Oil and Petrochemical Industry
Gas Detection Issues and Answers

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Gas Detection for Oil Industry Workers and Contractors

- Webinar goals:
  - Provide overview of gas detection issues and answers for the Oil and Petrochemical Industry:
    - Workers
    - Employers
    - Contractors
    - Emergency responders.
  - Provide framework for assessing gas detection needs:
    - What questions should you ask and what issues should you consider?
    - What is the best gas detection solution?
    - Asking better questions leads to better solutions, and to better results for your company!

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Oil and Petrochemical Site Visit
Gas Detection Questions

- Oil / chemical industry managers deal with extremely wide range of atmospheric hazards, monitoring applications and activities.
- Hazards can be generally present or associated with specific activities (like CS entry).
- Managers need to anticipate critical requirements ahead of time
- Dealing with atmospheric hazards is a constant concern!
- Make sure any instrument you considering is fit for purpose!

FITNESS FOR USE IS A FUNCTION OF SENSING TECHNOLOGY AND MANUFACTURER PORPOISE

What are the customer's most urgent gas detection concerns and problems?

- The more detailed grasp you have of the activities and risks that involve atmospheric hazards, the better.
- Drill down to make sure you understand what is most important.
- Are you currently meeting all requirements?
- Where do you need to make improvements?
- Gas detection issues are not necessarily limited to safety!
- And gas detection solutions are <u>definitely not</u> limited to portable instruments

Oil and chemical industry gas detection requirements can include

- Personal protection
- Industrial hygiene
- Exposure assessment
- Community (such as fence line or nuisance odor)
- Regulatory (EPA)
- Disaster response (explosion, spill or fire)
- Construction (shut-downs)
- Confined space
  - Routine entries
  - Large scale ongoing-entries
  - Entries into inerted vessels
  - Hot work
  - Special procedures (catalyst rebuilding)

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Fixed or Portable solution?

- When hazards are generally present or associated with specific activities (like CS entry) gas detection solutions focus more on portable instruments.
- When hazards are chronically present, or present in specific areas, fixed gas detection should be considered as well.
- Optimal solution often includes both fixed and portable instruments!

What are the major categories of oil and chemical industry sites and products?

- Different parts of the oil / petrochemical industry deal with different hazards.
- “Upstream” exploration and production:
  - Crude oil
  - Natural gas
  - Bitumen
- “Midstream” transportation and wholesale marketing of crude or unrefined products:
  - Pipeline
  - Rail
  - Tanker (truck)
  - Marine transport
- “Downstream” refining and processing:
  - Crude oil and bitumen into fuels (gasoline / diesel / jet fuel / fuel oil)
  - Processing and purifying raw natural gas

What are typical "Upstream" gas detection concerns?

- What are some typical upstream concerns?
  - Personal protection
  - Lone worker
  - Confined space entry
  - Local site protection (fixed systems)
- Rely on single and basic multi-gas instruments:
  - H_2S
  - 4 Gas with LEL / O_2 / CO / H_2S
  - 5 Gas with PID
  - Other toxic gases (SO_2 / NO_2 / benzene / etc.)

What about periodic testing and calibration?

- How often do you perform a bump test?
  - Before each day's use?
  - Do you keep bump test kits (with gas) with the instruments?
  - How do you prove your instruments have been bumped?
  - What do you do if you fail a bump test?
- How often do you perform a full calibration?
  - Do you use a docking station for bump tests and calibrations?
  - How do you prove your instruments are properly maintained and calibrated?
  - How do you retain maintenance and calibration records?

Manufacturers offer kits specifically designed for oil industry customers

- Complete G450 ecoBump kit with G450 with O_2, LEL, CO and H_2S sensors, push-button regulator, cylinder of test gas and foam lined carrying case.
- Each compact ecoBump cylinder provides up to 250 daily bump tests!
- Available with alkaline AA or rechargeable NiMH battery packs.

What are typical "Midstream" gas detection concerns?

- What are some typical midstream concerns?
  - Personal protection
  - Lone worker
  - Confined space
- Rely on single and basic multi-gas instruments:
  - H_2S
  - 4 Gas with LEL / O_2 / CO / H_2S
  - 5 gas with LEL / O_2 / CO / H_2S / SO_2
  - 5 Gas with PID
  - 6 gas with LEL / O_2 / CO / H_2S / SO_2 / PID
  - Other specific toxic gases (NH_3 / NO_2 / benzene / etc.)

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What are typical "Downstream" gas detection concerns?

- What are some typical downstream concerns?
  - Personal protection
  - Toxic exposure monitoring
  - Confined space
  - Shut-downs
  - Fixed systems
- Rely on single and multi-gas instruments:
  - H_2S
  - 4 Gas with LEL / O_2 / CO / H_2S
  - 5 gas with LEL / O_2 / CO / H_2S / SO_2
  - 5 Gas with PID
  - 6 gas with LEL / O_2 / CO / H_2S / SO_2 / PID
  - Other specific toxic gases (HF / NH_3 / NO_2 / benzene / etc.)

What happens during the refining process?

- Oil refineries use fractionation, cracking and reforming to turn petroleum into saleable products.
  - Cracking converts high molecular weight HCs into more useful, low molecular weight molecules that can be sold or processed into other products.
  - Catalytic cracking uses and produces hydrogen!
    - IR LEL sensors are unable to detect H_2.
    - H_2 may also interfere with CO sensors.
    - Make sure instrument includes sensor that can detect H_2.
    - If using IR LEL sensor, consider adding substance specific EC H_2 sensor.

What are the most common oil industry atmospheric hazards?

- Oxygen deficiency
- Oxygen enrichment
- Presence of toxic gases
  - H_2S
- Presence of combustible gases
- VOC vapors
- Typically use single-gas H_2S or a 4 gas or 5 gas detector with:
  - LEL
  - O_2
  - CO
  - H_2S
  - PID (for VOC)

Why is H_2S so common?

- Produced by anaerobic sulfate-reducing bacteria.
- The higher the sulfur content the greater the potential for H_2S.
- Older fields more prone to H_2S than new fields.
- Heavier than air:
  - Collects in vessels, pits, within protective berms, or in other low-lying areas.
  - Half-life in air = 12 to 37 hours.
  - Eventually breaks down in sunlight.
- Extremely toxic!
  - 1000 ppm leads to immediate “knockdown”
- Particularly dangerous in oil production areas subject to cold winter temperatures.
  - During very cold and dry conditions, half-life can exceed 37 hours.

