



Continuous Gas Monitoring

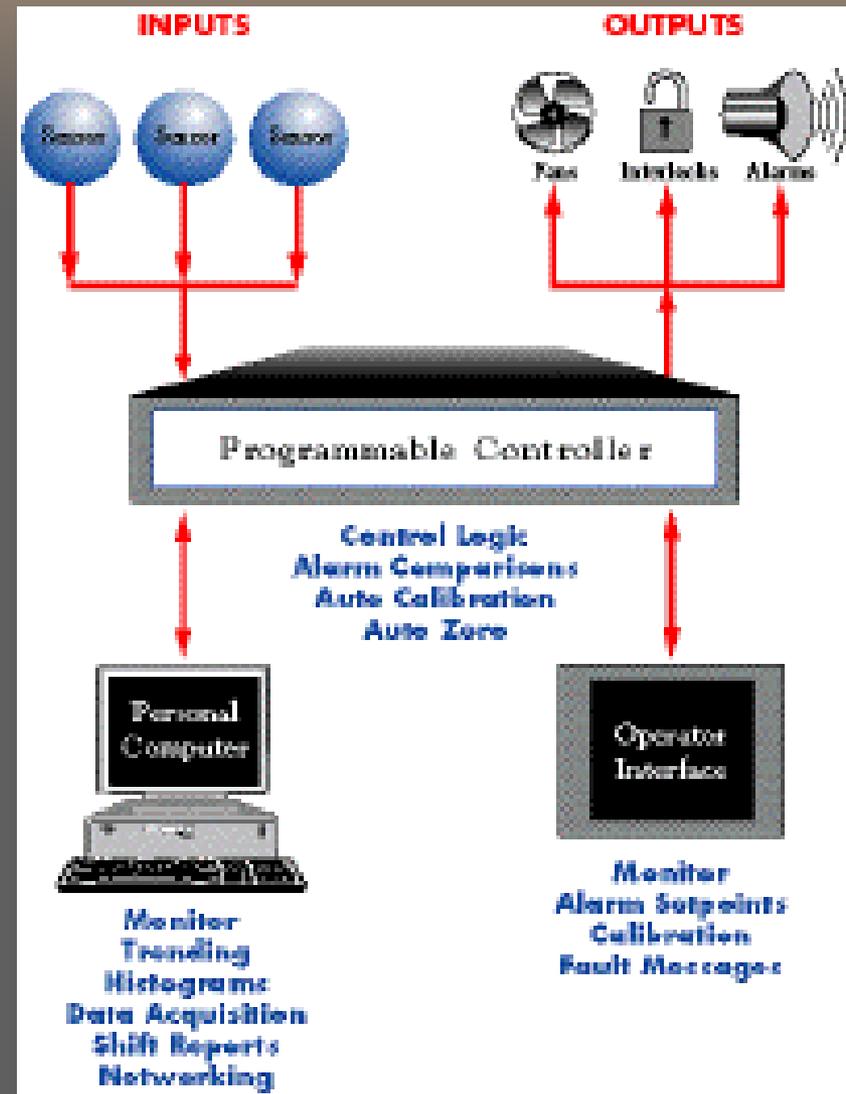
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Senior Waste Management Engineer



Overview

- ⇒ Background
- ⇒ Regulations
- ⇒ System Overview
- ⇒ Components & Cost
- ⇒ System Installation/
Operation & Maintenance
- ⇒ Implementation
- ⇒ Summary

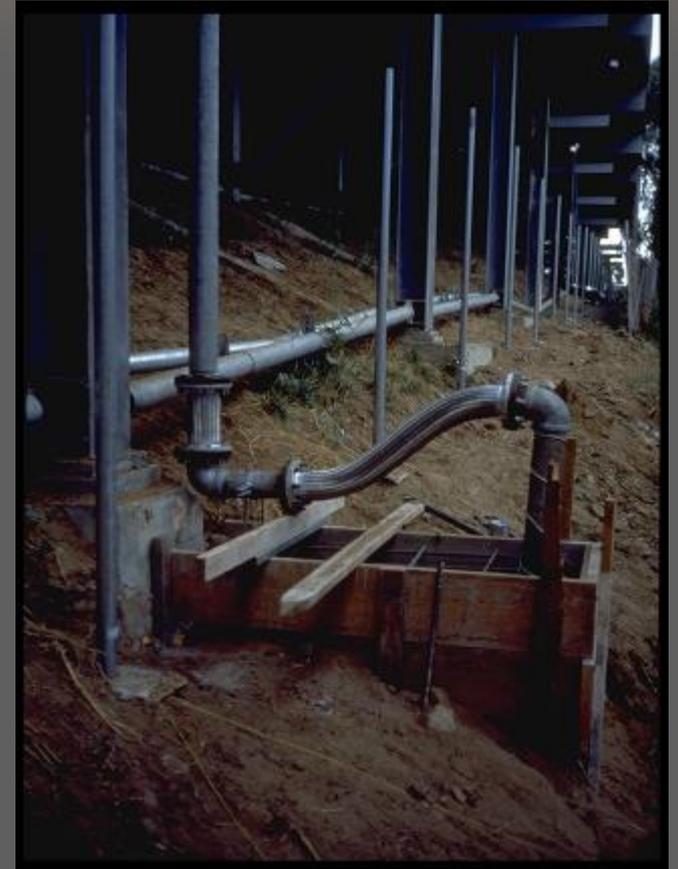


Background

- ⇒ Postclosure Land Use/Residential & Commercial Development of former disposal sites
- ⇒ Safety regulations (OSHA) drive industrial requirements for monitoring hazardous conditions (Petroleum and natural gas industry), which drove sensor technology development
- ⇒ Development of Direct Digital Control (Automatic) technology in 1980s to monitor and control building and utility systems for energy conservation
- ⇒ Combustible gas monitoring applied in industrial settings for safety purposes
- ⇒ Combustible gas monitoring applied in residential and commercial settings due to 27 CCR Landfill Gas Monitoring and Control requirements and Brownfield and industrial development



