BEGINNING LANDFILL GAS TRAINING

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ORIENTATION

INTRODUCTION

- **MONITORING LEVELS**

Screening
Specialized

COURSE OUTLINE

- LANDFILL GAS BASICS
- TITLE 27 LFG STANDARDS
- LFG SCREENING MONITORING
- MONITORING SYSTEM ASSESSMENT
- INTRODUCTION TO LFG INSTRUMENTS & INSTRUMENT OPERATION PROCEDURES

COURSE OUTLINE CONT.

- LUNCH
- LFG PROBE CONSTRUCTION
- HANDS ON EXERCISE
- DISCUSSION OF EXERCISE RESULTS
- QUESTIONS AND COMMENTS
- EXAM

LANDFILL GAS BASICS

Landfill Gas (LFG)

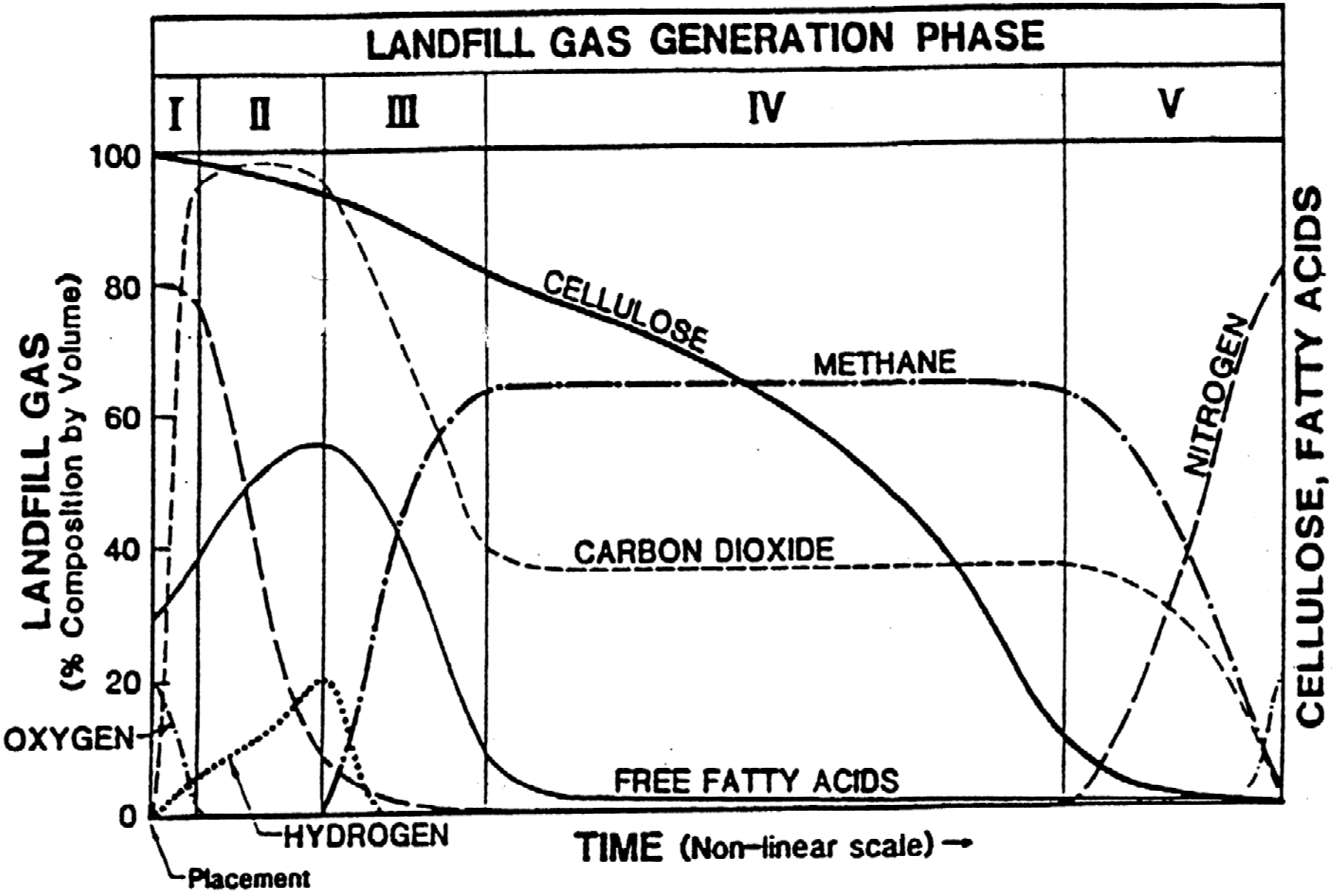
- **Methane gas is produced as a by-product of organic waste during decomposition.**

- **LFG may contain various chemical components in widely fluctuating quantities.**

ANAEROBIC REACTION

$$(C_6H_{10}0_5)_n + nH_20 \xrightarrow{\text{Anaerobic Bact.}} 3nCH_4 + 3nC0_2$$

TYPICAL LFG PHASE DIAGRAM



LANDFILL DECOMPOSITION GAS

- **METHANE (CH_4)**
  - **SIMPLE ASPHYXIANT**
  - **HIGH FIRE HAZARD**
  - **HIGH EXPLOSION HAZARD**
  - **LIGHTER THAN AIR**

