

FLIR Optical Gas Imaging Technology AWMA-MOECW Workshop Sarnia

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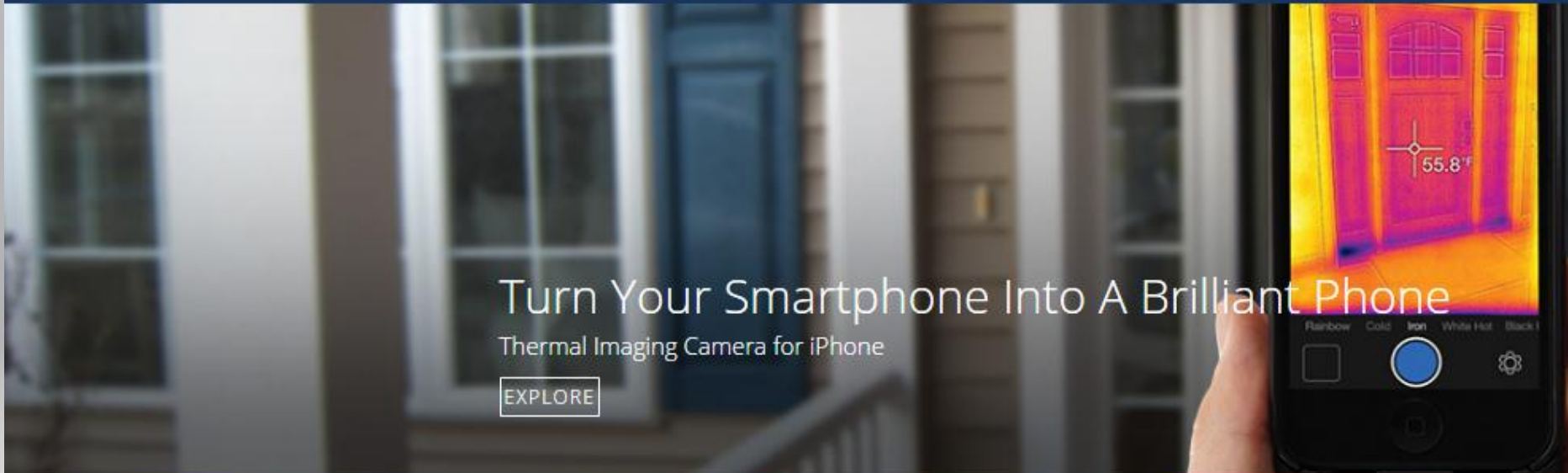
November 5, 2014



The World's Sixth Sense™

Presentation Agenda

1. FLIR Introduction
2. How Does The Camera Work?
3. Gas Detection Limits
4. Applications



Turn Your Smartphone Into A Brilliant Phone

Thermal Imaging Camera for iPhone

EXPLORE

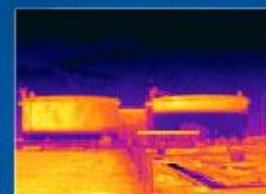


FLIR in the News





Optical Gas Imaging with NEW GF Series





FLIR Optical Gas Imaging GF Series Handhelds & G series "fixed"



