Cannabis Industry Gas Detection Issues and Answers

Bob Henderson
GfG Instrumentation, Inc.

1194 Oak Valley Drive, Suite 20, Ann Arbor, Michigan 48108

Toll free (USA and Canada): (800) 959-0329

Local: 734-769-0573

Internet: www.goodforgas.com

GfG Instrumentation

World-wide manufacturer of fixed and portable gas detection solutions

smart GasDetection Technologies

Cannabis Industry Gas Detection Questions

- Try to assess your needs beforehand so you will know the questions to ask and understand the answers.
- Try to characterize your needs to frame the discussion.
  - Safety?
  - Facilities?
  - License requirement?
- Discuss the ground rules for confidentiality
  - You need to be able to share at least to the extent necessary to discuss the issues and possible solutions

What are your most urgent concerns and problems?

- What can the distributor or equipment manufacturer do to help?
- Gas detection issues are not necessarily limited to safety!
- And cannabis gas detection requirements and solutions are definitely not limited to portable instruments!
  - The strictest cannabis industry requirements are for fixed CO_2 and LEL measurement

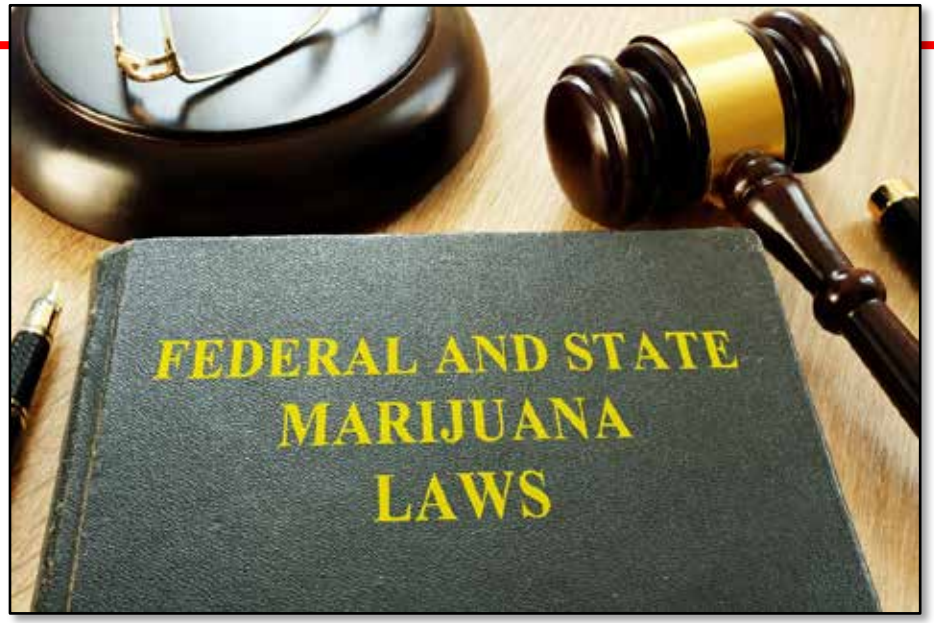
Fixed or Portable solution?

- Growers:

What are the most common cannabis industry gas detection applications?

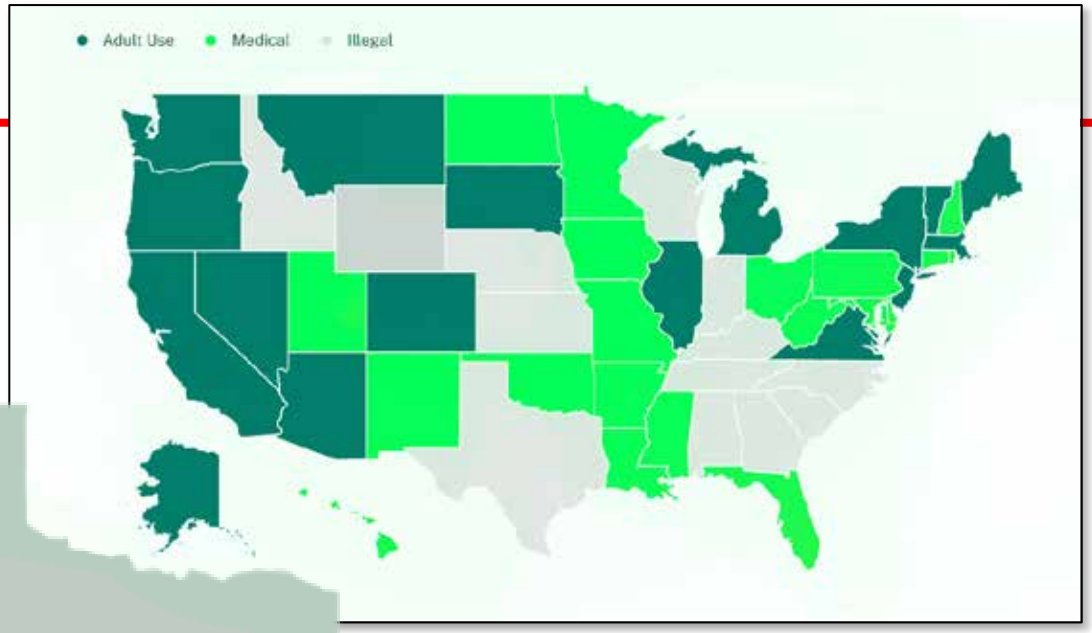
- Production (grower ops)
- Process (extraction)
- Manufacturing
- Facilities
- Industrial hygiene
- Community (such as fence line or nuisance odor)
- Regulatory (state, county, municipal)
- Disaster response (explosion)
- Construction
- Confined space

Growth and extraction of marijuana products now legal in some form in 36 states and all of Canada