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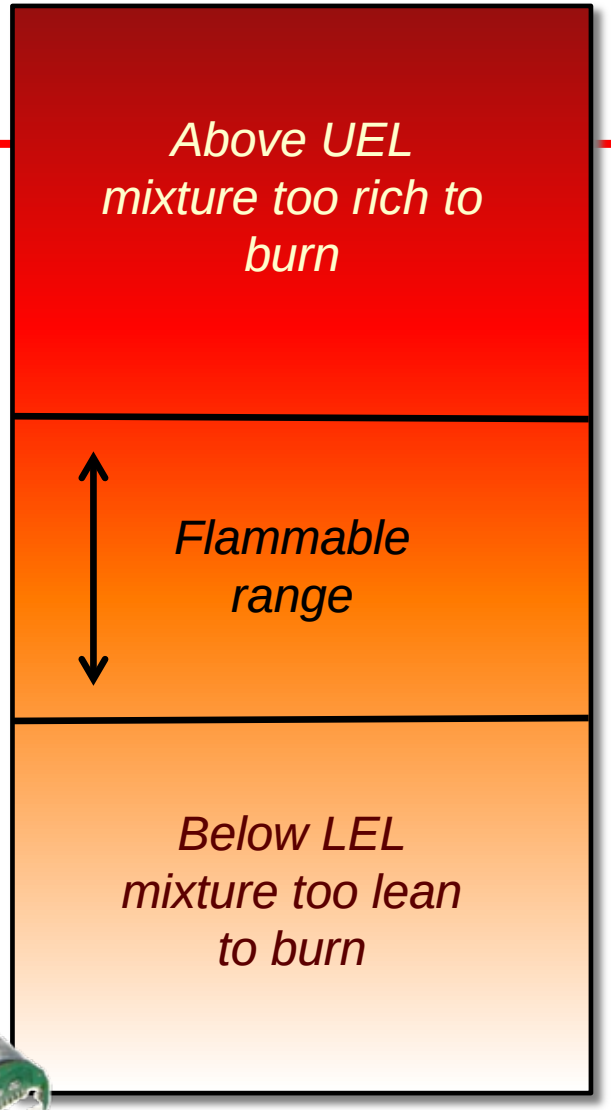
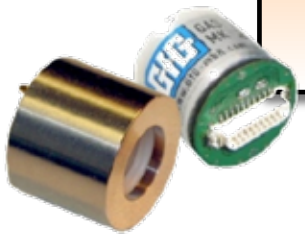
Choosing the right type of LEL sensor increasingly important issue!

- Make sure the LEL sensor you specify is fit for purpose!
  - None are perfect!
  - All have limitations!
- Several types of LEL sensors are widely available:
  - Traditional catalytic (Wheatstone bridge) LEL sensor.
  - Infrared (NDIR) LEL sensor.
  - MPS (Molecular Spectrometer) LEL sensor.





What is the best type of LEL sensor?

- It depends on the specific applications!
  - Traditional catalytic “pellistor” LEL
    - Detects gas by oxidation (heating) pellistor bead in sensor
  - Full size IR LEL
    - Detects gas by absorbance of IR light over longer optical path
  - Miniaturized (low power) MEMS IR LEL
    - Detects gas by absorbance of IR light over extremely small optical path (low power)
  - Miniaturized (low power) Molecular Properties Spectrometer (MPS)
    - Presence of a flammable gas causes changes in the thermo-conductive properties of the air/ gas mixture that are measured by the sensor transducer.

What are advantages and limitations of catalytic pellistor LEL sensors?

- Advantages:
  - Predictable, well understood technology
  - Predictable cross sensitivities, (most instruments have built-in CF library)
  - Able to detect H_2, acetylene and unsaturated HCs
- Disadvantages:
  - Uses more power
  - Poor response to larger molecules
  - Slower response to larger molecules
  - Easily poisoned
  - Exposure to high concentration combustible gas damaging to sensor
  - Must have minimum of 10% O_2 to accurately detect gas

What are IR LEL sensor advantages and limitations?

- Advantages:
  - Cannot be poisoned.
  - Does not require oxygen to detect gas.
  - Responds well to large hydrocarbon molecules that cannot be measured by means of standard LEL sensor.
    - The more C–H bonds in the molecule, the higher the response.
- Disadvantages:
  - Molecule must include chemical bonds that absorb at the wavelength(s) used for measurement.
  - Not all combustible gases can be detected!
    - Hydrogen (H_2) DOES NOT absorb IR and cannot be detected
    - NDIR sensors with short optical path-lengths may have limited ability to measure VOC gases with lower relative responses.

Proprietary long pathlength GfG IR LEL sensor.

Low power micro-miniaturized IR LEL sensor optimized for detection of CH_4 and natural gas – accuracy may be affected when used for other gases, may not respond at all to some VOCs.

Different IR LEL sensors may have very different performance characteristics

- Different IR LEL sensors can have very different capabilities
- Read the owner's manual!
- Make sure to verify with manufacturer before attempting to use the sensor to measure unsaturated hydrocarbons, aromatic VOCs or other gases not specifically listed in the owner's manual!

Appendix B

Detectable Combustible Gases

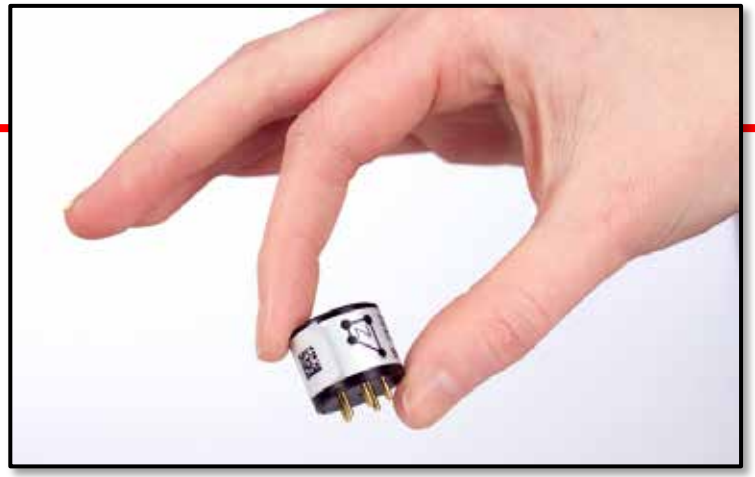
Gas[1]	Expected response at 20% LEL target gas[2]
Methane	20% LEL
Propane	15% LEL to 45% LEL
Butane	15% LEL to 35% LEL
Pentane	15% LEL to 45% LEL
Hexane	8% LEL to 28% LEL
Methanol/Ethanol[3]	6% LEL to 26% LEL
Hydrogen	No response
Acetylene	No response

[1]For any gases not listed, please contact Honeywell Analytics to find the best solution for your application.