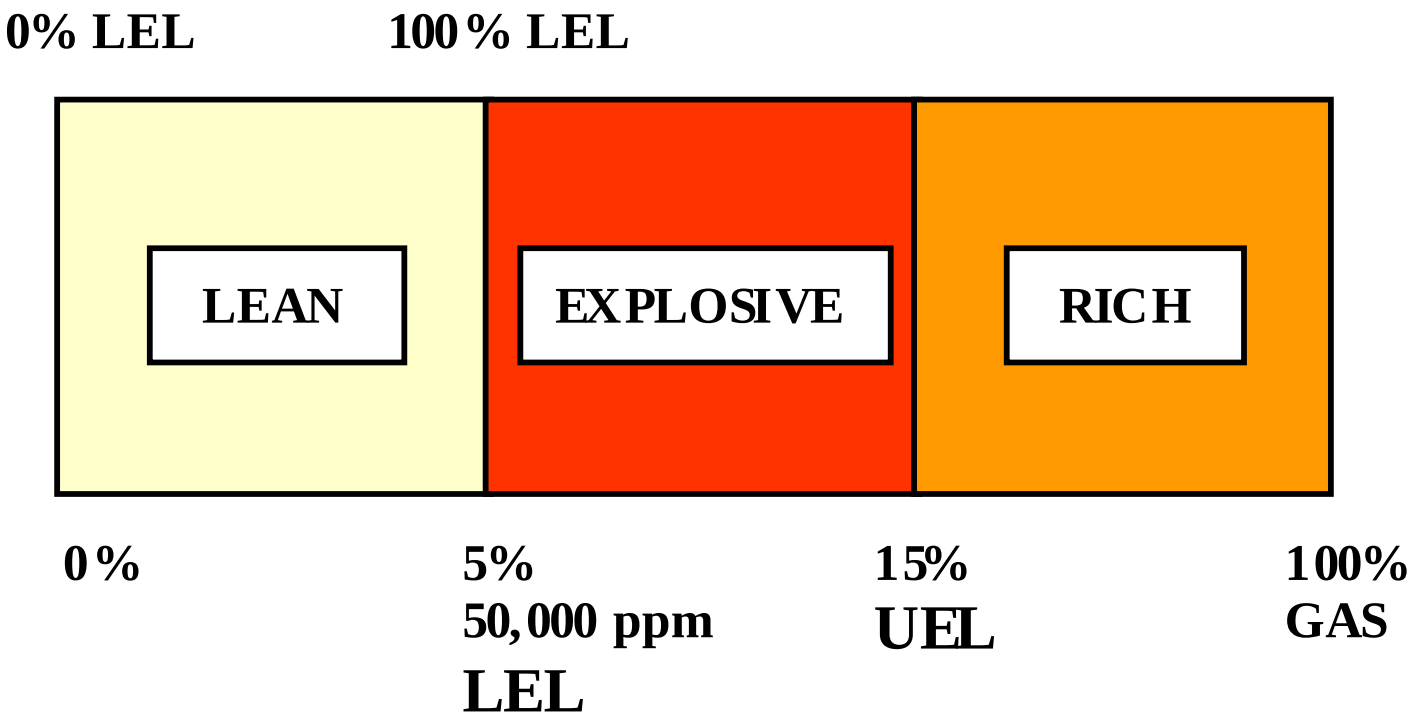
Basic Conversions

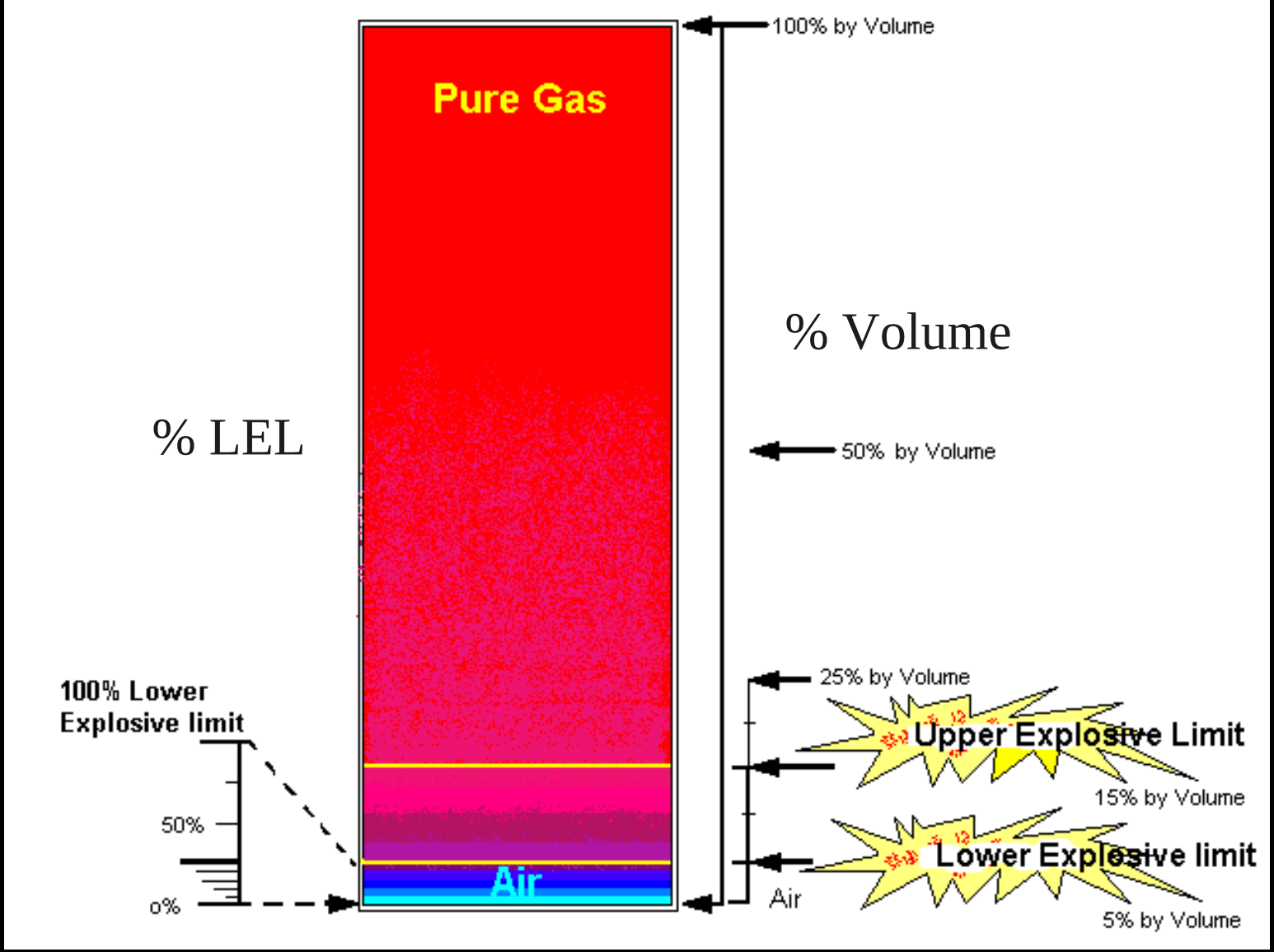
- **5% Methane in air = 50,000 PPM**
- **25% of the LEL=1.25% Methane in Air**
- **1.25% Methane in air = 12,500 PPM**
- **100% of the Lower Explosive Limit (LEL)= 5% Methane in Air**

Magnitude of Molecular Concentrations

- 1 ppm = 1 red half inch diameter marble in a box 4 ft x 4 ft x 4 ft filled with white marbles
- 1 ppb = 1 red marble in a room 40 ft wide x 200 ft long and 8 ft high.

METHANE FLAMMABILITY RANGE





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

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

Standard Temperature & Pressure

Standard Temperature

- $0^0C = 32^0F$

Standard Pressure

- 1 atmosphere at sea level
- 14.7 psi
- 33.96 ft-H_20 = 29.92 in-Hg
- 2 in-H_20 = 0.15 in-Hg

Sampling Perimeter Gas Probes

- If you check pressure with a magnehelic
  - < ± 2.0 in-H_20 => Diurnal pressure fluctuations
  - > + 2.0 in-H_20 => Subsurface pressure source
  - < - 2.0 in-H_20 => Influence from vacuum system
- Remember measured pressure is relative to atmospheric pressure.

