Outline

• Introduction to NMOCs
• Field sampling challenges
• Conducting NMOC testing under EPA Region 7 oversight
• Success with getting sites out of NSPS
• SCS NMOC database and NMOC trends
So Many Acronyms!!

VOC  CH4  GCCS
NMOC  LFG  NSPS  MSW
HAPs  CO2  QA/QC

I’m joining the S.E.W.L.T.U.I.F.E.

To the lay dog, it’s known as the “Society of Engineers who like to use initials for everything.”

We use acronyms to set us apart from the unwashed masses who don’t understand technology.

B.F.D.*
Introduction to NMOCs
What Are NMOCs and Where Do They Come From?

• Non-Methane Organic Compounds
  • Organic compounds with at least one carbon atom
  • Typically also contain hydrogen and may include oxygen, sulfur, chloride, etc.
    (butane, dichloroethane, carbon disulfide, benzene…)

• Constituents in Landfill Gas (LFG)
  • “Bugs” generate CO$_2$ and CH$_4$ under anaerobic conditions
  • NMOCs are “stripped” out of waste by LFG

NMOCs are a function of type of waste accepted, not a primary product of LFG generation!
Why Are NMOCs Important?

- NMOC mass emission rate is the basis for regulatory and permit applicability for MSW landfills
  - NSPS Subpart WWW
    - 50 Megagrams per year (Mg/yr) – Gas control limit
  - NSPS Subpart XXX
    - 34 Mg/yr – Gas control limit
  - St. Louis Metropolitan Area
    - 25 Mg/yr – Gas control limit
  - Permitting thresholds (39% of NMOCs = volatile organic compounds (VOCs))
How Do We Estimate NMOC Emissions ($M$)?

1. Collect Sample(s) of LFG
   - Surface probe samples (geoprobe)
   - Existing passive or active gas system

2. Analyze Sample(s) for NMOCs ($C_{NMOC}$)
   - Typically reported as parts per million by volume (ppmv) as carbon

3. Calculate LFG Flow Rate ($Q_{LFG}$)
   - LandGEM
   - Direct measurement from existing gas system

4. Do the math
   - $M_{NMOC} = Q_{LFG} \times C_{NMOC} \times \rho$
   - Don’t forget to convert to ppmv (as hexane) for NSPS determinations!
“We” get involved in Step 1: Collection of Samples
Typical Sampling Methods

**Surface Probes**
- Collect sample through temporary borehole inserted into waste
- **Pros**
  - Primary method specified in regulation
  - Results are typically accepted provided QA/QC is met
- **Cons**
  - Increased field work (cost)
  - Increased analytical costs

**Gas System**
- Collect sample through access port on gas system/vent
- **Pros**
  - Reduced field work (cost)
  - Reduced analytical costs
- **Cons**
  - Results more likely to be questioned
  - Ensure gas system is functional – have data to support use
Sample Collection Requirements

**Determine when required to control LFG**

“Tier 2 Test”

- Collect 2 LFG samples per hectare of landfill surface with waste in place for 2 or more years (maximum of 50 samples)
- As an alternative (or in combination), collect LFG samples from active or passive gas systems
- Analyze samples from NMOCs and calculate mass emission rate based on calculated LFG generation

**Determine when a GCCS can be removed**

- Collect 1 LFG sample from the common header pipe
- Measure flow rate of LFG in the common header pipe
- Analyze samples for NMOC and calculate mass emission rate based on the measured LFG flow rate
Surface Probe Sample Collection

- Insert surface probe rod
  - Hollow ~1.5 inch diameter
  - Expendable drive point
- At desired depth, pull back rod ~0.5-1 foot
- Insert tubing through rod and connect to sampling train
- QA/QC Check
  - <5% O₂ or <20% N₂
- Collect sample in Summa canister
- May composite multiple samples in one canister
Gas System Sample Collection

- Existing header pipe or individual well/vent
- Connect tubing with sample train to access port
- QA/QC Check
  - <5% $O_2$ or <20% $N_2$
- Collect sample in Summa canister
Field Sampling Challenges
!!Challenges!!

- Accessing surface probe locations
  - Steep slopes
  - Cover condition (muddy, icy, washouts)
  - Above grade piping

- Finding good gas (<5% O₂ or <20% N₂)
  - Old landfills
  - Balefills

- Air leaks
  - May not identify until after sample analysis
  - Can cause samples to fail QA/QC requirements
  - No vacuum in canister when received at laboratory!