Gas Measures at PCLU projects



Regulations

- ⇒ Federal Regulations (40 CFR Part 258.23) Explosive Gas Control
- ⇒ State Regulations (27 CCR Article 6)
- ⇒ 27 CCR Gas Monitoring & Control Regulations
 - 20919.5 (a) 1 Explosive Gas Control.
 - 20921 Gas M&C During Closure/PC
 - 20931 Structure Monitoring
 - 20934 Reporting
 - 20937 Control
 - 21190 Postclosure Land Use

Regulations

- ⇒ 27 CCR 20919.5 (a) 1 Explosive Gas Control “...owners...must ensure that: (1) The concentration of methane gas generated by a (MSWLF) facility does not exceed 25 percent of the LEL for methane in facility structures...”
- ⇒ 20921 (a) (1) requires that “...The concentration of methane gas must not exceed 1.25% by volume in air within on-site structures...”
- ⇒ 20931(a) “...monitoring network design shall include provisions for monitoring on site structures, including but not limited to buildings, subsurface vaults, utilities or other areas where potential gas buildup would be of concern...”

Regulations

- ⇒ 20931(c) “...Structures located on top the waste disposal area shall be monitored on a continuous basis..”
- ⇒ 20934 (a)(1) “...monitoring reports shall include: (1) the concentrations of the methane....within each on-site structure...”
- ⇒ 20937 (a)(3) “...the documentation of date, time, barometric pressure, atmospheric pressure, general weather conditions and probe pressures...”

Regulations

- ⇒ 20937 Control (d) “...When the results of monitoring in on site structures indicate levels in excess of those specified in Section 20923(a), the operator shall take appropriate action to mitigate the effects of landfill gas accumulation in on site structures, and public health and safety, shall include one or more of the following:....(4) Alarms, ... (5) Ignition source control... (7) Ventilation...”

