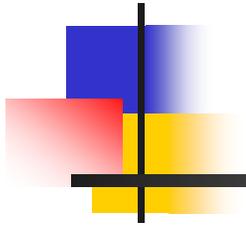


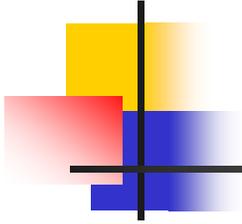
# LANDFILL GAS TRAINING



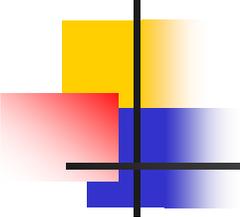
**John Bell**

**Peter Janicki**

**Gino Yekta**



# ORIENTATION



# INTRODUCTION

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- **TYPE OF MONITORING**

- Screening

- Specialized

- **GOALS**



# GOALS:

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- **UNDERSTAND LFG BASICS**
- **UNDERSTAND LFG  
MONITORING SYSTEMS**



# GOALS CONT.

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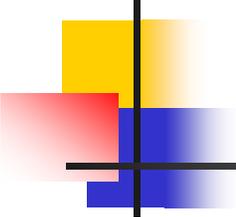
- **UNDERSTAND LFG EQUIPMENT**
- **PRACTICE PROPER LFG  
MONITORING PROCEDURES**



# **COURSE OUTLINE**

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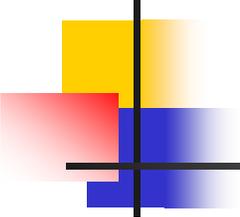
- **LANDFILL GAS BASICS**
- **MONITORING SYSTEM EVALUATION**
- **LFG SCREENING MONITORING**
- **INTRODUCTION TO LFG INSTRUMENTS**



# **COURSE OUTLINE CONT.**

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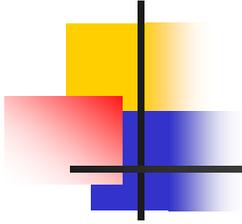
- **INSTRUMENT OPERATION PROCEDURES**
- **LUNCH**
- **FIELD EXERCISE**
- **DISCUSSION OF FIELD RESULTS**



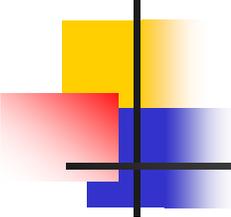
# **COURSE OUTLINE CONT.**

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- **QUESTIONS & COMMENTS**
- **EXAM**