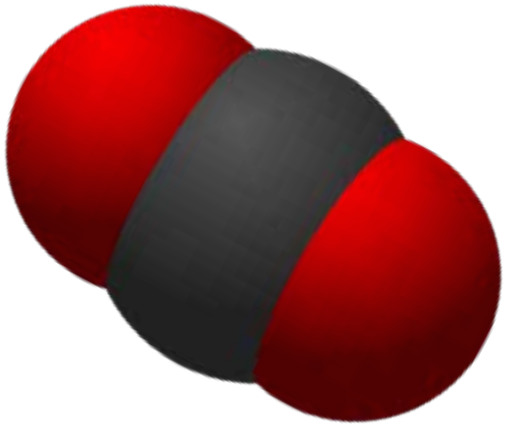
[2]The BW Clip4 LEL sensor is optimized to see methane. While the unit can detect and respond to the other combustible gases listed in the above table, the accuracy of the readings may be in-consistent. If the primary need is to detect a specific combustible gas other than methane, please contact Honeywell Analytics to discuss an alternative product.

[3]Please use caution when using the BW Clip4 around Methanol and/or Ethanol. The BW Clip4 CO sensor may become inhibited by prolonged exposure to concentrations of Methanol and/or Ethanol thus causing the unit to alarm. This condition can last up to 12 hours before the CO sensor recovers to normal levels.

Molecular Properties Spectrometer (MPS) sensor



- Low power, low-cost sensor that can measure H_2 and most other flammable gases in ambient air.
- Detects gas on the basis of changes in density, not flammability characteristics of the gas.
- MPS readings affected by barometric pressure and humidity – must be zero adjusted before use in the area where used.
- MPS sensor not advised for use in confined spaces!
  - Differences in humidity can strongly affect (reduce) readings for heavier than air gases like propane, butane and pentane
  - Presence of CO_2 or unusual inert gas mixtures (e.g., Argon) can affect (increase) readings.
    - MW CO_2 = 44.01 g/mol
    - MW propane = 44.1 g/mol
    - CO_2 exposure limit = 5,000 ppm
    - 2,100 ppm CO_2 = same density as10% LEL propane



CO_2

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

- New procedures
- New requirements
- New products
- New sensors
- Wireless communication
- Third party support through call centers
  - Emergency response
  - Record keeping and notifications
  - Internet based maintenance programs

In terms of units sold, personal H_2S detectors are still the most common oil industry instrument

- For personal protection instruments do you mostly use:
  - Single gas H_2S?
  - 4 gas meters?
  - Other single gas meters?
- Some of the other most commonly used personal single gas instruments include:
  - NO_2
  - SO_2
  - HF
  - NH_3
  - As well as many others!

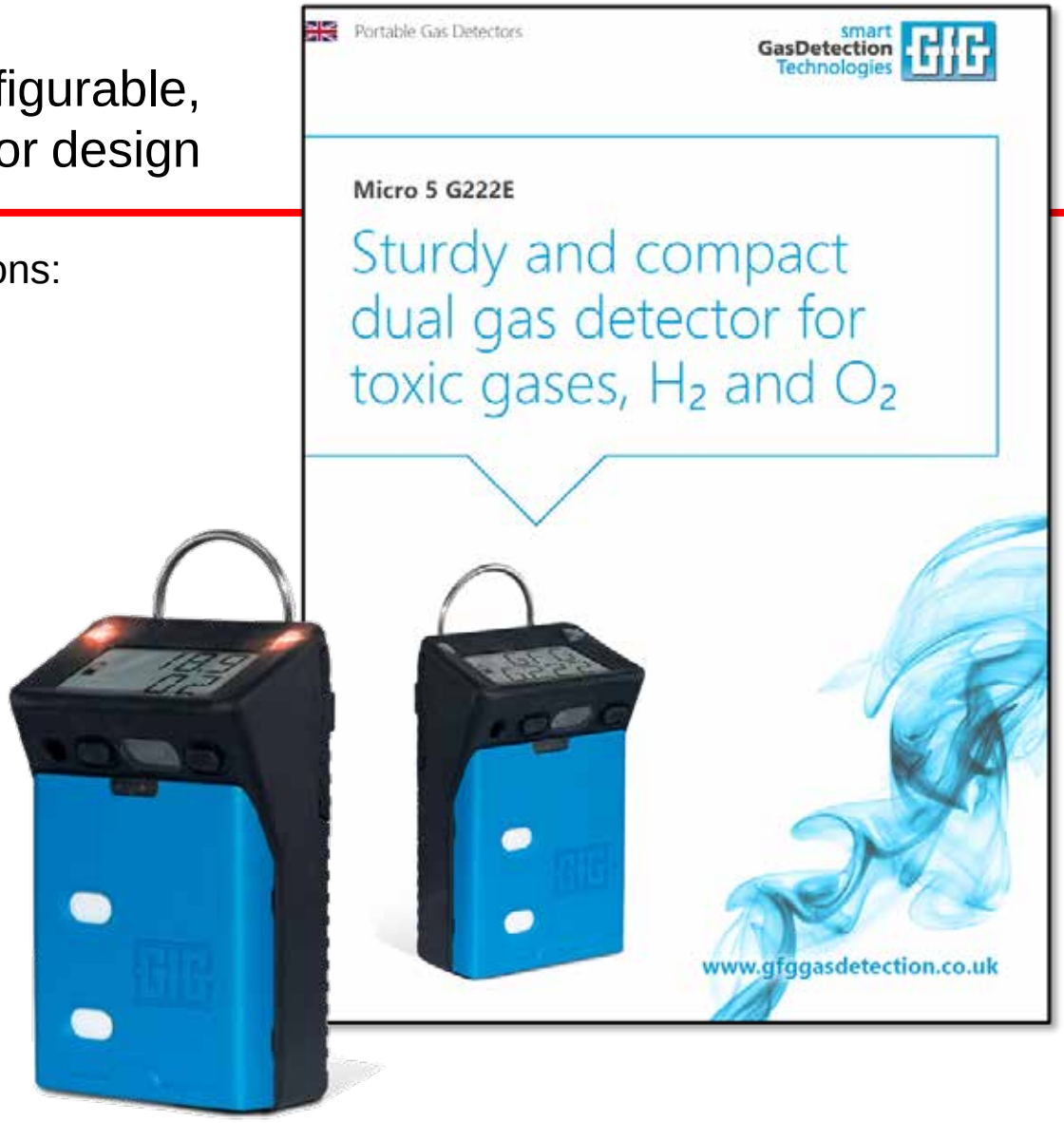
Do you need a second sensor?

- *G222E*
  - Sturdy and compact dual gas detector for monitoring toxic gases, H_2 and O_2
  - Easy to use!
  - Top mounted easy to read display
  - Easy to change alkaline battery provides up to 9 months of 10 hours per day use

Highly configurable, Smart-sensor design

- Notable two-gas combinations:
  - H_2S / SO_2
  - H_2S / THT
  - H_2S / TBM
  - NO / NO_2
  - HCN / CO
  - HCl / Cl_2
  - O_2 / CO
  - O_2 / H_2S

  …..and many more!