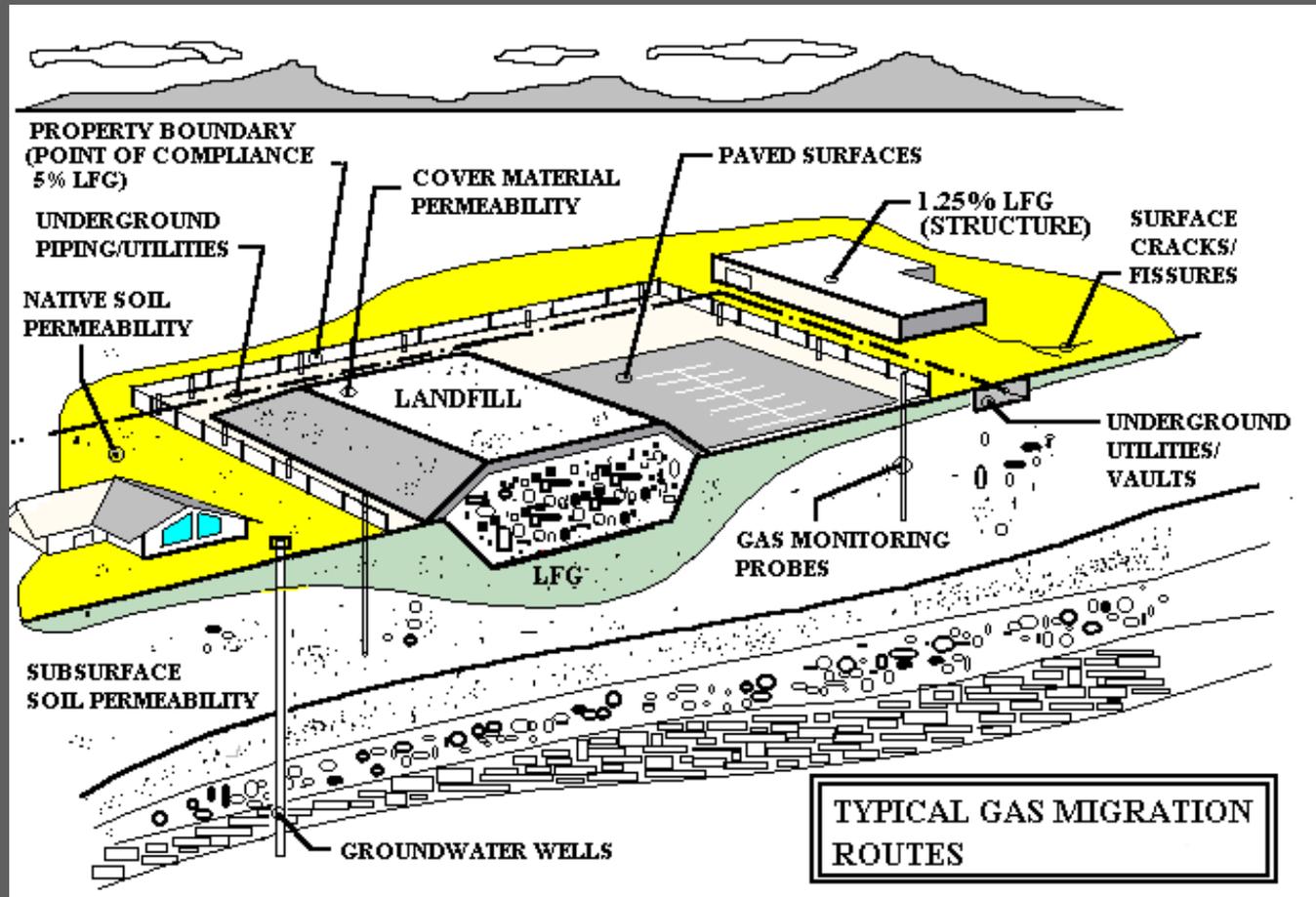
Regulations

- ⇒ 27 CCR 21190 a) Proposed PCLUs shall be designed and maintained to: ...(3) prevent landfill gas explosions...
- ⇒ 27 CCR 21190 e) “...Construction of structural improvements on top of landfilled areas...shall meet the following conditions:...(1) automatic methane gas sensors, designed to trigger an audible alarm when methane concentrations are detected, shall be installed in all buildings...”
- ⇒ 27 CCR 21190 e) (8) periodic methane gas monitoring shall be conducted inside all buildings...”

System Overview

- ⇒ Landfill Gas Migration Routes
- ⇒ Sensor Locations
- ⇒ Continuous Gas Monitoring System
- ⇒ HVAC Control Interface

