases (see above)	variable	1 ppb	5% at TLV	16.5	43.2	46	204	VAC	X	X	A, D
18-8-16	ZEL	Series 16	>50 gases (see above)	1/10–10 x TLV	1 ppb	5% at TLV	wall rack			204	VAC	X	X	A, D

* Manufacturer codes given in Table 18-I-14.

A. Tape sampler.
B. Portable, self-contained instrument.
C. Intrinsically safe.
D. Intended for unattended operation.
E. Grab sample.
F. UV Fluorescence.

TABLE 18–I-9. Thermal Conductivity Detectors

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-9-1	MGP	Leak Hunter 8066	nonflammable gases	–	CO_2:3.5×1, O^{-5}; Freon 12:1.2×10^{-5}; cc/sec leak	–	1.4	3.9	5.5	2.3	9V	X	X	–

* Manufacturer codes given in Table 18-I-14.

TABLE 18–I-10. Heat of Combustion Detectors

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-10-1	BAC	Leakator® 10	combustible gases	50-50,000 CH_4	50	–	21.6	5.7	4.4	0.5	5-C cells	–	–	B, D, E
18-10-2	BAC	TLV Sniffer®	combustible gases	0–100 0–100%LEL	3	5%FS	22.8	9.5	16.8	2.3	NiCd 6-D cells	X	–	A, D
18-10-3	BAC	Sniffer® 300 Series	combustible gases, O_2 def.	0–2000 0–100%LEL 0–25% O_2	–	5%FS	18	8.1	26.2	1.8	NiCd 4-D cells	X	X	A, D
18-10-4	GFG	ABL-50	CO in airlines	2–50	2	10%FS	5.1	5.5	2.2	7.3	VAC 12VDC	X	X	B, F
18-10-5	ENM	Ex-10	combustible gases	0–100%LEL	–	5%FS	4	6	18	0.5	NiCd VAC	X	X	A
18-10-6	MAC	GD-1	combustible gases	0–20%	–	–	11.4	12.7	3.8	0.45	VAC	X	X	A
18-10-7	MGP	8057	Cl_2, AsH_3, H_2, H_2S, PH_3, etc.	–	variable	–	1.1	2.4	0.5	0.4	NiCd 4-AA	X	X	B, E
18-10-8	SCA	D Series	combustible gases	%LEL % gas	–	–	5.75	3.25	5.75	2.3	8-D cells	X	X	A
18-10-9	SPE	A-21ZX	O_3	0–0.3 0–10	0.01	20%	5	10	2.5	0.14	NiMH	X	X	B, C
18-10-10	SPE	SXC-20	VOCs	–	3–5	–	10.7	11.7	6.1	0.9	battery or VAC	–	X	B, G

* Manufacturer codes given in Table 18-I-14.

A. Heated catalytic combustion sensor.
B. Metal oxide semiconductor sensor.
C. Diffusion sampler.
D. Intrinsically safe.
E. Designed as leak detector.
F. Airline monitor.
G. Data logging.

TABLE 18-I-11. Gas Chromotograph Analyzers

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Dectectors	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-11-1	CDI	ISFID ISFIDGC	organics	0–100, 1000, 10000	0.05	FID	–	–	–	5	6-C cells	X	X	A, B
18-11-2	FOX	TVA1000	See instr. 18-4-2	–	–	–	–	–	–	–	–	–	–	–
18-11-3	HNU	311D	organics	1, 10, 100	–	PID, FID, ECD, TCD, FUVAD	26.7	35	28	11.3	VAC	–	–	A, C
18-11-4	PEE	Voyager®	organics	wide	0.01	PID, ECD	39	27	15	6.8	10–18 VDC	X	–	A, B, C
18-11-5	SST	Scento-graph Plus II	organics	0.1–2000	0.1	PID, AID, MAID, ECD, TCD	15.2	52	50.8	24	12VDC VAC	X	–	A, C

* Manufacturer codes given in Table 18-I-14.
A. Intrinsically safe.
B. Data logging.
C. Designed for portable operation.