Do you need a multi sensor instrument with 4, 5 or 6 channels?

- *G450*
  - *Basic one to four sensor O_2 / LEL / CO / H_2S*
- *G888*
  - *Compact 1 – 6 channel multi-gas meter for diffusion operation*
- *G999*
  - *One to seven channel multi-gas meter with internal pump*

How do you sample the atmosphere from within the confined space?

- Are you using a diffusion only design?
- Does the instrument have an attachable sample pump?
- Does the instrument have a built-in pump?
- Does the instrument have the option of switching from diffusion to sampling by means of the built-in pump?

Do you have plans to update, expand, replace or change the equipment you are currently using?

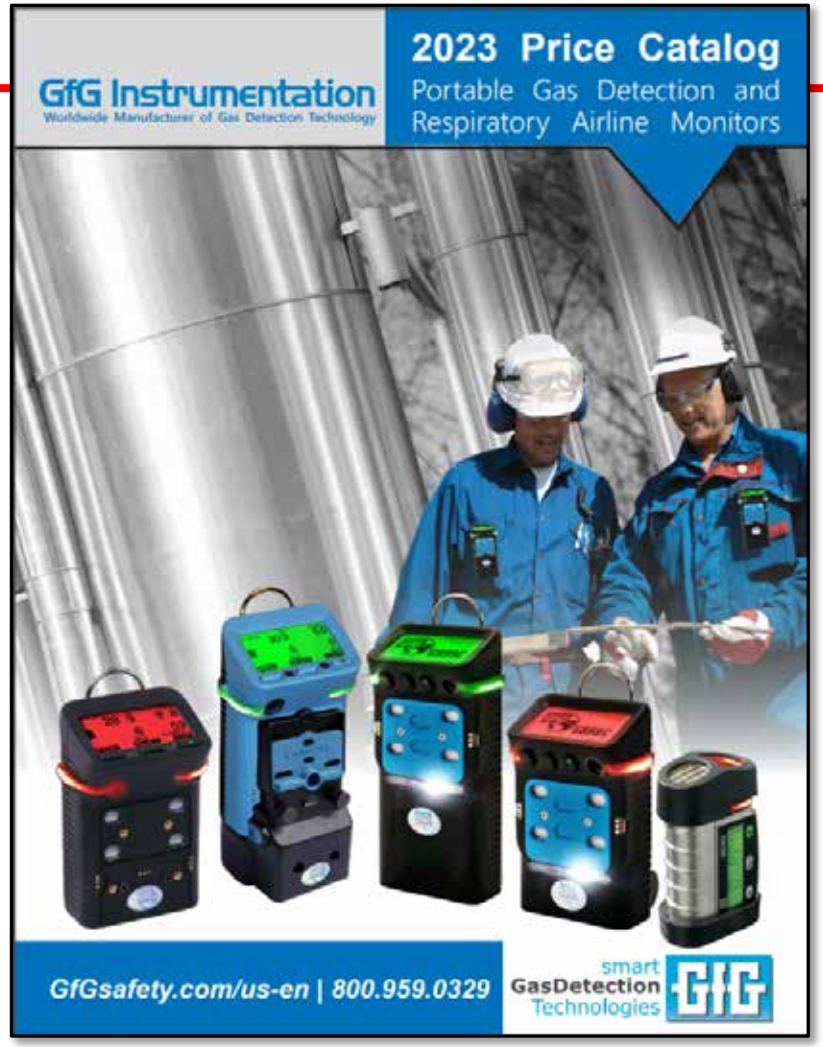
- Before making a change or investigating new products, make sure you understand your current products and requirements
  - If you are not sure, make sure to find out the brands and models currently in service.
  - Make sure you understand the capabilities; the strong points as well as the weak points, of the products you are currently using.
- Ask the manufacturers or distributors of the products you work with (or are interested in) for help.
  - Download specifications and comparison charts if the manufacturer has them.
  - Discuss ways the manufacturer and distributor can help meeting your needs with regards to product, capabilities or support.

How well is your current equipment performing?

- This is a critical starting point in the conversation.
  - Are you generally happy?
  - Are you experiencing problems?
  - How old is your current equipment?
  - What features have you heard about that you are interested in?
  - What brand(s) and model(s) of gas detectors are you considering?
  - What are the alternatives?
- Distributors are a great source for product information!
- When in doubt, or with regards to advanced technical questions, ask the manufacturer!

Avoid being overly focused on price!

- Eventually, the decision of whether to proceed involves price and affordability.
- However, there is a difference between the initial purchase price and the true cost of ownership.
  - The questioning process is designed to uncover your needs, and what would provide the optimal solution.
  - Once you fully identify the problems and how the new product is going to help, it's easier to understand the costs.
  - Once you have clarified the tradeoff between benefits and costs is when to widen or restrict choices as a function of price.



Identify "cost of ownership" issues

- Are you spending a fortune keeping your current equipment in service?
- Are you being charged a monthly fee for reports and factory support?
- 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 getting a good deal?</u>

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Who is currently looking after your instruments?

- Do you do it yourself, use a third-party service, or work depend on the factory?
- If you like the instruments you are currently using, and want to keep them in service, you might want to talk about maintenance agreements or refurbishment programs.
- Ask your local distributor whether they offer calibration or repair services.
- You should expect excellent after the sale support!

What sensor configurations do you currently use for confined space entry?

- Do you have the right configuration, or are you thinking about a change?
- How many / what kinds of sensors are installed in your instruments?
  - Traditional 4 gas (LEL / O_2 / CO / H_2S)?
  - 5 gas with PID?
  - Some other sensor configuration?
- What type of sensor are you using (or interested in using) for LEL?
  - Traditional CC LEL?
  - IR LEL?
- Do you use different multi-sensor instruments for different activities or types of CS entry?
  - Confined spaces that contain VOC vapors?
  - CS entry into inerted vessels?

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Do you have alcohol, heavy fuels or VOCs on site?

- Are VOCs are a concern during confined space entry?
  - If so, your CS instruments should have PID sensor as well.
- PID equipped instruments are the best choice for measurement of VOCs at exposure limit concentrations
  - For most VOCs, long before you reach a concentration sufficient to register on a combustible gas indicator, you will have easily exceeded the toxic exposure limits for the contaminant
  - Especially true for VOCs like benzene, toluene and xylenes.
  - Consider including a PID in multi-gas instruments used for fuel spills and other situations that involve VOC vapor.