Landfill Gas Migration Routes



Gas Migration Routes



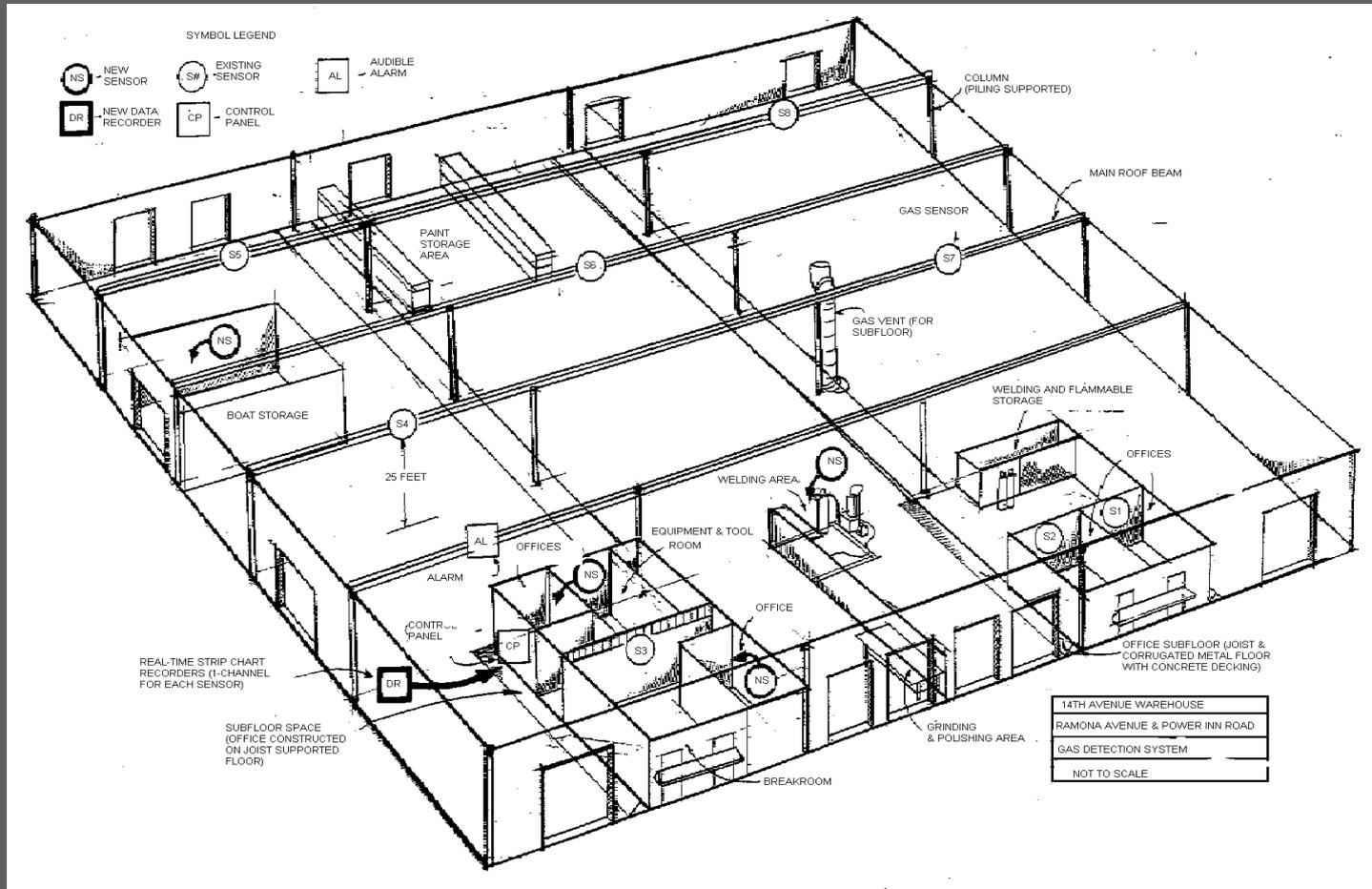
Gas Migration Paths



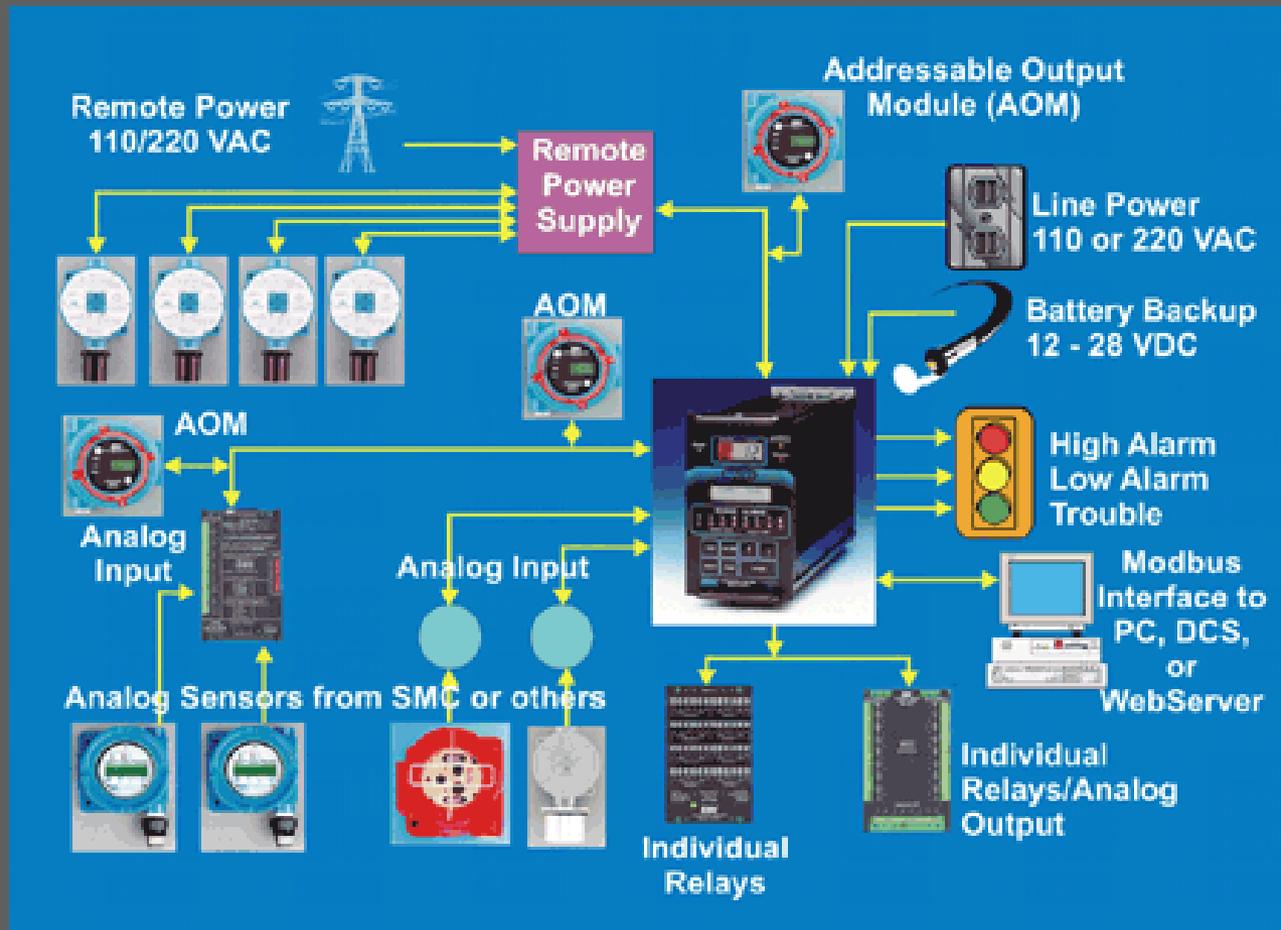
Gas Sensor Placement

- ⇒ Any accessible confined spaces near a landfill where a 5-15% LEL-UEL condition would most likely occur
- ⇒ Structures on or within 1000 feet of the landfill (homes, buildings, warehouses, etc)
- ⇒ Basements, subfloors and raised foundations
- ⇒ Utility systems: manholes, vaults, boxes and subsurface trenches, storm drains, water & electrical distribution in the vicinity or through the disposal area
- ⇒ Utility closets, mechanical rooms, bathrooms (utility penetrations)
- ⇒ Water wells, excavations (pools)