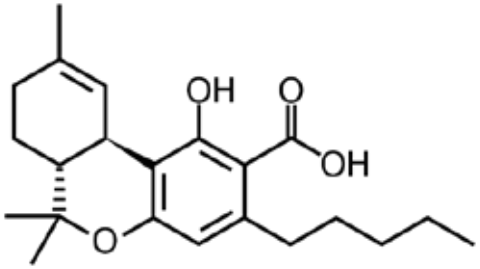
- What is the status in your jurisdiction?
- Use and possession of cannabis still officially illegal under federal law.
  - "*Controlled Substances Act of 1970*" lists cannabis as a Schedule I drug, which prohibits even medical use.
  - Laws at state and local level increasingly at variance with federal law.
- Medical use is legal in 36 states.
  - Rohrabacher–Farr amendment of 2014 prohibits federal prosecution of individuals in compliance with state medical cannabis laws.
- Recreational use of cannabis is legal in 16 states
  - Another 14 states have partly or completely decriminalized its use.
  - Twelve additional states have laws that allow access to cannabidiol (CBD) products that are very low in THC

Legalization status often murky



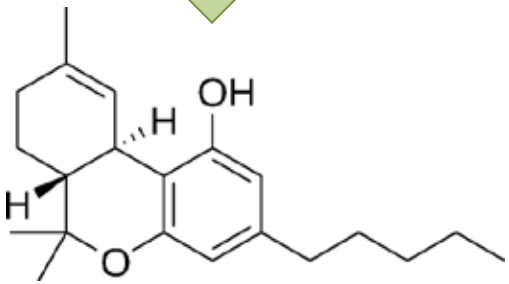
- De facto legalization status can vary within a state
- Current status possibly subject to future revision
- Consider Texas:
  - Officially illegal to cultivate or use cannabis throughout Texas
  - In some cities (e.g. Austin) possession of less than 4 oz. not prosecuted
  - CBD is legal if it has under 0.3% THC

What is the difference between THCA and THC?



THCA

HEAT

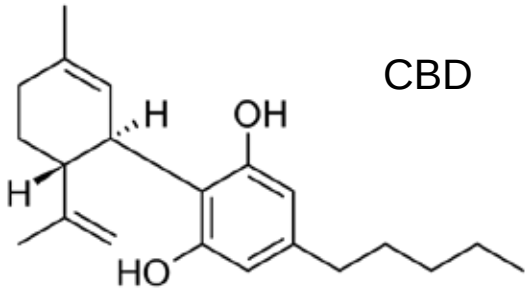


THC

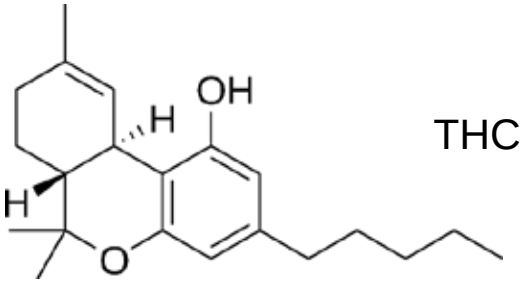
- THCA (tetrahydrocannabinolic acid) is found fresh, undried cannabis
  - THCA is non-psychoactive precurser chemical to THC in raw cannabis
  - Converted into THC by decarboxylation when dried or by heating (as when smoked or cooked into edibles)
  - Decarboxylation is a chemical reaction that removes a carboxyl group (COOH) from molecule and releases carbon dioxide (CO_2)
  - THCA is often the major constituent in cannabis resin concentrates, such hashish and hash oil

What is the difference between CBD and THC?

- THC (tetrahydrocannabinol) is the principal psychoactive component in cannabis
- CBD (cannabidiol) second most prevalent of the active ingredients of cannabis (marijuana)
  - Active but not psychoactive!
  - One of over 85 terpenes and cannabinoids present in hemp and cannabis plants
- Both hemp plant and cannabis plant produce CBD
  - Up to 40% of total extract from cannabis is CBD
- Is cannabidiol legal?
  - Legal status of CBD is in flux
  - Federal government still considers CBD in the same class as marijuana
  - State position depends in part on whether the CBD comes from hemp or marijuana
  - Legality of CBD is expected to change, as there is currently bipartisan consensus in Congress to make the hemp crop legal