FID = Flame Ionization Detector
PID = Photoionization Detector
ECD = Electron Capture Detector
TCD = Thermal Conductivity Detector
AID = Argon Ionization Detector
MAID = Micro Argon Ionization Detector

TABLE 18-I-12. Multi-Gas Monitors

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-12-1	AIM	Series 200 Series 300	%LEL, 0_2, CO, H_2S, SO_2, NO, NO_2, Cl_2, H_2, HCN, HCl	variable	variable	–	39.9	64 dia		1.0	battery	X	X	A, B, D
18-12-2	AIM	Series 500	%LEL, O_2, CO, H_2S	0–100%LEL 0–25% O_2 0–200 H_2S 0–500 CO	variable	2.5%FS	19	10.2	6.4	1.4	Pb-acid	X	X	B, C, D
18-12-3	BAC	Body-guard®	%LEL, O_2, CO, H_2S	0–100%LEL 0–30% O_2 0–999 CO 0–500 H_2S	variable	–	7.3	4.1	12	0.4	2-AA	X	X	A, B
18-12-4	BAC	Gas Pointer II®	%LEL, O_2, CO	0–100%LEL 0–25% O_2 0–2000 CO	variable	–	20.5	9.4	5.6	0.9	NiCd	X	X	A, B
18-12-5	BAC	Sentinel® 44T	%LEL, O_2, CO, H_2S, SO_2, HCN, Cl_2, NO_2	0v100%LEL 0–25% O_2 variable	variable	–	11.4	19.7	5.1	1.13	Pb-acid	X	X	A, B, D
18-12-6	BAC	Sniffer® 500	%LEL, O_2, CO, H_2S	0–100%LEL 0–25% O_2 0–500 CO 0–100 H_2S	variable	–	25.4	19.4	15.9	4.3	Pb-acid	X	X	A, B
18-12-7	BI2	PhD Series Ultra	%LEL, O_2, CO, H_2S, Cl_2, ClO_2, HCN, NO_2, NO	variable	variable 0.1	–	17	9.5	5	0.6	NiCd or 3-AA	X	X	A, B, C, D
18-12-8	BWT	Defender	%LEL, O_2, CO, H_2S, SO_2, Cl_2, ClO_2, HCN, NO_2	variable	variable	–	11.8	10.3	2.9	0.4	NiCd	X	X	A, B, C, D
18-12-9	CEA	LMS-40	CH_4, CO_2, O_2, temp., press.	variable	variable	–	–	–	–	–	battery	X	X	C
18-12-10	CDI	Custodian	%LEL, O_2, 2 toxics	variable	variable	–	15.5	10.2	5.2	0.5	NiCd	X	X	A, B, C, D
18-12-11	CSE	EXPLORER®	3 gases, % LEL, O_2, CO, H_2S	variable	variable	–	7.6	15.6	4.2	0.54	NiMH	X	X	A, B, D