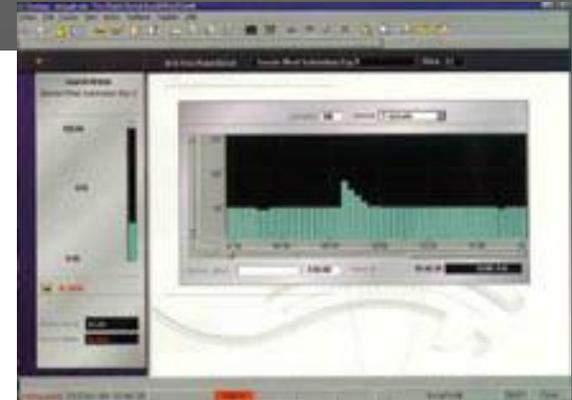
Gas Sensor Placement



Continuous Gas Monitoring System



Bldg Monitoring & Control Systems



Components & Costs

- ➔ Sensors
- ➔ Controller
- ➔ Data Loggers
- ➔ PC-interface



Gas Sensor



Controller



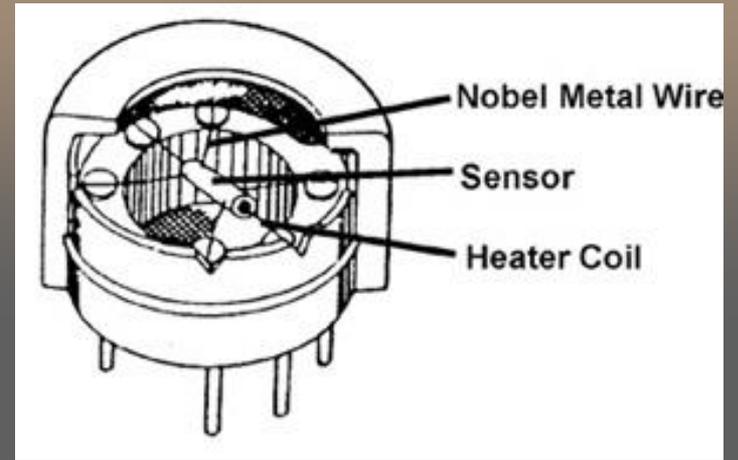
PC-Interface



Data Logger

Gas Sensors

- ⇒ Detects presence and measures concentrations of combustible gas
- ⇒ Generally CGI instruments calibrated to “known” gas (methane)
- ⇒ Catalytic Bead or Infrared (IR) Sensor
- ⇒ IR sensors do not require oxygen
- ⇒ Explosion Proof Housing
- ⇒ 24 VDC Power to Sensor/Transmitter
- ⇒ 4-20 mA Analog Output Signal
- ⇒ Wall mounted NEMA 4X Enclosure
- ⇒ Wireless models available
- ⇒ Cost: \$300-\$1500/sensor



Gas Sensors (CG/LEL)



Scott
GasPlus-IR



GDS M-1



RKI PS-2
Single Point
(\$425)



Biosystems
GasChek1 (\$2295)



Safe T Net Model
128 1-Ch

Gas Sensors (CG/LEL)



BW Gas Point Sensor



RKI Eclipse Sensor
Catalytic
(\$550)



Biosystems
GasChek/Catalytic
Bead/EXP (\$995)



RKI S-Series
Catalytic

Controllers

- ⇒ Controller used to “receive” 4-20 mA sensor (transmitter) analog output signal, store in data acquisition unit (if present), and control “output” devices such as alarms, electric switches, solenoid valves or other “controls”, e.g. turn-on heating, ventilation and air conditioning system (HVAC)
- ⇒ Controllers are microprocessor based and programmable (but require software and a PC interface).
- ⇒ Controllers require power source (120V/60-hz)
- ⇒ Controllers are wall-mounted in weatherproof NEMA 4X enclosures
- ⇒ Controllers can be single or multichannel (typical: 4, 8, 10, 16, 32 and up (cost increases); for a typical closed disposal site with commercial or residential structures a 16-channel should suffice
- ⇒ Controllers generally cost between \$500-\$3500

Controllers



**RKI BL-7000
16-Ch**



**PEMTECH
PT-1008 8-Ch**



**RKI Beacon 800
8-Ch (\$1995)**



**GMI Active 8
8-Ch**

Controllers



BW CR-8700 8-Ch



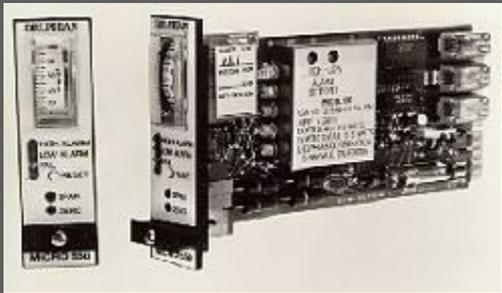
SMC Sentry 8-ch



ANTX 40-Ch



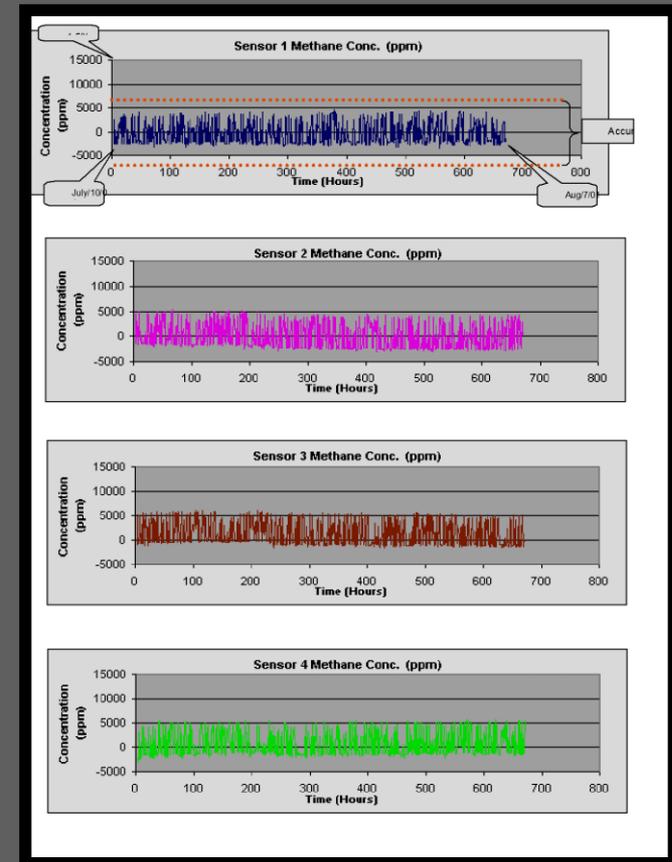
CR-9600
96 Channels



Gas Tech 1-Ch

Data Loggers (Data Acquisition)