# LANDFILL GAS BASICS



## Landfill Gas (LFG)

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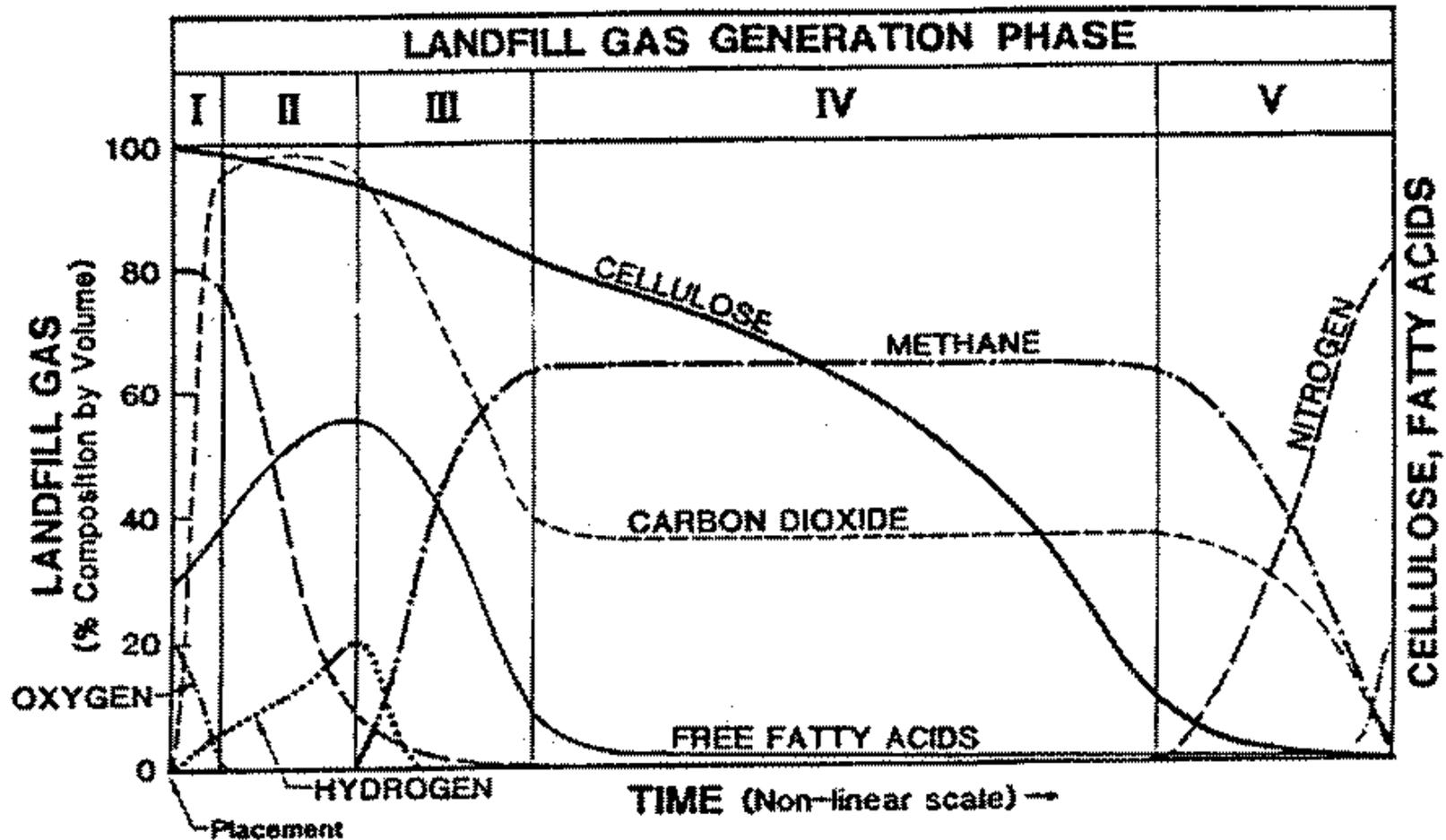
- **Gaseous emissions produced as a by-product of organic waste during decomposition.**
- **May contain various chemical components in widely fluctuating quantities.**

# ANAEROBIC REACTION

Anaerobic Bact.

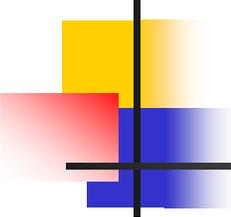


# TYPICAL LANDFILL GAS GENERATION PATTERN



SOURCE: Farquar and Rovers, 1973, as modified by Rees, 1980, and Augenstein & Pacey, 1991

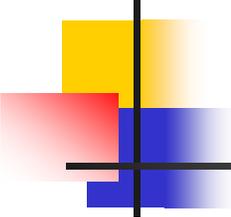
Figure 2. Typical landfill gas generation pattern



# LANDFILL DECOMPOSITION GAS

---

- **METHANE CH<sub>4</sub>**
  - **SIMPLE ASPHYXIANT**
  - **HIGH FIRE HAZARD**
  - **HIGH EXPLOSION HAZARD**
  - **LIGHTER THAN AIR**