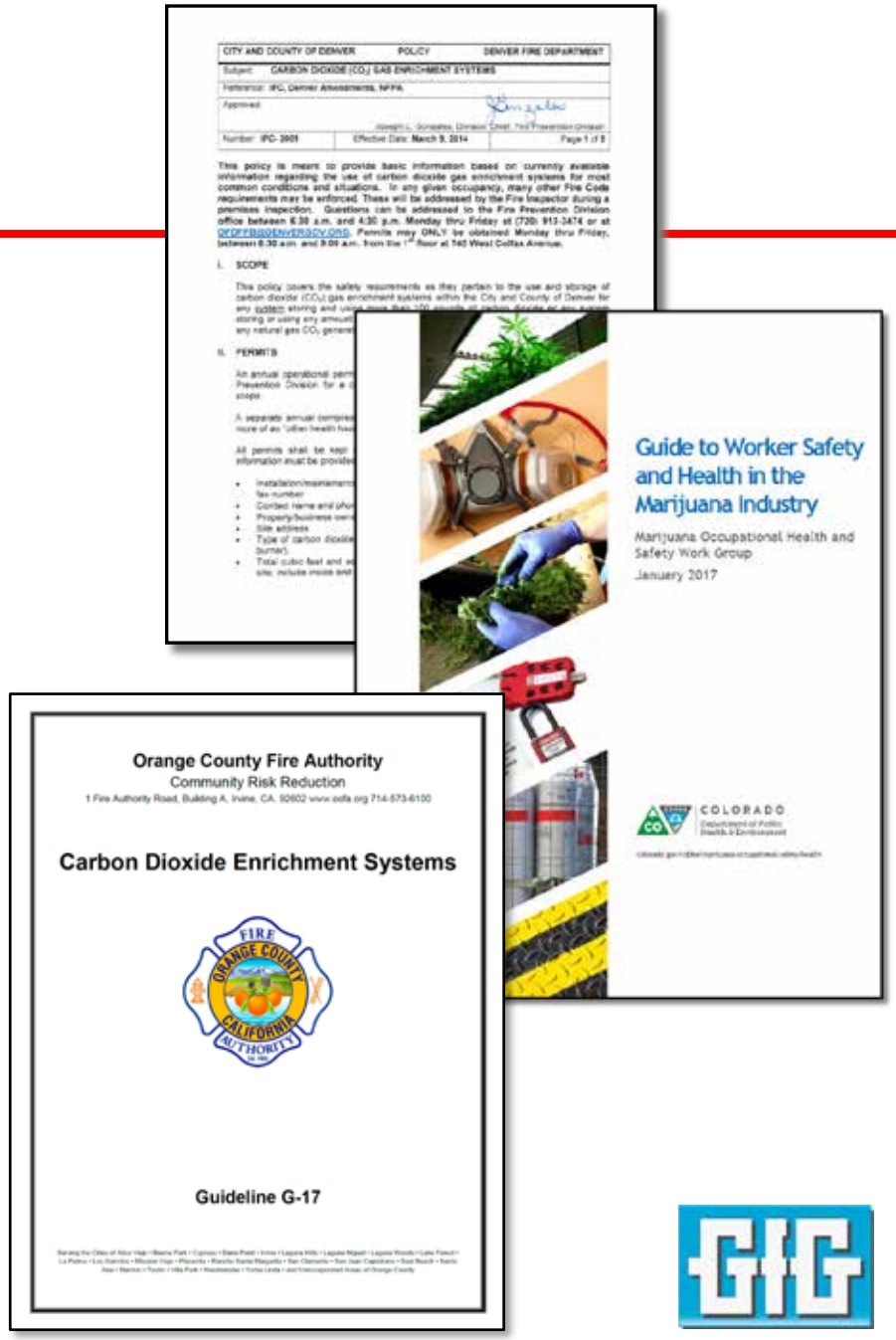
CBD



THC

Where do cannabis industry regulations come from?

- Cannabis enterprises highly regulated, with many requirements for monitoring atmospheric hazards
- Regulated at:
  - State level
  - County level
  - City / community level
- Atmospheric hazards exist in many enclosed areas such as greenhouses and extraction rooms
- Municipal and fire service personnel perform periodic inspections at licensed commercial sites, and are exposed to potentially dangerous atmospheric conditions
- Emergency response can expose fire department personnel to additional risks



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What are the types of cannabis enterprises?

- Non-commercial
  - Products for personal use only
  - Non licensed
  - May or may not be legal depending on jurisdiction
- Commercial (licensed) enterprises
  - Recreational marijuana
    - Grower operations are distinct from extractor operations
    - Smaller scale, heavily taxed, (may be) minimally funded
  - Medical marijuana
    - Larger scale, integrated growth and extraction, better funded, well managed, increasingly big business
  - CBD products (non psychoactive)

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What are the typical gas detection requirements for licensed cannabis enterprises?

- Colorado and California requirements are models for regulations in other states
- License requires signoff and periodic inspection by local fire department and municipal authorities
- "Grow" areas (greenhouses):

  Cultivation areas where atmosphere often artificially enriched by adding CO_2

  Required to be monitored by means of fixed CO_2 detection system with alarm at 5000 ppm

- "Extraction" rooms:

  Rooms where LPG (butane) or solvents used to extract "hash oil" (BHO) and other fractionated products deemed to be Class I Division 1 hazardous locations

  Adjacent areas deemed to be Class I Division 2 areas

  Required to be monitored for combustible gas

  Rooms where supercritical CO_2 used for extraction must be monitored for carbon dioxide

Infrared (IR) CO_2 transmitter for use in greenhouses and areas which do not have the presence of combustible gas

Explosion proof CC LEL transmitter for use in Class I Div 1 Hazardous Locations (Zone 1)

What are the grower hazards?

- CO_2 necessary for plant growth (photosynthesis)
  - Increasing light (lumens), temperature, humidity and CO_2 concentration used to accelerate growth
- Optimal CO_2 concentration for growth between 1200 and 1500 ppm
  - Grow area tightly sealed
- At most <u>licensed</u> enterprises CO_2 introduced via:
  - Compressed CO_2 gas: cylinders of high concentration gas controlled with solenoids and valves
  - CO_2 generators: make CO_2 by burning alcohol or natural gas
- At non-commercial sites CO_2 generation via:
  - Open flame burners, fermentation (sugar yeast and water), dry ice, vinegar + baking soda, composting (aerobic decomposition)

How do CO_2 enrichment systems work?

- CO_2 from gas burner

- CO_2 from cylinder

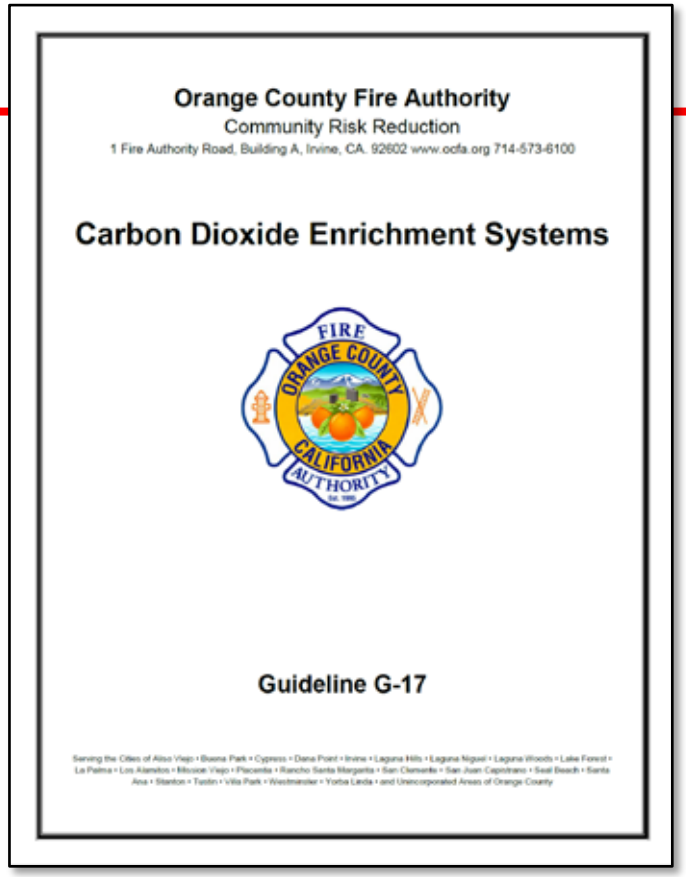
CO released near ceiling, flows downward as consequence of density