- ➔ Loggers provide memory to store data points produced by 4-20 mA measurements (gas concentration measurement normally 0 to 5% V_{gas}/V_{air}) taken by gas sensor
- ➔ Loggers can be programmed to query and store data at user defined timepoints and frequencies, e.g. 1 measurement per hour, 24 hrs per day, 7 days per week, 365 days per year.
- ➔ Logger programs can output data to spreadsheets for documentation and data analysis, e.g. graphical representation (measurement versus time) for time trend analysis
- ➔ Provides documentation and defensible evidence for determining 1.25% in structures and 5% at the perimeter boundary.



Data Loggers (Data Acquisition)

- ⇒ Manufacturers: Logic Beach, Omni Instruments, DataQ, HOBO, WebDAQ, Yokogawa, MadgeTech
- ⇒ Data Logger may require: software for PC interface, additional memory, modem, wireless transmitter (these are not included in base unit cost)
- ⇒ Data Logger requires power (120V or 24V source), phone line connection
- ⇒ Data Loggers with multichannel capability, PC interface software, memory and modem can run between \$1500 and \$3500
- ⇒ See The Data Logger Store: <http://www.microdaq.com/>

Loggers (Data Acquisition Units)

DataQ DI-710 (\$1400)



Logic Beach HyperLogger (\$3000)



WebDAQ 100 (\$1295)



Omni DAQ 4000 Logger
(695 British Pounds)

System Installation

- ➔ Power source (120 V/60 Hz) required to operate data logger, controller, sensor and PC interface (if on-site); power consumption is nominal; Battery back-up required
- ➔ Standard telephone connection (modular jack) required to data logger for remote data access and downloading
- ➔ Sensor should not be placed in a corrosive environment or subject to irrigation waters, although designed for outdoor use
- ➔ Sensors can be used in constructed “probe vaults” to simulate utility boxes
- ➔ Wireless systems should be used if feasible to minimize installation costs
 - Ensure receivers and transmitters are “line-of-site” without obstructions
 - Locate antennas as high as possible in structures
 - Purchase and use signal repeaters if signals are weak
- ➔ For systems where “hard-wiring” is used:
 - Cable runs should consider subsurface utilities and landscaping (cost increases with burying cable in areas with pavement, landscape and utilities)
 - Conduit may be considered for cables in common areas or potentially subject to traffic or vandalism; 12 inch direct burial of cable is acceptable (per NEC)
 - Cable runs need to meet voltage drop requirements based on length of run and cable or wire size (generally 1000 feet or less for No. 12 AWG)
 - Sensor should be “clustered” if possible to minimize installation disturbance

System Installation



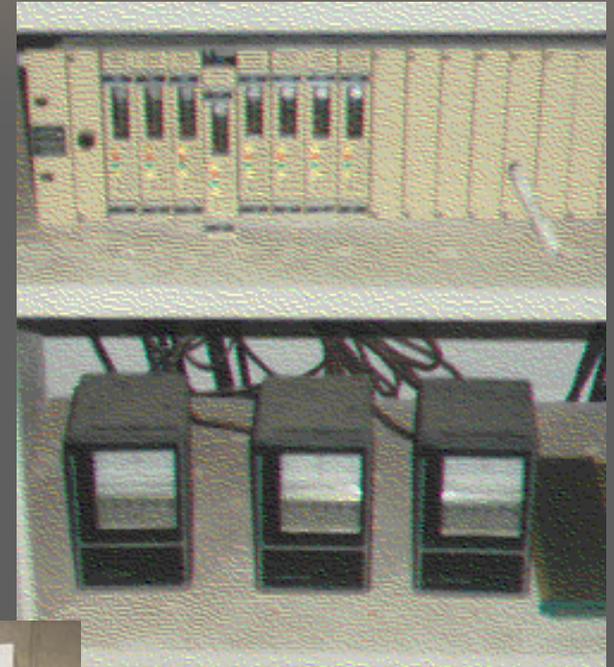
System Operation & Maintenance

- ⇒ System should be calibrated once per quarter or if erroneous readings are detected during monthly download
- ⇒ System data should be downloaded monthly or as required based on memory size and data collection frequency (24-hr, 7-day, 365-day is typical)
- ⇒ System requires a dedicated phone line and power supply (with separate circuit and breakers).
- ⇒ Most systems come with back-up battery to maintain data; however power restoration is critical



“Zero-Span” Calibration

System Operation & Maintenance



Implementation

- ➔ Drawings & Specifications
- ➔ Consultants & Contractors
- ➔ Equipment Manufacturers
- ➔ Equipment Distributors



Multi-Channel Gas Leak Detector/Alarm **NIST**

The detection of a gas leak in an industrial process is a critical function. The NIST Multi-Channel Gas Leak Detector/Alarm is a rugged, reliable, and easy-to-use device that provides a high level of protection for your facility. It features a built-in alarm and a multi-channel gas leak detector. The device is designed to detect a wide range of gases, including methane, propane, and butane. It is available in a variety of models, including the Model 2102, Model 200X, and Model 20X. The Model 2102 is a large, industrial-grade unit that is suitable for use in a wide range of environments. The Model 200X is a smaller, more compact unit that is ideal for use in confined spaces. The Model 20X is a small, cylindrical unit that is easy to install and maintain. All models are designed to provide reliable, accurate detection of gas leaks, helping to prevent accidents and protect your facility.