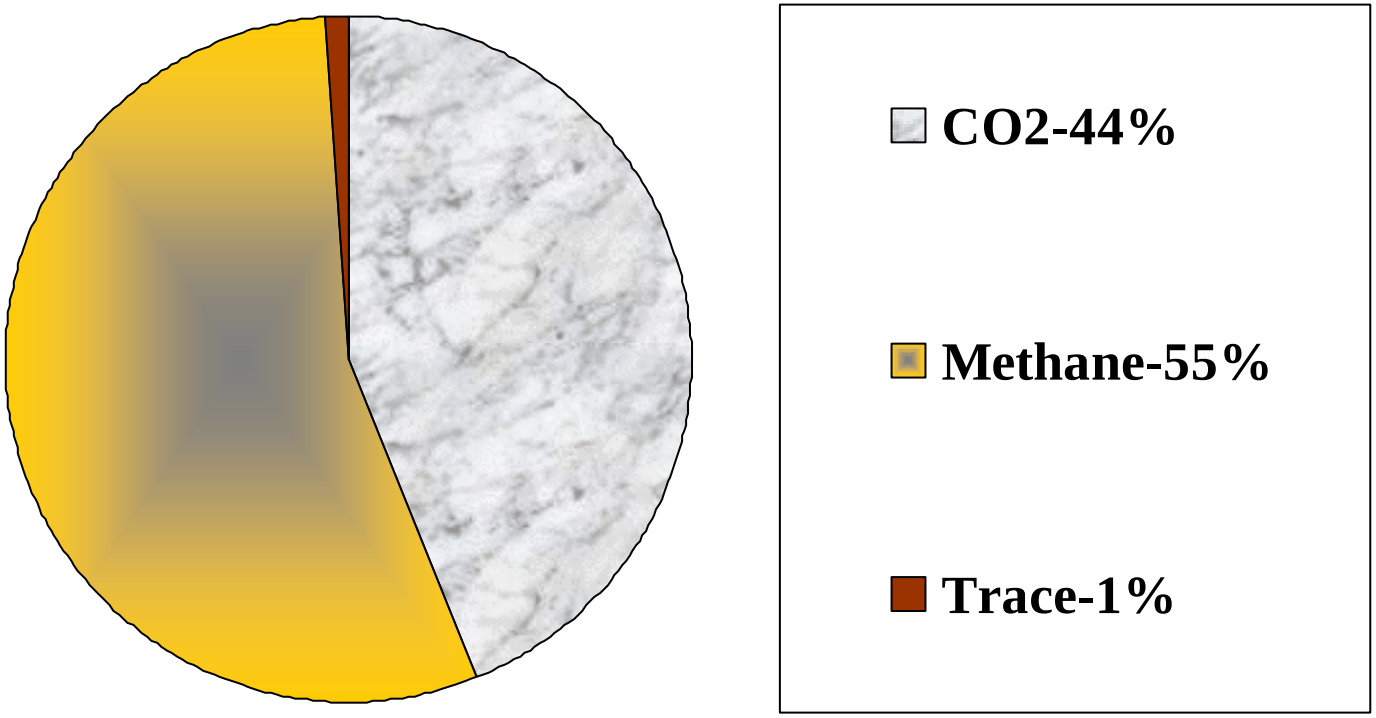
LFG MOVEMENT

Transport mechanisms

LFG Moves By:

Diffusion & Convection

COMPOSITION OF LFG



LANDFILL GAS (LFG) CONT.

- **LFG may contain variable amounts of:**

  -water vapor
  -hydrogen sulfide (H_2S)
  -carbon monoxide (CO)
  -trace gases

LANDFILL GAS (LFG) CONT.

Trace contaminants in LFG can include:

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

Other trace gasses:

	Hydrogen Sulfide	H2S
	Ammonia	NH3
VOCs	Vinyl Chloride	C2H3CL
VOCs	Benzene	C6H6
VOCs	Methylene Chloride	CH2CL2
VOCs	Trichloroethylene	C2HCL3

LANDFILL GAS (LFG) CONT.

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

Theoretically any combination of components is possible

LANDFILL GAS (LFG) CONT.

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 has been shown to be very low.

ACRONYMS AND SYMBOLS

- PPM - PARTS PER MILLION
- % O_2 - PERCENT OXYGEN
- CO - CARBON MONOXIDE
- H_2S - HYDROGEN SULFIDE
- LEL - LOWER EXPLOSIVE LIMIT
- UEL - UPPER EXPLOSIVE LIMIT

QUESTIONS
&
COMMENTS

TITLE 27

LFG STANDARDS

SECTION 20919 – Gas Control

- **Original CIWMB gas standard**
- **Gives authority to EA, fire and building authorities and CIWMB to have the operator:**

1. Take action if an LFG hazard and/or nuisance is believed to exist
2. Monitor for the presence and movement of LFG
3. Develop an LFG monitoring program for their approval
4. Discontinue the monitoring program
5. To submit monitoring results
6. To construct an approved gas control system if needed.

SECTION 20919.5 – Explosive Gas Control

- **Federal LFG standards for active sites**
- **Deleted**

SECTION 20920 – Scope and Applicability for gas monitoring and control requirements

- Applies to active and post 1988 closed sites
- Can apply to pre-1988 sites per 27 CCR 21100(d)

SECTION 20921 – Gas Monitoring and Control

- **Contains LFG standards**

1. **1.25% methane by volume in onsite structures**
2. **5% at the permitted facility boundary**
3. **Trace gases shall be controlled to prevent acute and chronic exposure**

SECTION 20921 – Cont.

- **Includes timeline for compliance**

1. **New sites and lateral expansions shall comply prior to receipt of waste**
2. **Sites which have received final waste shipment shall comply immediately**
3. **Existing active disposal sites shall comply in accordance with the following schedule:**

- **> 20 TPD shall comply 1 yr from affective date**
- **= or < 20 TPD shall comply by 2 yrs from effective date**

SECTION 20921 – Cont.

- A site gas monitoring and control program shall continue until written authorization to discontinue is given by EA with CIWMB concurrence
- The gas monitoring and control program shall be included in the JTD and Preliminary and Final CPCMP
- The gas monitoring and control program shall be modified to reflect change in site and adjacent land uses

SECTION 20921 – Cont.

- **Post closure land use shall not interfere with gas monitoring and control systems**
- **A reduction in control and monitoring activities must be based on data collected**
- **The permitted facility boundary shall be defined in the most recently approved appropriate document**

SECTION 20923 - Monitoring

- **A gas monitoring and control program must satisfy the following requirements:**

1. The monitoring network shall be designed by a PE or PG
2. The monitoring network shall be designed for:

- **Local hydro-geological, hydrological & soil and rock conditions**
- **Location of buildings and structures relative to the disposal area**
- **Adjacent land use and inhabitable structures within 1,000 feet of the permitted facility boundary**
- **Man-made pathways such as underground construction**
- **Nature and age of the waste and its potential to generate LFG**

SECTION 20925- Perimeter Monitoring Network

- **Monitoring well location**

1. **Perimeter wells may not be needed around the entire site due to geologic barriers, and no inhabitable structures and no threat to properties within 1,000 feet of the permitted facility boundary**

2. **Perimeter wells can be located at an alternative boundary closer to the waste**

SECTION 20925- Perimeter Monitoring Network (cont.)