TABLE 18-I-12. (cont.). Multi-Gas Monitors

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-12-12	NDR	Multiwarn II	1–5 gases, % LEL, O_2, 35 toxic gases, IR sensor available	variable	variable	–	–	–	–	1	NiCd	X	X	A, B, C
18-12-13	EST	BLAQ Box 1300	CO_2, CO, temp., %RH	0–5000 CO_2 0–500 CO	100 CO_2	5%	34	30	15.2	7.7	VAC	–	–	C
18-12-14	EST	Telaire 7001	CO_2, temp.	0–10,000	1	5%	–	–	–	–	4-AA	–	–	D
18-12-15	ENM	CGS-90R	%LEL, O_2, CO, + toxics	0–100%LEL 0–30% O_2 0–100 toxics	variable	–	19.2	11.1	6.1	1.77	9.6VDC	X	X	A, B, C
18-12-16	ENM	Omni 4000	CO, H_2S, NH_3, SO_2, Cl_2, HCN, HCl, NO, NO_2, %LEL, O_2, H_2	variable	variable	–	19.4	11.9	5.8	1	NiCd	X	X	A, B, C
18-12-17	ENM	Quadrant 4 gas	%LEL, O_2, CO, H_2S	0–100%LEL 0–25% O_2 0–500 CO 0–100 H_2S	variable	–	15	8	4	0.45	NiCd	X	X	A, B, C, D
18-12-18	GAT	STM 2100 4 gas	%LEL, O_2, CO, NH_3, Cl_2, HCN, H_2S, NO, NO_2, SO_2	variable	variable	5–10%	–	–	–	0.68	NiMH or alk	X	X	A, B, C, D
18-12-19	GFG	G750 Polytector II	6 gases: IR-CO_2, O_2, %LEL, CO, H_2S, SO_2	0–100%LEL 0–200 CO 0–25% O_2	variable	2 ppm CO .2% O_2	3.3	1.4	0.9	0.9	–	–	–	B, D
18-12-20	GFG	CGM II 900	%LEL, O_2, CO, H_2S, Tox Alert	0–100%LEL 0v25% O_2 0–1000 CO	± 1%LEL ± 1 ppm	1%LEL 1ppm CO	19	11.2	5.7	1.4	NiCd or alk	X	X	A, B, D
18-12-21	ISC	ATX612	4 gases: %LEL, O_2, CO, Cl_2, H_2S, NO_2, SO_2	0–100%LEL 0–30% O_2 0–999 toxic	1% 1	–	20.8	9.4	8.1	1.5	NiCd or alk	X	X	A, B, D
18-12-22	ISC	LTX310	3 gases: %LEL, O_2, CO, Cl_2, HCN, H_2S, NO, NO_2, SO_2	same as above	1%	– 1	12.1	7.0	4.2	0.6	NiCd or alk	X	X	A, B, D

TABLE 18-I-12. (cont.). Multi Gas Monitors

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-12-23	ISC	TMX-412	4 gases: %LEL, O_2, CO, Cl_2, H_2S, NO_2, SO_2	0–100%LEL 0–5, 30% O_2 0–999 variable	0.1% 0.1-1.0	–	12.1	7.0	5.0	0.7	NiCd or alk	X	X	B, C, D
18-12-24	LSP	Micro-MAX	5 gases: %LEL, O_2, CO, H_2S, SO_2,HCN, PH_3, NH_3, Cl_2, ClO_2	0–100%LEL 0–25% O_2 toxics vary	variable	2%	12.1	7.6	4.6	0.4	NiCd or alk	X	X	A, B, C* D
18-12-25	MGP	IQ 1000	Up to 100 gases	variable	variable	–	–	–	–	–		–	–	—
18-12-26	MSA	Passport®	5 gases: %LEL, O_2, CO, H_2S, SO_2, NO, NO_2	variable	variable	–	–	–	–	0.5	NiCd	X	X	A, B, C, D
18-12-27	MET	pm-7400	4 gases: %LEL, O_2, CO, NH_3, Cl_2, + 7 others	variable	variable	–	–	–	–	–	NiCd	X	X	A, B, C, D
18-12-28	NDR	MiniWarn	1–5 gases: %LEL, O_2, VOCs, + 9 toxics	0-100% variable	variable	–	7.8	14.3	5.8	0.45	NiCd alk NiMH	X	X	A, B, C, D
18-12-29	RAE	MultiRAE	1–5 gases: %LEL, O_2, VOCs, + 9 toxics	0–100%LEL 0–30% O_2 0-5, 10, 50, 100, 500	0.1% 0/1-1	–	11.8	7.6	4.8	0.45	NiCd or alk	X	X	A, B, C, D
18-12-30	RKI	GX-Series GX-94	3–4 gases: % LEL, O_2, CO, H_2S, SO_2	0–100%LEL 0–40% O_2 0–100 H_2S 0–200 CO	variable	0.5-10%FS	9	6.4	16	0.7	NiCd 2-C cells	X	X	A, B, C, D
18-12-31	RKI	Eagle®	4 gases: %LEL, O_2, CO, H_2S, + 11 super toxics variable	0–100%LEL (0–50,000 ppm) 0–40% O_2	variable	5%FS	26.7	15	17.8	2.3	NiCd 4-D cells	X	X	A, B, C*
18-12-32	RA2	GMP 1000	5 gases + opacity: CO, CO_2, SO_2, NO, NO_x, O_2, THC	variable	variable	0.1%	rack mounted			–	VAC	–	–	–