Regulatory Customers



Clients



FLIR Gas Imaging History



GasFindIR



GasFindIR **HSX**

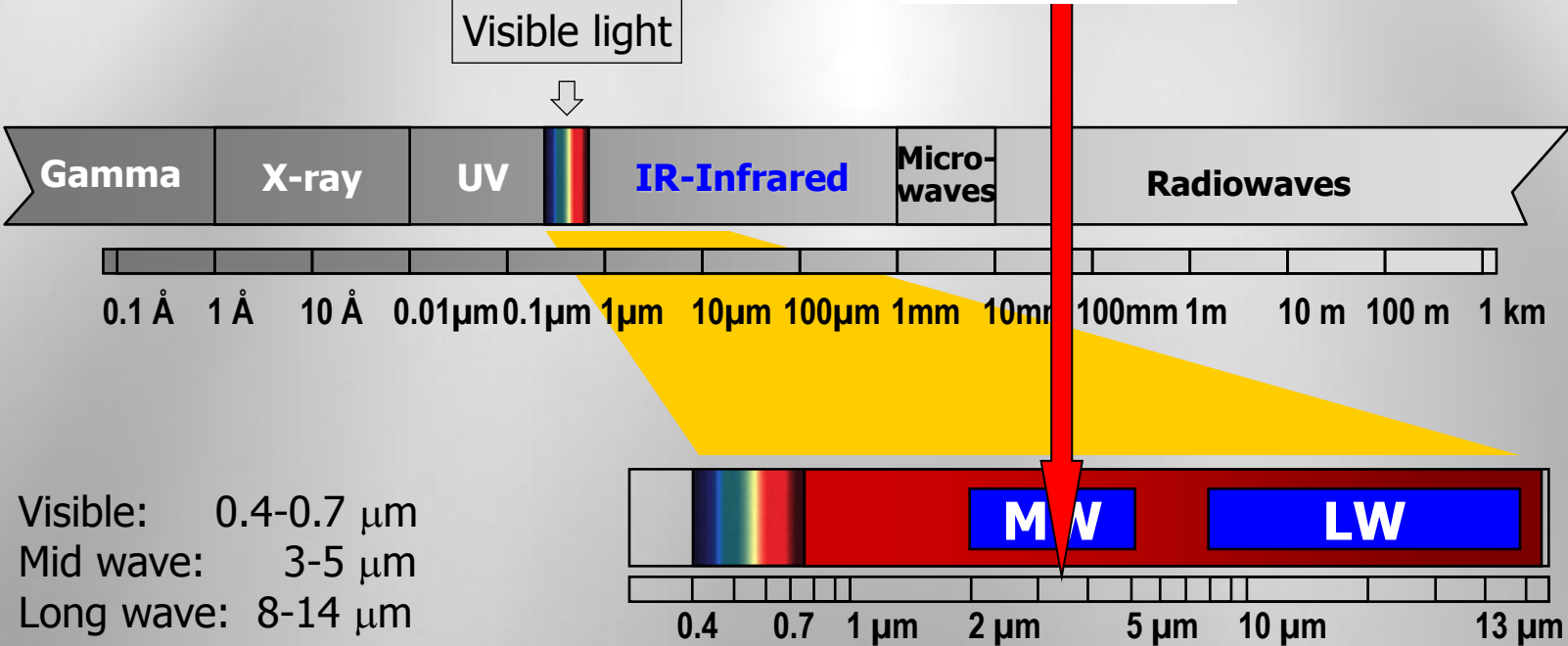


GF3xx Series



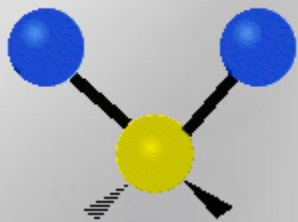
- **May 2005 - ThermaCam GasFindIR**
 - Worlds 1st portable “passive” optical gas imager
 - ISA-Fugitive Emissions – League City, TX
- **Feb 2008 - ThermaCam GasFindIR HSX**
 - Improved features
 - High Sensitivity Mode (HSM)
 - Extended Ranges
 - Longer Life Li-Ion Batteries
- **May 2009 – GF Series**
 - Completely New Design
 - based on customer feedback and input
- **September 2014 – Fixed OGI systems**
 - 3 models
 - 2 OEM models, 1 pan/tilt complete unit

How does it work?

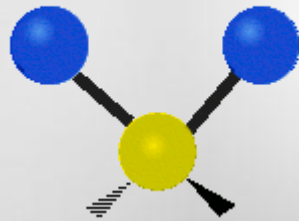


How Does the GF Series “See” Gas

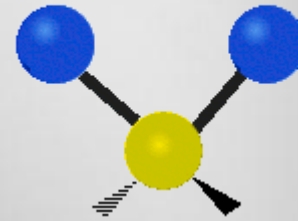
- The camera employs a spectral filter designed to transmit in a region of the IR spectrum that is coincident in wavelength with vibrational/rotational energy transitions of VOC molecular bonds.
- These transitions are typically strongly coupled to the field via dipole moment changes in the molecule, and are common to many types of gases and vapors.
- With this in mind, the camera’s detection sensitivity to a wide variety of gases and vapors is extremely small.
- Thermally, the camera’s sensitivity is <30mK when FLIR’s adaptive temporal filter is engaged.