Model 2102 **Model 200X** **Model 20X**

Multi-Channel Gas Leak Detector/Alarm

Gas Selection Chart

Gas	Range
CH ₄	0-100 ppm
CO	0-100 ppm
CO ₂	0-100 ppm
C ₂ H ₆	0-100 ppm
C ₃ H ₈	0-100 ppm
H ₂	0-100 ppm
H ₂ O	0-100 ppm
NO ₂	0-100 ppm
SO ₂	0-100 ppm
VO ₂	0-100 ppm
Other	0-100 ppm

Technical Specs

Swing-out Range	100 to 1000 ppm (100 to 1000)	Dimensions	100 x 100 x 100 (mm)
Resolution	1 ppm	Weight	100 g
AC Power Input	100-240 VAC, 50/60 Hz	Panel Size	100 x 100 (mm)
Alarm Output	Relay, 24VDC, 1A	Output Range	0 to 1000 ppm
Gas Alarm Output	Relay, 24VDC, 1A	Mounting	Panel Mount
LED Indicators	Power, Alarm, Gas, Fault	Mounting Options	Panel Mount, Wall Mount
Panel Mounting	100 x 100 (mm)	Power Supply	100-240 VAC, 50/60 Hz
Power Supply	100-240 VAC, 50/60 Hz	Other	See specifications for details

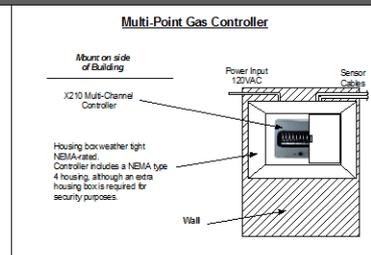
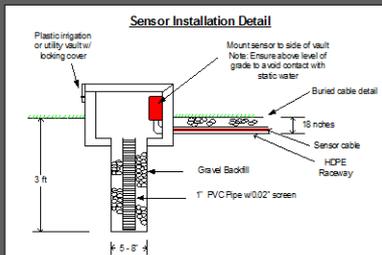
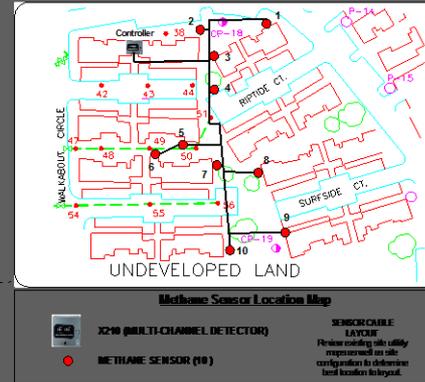
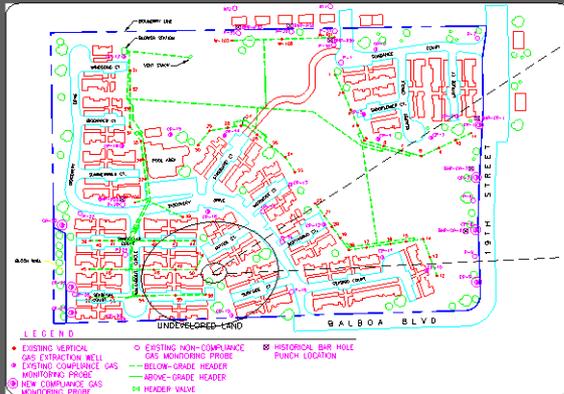
ORDERING INFORMATION

Model	Description	Price	Accessories and Options
2102	Multi-Channel Gas Leak Detector/Alarm	\$1,200.00	Gas Selection Chart
200X	Multi-Channel Gas Leak Detector/Alarm	\$800.00	Gas Selection Chart
20X	Multi-Channel Gas Leak Detector/Alarm	\$400.00	Gas Selection Chart
2102-1	Multi-Channel Gas Leak Detector/Alarm (1 Channel)	\$1,200.00	Gas Selection Chart
2102-2	Multi-Channel Gas Leak Detector/Alarm (2 Channels)	\$1,400.00	Gas Selection Chart
2102-3	Multi-Channel Gas Leak Detector/Alarm (3 Channels)	\$1,600.00	Gas Selection Chart
2102-4	Multi-Channel Gas Leak Detector/Alarm (4 Channels)	\$1,800.00	Gas Selection Chart
2102-5	Multi-Channel Gas Leak Detector/Alarm (5 Channels)	\$2,000.00	Gas Selection Chart
2102-6	Multi-Channel Gas Leak Detector/Alarm (6 Channels)	\$2,200.00	Gas Selection Chart
2102-7	Multi-Channel Gas Leak Detector/Alarm (7 Channels)	\$2,400.00	Gas Selection Chart
2102-8	Multi-Channel Gas Leak Detector/Alarm (8 Channels)	\$2,600.00	Gas Selection Chart
2102-9	Multi-Channel Gas Leak Detector/Alarm (9 Channels)	\$2,800.00	Gas Selection Chart
2102-10	Multi-Channel Gas Leak Detector/Alarm (10 Channels)	\$3,000.00	Gas Selection Chart

See Price and Feature Bulletin website for more information.