# Basic Conversions

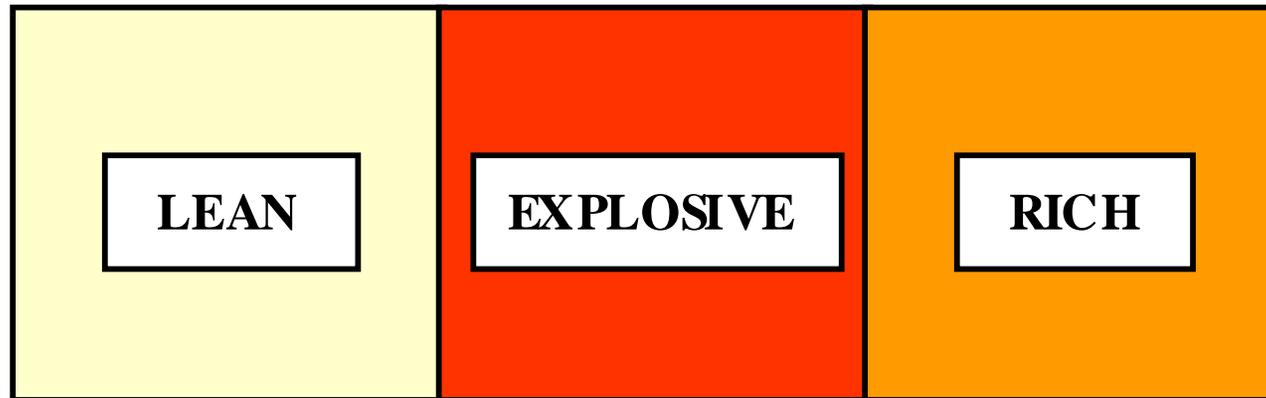
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- **5% Methane in air = 50,000 PPM**
- **1.25% Methane in air = 12,500 PPM**
- **100% of the Lower Explosive Limit (LEL)= 5% Methane in Air**
- **25% of the LEL=1.25% Methane in Air**