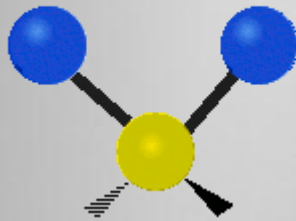
Symmetric stretch



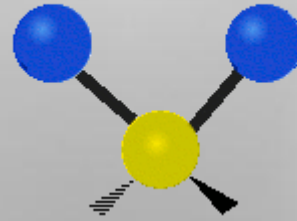
Twisting



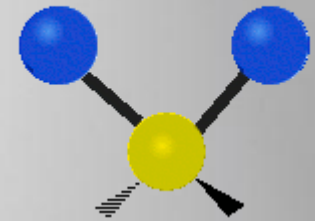
Scissoring



Asymmetric stretch



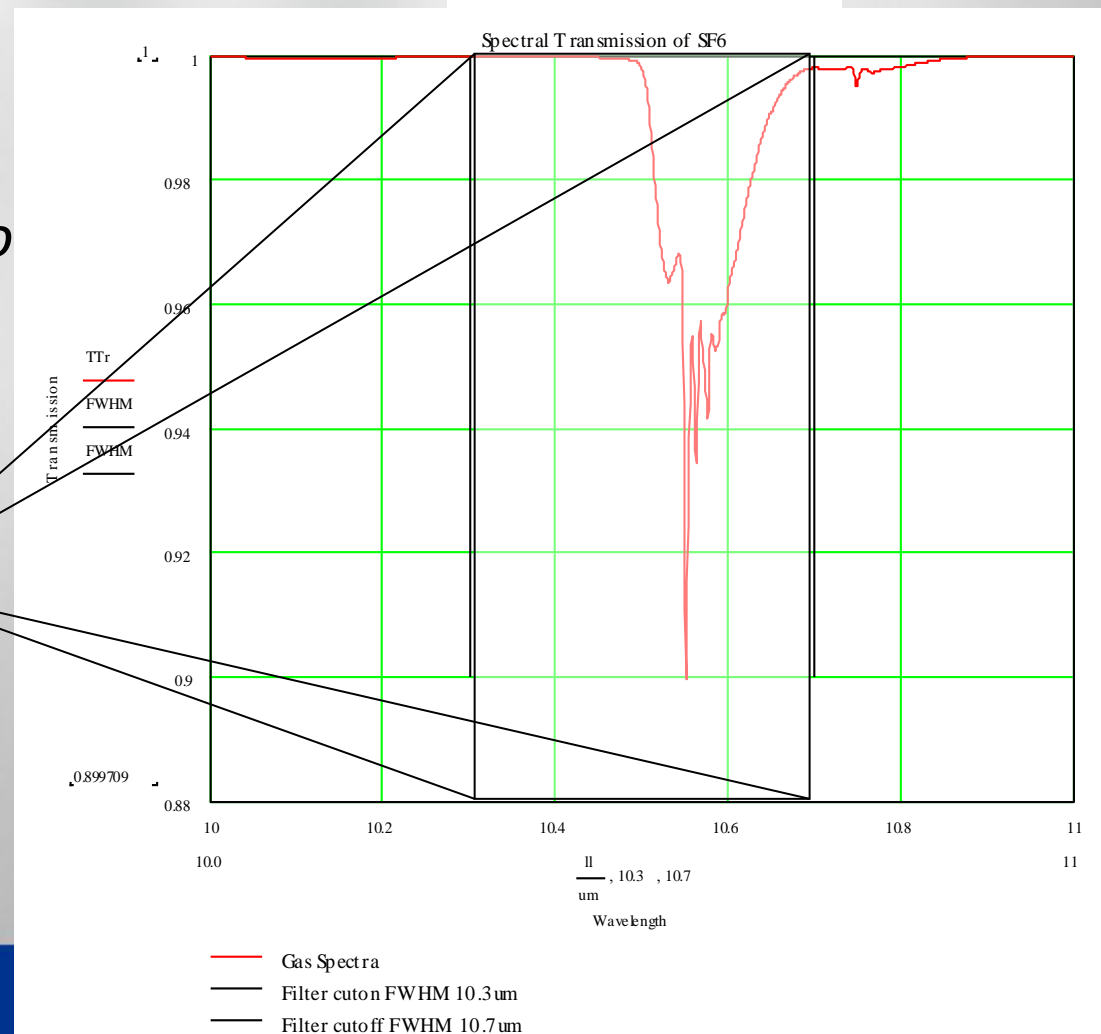