- **Spacing**

1. **Lateral spacing between monitoring wells shall not exceed 1,000 feet unless the operator can demonstrate no adverse impact by being greater than 1,000 feet**
2. **Spacing of monitoring wells shall be based on the nature of structures protected & proximity to refuse**
3. **Monitoring well spacing can be reduced based on site specific conditions**

SECTION 20925- Perimeter Monitoring Network (cont.)

- **Depth**

1. **Shallow probes shall be 5 to 10 feet deep**
2. **Intermediate probes at near half depth of waste**
3. **Deep probes at or near depth of waste**
4. **Probe screens shall be in soil strata that is permeable to gas migration**
5. **Probes shall be above the seasonal low water table**
6. **Probes shall be above and below perched ground water**
7. **Probes shall be above bedrock**
8. **Two probes are required when the depth of waste does not exceed 30 feet**

SECTION 20925- Perimeter Monitoring Network (cont.)

- **Monitoring Well Construction**

1. **Monitoring wells shall be:**

- **Drilled by a licensed drilling contractor**
- **Drilled under supervision by an engineer or engineering geologist**
- **Logged during drilling by an engineer or engineering geologist**
- **Logged using ASTM visual classification**

SECTION 20925- Perimeter Monitoring Network (cont.)

2. **Each monitoring well record shall be maintained by the operator and available to the EA and shall include:**

- **A map showing monitoring well locations**
- **Well logs including names of persons logging the borehole**
- **As-built description of monitoring probe construction**

3. **Operator shall provide a minimum seal of 5 feet of bentonite at the surface and between monitored zones**

SECTION 20931 – Structure Monitoring

- All areas with the potential for LFG build up within the permitted site boundary shall be monitored for LFG
- Methods for monitoring may include periodic monitoring of probes and/or the use of continuous monitoring systems
- When practical, monitor structures at night and on weekends
- Structures on top of the waste footprint shall be monitored on a continuous basis

BREAK

SECTION 20932 – Monitored Parameters

- **The EA may require a sample to be collected for specified trace gases when there is a possibility of acute or chronic exposure.**

SECTION 20933 – Monitoring Frequency

- **At a minimum, quarterly monitoring is required**

1. **The EA may require more frequent monitoring based on site specific factors**
2. **More frequent monitoring may be required at locations where there is evidence of LFG migration**
3. **The operator shall increase the monitoring frequency as necessary to insure compliance**

SECTION 20933 – Monitoring Frequency (cont.)

- **Monitoring frequencies may be reduced:**

1. **If the MSW landfill accepts 20 tons or less of waste per day**
2. **With concurrence by the CIWMB**
3. **After consideration of the unique characteristics of MSW landfill and its surroundings, etc.**
4. **With 30 day public comment period**
5. **The EA or CIWMB may suspend the reduced monitoring frequency**

SECTION 20934 - Reporting

- **Monitoring report shall include:**

1. **LFG concentrations measured at each probe and within each on site structure**
2. **Concentrations of specified trace gases (if required by EA)**
3. **Documentation of date, time, barometric pressure, temperature, probe pressure measured at the time the probe was monitored.**
4. **Names of sampling personnel, and description of apparatus and sampling methods used**
5. **A numbering system correlating monitoring results to well and probe locations**

SECTION 20937 – Reporting and Control of Excessive Gas Concentrations

- **When concentrations of methane or trace gases are in excess of the requirements of Section 20921(a), the operator shall:**

1. **Notify the EA**
2. **Within 7 days of detection, the operator shall verify:**

- **The validity of probe readings**
- **The possibility of liquid interference**
- **The possibility of the control well influence**
- **The possibility of barometric pressure effects**

SECTION 20937 – Reporting and Control of Excessive Gas Concentrations (cont.)

3. **The operator shall place in the operating record a description of:**

- **Levels of methane or trace gas detected**
- **Brief description of the nature and extent of the problem**
- **Steps taken to protect public health & safety and the environment**
- **Brief description of any other corrective actions the operator or others need to take to adequately protect public health & safety and the environment.**

SECTION 20937 – Reporting and Control of Excessive Gas Concentrations (cont.)

4. **Within 60 days of detection, implement an approved remediation plan, place a copy in the operating record and forward a copy to the EA & the CIWMB**

4. **Construct a gas control system:**

- **Designed by a registered civil or mechanical engineer**
- **Within a time period specified by the EA**
- **Approved by the EA in coordination with RWQCB**

SECTION 20937 – Reporting and Control of Excessive Gas Concentrations (cont.)

- **The EA, in compliance with CIWMB may establish an alternative schedule for demonstrating compliance**

- **The EA shall forward notifications and approvals made pursuant to all above items in this standard**

SECTION 20939 – Control of Excessive Gas Concentrations

- **LFG control system shall be designed to:**

1. **Prevent methane accumulation in on site structures**
2. **Reduce methane concentrations at the permitted facility boundary**
3. **Reduce trace gas concentrations to the requirement (20921(a))**
4. **Provide for collection, treatment & disposal of LFG condensate**

SECTION 20939 – Control of Excessive Gas Concentrations (cont.)