Localized pockets of CO or elevated O can affect growth

Use fans to disperse and bring gas to plants

Orange County, CA carbon dioxide gas enrichment system policy

- Gas Detection System:
  - A gas detection system shall be provided in rooms or indoor areas in which the CO enrichment process is located
  - CO sensors shall be provided within 12 inches of the floor in the area where the gas is expected to accumulate
  - Activate low-level alarm upon detection at 5,000 ppm
  - Activate high-level alarm 30,000 ppm
- Activation of low-level gas alarm shall automatically:
  - Stop the flow of carbon dioxide (CO) to the piping system
  - Activate the mechanical exhaust ventilation system
  - Activate an audible and visible supervisory alarm signal at an approved location within the building
  - Readings visible from outside
- Activation of high-level alarm shall automatically:
  - Stop the flow of CO to the piping system
  - Activate the mechanical exhaust ventilation system
  - Activate an audible and visible evacuation alarm both inside and outside of the CO enrichment area, and the area in which the carbon dioxide (CO) containers are located



Orange County Fire Authority

Community Risk Reduction

1 Fire Authority Road, Building A, Irvine, CA. 92602 www.ocfa.org 714-573-6100

Carbon Dioxide Enrichment Systems

Guideline G-17

What are the properties of CO_2 ?

- Present as a natural component in fresh air (approximately 420 ppm)

  Colorless

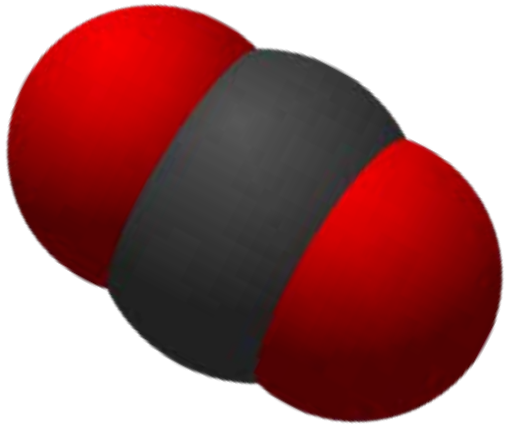
  Odorless

  Tasteless

  Heavier than air (density of 1.5 times that of fresh air)

  When released into enclosed space it tends settle to bottom

  Because of tendency to settle, as CO_2 produced it can reach higher and higher concentrations



What are the symptoms of exposure to CO_2 ?

- Besides displacing oxygen in fresh air, high concentrations may worsen symptoms related to oxygen deficiency, and interfere with successful resuscitation
- Exposure Symptoms include:

  Headaches

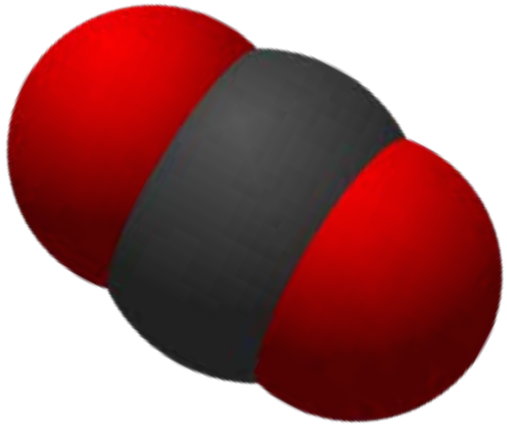
  Dizziness

  Shortness of breath

  Nausea

  Rapid or irregular pulse

  Depression of central nervous system



- Even moderate exposure can be serious

  Normal indoor fresh air concentration: 420 – 1000 ppm

  1000 – 2000 ppm: complaints of drowsiness

  Optimal cannabis greenhouse concentration: 1200 – 1500 ppm

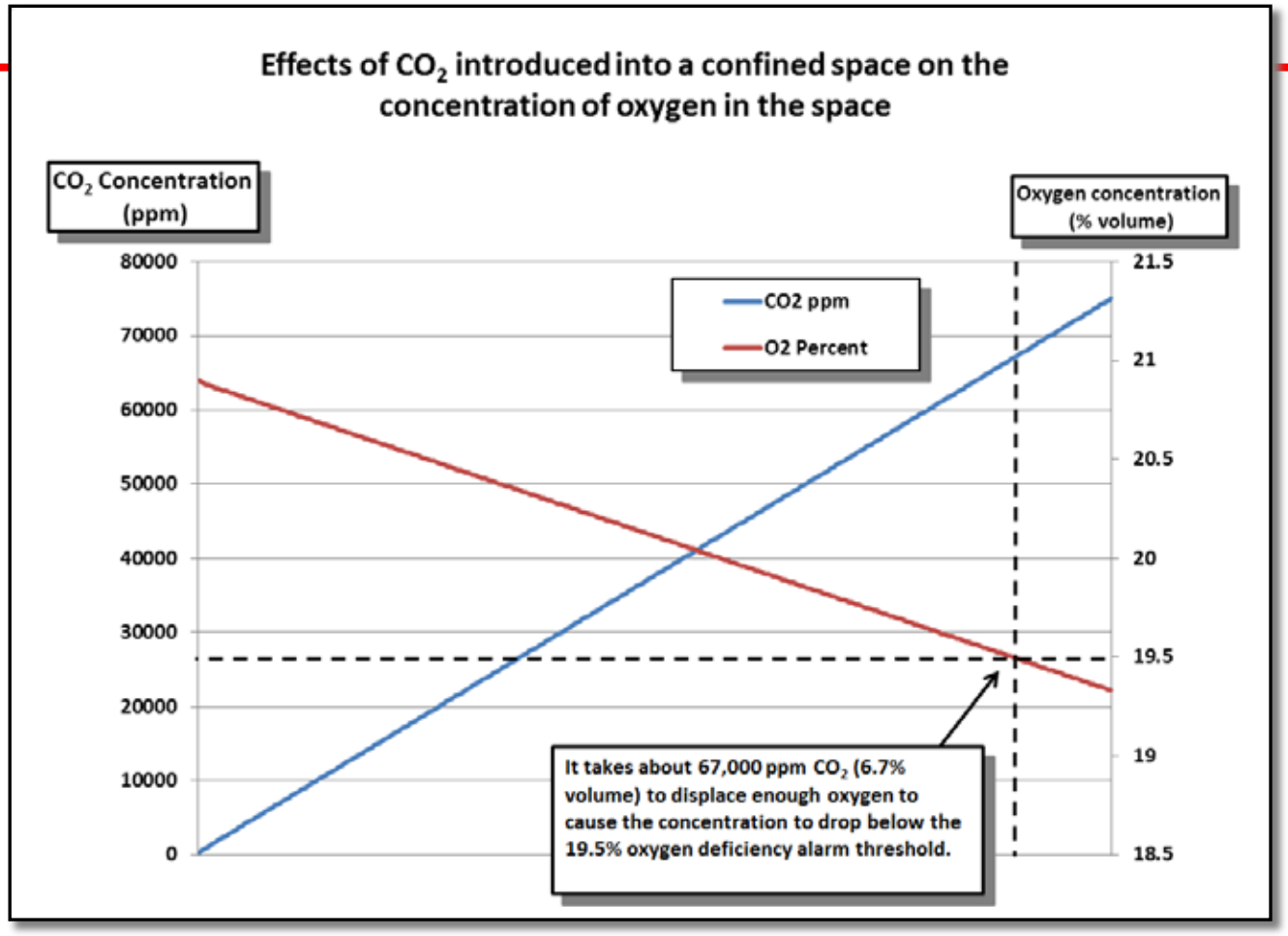
  OSHA / NIOSH / TLV: 5000 ppm TWA limit

  IDLH: 30,000 ppm

  Exposure to very high concentrations (30% volume CO_2 for 20-30 seconds) linked to losing consciousness and permanent heart damage

Presence of displacing gas on oxygen concentration

- Be very cautious when using O_2 concentration to estimate concentration of some other displacing gas
- Every 5% of displacing gas introduced into an enclosed space reduces O_2 concentration by only about 1%



What are the periodic calibration and inspection requirements?

- All CO_2 Detectors must be calibrated, and pass inspection by the licensing and inspection authorities
- Typically inspected quarterly or biannually
- Typically calibrated or tested by exposure to gas at least biannually

GMA 200 MW/4 one to four-point controller

CO_2 gas sensor assembly (transmitter) with display

"Blind" CO_2 gas sensor assembly (transmitter) w/o display

What about exposure to terpenes and nuisance odors?

- "Terpenes" are the aromatic compounds that give plants and extracts their distinctive flavors and aromas
  - Greenhouses often equipped with scrubber systems to remove nuisance odors and keep the smell from reaching nearby neighborhoods.
  - Many terpenes are known to be respiratory irritants, but exposure limits for most terpenes remain to be determined.
  - The dominant terpenes that produce the characteristic cannabis odor are myrcene, pinene and limonene.
  - Pinene is an exception to this general rule.
    - Pinene is the major component in turpentine (about 65%).
    - OSHA PEL for pinene is 100 ppm (as turpentine) and the threshold limit value (TLV®) is 20 ppm averaged over an 8-hour workshift.
    - The IDLH concentration is 800 ppm.

How do you measure terpenes and where do you set the alarms?

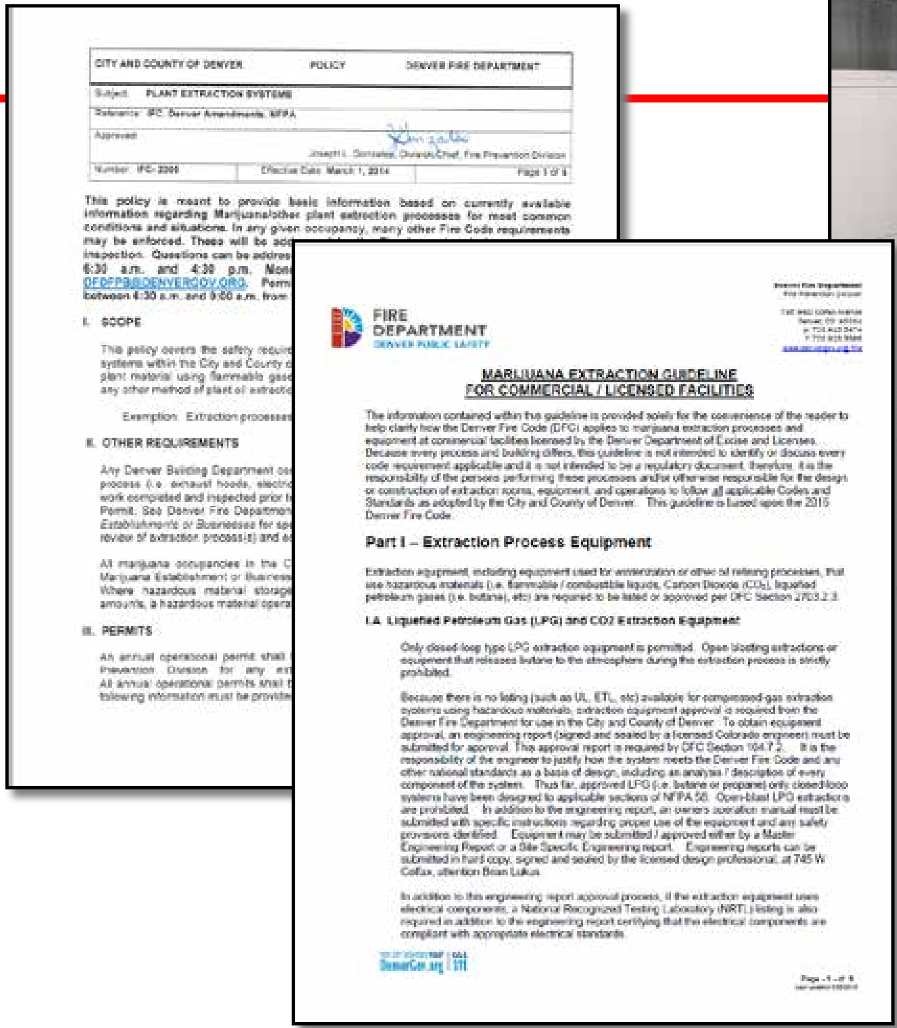
- Best way to measure terpenes is by means of PID
  - Stationary PID sensors can be installed within the greenhouse as part of an integrated fixed gas detection system or
  - Positioned downstream from air scrubbing systems to alert operators if there is breakthrough, and odors have started to escape.
  - Health and Safety:
    - Low instantaneous alarm at 3X TWA (= 300 ppm)
    - High instantaneous alarm at 5X TWA (= 500 ppm)
    - IDLH 800 ppm
- Where should you set nuisance odor alarm?
  - Many of the terpenes in cannabis, such as limonene, are nose detectable by human beings at concentrations as low as 1.0 ppm.
  - Set nuisance odor alarm as low as possible