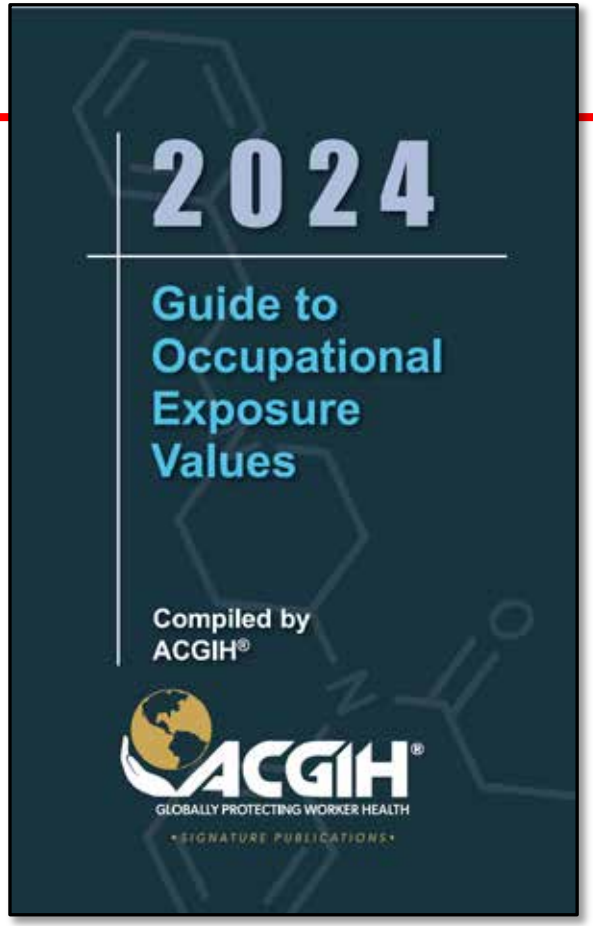
What about benzene?

- Volatile, toxic and highly flammable liquid at room temperature.
  - No safe exposure level; even tiny amounts can cause harm
  - Workers are exposed primarily by breathing air that is contaminated with benzene.
  - Exposure increases the risk of developing leukemia, aplastic anemias and other and other blood disorders.
- Naturally present in crude oil.
  - Minor component in diesel, jet fuel and gasoline, as well as engine exhaust.
  - Other sources include gas emissions from volcanoes, forest fires and cigarette smoke.
  - Half of all exposure to benzene in USA comes from cigarette smoking.

What about benzene?

Benzene exposure limits

- In January 2024, the ACGIH reduced the TWA for Benzene to 0.02 ppm and eliminated the STEL.
- The OSHA Permissible Exposure Limit (PEL) and NIOSH Recommended Exposure Limit REL) have not been updated.
  - OSHA PEL
    - TWA = 1.0 ppm
    - STEL = 5.0 ppm
  - NIOSH REL
    - TWA = 0.1 ppm
    - STEL = 1.0 ppm
  - Old TLV®
    - TWA = 0.5 ppm
    - STEL = 2.5 ppm
  - 2024 TLV®
    - TWA = 0.02 ppm



What are the options for setting the alarms?

- Should you focus exclusively on benzene?
- Should you depend on the TWA alarm only?
- What about other toxic VOCs that are likely to be present?
- How should you set the instantaneous alarms?
- Is it possible to take action on TVOC (if you know the fractional percentage of benzene)?
- Are there other TLVs that you may be able to use that provide better protection?

ACGIH Guidance

For many substances with a TLV–TWA, there is no TLV–STEL.

Never-the-less, short-term peak exposures above the TLV–TWA should be controlled, even where the 8-hour TLV–TWA is within recommended limits.

The following default short-term exposure limits apply to those TLV–TWAs that do not have a TLV–STEL:

> Transient increases in workers' exposure levels may exceed 3 times the value of the TLV–TWA level for no more than 15 minutes at a time, on no more than 4 occasions spaced 1 Hour apart during a workday, and under no circumstances should they exceed 5 times the value of the TLV–TWA level when measured as a 15-min TWA.
>
> In addition, the 8-hour TWA is not to be exceeded for an 8-hour work period.

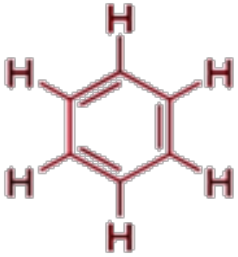
This guidance on limiting peak exposures above the value of the TLV–TWA is analogous to that for the TLV–STEL, and both represent 15-minute exposure limits.

Example: TVOC alarm setting based on fractional concentration of benzene measured during gasoline fuel barge accident cleanup

- Solve for desired take-action level of 1.0 ppm benzene (OSHA PEL)
  - During this emergency response, the “worst case” measured concentration of benzene as fraction of TVOC from anywhere on barge = 0.0058
  - TVOC threshold alarm = 1.0 ppm ÷ 0.0058 = 172.4 ppm
  - Setting TVOC hazardous condition threshold alarm of 172.41 ppm isobutylene ensures the PEL for benzene of 1.0 PPM is not exceeded: 172.4 x .0058 = 0.9999 ppm

	OSHA PEL	NIOSH REL	TLV
Benzene target exposure limit	1.0 ppm	0.1 ppm	0.02 ppm
TVOC alarm setting	172.5 ppm	17.3 ppm	3.5 ppm