TABLE 18-I-12. (cont.) Multi Gas Monitors

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-12-33	SCA	SA2000	4 gases: %LEL, O_2, CO, H_2S	0–100% 0–25% 0–200 0–1000	–	3%–5 ppm	7.5	3.75	1.75	0.68	NiCd	X	X	A, B, C
18-12-34	TSI	8570	2–4 gases, % LEL, O_2, CO, H_2S, SO_2, NO, NO_2	0–100%LEL 0–30% 0–20, 400	variable	–	14.6	7.6	5.1	0.64	NiMH or alk	X	X	A, B, C, D
18-12-35	TSI	Q-Trak® 8551	CO_2, CO, temp., %RH	0–5000 CO_2 0–500 CO 0–50° C 5–95%RH	1 1 0.1° C 0.1%RH	3 %	10.7	18.3	3.8	0.6	4-AA VAC	–	–	C, D
18-12-36	ZEL	MiniGas XL	4 gases: % LEL, O_2, CO, H_2S, Cl_2, SO_2	0–100% 0–25% 0–100, 500, 1000	0.1% 0.1% 0.1–1	0.3% 3% .5–5ppm	5.5	7.2	18	0.86	NiMH NiCd alk	X	X	A, B, C, D

* Manufacturer codes given in Table 18-I-14.

A. Intrinsically safe.
B. Good for confined space entry.
C. Data logging capabilities.
D. Diffusion sampling.

TABLE 18-I-13. Portable Mass Spectrometers

Instrument No.	Mfg./ Supp.*	Model	Analytes	Range (ppm)	Detection Limit (ppm)	Precision (±)	Dimensions (cm) H	W	L	Weight (kg)	Power	Alarms Aud.	Vis.	Comments
18-13-1	ISC	MG 2100	VOCs	10–200amu	–	–	23	33	58.4	15.5	VAC	–	–	–

* Manufacturer codes given in Table 18-I-14.

TABLE 18-I-14. List of Instrument Manufacturers

AI2 AIM USA
8403 Cross Park Drive, #1C
Austin, TX 78754
(512) 832-5665 or (800) 275-4246
FAX (512) 832-2188

AIC Arizona Instrument Corp.
1912 W. 4th Street
Tempe, AZ 85281
(602) 470-1414 or (800) 528-7411
FAX (602) 804-0656
www.azic.com

BAC Bacharach, Inc.
625 Alpha Drive
Pittsburgh, PA 15238
(412) 963-2000 or (800) 736-4666
(412) 963-2091
help@bacharach-inc.com
www.bacharach-inc.com

BI2 Biosystems, Inc.
651 S. Main Street
Middletown, CT 06457
(860) 344-1079 or (800) 711-6776
FAX (860) 344-1068
www.biosystems.com

DYM GFG/Dynamation Gas Monitors
3784 Plaza Drive
Ann Arbor, MI 48108
(734) 769-0573 or (800) 959-0329
FAX (734) 769-1888
gfg@dynamationinc.com
www.dynamationinc.com

ESD Engineering Systems & Design
17 W. Jefferson Street, Suite 5
Rockville, MD 19713
(302) 456-0446 or (800) 328-0516
FAX (302) 456-0441

BKJ Bruel & Kjaer Instruments, Inc.
185 Forest Street
Marlborough, MA 01752-3029
(508) 481-7000
FAX (508) 485-0519
www.bkhome.com

BWT BW Technologies
#242, 3030-3 Ave. NE
Calgary AB Canada T2A 6T7
(403) 248-9226 or (800) 663-4164
FAX (403) 273-3708
info@bwtnet.com
www.bwtnet.com

CA2 Calibrated Instruments, Inc.
20 Saw Mill River Road
Hawthorne, NY 10532
(914) 741-5700 or (888) 779-2064
FAX (914) 741-5711
www.calibrated.com