Wagging



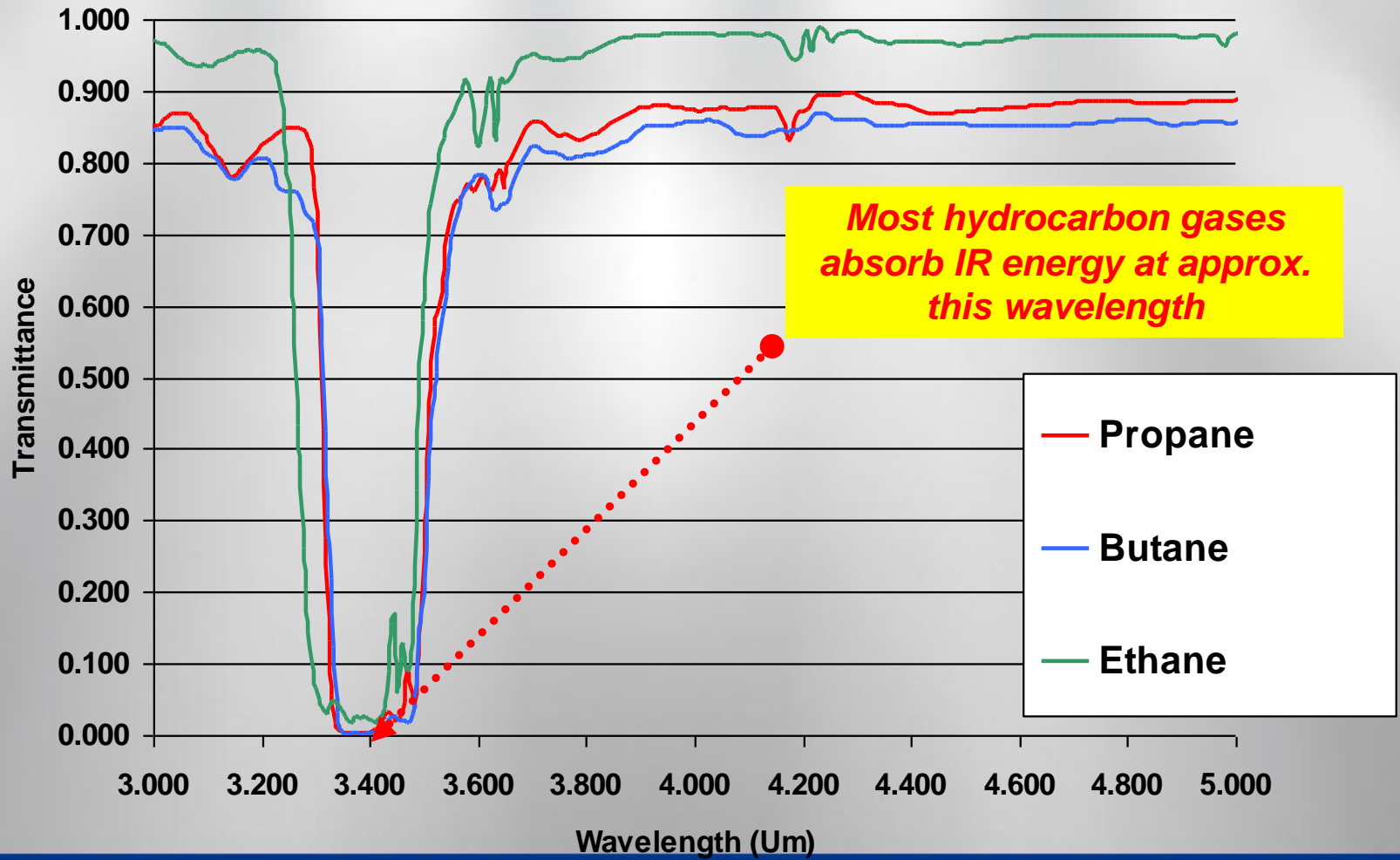
Rocking

How Does the GF Series “See” Gas

- We “match” the spectral response of the camera to the “peak” spectral absorption of the gas!