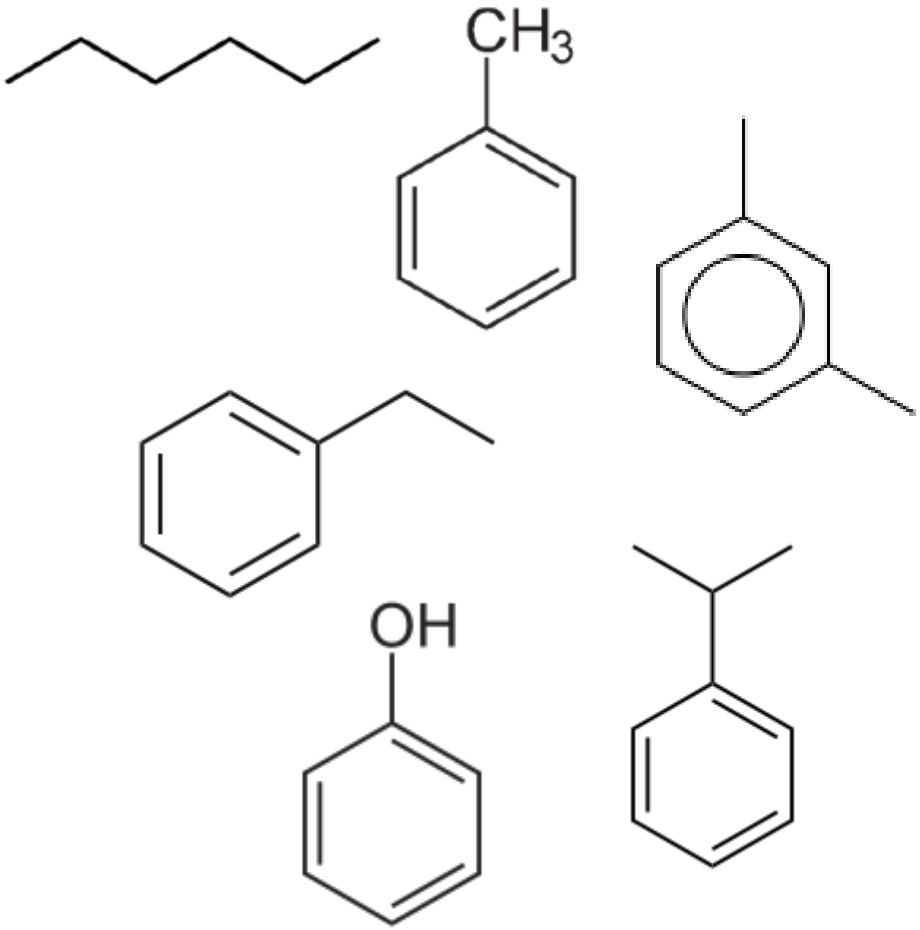
Other TLV ® exposure limits to consider



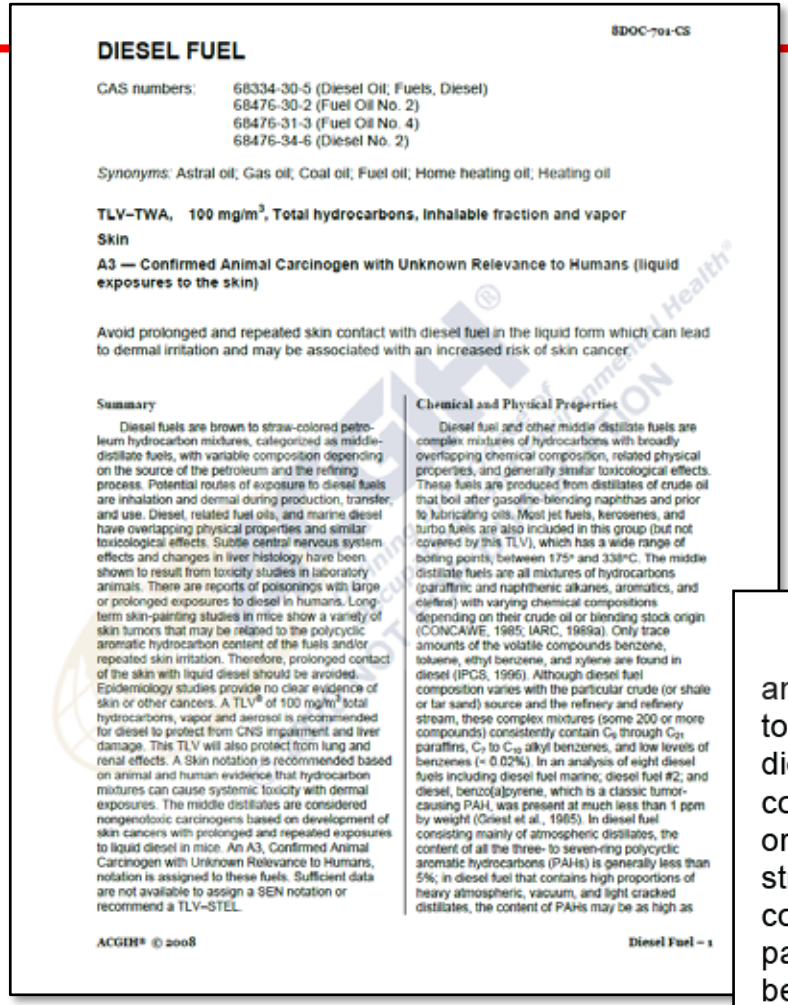
- Benzene is almost never present all by its by itself.
- Benzene is usually minor fraction of total VOC present.
- When the combustible liquid has an established PEL or TLV® you can test for total hydrocarbons (TVOC):
  - Diesel 100 mg/m3 ≈ 15 ppm vapor
  - Kerosene 200 mg/m3 ≈ 30 ppm vapor
  - Jet Fuel (JP-8) 200 mg/m3 ≈ 30 ppm vapor
  - Gasoline 300 ppm vapor

What other toxic hydrocarbons are in crude oil?

- All are toxic!
- n-Hexane – unbranched form of molecule is the most toxic, TLV® = 50 ppm TWA
- Toluene – CH_3 group, TLV® = 20 ppm TWA
- Xylene – two CH_3 groups, TLV® = 20 ppm TWA
- Ethylbenzene – Ethyl group, TLV® = 20 ppm TWA
- Cumene – Isopropyl group, TLV® = 5 ppm TWA
- Phenol – OH group, TLV® = 5 ppm TWA



The diesel fuel TLV® is protective for the entire mixture



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DIESEL FUEL

CAS numbers: 68334-30-5 (Diesel Oil; Fuels, Diesel)
68476-30-2 (Fuel Oil No. 2)
68476-31-3 (Fuel Oil No. 4)
68476-34-6 (Diesel No. 2)

Synonyms: Astral oil; Gas oil; Coal oil; Fuel oil; Home heating oil; Heating oil

TLV–TWA, 100 mg/m³, Total hydrocarbons, inhalable fraction and vapor

Skin

A3 — Confirmed Animal Carcinogen with Unknown Relevance to Humans (liquid exposures to the skin)

Avoid prolonged and repeated skin contact with diesel fuel in the liquid form which can lead to dermal irritation and may be associated with an increased risk of skin cancer.

Summary

Diesel fuels are brown to straw-colored petroleum hydrocarbon mixtures, categorized as middle-distillate fuels, with variable composition depending on the source of the petroleum and the refining process. Potential routes of exposure to diesel fuels are inhalation and dermal during production, transfer, and use. Diesel, related fuel oils, and marine diesel have overlapping physical properties and similar toxicological effects. Subtle central nervous system effects and changes in liver histology have been shown to result from toxicity studies in laboratory animals. There are reports of poisonings with large or prolonged exposures to diesel in humans. Long-term skin-painting studies in mice show a variety of skin tumors that may be related to the polycyclic aromatic hydrocarbon content of the fuels and/or repeated skin irritation. Therefore, prolonged contact of the skin with liquid diesel should be avoided. Epidemiology studies provide no clear evidence of skin or other cancers. A TLV® of 100 mg/m³ total hydrocarbons, vapor and aerosol is recommended for diesel to protect from CNS impairment and liver damage. This TLV will also protect from lung and renal effects. A Skin notation is recommended based on animal and human evidence that hydrocarbon mixtures can cause systemic toxicity with dermal exposures. The middle distillates are considered nongenotoxic carcinogens based on development of skin cancers with prolonged and repeated exposures to liquid diesel in mice. An A3, Confirmed Animal Carcinogen with Unknown Relevance to Humans, notation is assigned to these fuels. Sufficient data are not available to assign a SEN notation or recommend a TLV–STEL.