CEA CEA Instruments, Inc.
16 Chestnut Street
Emerson, NJ 07630
(201) 967-5660 or (888) 893-9640
FAX (201) 967-8450
ceainstr@aol.com
www.CEAinstr.com

ENS Environmental Sensors Co.
3201 North Dixie Highway
Boca Raton, FL 33431
(561) 338-3116 or (888) 338-4230
FAX (561) 338-5737
www.environmentalsensors.com

FOX Foxboro Environmental
600 North Bedford Street
East Bridgewater, MA 02333
(508) 378-5556 or (888) 369-2676
FAX (508) 378-5505
www.foxboro.com

FRC Forney Corporation
3405 Wiley Post Road
Carrolton, TX 75006
(972) 458-6100 or (800) 356-7740
FAX (972) 458-6455
www.forneycorp.com

CDI Crowcon Detection Instruments
2001 Ford Circle, Suite F
Milford, OH 45150
(513) 831-3877 or (800) 527-6926
FAX (513) 831-4263
crowcon@aol.com
www.crowcon.com

CSE CSE Corporation
600 Seco Road
Monroeville, PA 15146
(412) 856-9200 or (800) 245-2224
FAX (412) 856-9203

DEZ Dasibi Environmental Corporation
506 Paula Avenue
Glendale, CA 91201
(818) 247-7601
FAX (818) 247-7614
www.dasibi.com

HNU HNU Systems
25 Walpole Park So. Drive
Walpole, MA 02081
(508) 660-5001
FAX (508) 660-5040
sales@hnu.com
www.hnu.com

HOR Horiba Instrument Corp.
17671 Armstrong Avenue
Irvine, CA 92614
(949) 250-4811 or (800) 446-7422
FAX (949) 250-0924
labinfo@horiba.com
www.neptune.net/horiba/

TABLE 18-I-14. (cont.). List of Instrument Manufacturers

ENM
Enmet Corporation
P.O. Box 979
Ann Arbor, MI 48106
(734) 761-1270
FAX (734) 761-3220
info@enmet.com
www.enmet.com

EST
Engelhard Sensor Technologies
6489 Calle Real
Goleta, CA 93117
(805) 964-1699 or (800) 472-6075
FAX (805) 964-3680

ITS
Interscan Corp.
P.O. Box 2496
Chatsworth, CA 91313
(818) 882-2331 or (800) 458-6153
FAX (818) 341-0642
www.gasdetection.com

LSP
Lumidor Safety Products
11221 Interchange Circle S.
Miramar, FL 33025
(954) 433-7000 or (800) 433-7220
FAX (954) 433-7730
www.lumidor.com

MAC
Macurco, Inc.
3946 S. Mariposa Street
Englewood, CO 80110
(303) 781-4062
FAX (303) 761-6640
info@macurco.com
www.macurco.com

MGP
Matheson Gas Products
166 Keystone Drive
Montgomeryville, PA 18936
(215) 641-2700 or (800) 416-2505
FAX (215) 641-2714
www.mathesontrigas.com

GAT
GasTech, Inc.
8407 Central Avenue
Newark, CA 94560
(510) 745-8700 or (877) 427-8324
FAX (510) 794-6201
sales@gastech.com
www.gastech-inc.com

GCI
G.C. Industries, Inc.
5696 Stewart Avenue
Fremont, CA 94538
(510) 226-1329
FAX (510) 226-1112

MST
MST Measurement Systems, Inc.
975 Deerfield Parkway
Buffalo Grove, IL 60089
(847) 808-2500 or (800) 547-2900
FAX (847) 808-9976
info@mst-us.com
www.mst-us.com

MET
Metrosonics, Inc.
P.O. Box 23075
Rochester, NY 14692
(716) 334-7300
FAX (716) 334-2635
www.metrosonics.com

MSA
Mine Safety Appliances
Company
P.O. Box 427
Pittsburgh, PA 15230
(724) 776-8600 or (800) 672-4678
FAX (724) 776-3280
www.msanet.com