# METHANE FLAMMABILITY RANGE

**0% LEL**

**100% LEL**

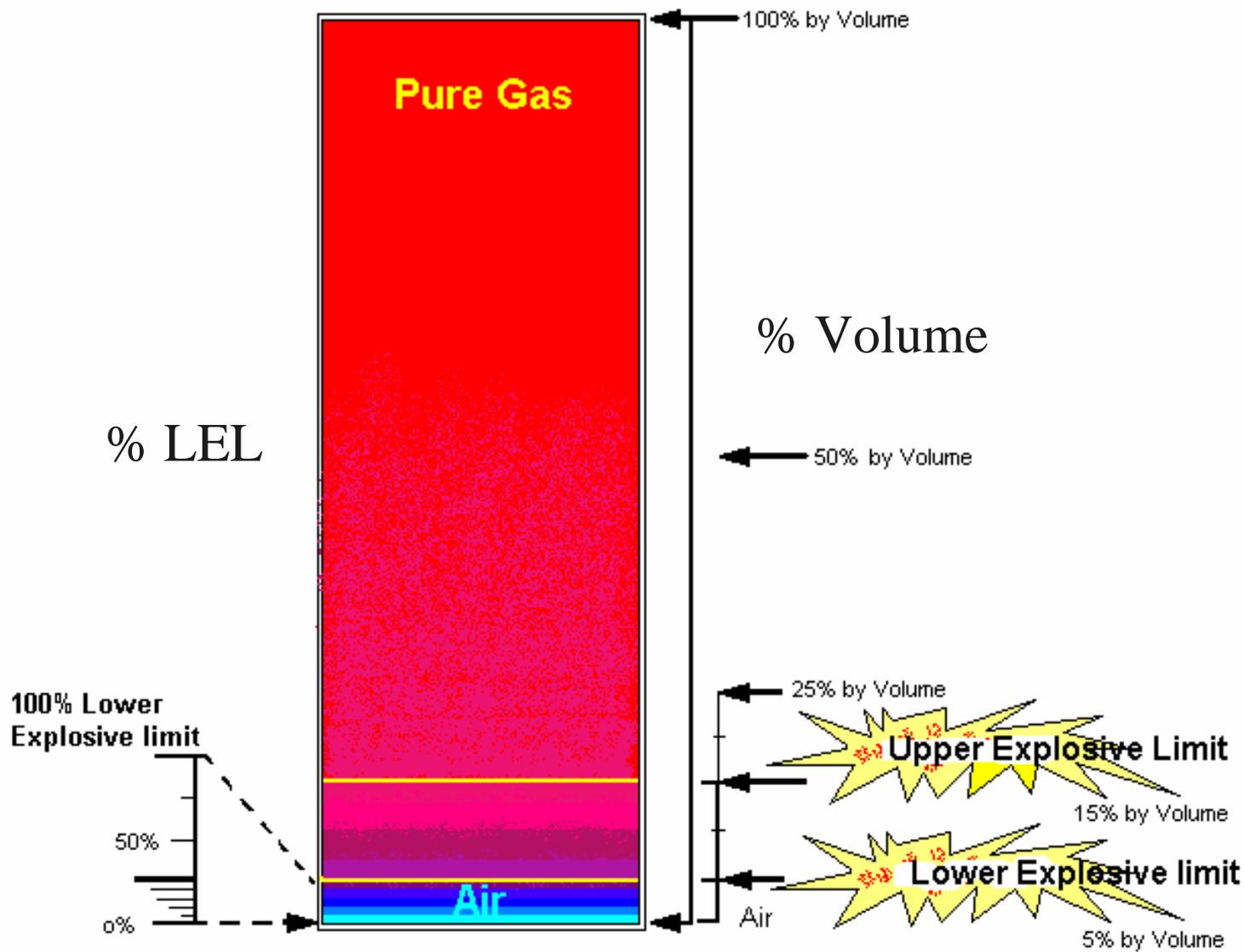


**0%**

**5%**  
**50,000 ppm**  
**LEL**

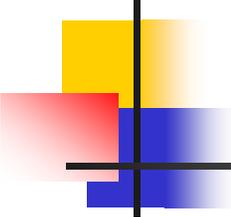
**15%**  
**UEL**

**100%**  
**GAS**

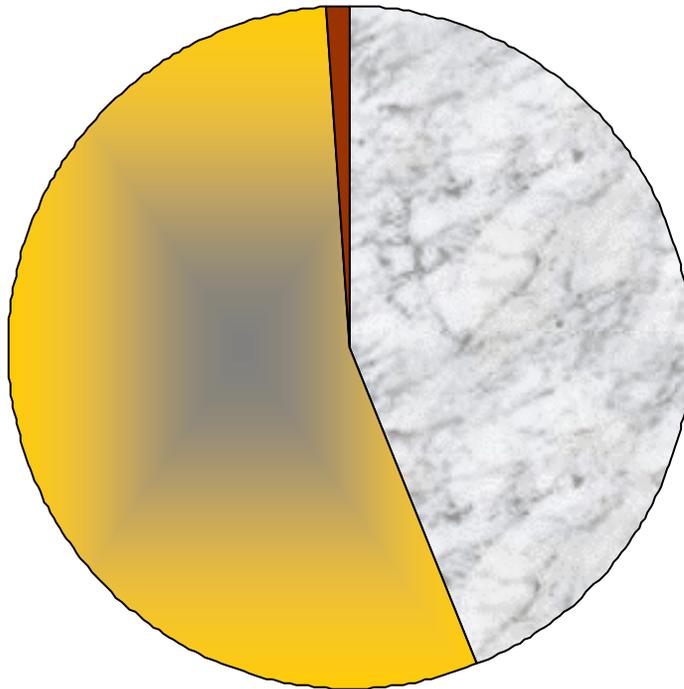


LEL=5% Gas by Volume=50,000 ppm

UEL=15% Gas by Volume=150,000 ppm



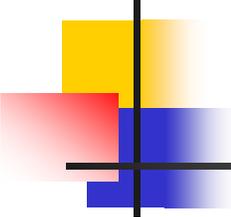
# COMPOSITION OF LFG



■ **CO2-44%**

■ **Methane-55%**

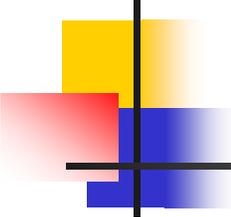
■ **Trace-1%**



## **LANDFILL GAS (LFG) CONT.**

---

- **Up to 60% Methane (CH<sub>4</sub>) by volume,**
- **Variable amounts of:**
  - water vapor,**
  - carbon dioxide (CO<sub>2</sub>),**
  - hydrogen sulfide (H<sub>2</sub>S),**
  - carbon monoxide (CO)**