Infrared Gas Spectra



Infrared Gas Spectra



GF Series

Detection Limits



How many ppm will it see?



Instantaneous Volume (3D)?

Gas Makeup (Species)?

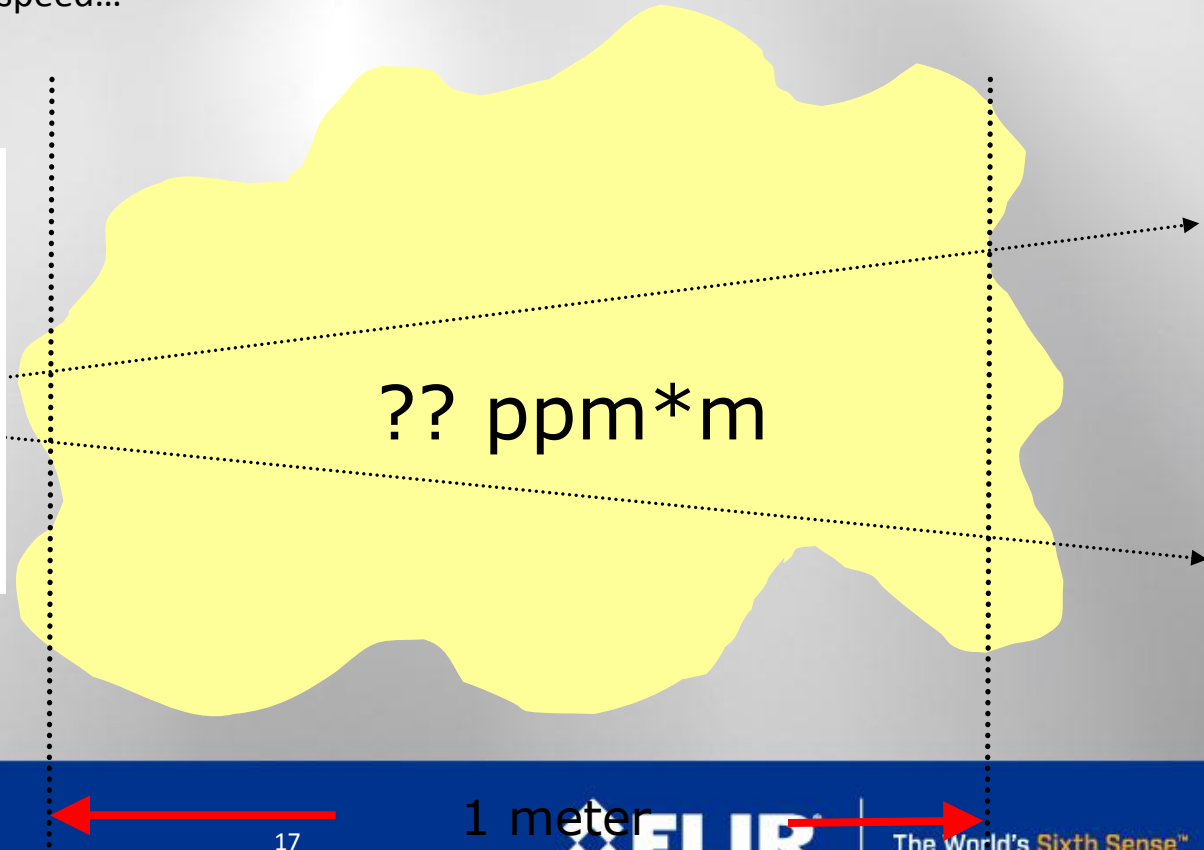
Exact Gas Concentration(s)?