- **Subsurface LFG control systems may include:**

1. **Active perimeter or interior control systems**
2. **Perimeter air injection systems installed in native soils**
3. **Passive systems including cutoff trenches, slurry walls & vent trenches**

SECTION 20939 – Control of Excessive Gas Concentrations (cont.)

- **LFG control measures to protect structures and public H&S shall include one or more of the following:**

1. **Flexible membrane liners**
2. **Active collection systems**
3. **Passive collection systems designed to be upgraded to active systems**
4. **Alarms**
5. **Ignition source control**
6. **Utility collars installed within structures and outside in trenches**
7. **Ventilation**

SECTION 20939 – Control of Excessive Gas Concentrations (cont.)

- **The operator shall provide for system monitoring and adjustment to ensure LFG control system is operating at optimum efficiency**
- **The operator shall implement a maintenance program in accordance with:**

1. **Site specific operation & maintenance (O&M) manual**
2. **O&M shall provide for periodic inspections and servicing of gas control equipment**
3. **O&M shall be recorded and records retained by the operator**

SECTION 20939 – Control of Excessive Gas Concentrations (cont.)

- **Construction quality assurance/quality control**

1. **The operator shall be responsible for providing inspections**
2. **The designer shall verify that all equipment used or to be used in gas control system is in accordance with industry standards**

Questions & Comments

LFG SCREENING MONITORING

SCREENING MONITORING

- **Will greatly <u>conserve</u> time**
- **Will <u>simplify</u> procedures**
- **Will yield <u>accurate</u> results**
- **Will <u>detect</u> most LFG issues**

SCREENING MONITORING

- **Screening monitoring should focus on a few probes to be sampled on the on the permitted facility boundary by selecting:**

1. Probes adjacent to sensitive receptors
2. Probes that have had major fluctuations or changes
3. Probes outside the facility permitted boundary

SCREENING MONITORING

- **Probe evacuation is not necessary**
- **Connect directly to each probe:**

1. Using a long sampling hose and/or water trap in the sampling line
2. Having appropriate filters in place
3. Watching for water in the line and/or trap
4. Know probe history and previous sampling results