504 **Gas Detection / Environmental** Call Toll Free 1-800-368-3516

Drawings & Specifications



Notes:

- Davis Instruments: Multi-Channel Gas Detector Model X210 for 10 Channels, Catalog No. UF7301503, Operating Power 115V-10VAC/220VAC 50/60Hz or 24 VDC.
- X210 Dimensions: 24" x 6 1/2" x 6 1/2"
- Panel Box: NEMA type 4 panel enclosure (included), an extra housing box is needed for security purposes, weather tight NEMA rated.
- Cable Length: #22 or #24AWG Shield, 3 conductor cable, up to 3000 ft.
- Sensors Required: Total of 10 Methane sensors, Model S210R8
- Sensor cables buried at minimum depth of 18" enclosed in HDPE conduit (please review site configuration to determine best location to bury the cables).
- Drawing as to scale.

California Integrated Waste Management Board
1001 I Street - Sacramento, CA 95814
Permitting & Enforcement
(Closed: Illegal & Abandoned Sites Investigation Unit)

Date: 08/29/2011

Prepared By: Glenn K. Young/Abel Martinez-Centano

Continuous Gas Monitoring System
Newport Terrace Condominiums

Consultants & Contractors

- ⇒ SCS
- ⇒ BAS (Bryan A. Stirrat & Associates)
- ⇒ URS
- ⇒ TetraTech
- ⇒ Ninyo-Moore

Equipment Manufacturers

- ➔ ATI http://www.apisystemsgroup.com/products/fire_detection_systems.php
- ➔ Biosystems <http://www.biosystems.com/>
- ➔ BW Technologies <http://www.gasmonitors.com/main.cfm?deploc=1&depid=1>
- ➔ Crowcon : <http://www.crowcon.com/>
- ➔ Det-Tronics <http://www.detrionics.com/>
- ➔ Drager http://www.draeger.com/ST/internet/US/en/Products/Detection/StationaryGasDetection/stationary_gas_detection.jsp
- ➔ General Monitors <http://www.generalmonitors.com/>
- ➔ GDS Corp <http://www.gdscorp.com/>
- ➔ GMI <http://www.gmiuk.com/>
- ➔ Industrial Scientific <http://www.indsci.com/>
- ➔ LandTEC <http://www.ces-landtec.com/>
- ➔ Manning Systems <http://www.manningsystems.com/>
- ➔ MSA <http://www.msanet.com/catalog/catalog507.html>
- ➔ RAE Systems <http://www.raesystems.com/>
- ➔ RKI Instruments <http://www.rkiinstruments.com/>
- ➔ Scott Instruments <http://www.scottinstruments.com/>
- ➔ Sensidyne <http://www.sensidyne.com/>
- ➔ Sieger http://www.gas-detection-equipment.co.uk/combustible_gas_sensor.htm
- ➔ Sierra Monitor Corp (SMC) <http://www.sierramonitor.com/>
- ➔ Thermo-GasTech <http://www.thermo.com/BURedirect/welcomeMsg/1,5107,73,00.html>
- ➔ ZellWeger

Distributors

⇒ A-L Compressed Gases

<http://www.calrecycle.ca.gov/Laws/Regulations/Title14/ch9a63.htm>

⇒ Industrial Safety Equipment & Supplies

<http://www.majorsafety.com/category.cfm?Category=17>

⇒ Jensen Instrument, Co.

<http://www.jenseninstrument.com/Products.html>

⇒ Davis Instruments

Summary

- ⇒ Automated or Direct digital control systems have been in use for over 20 years and if properly calibrated and maintained are reliable, efficient and cost-effective
- ⇒ Systems can provide time-trend gas monitoring data that is accurate and legally defensible (can be used to show 1.25% by volume in air levels for enforcement purposes)
- ⇒ Difficult to demonstrate compliance with 1.25% rule
- ⇒ In addition to monitoring, systems can be used to control alarms and ventilation, which would directly protect public health and safety
- ⇒ System components (sensors, data acquisition systems, controllers, etc.) can be purchased off the shelf from numerous manufacturers

Summary

- ⇒ Cost of continuous gas monitoring system (<\$50K) is substantially less than typical landfill gas extraction and treatment systems (\$500K-\$1.5M), e.g. if project costs are to be prioritized the first remedy would be to implement a continuous monitoring system in structures to protect public health and safety. For example a wireless continuous monitoring system with 10 sensors would cost
 - 10 sensors @ \$1000/sensor or \$10K
 - 1 each 16-channel controller @ \$4500 or \$4.5K
 - 1 each data logger @ \$3000 or \$3.0K
 - 10 wireless transmitters and receiver @ \$5K
 - Design and Installation Cost \$10K
 - Total system cost: \$32.5K

Summary

- ⇒ Continuous systems should be “designed”, specified and installed by a qualified and experience consultant and contractor
- ⇒ Continuous monitoring systems must be operated, calibrated and maintained to minimize the risk of gas migration into structures and protect public health and safety