## LANDFILL GAS (LFG) CONT.

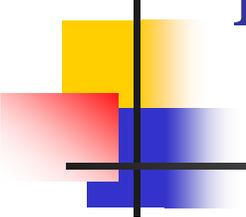
---

Trace contaminants, including but not limited to:

- Benzene
- Ethyl Benzene
- Toluene
- Vinyl Chloride
- Dichloromethane
- Trichloroethylene (TCE)
- 1,2, Dichloroethylene
- Tetrachloroethylene(PCE)

# TYPICAL TRACE GASES

	Hydrogen Sulfide	H <sub>2</sub> S
	Ammonia	NH <sub>3</sub>
VOCs	Vinyl Chloride	C <sub>2</sub> H <sub>3</sub> Cl
	Benzene	C <sub>6</sub> H <sub>6</sub>
	Methylene Chloride	CH <sub>2</sub> Cl <sub>2</sub>
	Trichloroethylene	C <sub>2</sub> HCl <sub>3</sub>

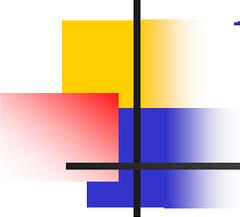


## **LANDFILL GAS (LFG) CONT.**

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**Each of the components, including the trace compounds, may or may not be found together either at concentrated subsurface sources or as dilute zones within ambient air.**

**Theoretically any combination or permutation of components is possible**

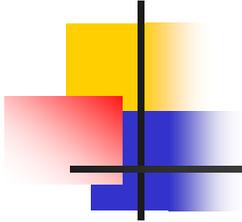


## LANDFILL GAS (LFG) CONT.

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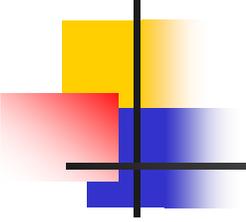
**The potential for detecting the trace components in ambient air without substantial concentrations of methane or hydrogen sulfide gas as a carrier at other than a concentrated emission source, however, has been shown to be very low.**

# QUESTIONS



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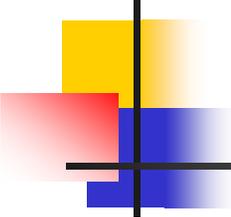
# **MONITORING SYSTEM EVALUATION**



## **INFORMATION GATHERING**

---

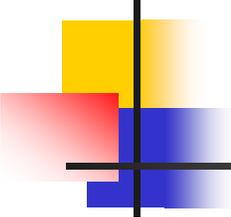
- **Review previous LFG inspection reports**
- **Identify specific probes to be sampled**
- **Obtain monitoring system maps & as-built drawings**
- **Check probe depths & location with respect to extraction wells**



# INFORMATION GATHERING

---

- **Review LFG monitoring probe design**
- **Consider type, quantity & depth of waste**
- **Consider proximity of receptors**
- **Make sure all probes are functional**



# **INFORMATION GATHERING**

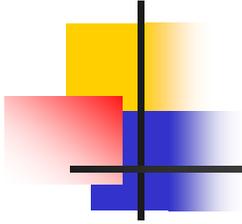
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## **Determine if probes are properly placed**

- **At (within 2 feet) the permitted (property boundary)**
- **At a point of compliance**
- **At a point approx. midway between LFG control wells**
- **At a proper spacing & depth**
- **Adjacent to critical receptors**