MLI
Monitor Labs, Inc.
76 Inverness Drive East
Englewood, CO 80112-5189
(303) 792-3300 or (800) 422-1499
FAX (303) 799-4853
www.monitorlabs.com

HAI
Houston Atlas, Inc.
22001 North Park Drive
Kingwood, TX 77339
(281) 348-1700
FAX (281) 348-1286
www.houstonatlas.com

ISC
Industrial Scientific Corporation
1001 Oakdale Road
Oakdale, PA 15071
(412) 788-4353 or (800) 338-3287
FAX (412) 788-8353
www.indsci.com

NDR
National Draeger, Inc.
101 Technology Drive
P.O. Box 120
Pittsburgh, PA 15230
(412) 787-8383 or (800) 922-518
www.draeger-usa.com

NEO
Neotronics
4331 Thurmond Tanner Road
P.O. Box 2100
Flowery Branch, GA 30542
(770) 967-2196 or (800) 535-0606
FAX (770) 967-1854
www.zelana.com/neotron/

PEC
PE Photovac
2851 Brighton Road
Oakville, Ontario Canada L6H 6C9
(905) 829-0030
FAX (905) 829-4701
www.can-am.net/suppliers/photovac.htm

PRA
Process Analyzers, Inc.
231 Lower Morrisville Road
Fallsington, PA 19058
(215) 736-2596
FAX (215) 736-8194

TABLE 18-I-14. (cont.). List of Instrument Manufacturers

RAE
RAE Systems, Inc.
1339 Moffett Park Drive
Sunnyvale, CA 94089
(877) 723-2878 or (408) 752-0723
FAX (408) 752-0724
www.raesystems.com/home1.html

RAI
Rosemount Analytical, Inc.
4125 La Palma Avenue
Anaheim, CA 90631
(330) 682-9010 or (800) 433-6076
FAX (330) 684-4434
www.frco.com/proanalytic

RKI
RKI Instruments, Inc.
(510) 441-5656 or (800) 754-5165
FAX (510) 441-5650
www.rkiinstruments.com

SMC
Sierra Monitor Corp.
1991 Tarob Court
Milpitas, CA 95035
(408) 262-6611 or (800) 727-4377
FAX (408) 262-9042
www.sierramonitor.com
sierra@sierramonitor.com

VCI
VICI Metronics, Inc.
2991 Corvine Drive
Santa Clara, CA 95051
(408) 737-0550
FAX (408) 737-0346
metronics@vici.com
www.vicimetronics.com

SCA
Scott Aviation
309 West Crowell Street
Monroe, NC 28112
(704) 282-8400
FAX (704) 282-8424
www.scottaviation.com

SEN
Sensidyne, Inc.
16333 Bay Vista Drive
Clearwater, FL 33760
(727) 530-3602 or (800) 451-9444
FAX (727) 839-0550
www.sensidyne.com

SST
Sentex Sensing Technology
553 Broad Avenue
Ridgefield, NJ 07657
(201) 945-3694 or (800) 736-8394
FAX (201) 941-6064

THE
Thermo Environmental Instruments
8 West Forge Parkway
Franklin, MA 02038
(508) 520-0430
FAX (508) 520-1460
www.thermoei.com

ZEL
Zellweger Analytics
405 Barclay Boulevard
Lincolnshire, IL 60069
(847) 634-2800 or (800) 323-2000
FAX (847) 634-1371
www.zelena.com

SPE
Spectrex Corporation
3580 Haven Avenue
Redwood City, CA 94063
(650) 365-6567 or (800) 822-3940
FAX (650) 365-5845
www.spectrex.com

SSI
Sunshine Scientific Instruments
1810 Grant Avenue
Philadelphia, PA 19115
(215) 673-5600 or (800) 343-1199
FAX (215) 673-5609

TEL
Teledyne Analytical Instruments
16830 Chestnut Street
Industry, CA 91749
(626) 934-1500 or (888) 789-8168
FAX (626) 961-2538
www.teledyne.com

TSI
TSI, Inc.
P.O. Box 64394
St. Paul, MN 55164
(651) 483-0900
FAX (651) 490-2748
info@tsi.com
www.tsi.com

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