Chemical and Physical Properties

Diesel fuel and other middle distillate fuels are complex mixtures of hydrocarbons with broadly overlapping chemical composition, related physical properties, and generally similar toxicological effects. These fuels are produced from distillates of crude oil that boil after gasoline-blending naphthas and prior to lubricating oils. Most jet fuels, kerosenes, and turbo fuels are also included in this group (but not covered by this TLV), which has a wide range of boiling points, between 175° and 338°C. The middle distillate fuels are all mixtures of hydrocarbons (paraffinic and naphthenic alkanes, aromatics, and olefins) with varying chemical compositions depending on their crude oil or blending stock origin (CONCAWE, 1985; IARC, 1989a). Only trace amounts of the volatile compounds benzene, toluene, ethyl benzene, and xylene are found in diesel (IPCS, 1996). Although diesel fuel composition varies with the particular crude (or shale or tar sand) source and the refinery and refinery stream, these complex mixtures (some 200 or more compounds) consistently contain C_9 through C_{21} paraffins, C_7 to C_{10} alkyl benzenes, and low levels of benzenes (< 0.02%). In an analysis of eight diesel fuels including diesel fuel marine; diesel fuel #2; and diesel, benzo[a]pyrene, which is a classic tumor-causing PAH, was present at much less than 1 ppm by weight (Griest et al., 1985). In diesel fuel consisting mainly of atmospheric distillates, the content of all the three- to seven-ring polycyclic aromatic hydrocarbons (PAHs) is generally less than 5%; in diesel fuel that contains high proportions of heavy atmospheric, vacuum, and light cracked distillates, the content of PAHs may be as high as

ACGIH® © 2008 Diesel Fuel – 1

- Diesel fuel is a complex mixture of over 200 compounds – all of which are toxic to some degree.
- The DIESEL FUEL TLV® takes the exposure limits and toxicity of all the chemicals in the mixture – including benzene - into account.
- 10.6 eV PID CF_{ISO} typically 0.8 – 0.9 (depends on PID manufacturer)

> "Only trace amounts of the volatile compounds benzene, toluene, ethyl benzene, and xylene are found in diesel (IPCS, 1996). Although diesel fuel composition varies with the particular crude (or shale or tar sand) source and the refinery and refinery stream, these complex mixtures (some 200 or more compounds) consistently contain C_9 through C_{21} paraffins, C_7 to C_{10} alkyl benzenes, and low levels of benzenes (< 0.02%)."

If you need to take action based on substance-specific benzene measurement, make sure the instrument you use is fit for purpose!