Ion Science Falco
Fixed PID transmitter

What are the hazards associated with extraction rooms and activities?

- Cannabis can be sold in the form of leaf or buds, but the most valuable products are essential oils and extracts.
- Extraction is the process of separating the active chemicals from the raw material and turning it into a usable form.
- Medical extracts are mostly based on cannabidiol (CBD) while recreational extracts are based on tetrahydrocannabinol (THC).
- The most common extraction techniques involve the use of flammable gas (like butane or propane) or solvents (like ethanol or methanol) to separate the chemicals from the plant material.
- Extraction rooms are hazardous locations where explosive concentrations of gas or vapor can easily develop.
  - Using butane is the cheapest but potentially most dangerous method of extraction
  - When using liquefied petroleum gas, (like butane or propane) only closed-loop type extraction equipment is permitted
  - Supercritical CO_2 is more expensive, but safer, and produces better results

What are the requirements for extraction rooms?



CITY AND COUNTY OF DENVER — POLICY — DENVER FIRE DEPARTMENT

Subject: PLANT EXTRACTION SYSTEMS

Number: IFC-2000 — Effective Date: March 1, 2014 — Page 1 of 4

I. SCOPE

II. OTHER REQUIREMENTS

III. PERMITS

FIRE DEPARTMENT
DENVER PUBLIC SAFETY

MARIJUANA EXTRACTION GUIDELINE
FOR COMMERCIAL / LICENSED FACILITIES

Part I – Extraction Process Equipment

I.A. Liquefied Petroleum Gas (LPG) and CO2 Extraction Equipment

- Extraction rooms where combustible gas or flammable solvents used are Class I Division 1 Hazardous Locations which must be continuously monitored for combustible gas
- Adjacent rooms are Class I Division 2 Hazardous locations which must also be monitored

Butane (BHO) extraction

- Less expensive, much more dangerous
- Butane (LPG) run through macerated plant matter, pulling out the desirable oils
- To remove the residual solvent, the solution is heated (butane evaporates in low temperatures) in a vacuum
- Only closed loop BHO systems permitted at licensed facilities
- 90% of the cannabinoids remain in the extracts

What is supercritical CO_2 extraction?

- Extraction techniques need to separate the active molecules from the plant material without causing them to "deactivate" or lose their bioactive potency.
- Supercritical CO_2 extraction is the most expensive extraction method, but also the safest as it avoids the use or creation of explosive gases or vapors.
- In certain pressure and temperature conditions, CO_2 behaves as both a gas and a liquid at the same time.
  - This "critical" point is reached at around 1,071 psi (the critical pressure) and 90^{o} F (the critical temperature).
  - The temperature is well below the deactivation temperature for the cannabinoids and terpenes that are targeted for extraction.
  - The supercritical CO_2 is forced through the macerated plant material.
  - The liquid passes through separators where CO_2 is removed and the various fractions of the extract are collected.

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What is winterizing?

- Subcritical CO_2 extraction, known as winterizing, requires less pressure and uses a lower temperature, non-supercritical liquid form of CO_2.
  - Winterizing takes longer, is less efficient and produces lower yields, but is easier on the fragile molecules being extracted, which can produce higher quality (and higher priced) extracts.
  - The winterization process usually uses ethanol to further separate the pure cannabinoids and terpenes from other byproducts.
  - Constituents that are not soluble in alcohol or water can be extracted using a range of other solvents such ether, naphtha, benzene, butane, methanol, isopropyl alcohol, and even olive oil.

What are best detection techniques for use in Class I Div 1 and Class I Div 2 extraction room hazardous locations?

- For butane or propane use either catalytic (CC) LEL or IR LEL transmitters
- For LEL alcohol measurement use IR LEL transmitters
- For ppm solvent measurement use PID
- For CO_2 measurement recommend IR CO_2

Intrinsically safe CC LEL or IR CO2 transmitter for use in Class I Div 1 Hazardous Locations

Explosion Proof CC LEL transmitter for use in Class I Div 2 Hazardous Locations

Explosion Proof PID transmitter for use in Class I Div 1 Hazardous Locations

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Don’t be afraid of fixed systems!