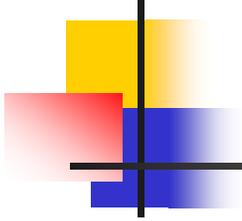


**QUESTIONS**

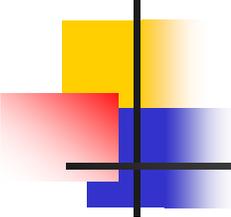


# BREAK





# **LFG SCREENING MONITORING**



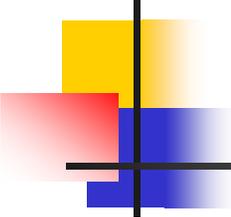
# Basic Conversions

---

- 5% Methane in air = 50,000 PPM

Remember that 1% = 10,000 ppm

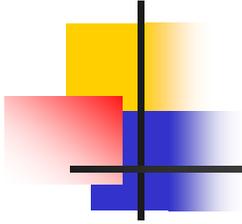
- 1.25% Methane in air = 12,500 PPM
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5% Methane in Air
- 25% of the LEL=1.25% Methane in Air



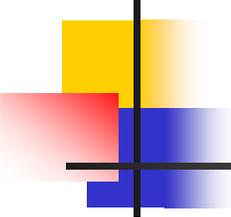
# ACRONYMS AND SYMBOLS CONT.

---

- PPM - PARTS PER MILLION
- % O<sub>2</sub> - PERCENT OXYGEN
- CO - CARBON MONOXIDE
- H<sub>2</sub>S - HYDROGEN SULFIDE
- LEL - LOWER EXPLOSIVE LIMIT
- UEL - UPPER EXPLOSIVE LIMIT



# INTRODUCTION TO LFG INSTRUMENTS

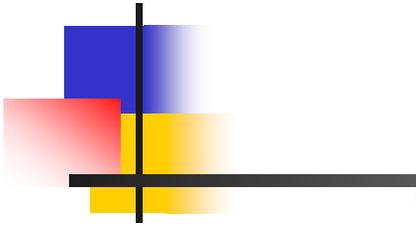


# SENSORY THEORY

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- CATALYTIC - PPM AND 0 TO 10% GAS (O<sub>2</sub> DEPENDENT TO 2%)
- THERMAL - 10% TO 100% GAS BY VOLUME (NON O<sub>2</sub> DEPENDENT)
- CHEMICAL - O<sub>2</sub>, H<sub>2</sub>S, CO

# GMI INSIDE CASE



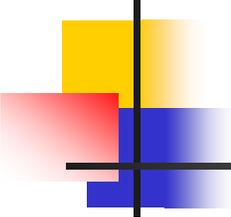
# GMI AND SAMPLING COMPONENTS



# GMI BODY AND BATTERY



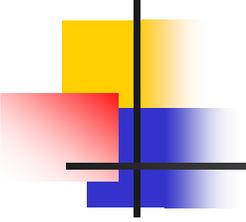




## **GMI IN COMBUSTIBLE GAS INDICATOR MODE USES AND FEATURES**

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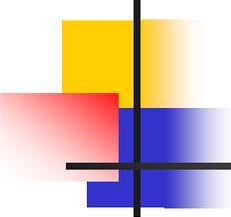
- **COMBUSTIBLE PPM RANGE**
- **NO AUDIBLE OR VISUAL ALARMS**
- **MANUAL DATA LOGGING ONLY**
- **MANUAL RANGE VIEWING WITHOUT  
AUTOMATIC HAZARD OVERRIDE**



# GMI IN COMBUSTIBLE GAS INDICATOR MODE USES AND FEATURES CONT.

---

- MEASURES CO AND H<sub>2</sub>S, PPM RANGES
- HEALTH & SAFETY AND REGULATORY SCREENING TOOL
- NOT TO BE USED IN LIEU OF LAB ANALYSIS