Wind Speed?

Etc...

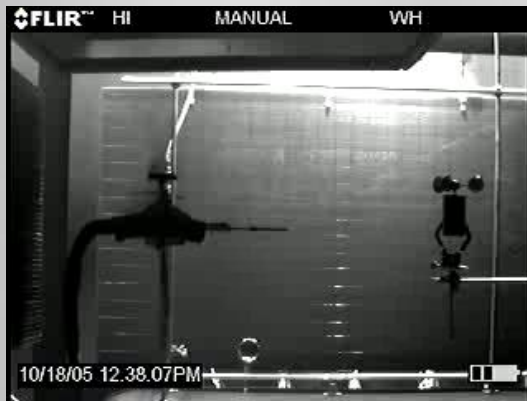
Is there any way to report detection in ppm?

- If we knew:
 - Exact gas makeup and concentration(s)
 - Exact gas cloud thickness
 - Exact wind speed...



How Do We Report Detection Limits?

- Minimum Detectible Leak Rates (MDLR)
 - Mass flow rate (grams per hour)
 - The minimum size leak you can see, given certain controlled parameters
- API Laboratory Parameters
 - A given distance to the leak
 - Known concentration of gas
 - Known wind speed
 - Known leak rate



Some of the tested gases

- Benzene
- Butane
- Ethane
- Ethanol
- Ethylbenzene
- Ethylene
- Heptane
- Hexane
- Isoprene
- MEK
- Methane
- Methanol
- MIBK
- Octane
- Pentane
- 1-Pentane
- Propane
- Propylene
- Toluene
- Xylene

Minimum Detectible Leak Rates (MDLR's)

GasFindIR Camera - Tested OCT 2005	
Compound	g/hr
Benzene	3.5
Ethanol	0.7
Ethylbenzene	1.5
Heptane	1.8
Hexane	1.7
Isoprene	8.1
Methanol	3.8
MEK	3.5
MIBK	2.1
Octane	1.2
Pentane	3.0
1-Pentene	5.6
Toluene	3.8
Xylene	1.9
Butane	0.4
Ethane	0.6
Methane	0.8
Propane	0.4
Ethylene	4.4
Propylene	2.9

MDLR's in Grams/Hr	Wind Speed in MPH		
	0	2	5
Compound			
Benzene	3.5	17.5	38.6
Ethanol	0.7	3.5	14
Ethylbenzene	1.5	7.6	17.5
Heptane	1.8	4.8	8.4
Hexane	1.7	3.5	8.7
Isoprene	8.1	14.3	38.8
Methanol	3.8	7.3	24.3
MEK	3.5	17.7	31.8
MIBK	2.1	4.9	13.3
Octane	1.2	3.4	8.7
Pentane	3.0	6.1	17.7
1-Pentene	5.6	19.7	43.8
Toluene	3.8	5.3	14.3
Xylene	1.9	9.1	18.9

Distance = 3m

Distance = 3m, Wind = 0mph

Minimum Detectible Leak Rates (MDLR's)

Methane-vs- Distance -vs- Optic

†MDLR in g/hr	Lens Back Focal Distance in mm								
	25			50			100		
Gas									
Standoff distance (m)	3	6	12	3	6	12	3	6	12
Methane MDLR	0.8	1.4	4.0	0.4	0.8	1.6	±0.3	0.5	0.8
†MDLR was measured at 0 wind speed with no N ₂ mixing. ‡Lower limit of delivery system.									