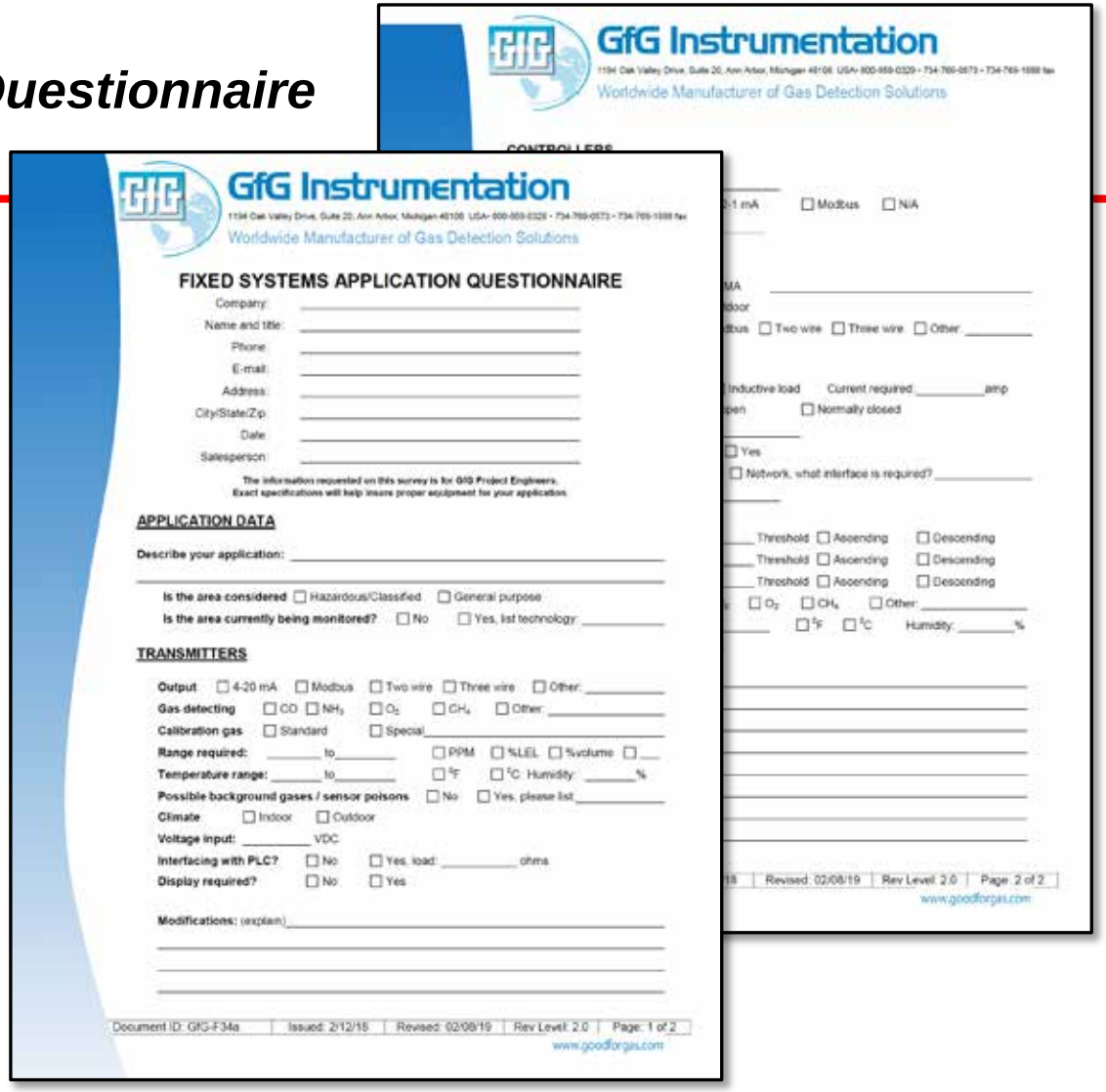
- Most common solution is often small standalone system with 1 to 4 points of detection.
- Larger systems can be complicated, but your manufacturer partners are there to help you through the specification process.

Do you have a "Fixed System Questionnaire" from the manufacturer you are working with?

- Your supplier or manufacturer partner can't provide a solution without the information in this usually simple form.
- If you do not have a copy, contact the manufacturer BEFORE the visit!
  - Clarifying what you need by means of a detailed questionnaire reduces the chances for specifying or purchasing the wrong equipment.
  - Don't be afraid to ask if you need help with the answers.
  - Answer as many questions as you can, but don't worry if you can't answer them all.
  - The manufacturer will tell you if there is something that must be nailed down before you can generate a quote.
- Don't go it alone!
  - Don't be afraid to ask the manufacturer to help.

Example Fixed System Questionnaire

- Simple information but critical to know
- The questionnaire will help you to ask the right questions
- Vital to provide the best solution!



GfG Instrumentation

Worldwide Manufacturer of Gas Detection Solutions

FIXED SYSTEMS APPLICATION QUESTIONNAIRE

Company:
Name and title:
Phone:
E-mail:
Address:
City/State/Zip:
Date:
Salesperson:

The information requested on this survey is for GfG Project Engineers. Exact specifications will help insure proper equipment for your application.

APPLICATION DATA

Describe your application:

Is the area considered ☐ Hazardous/Classified ☐ General purpose

Is the area currently being monitored? ☐ No ☐ Yes, list technology:

TRANSMITTERS

Output ☐ 4-20 mA ☐ Modbus ☐ Two wire ☐ Three wire ☐ Other:

Gas detecting ☐ CO ☐ NH_3 ☐ O_2 ☐ CH_4 ☐ Other:

Calibration gas ☐ Standard ☐ Special

Range required: to PPM ☐ %LEL ☐ %volume ☐

Temperature range: to ☐ °F ☐ °C Humidity: %

Possible background gases / sensor poisons ☐ No ☐ Yes, please list

Climate ☐ Indoor ☐ Outdoor

Voltage input: VDC

Interfacing with PLC? ☐ No ☐ Yes, load: ohms

Display required? ☐ No ☐ Yes

Modifications: (explain)

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What about municipal and fire service personnel visiting sites as part of licensing process?