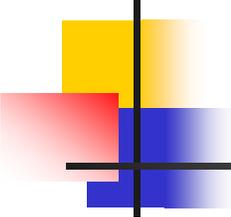


# USING THE GMI IN COMBUSTIBLE GAS INDICATOR MODE (CGIM)

---

- Press SECOND button ONCE\* to turn on
- Press second button ONCE to change range
- Press second button TWICE to re-zero ppm range
- Press third button to take samples
- Press top/first button twice to turn off

\* ONE SECOND OR MORE



# CGI Mode-Ranges

---

- % GAS BY VOLUME
- TOTAL COMBUSTIBLE GAS IN PPM
- % OXYGEN BY VOLUME
- PPM CARBON MONOXIDE (CO)
- PPM HYDROGEN SULFIDE (H<sub>2</sub>S)

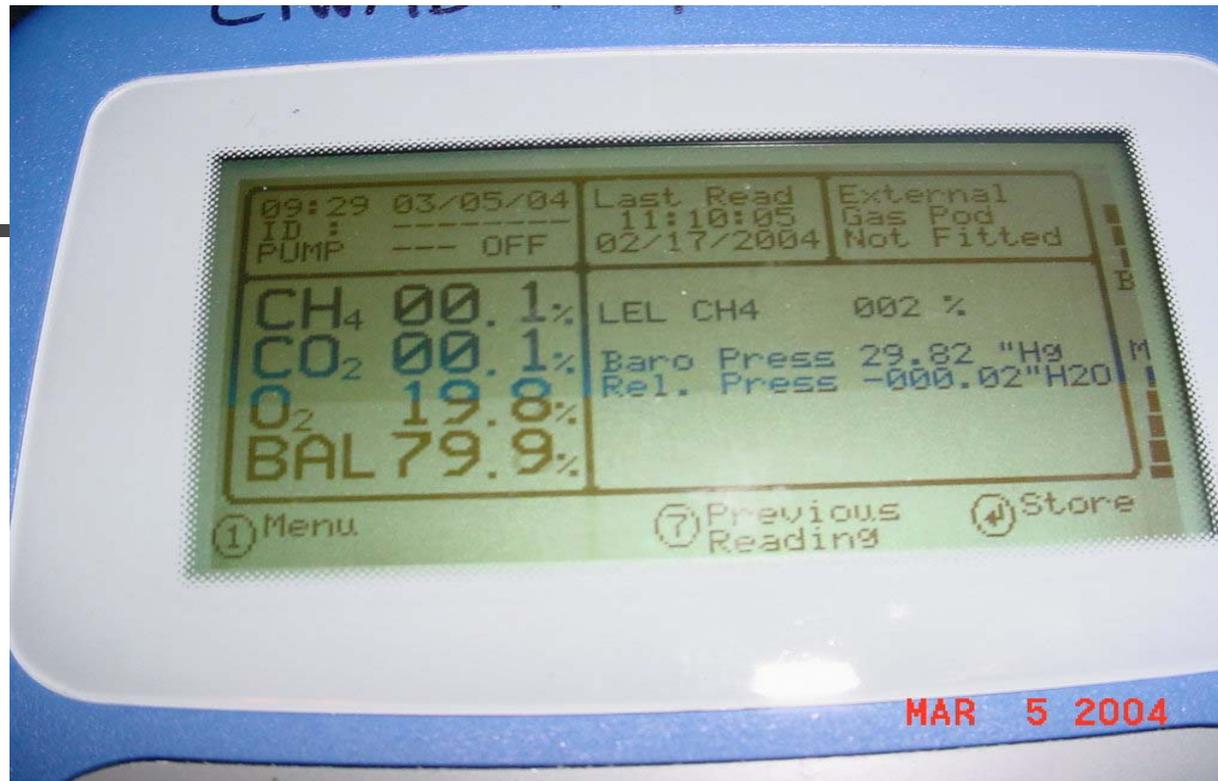
THEN BACK TO

- % GAS BY VOLUME

# GEM CASE

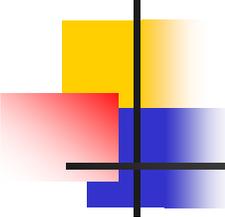