TIGER XT Range
COMPARISON DOCUMENT

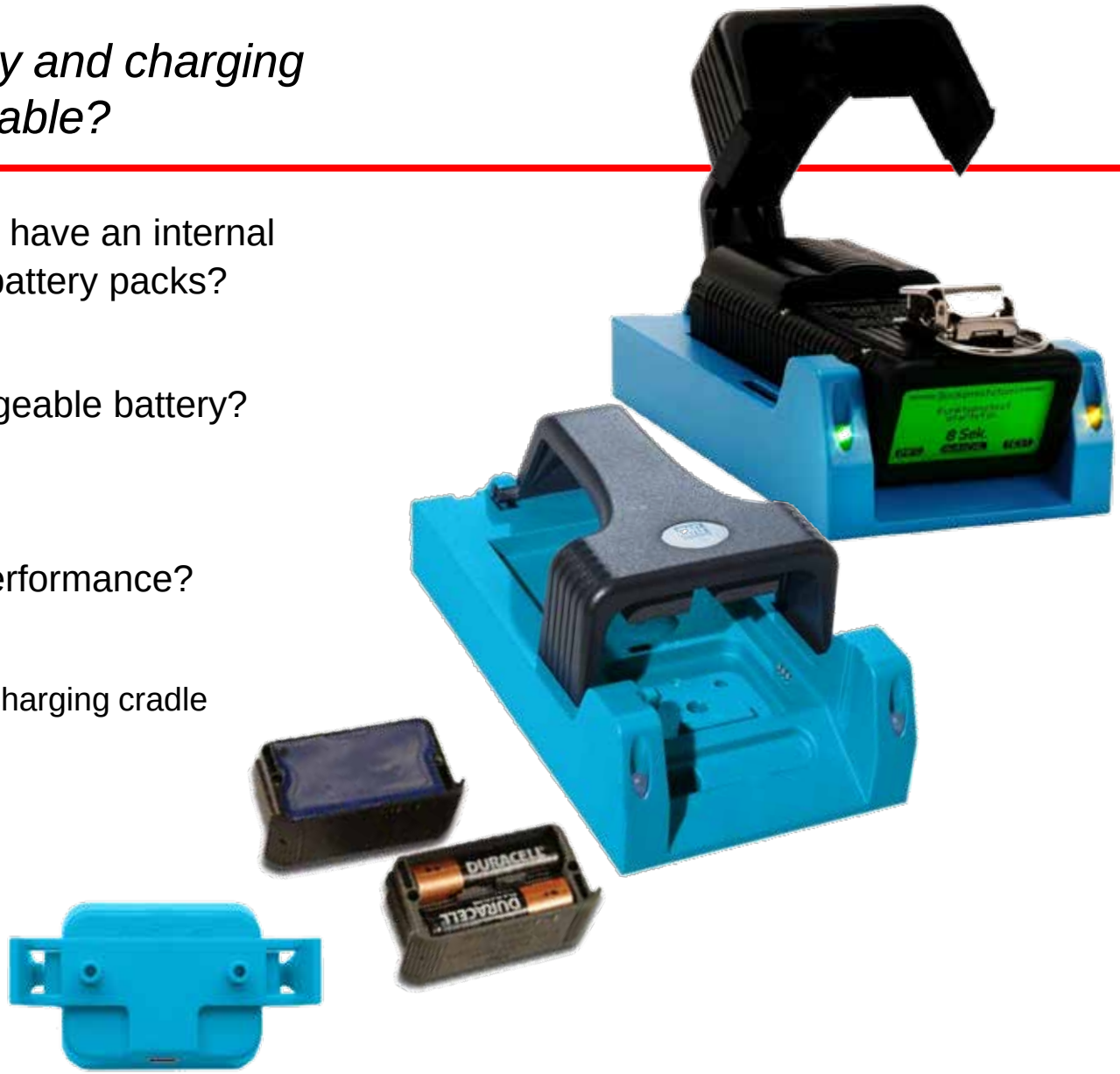


	ION Science Tiger XTL 10.6 eV	ION Science Tiger XT 10.6 eV	ION Science Tiger XT Select 10.0 eV
General VOC Detection Range:	0.1 ppm - 5,000 ppm	1 ppb - 20,000 ppm	1 ppb - 20,000 ppm
General VOC Minimum Resolution:	0.1 ppm	1 ppb	1 ppb
T90 Response Time (VOCs):	<2 seconds	<2 seconds	<2 seconds
Benzene Detection Range:	✗	✗	0.01 ppm - 200 ppm
Benzene Minimum Resolution:	✗	✗	10 ppb
Response Time (Benzene):	✗	✗	130 seconds (at 20oC)
Lamp Options:	10.6 eV	10.6 eV, 11.7 eV	10.0 eV
Easy Change PID:	✓	✓	✓
Internal Gas Table:	✗	>750 VOCs	>750 VOCs
Weight:	870g	870g	870g
Humidity Handling:	Fence Electrode	Fence Electrode	Fence Electrode
Audible Alarm:	95 dB	95 dB	95 dB

- The same manufacturer may have multiple versions of the same instrument.
- If you are following the OSHA PEL or NIOSH REL, you may not need as much resolution.
- Make sure you know what you intend to do with the monitoring results.
- Make sure you know how you will be setting the alarms

What types of battery and charging technology are available?

- Does the instrument have an internal or interchangeable battery packs?
- Alkaline option?
- What type of rechargeable battery?
  - Li Ion?
  - NiMH?
- Cold temperature performance?
- Charging options
  - Is the charger or charging cradle included?



Are your gas detectors wirelessly enabled (or are you considering this option)?

- Most manufacturers now offer a “wireless” communication option.
  - Each manufacturer has its own strategy, with its own benefits and limitations.
  - Make sure you understand the wireless options and competitive benefits!
- Common communication methods:
  - Blue Tooth
  - Cellular
  - ISM RF
- Do you intend to use wireless communication during CS entry?
  - How do you get the information out of the space?

What about after the sale support?

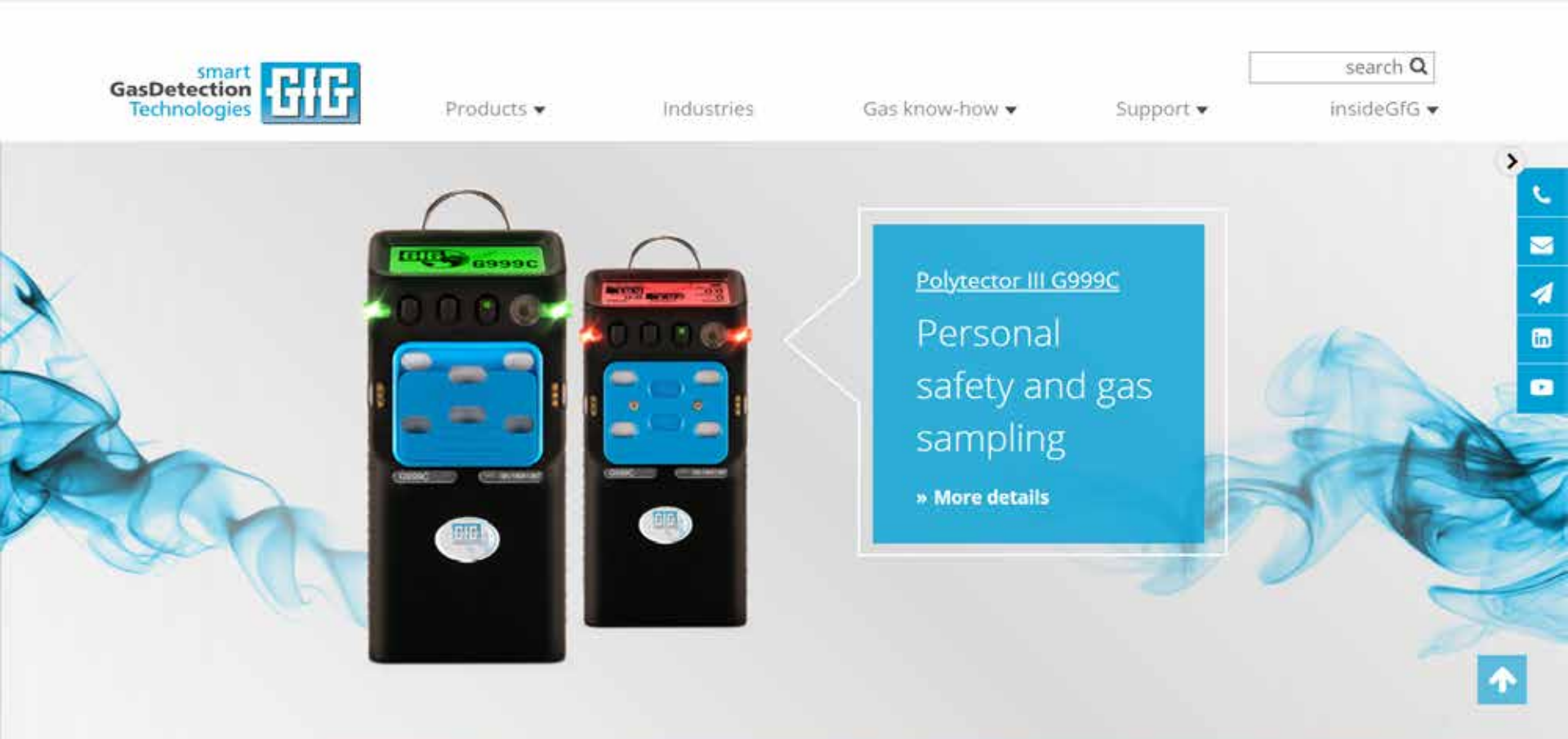
- Satisfaction is a function of ongoing support.
  - Atmospheric monitors and systems are life critical safety equipment.
  - You should expect excellent after the sale support!
- Don’t forget to consider:
  - Warranty
    - Sensors
    - Instrument
- Technical support
  - Is your vendor there to provide help?
- Training
  - Videos?
  - In person?
  - Internet resources?

What is GfG doing to help?

- We hope the GfG benefits include:
  - Great products!
  - Great distributors!
  - Great support
  - Excellent resources:
    - Training videos
    - In person training
    - Application notes
    - Webinars

Brand new, totally awesome, updated GfG website

- GfG Instrumentation website:
  www.gfgsafety.com/us-en



Questions?

Thank you!

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bhenderson@goodforgas.com

For additional information or gas detection help:
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Local: 1-734-769-0573