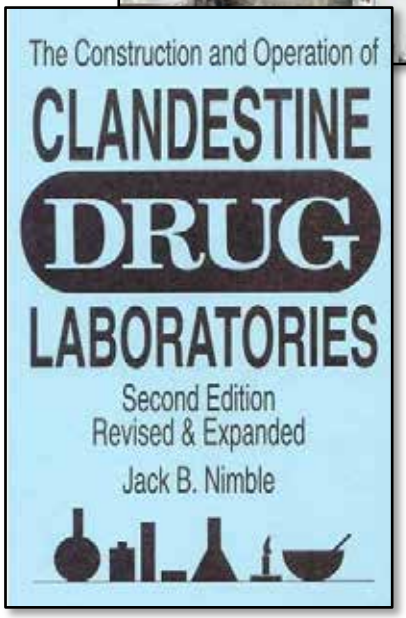
- Fire department and municipal personnel are regularly on site at licensed facilities for periodic inspection
- Fire department personnel also potentially involved in emergency response at licensed and unlicensed facilities
- Standard 4 gas meter with O_2 / LEL / CO / H_2S sensors does not adequately protect inspectors or emergency responders!
- Use same 5 or 6 gas meter you use for HAZMAT response with LEL / O_2 / PID / CO_2 / CO and H_2S sensors.
- Make sure to include LEL sensor capable of both combustible gas and LEL range alcohol
  - Alcohol vapor very hard on CC LEL sensors in portable instruments, and response to alcohol is slow
  - Consider using IR LEL for alcohol measurement
- Make sure to include PID for ppm solvent and terpene detection
- Make sure to include IR CO_2 sensor
  - Many designs offer dual channel IR LEL / IR CO_2 sensor

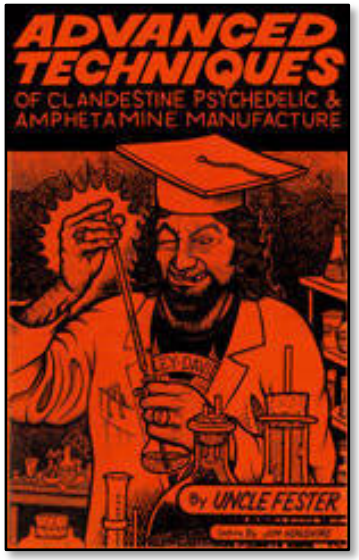
G999 one to seven channel gas detector with IR LEL / IR CO_2 / O_2 / PID and COSH sensors.

Contaminant	LEL (Vol %)	Flashpoint Temp (ºF)	OSHA PEL	NIOSH REL	TLV	5% LEL in PPM
Acetone	2.5%	-4ºF (-20 ºC)	1,000 PPM TWA	250 PPM TWA	500 PPM TWA; 750 PPM STEL	1250 PPM
Diesel (No.2) vapor	0.6%	125ºF (51.7ºC)	None Listed	None Listed	15 PPM	300 PPM
Ethanol	3.3%	55ºF (12.8 ºC)	1,000 PPM TWA	1000 PPM TWA	1000 PPM TWA	1,650 PPM
Gasoline	1.3%	-50ºF (-45.6ºC)	None Listed	None Listed	300 PPM TWA; 500 PPM STEL	650 PPM
n-Hexane	1.1%	-7ºF (-21.7 ºC)	500 PPM TWA	50 PPM TWA	50 PPM TWA	550 PPM
Isopropyl alcohol	2.0%	53ºF (11.7ºC)	400 PPM TWA	400 PPM TWA; 500 PPM STEL	200 PPM TWA; 400 PPM STEL	1000 PPM
Kerosene/ Jet Fuels	0.7%	100 – 162ºF (37.8 – 72.3ºC)	None Listed	100 mg/M3 TWA (approx. 14.4 PPM)	200 mg/M3 TWA (approx. 29 PPM)	350 PPM
MEK	1.4%	16ºF (-8.9ºC)	200 PPM TWA	200 PPM TWA; 300 PPM STEL	200 PPM TWA; 300 PPM STEL	700 PPM
Turpentine	0.8	95ºF (35ºC)	100 PPM TWA	100 PPM TWA	20 PPM TWA	400 PPM
Xylenes (o, m & p isomers)	0.9 – 1.1%	81 – 90ºF (27.3 – 32.3 ºC)	100 PPM TWA	100 PPM TWA; 150 PPM STEL	100 PPM TWA; 150 STEL	450 – 550 PPM

What about clandestine labs?

- Even in states where recreational cannabis is fully legal, unlicensed and clandestine labs are still a concern
- Licensed cannabis enterprises pay their taxes, are generally well run, and willing to conform with local regulations
- In some states no license is required for products manufactured for personal consumption
- Butane extraction is still the cheapest approach, and the equipment is readily available over the Internet
- Some of the instructions you can download from the Internet are pretty good, some are dubious or downright dangerous
- Cannabis lab explosions are still a routine occurrence!





There are <u>many</u> new developments in gas detection!

- New products
- New sensors
- Wireless communication
- Integrated fixed and portable networks
- Third party support through call centers
  - Emergency response
  - Record keeping and notifications
  - Internet based maintenance programs

Avoid being overly focused on price!

- Eventually, the decision of whether to proceed involves price and affordability.
  - There is a difference between the purchase price and the true cost of ownership.
  - Once you fully identify the problems and how the new product is going to help, it's easier to understand the costs.

Identify "cost of ownership" issues

- Are you spending a fortune keeping the equipment in service?
- Do you trust your gas detectors?
- Do you have many sensor failures?
  - If so, what kinds of sensors are failing?
- Do you have battery problems?
  - Do the instruments run long enough on a single charge or set of batteries?
- How often do you test and calibrate your instruments?
  - Do you do it yourself or use a service?
- Are there any special conditions or contaminants that are causing problems?
- <u>Do you feel you are currently getting a good deal?</u>

Who is looking after the instruments?

- Do you do it yourself, use a third-party service, or work directly with the factory?
- If you like your current equipment, you might want to talk about maintenance agreements or refurbishment programs.
- Deciding on how to calibrate and maintain fixed detection systems is an important issue.
  - Make sure to discuss!

Questions?

Thank you!

For additional information or gas detection help:

Bob Henderson
bhenderson@goodforgas.com

GfG Technical Support:
service@goodforgas.com
USA and Canada: 800-959-0329
Local: 1-734-769-0573