SCREENING MONITORING

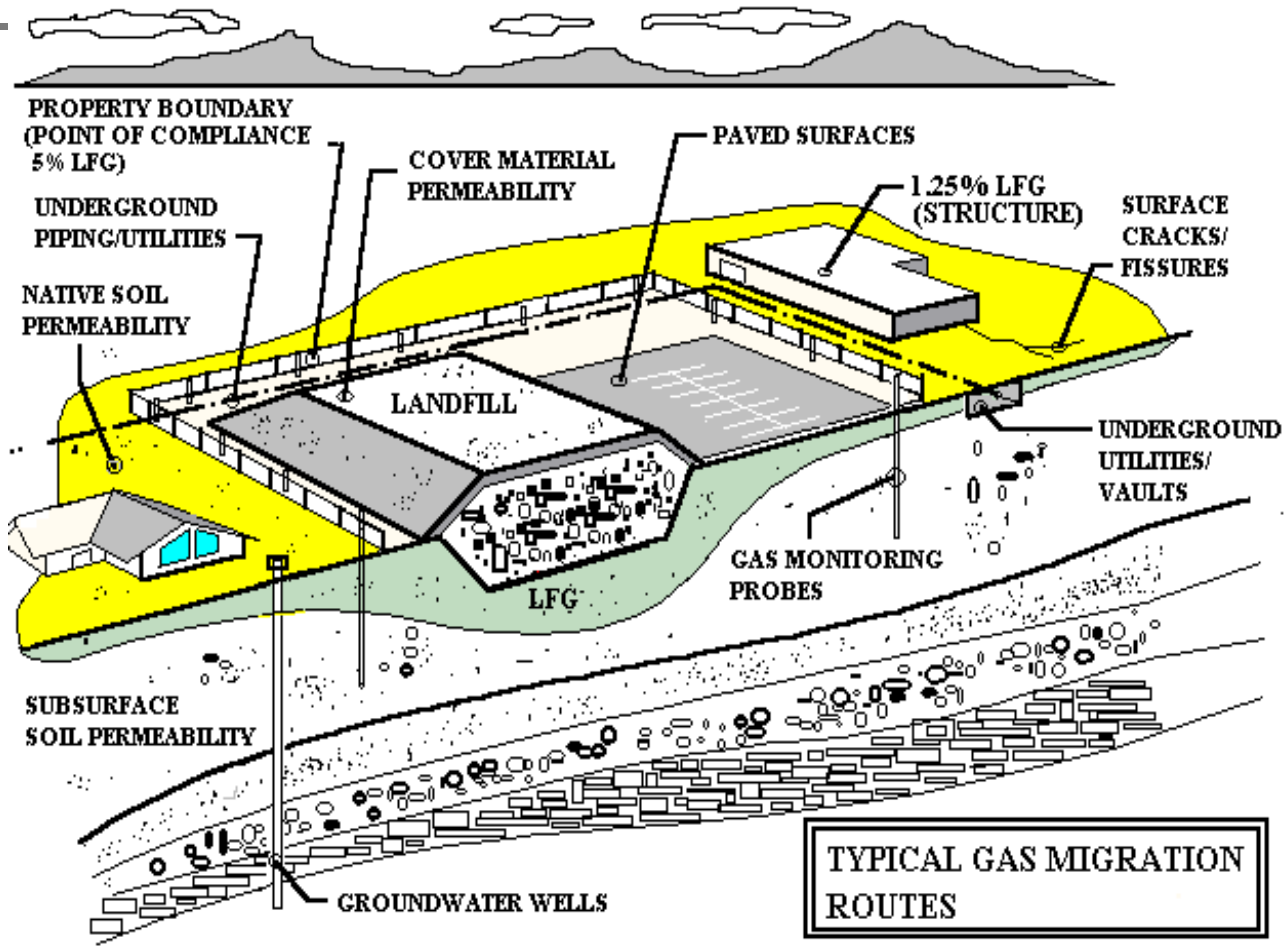
- **In on site structures for 1.25%:**

1. Monitor places where gas could accumulate
2. Use a catalytic LFG monitor
3. Check floor cracks, vents & conduits

Screening Guidelines

Screening checklist

- Functional monitoring equipment
- Check past gas data
- Direct connect
- Don't evacuate well
- Sensitive receptors
- Check control well proximity



Questions & Comments

MONITORING SYSTEM ASSESSMENT

A recent statewide evaluation of the functionality of LFG monitoring probes (using a video borescope) seems to show that a significant number of these probes are either totally non-functional or not configured to function properly

INFORMATION GATHERING

Identify potential monitoring system problems by:

- **Reviewing past monitoring records**
- **Obtaining & evaluating monitoring system maps & as-built drawings**
- **Checking probe depths and screen location with respect to extraction wells and boring logs**
- **Considering the proximity of sensitive receptors**

INFORMATION GATHERING

Remember to determine if probes are properly placed <u>inside</u> the permitted facility property boundary:

- **At (within 2 feet) of 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 AND COMMENTS

INTRODUCTION TO LFG INSTRUMENTS & INSTRUMENT OPERATIONS PROCEDURES

1-PPM, % Methane, LEL, UEL

2-Probe Construction

3-Probe Location

4-Are there adequate # of probes installed?

5-Location of extraction wells in relation to monitoring probe locations.

6-Gas movement from the site

7-Any question in regards to LFG.

SENSORY THEORY

- CATALYTIC - PPM AND 0 TO 10% GAS (O_2 DEPENDENT TO 2%)
- THERMAL - 10% TO 100% GAS BY VOLUME (NON O_2 DEPENDENT)
- CHEMICAL - O_2, H_2S, CO

GMI INSIDE CASE

GMI AND SAMPLING COMPONENTS

GMI BODY AND BATTERY

PROBE AND COMPONENTS

GMI IN COMBUSTIBLE GAS INDICATOR MODE USES AND FEATURES

- 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 H2S, 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 (H2S)