MDLR versus concentration (ppm)



Leak Rate = 3 grams/hour

MDLR versus concentration (ppm)



MDLR versus concentration (ppm)

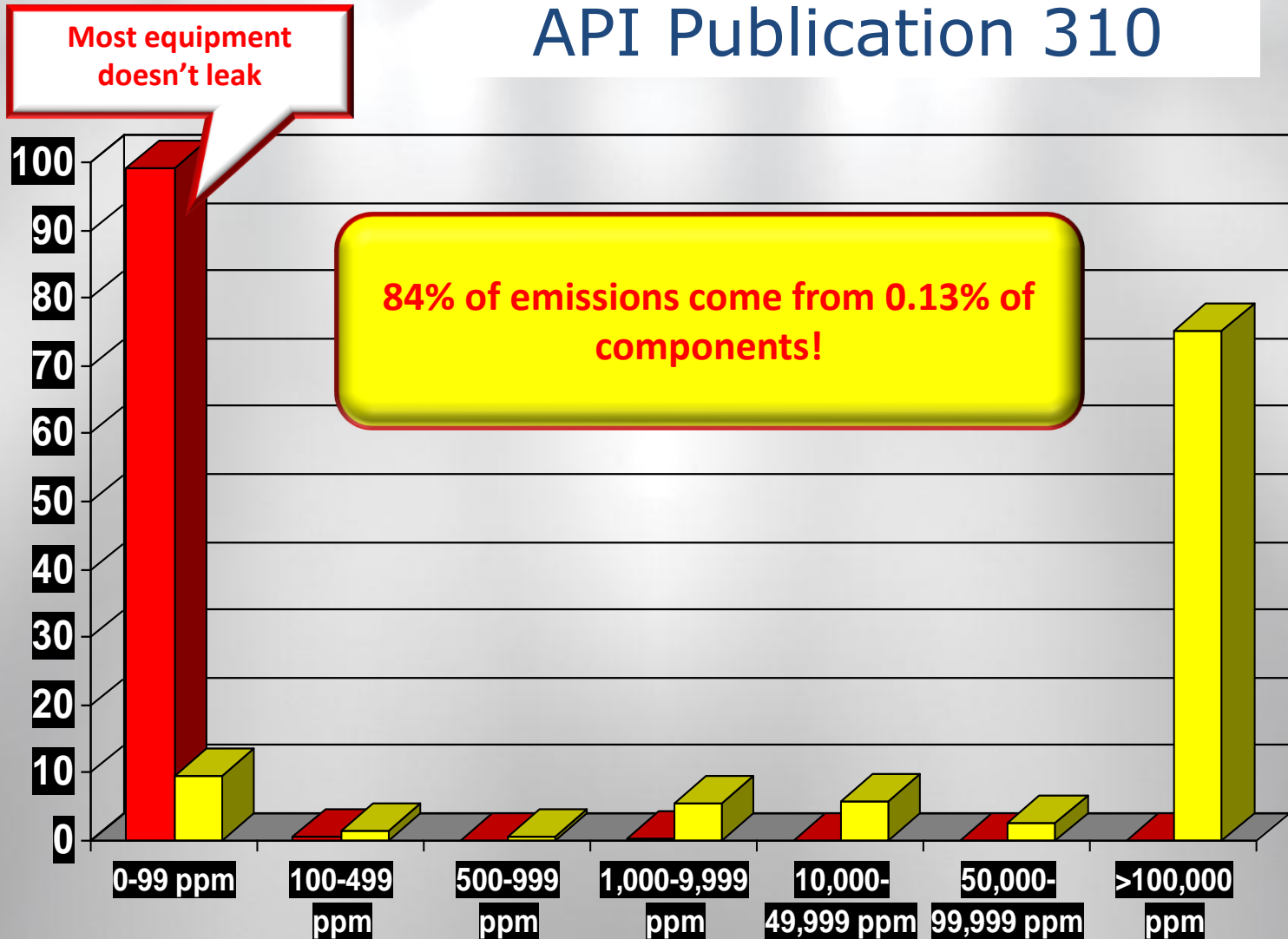


MDLR versus concentration (ppm)