# GEM FACE PANEL



# GEM CONTROL PANEL





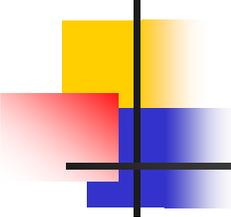
# GEM COMPONENTS

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# GEM COMPONENTS

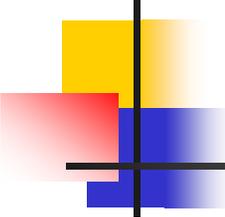




# **GAS SAMPLING EQUIPMENT**

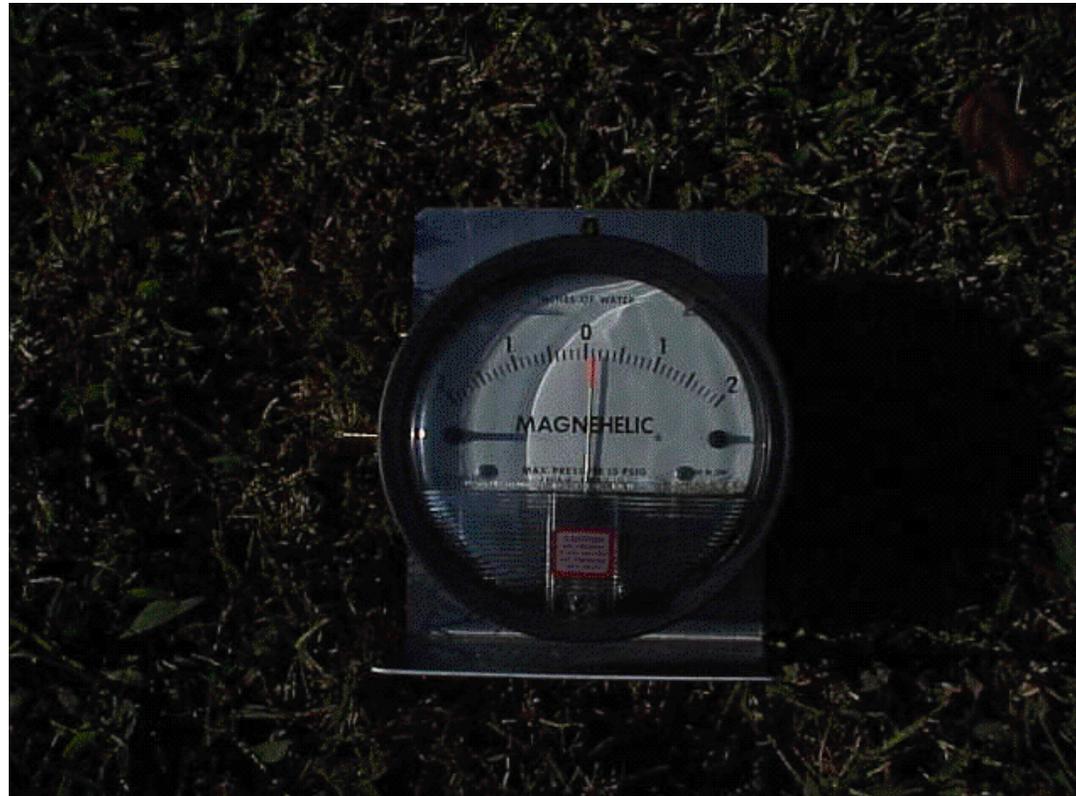
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- **MAGNAHELICS**
- **EVAC/TRANSFER PUMP**
- **TEDLAR BAGS**
- **TUBING AND CONNECTORS**



# MAGNEHELIC

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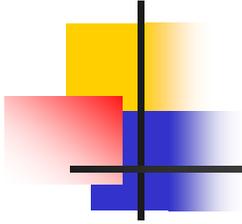


# EVAC/TRANSFER PUMP



# QUESTIONS





# LUNCH