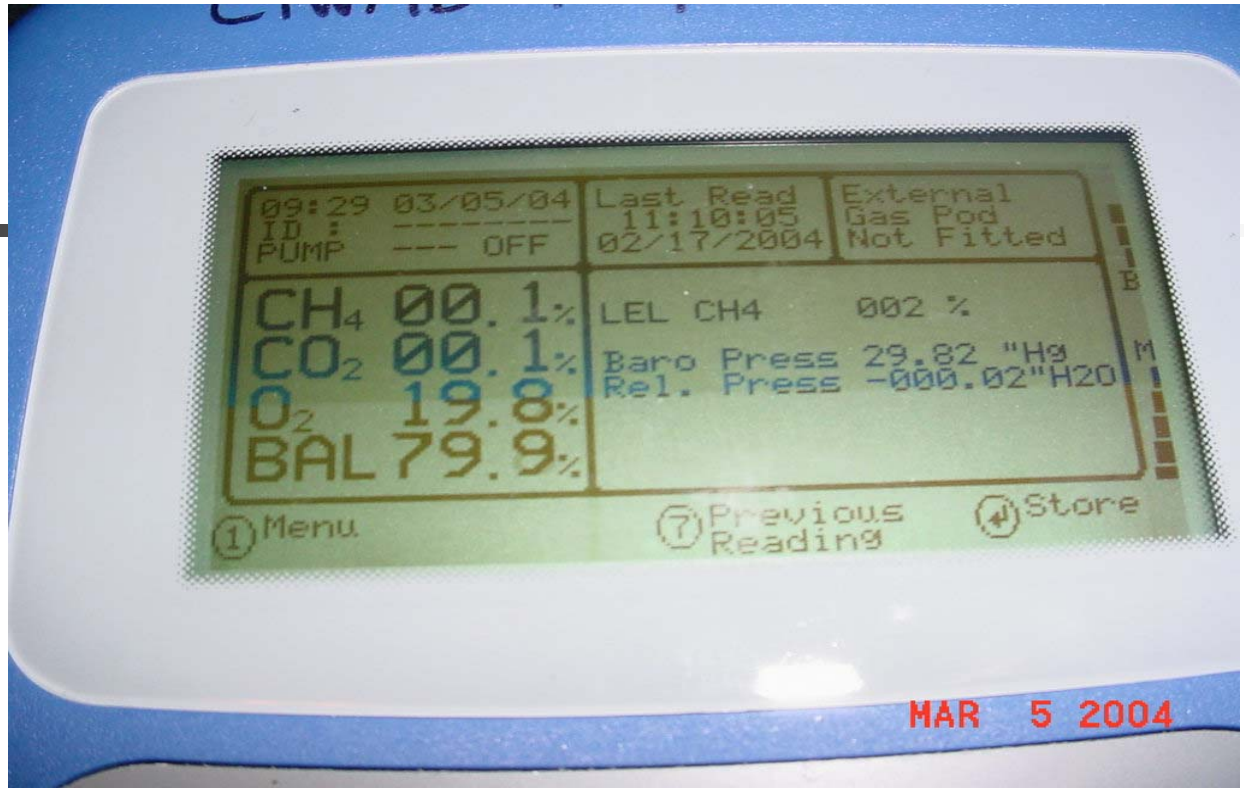
THEN BACK TO

- % GAS BY VOLUME

GEM CASE

CIWMB
Gem 2000
4
S/N 07033
PELICAN
1500 CASE
PELICAN PRODUCTS TORRANCE, CA USA
MAR 5 2004

GEM FACE PANEL



GEM CONTROL PANEL

GEM COMPONENTS

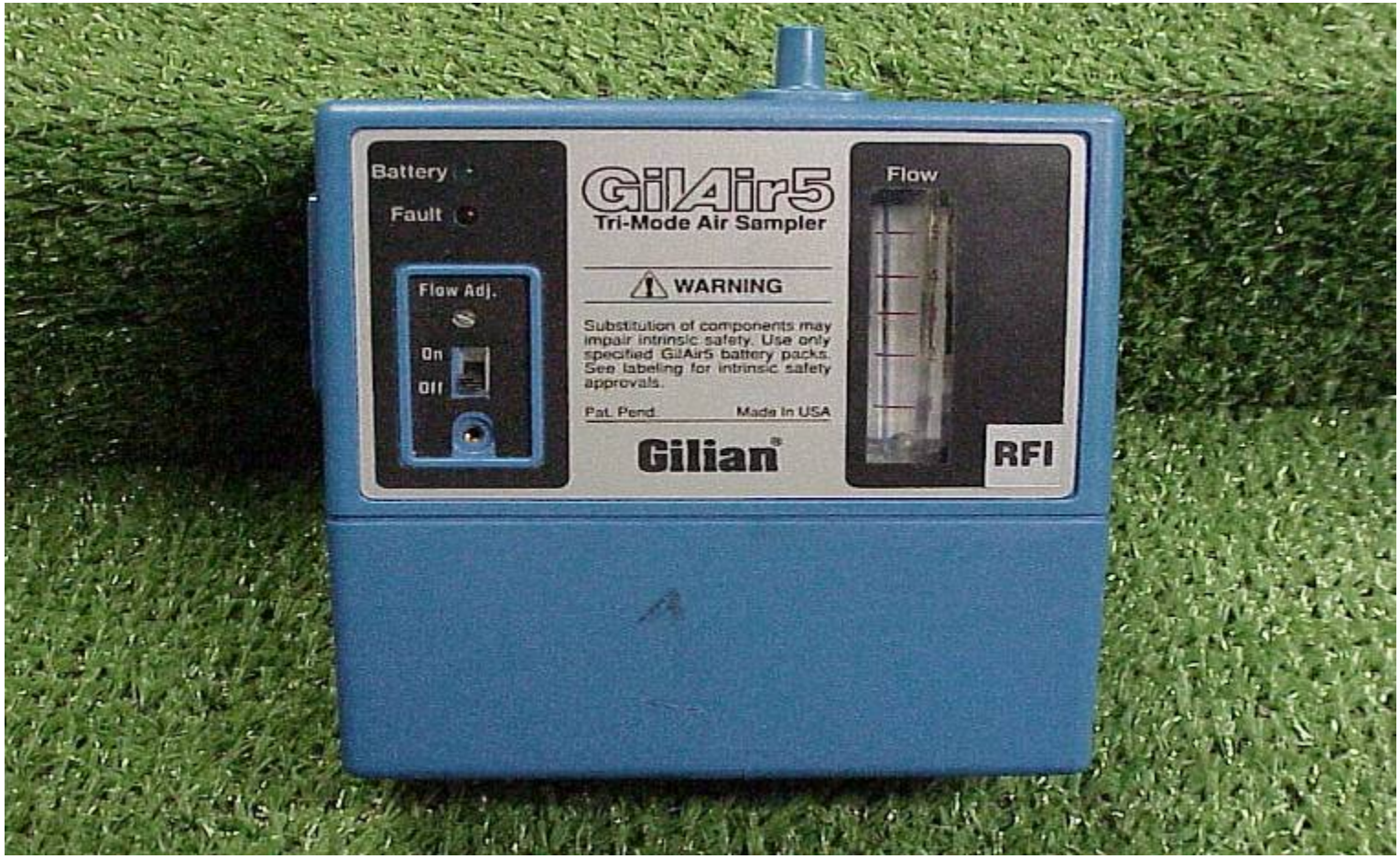
GEM COMPONENTS

GAS SAMPLING EQUIPMENT

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

MAGNEHELIC

EVAC/TRANSFER PUMP



QUESTIONS AND COMMENTS

LUNCH