From 20' away...it's still a leak

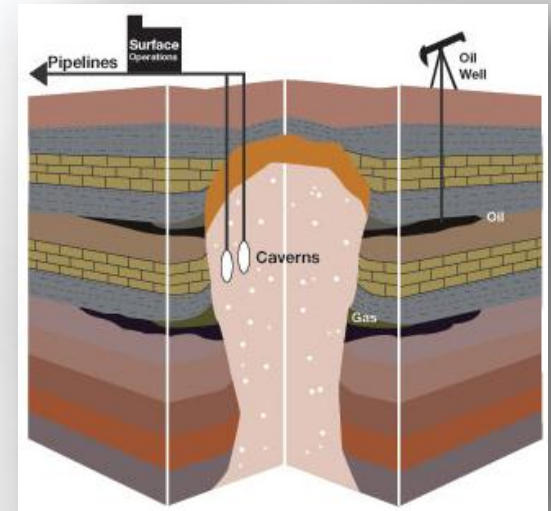
API Publication 310



Taback et al., 1997, API Publ 310, "Analysis of Refinery Screening Data"

Main Applications

- Gas Storage
 - Above & Below Ground
 - Vents, Vacuum breakers, Relief Valves





FLIR GF306 Ammonia Leak Examples

FLIR GF320 Methane Leak Examples

Main Applications

- Processing Plants
 - LDAR & Non-LDAR Components



Flares – unburned VOC



Main Applications



- Compressor Stations
 - Seal Leaks
 - Flanged Connections
 - PRV's

Compressors



Valves



Main Applications

- Pipelines
 - Transmission
- Gas Mains
 - Distribution



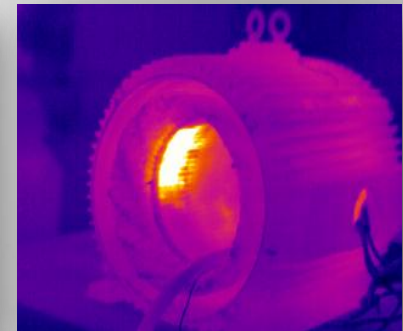
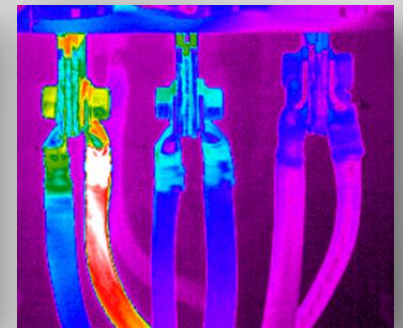
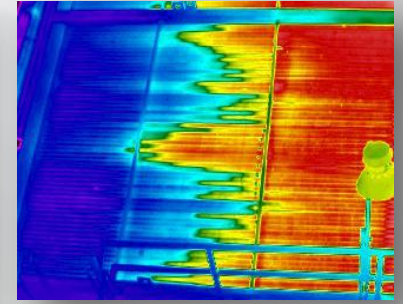
Automated Gas Imaging



Intelliview – Calgary, AB

More Applications

- Flares
- Tank Levels
- Welded pipe
- Insulated pipe
- Entire Vessel Inspection
- Exchangers / Fin Fans
- Valves / Relief Valves
- Steam Traps
- Electrical Connections
- Motors
- Unit Start Up Applications
- Temp. Measurement (GF320)



FLIR OGI Options

- Handheld, battery powered, portable systems:
 - Hydrocarbon VOC, MEK, many others (GF320, GF300)
 - Ammonia, SF6, Vinyl monomer (GF306)
 - CO (GF346)
 - CO2 (GF343)
- Automated, hard wired, permanent installations:
 - Hydrocarbon VOC (G300a – requires integration, G300pt, 3rd party integrated systems, eg. Intelliview)
 - Most other gases (A66xx – requires integration)



Questions?

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Automated Systems