Collect duplicates!
(They don’t have to be analyzed unless needed)
Other Considerations

High Liquid Levels
- Prevent sample collection at minimum required depth
- Low gas quality (fail QA/QC)

Elevation of Facility
- Most labs are located in California, Sea Level!
- The amount of gas a Summa canister will collect is reduced by $-0.20$ liters per 1,000-ft rise in elevation

Elevated Landfill Pressure
- Field hazard can be created

Sampling from Gas System (Tier 2)
- Ensure system is “representative” of the 2-probe per hectare requirement of NSPS
- EPA Region 7 scrutiny
Case Example – Think on Your Feet!

• September 2010 Tier 2 Testing
• Wyoming
  • Arid climate
  • Elevation 5,150 ft MSL
• Closed balefill
  • 107 acres (264 hectares)
    • Maximum 50 samples required
    • Geocomposite final cover system
    • Passive gas vents
• Work Plan submitted/approved by WDEQ
  • Collect samples from passive gas vents
Proposed to close shut off valve prior to sample collection
Can you spot the problem?
Problem 1?

No Shut-Off Valve
Solution 1!

Heavy Vinyl Trash Bags and Duct Tape!
Problem 2?

• Morning of day 2
(After installation of 50 improvised vent seal systems 😊)
• Initial gas readings at most vents
  ~21% oxygen
  ~79% balance gas (nitrogen)
  Ambient air
Solution 2!

- Wyoming temperature fluctuates 20-30 degrees in one day
- Wait until the ambient temperature increases
  - Landfill needs to breathe
- Checked vents in the afternoon
  - Good gas!!
- Limited to collecting samples in the afternoon/early evening
Conducting NMOC Testing Under EPA Region 7 Oversight
EPA Region 7 Scrutiny

“samples may be collected from gas removal systems instead of surface probes provided the removal system can be shown to provide sampling as representative as the two sampling probe per hectare requirement”

• EPA questions the “representativeness” of a gas system to meet the 2-probe per hectare requirement
• Additional testing required
What Does “Representative” Mean?

- Provide documentation: 2 probe per hectare
  - Wellfield data before, during, and after testing
    - Gas composition
    - Flow rate
    - Position of valve
    - Liquid level
  - Control device data
    - Flow rate before, during, and after testing
  - Date and description of each change made to gas system
    - Well additions and decommissions
  - Notes, drawings, and reports associated with design and operation of system
  - Justification for fluctuating NMOC emission rate
    - Probe versus gas system samples and changes over time
Additional Testing

• Wellfield balancing the day before with EPA observation
  • Shutoff non-productive wells
• Removal of demister pad in condensate knockout
• Common header line sample collection
  • Measurement of temperature, pressure and flowrate per Method 2 requested
    • Proposed
      • Use of GEM 2000 for temperature and pressure
      • Use of existing calibrated thermal mass flow meter
    • Compromise
      • Temperature and pressure – Method 2 by stack test firm
      • Use of existing calibrated mass flow meter

Stack test confirmed GEM 2000 readings 😊
Positive Note!
Success Getting Sites Out of NSPS
Getting Out of NSPS!

If your site is closed and has operated a GCCS for at least 15 years, suggest collecting a sample!!

Criteria
- Closed site
- Gas system operational for at least 15 years
- Demonstrate NMOCs below threshold during 3 successive test dates

SCS Success
- California
- Florida
- Kansas
- Massachusetts
- Missouri
- New York (pending approval)
- Texas

Several no longer subject to Title V permit!
SCS NMOC Database and Trends
SCS Database

- NMOC test data collected from sites across the country
  - 1996 through current
  - Over 270 landfills
- Includes
  - Landfill specifics (capacity, in-place waste)
  - Test method (probe and/or gas system samples)
  - Test results (NMOC concentration, calculated emission rate)
- Useful tool!
  - Look for trends or identify outliers
  - Predict future rates?
Noted Trends and Impacts

Average Concentration (from database)
- Average - 400 ppmv
- Highest - 2,530 ppmv
- Lowest - >5 ppmv
- As a reference
  - Tier 1 = 4,000 ppmv
  - AP-42 = 595 ppmv

Long-Term Trend
- Industry has seen a decrease in NMOCs over time
- Implementation of Subtitle D – less NMOC-containing waste being disposed
  - Load checking
  - Household hazardous waste programs
  - Recycling and sustainability programs also reduce NMOC-containing wastes

Age of Waste – New Waste
- Higher concentrations typical
  - NMOCs are just starting to be stripped out of the waste by LFG
  - New waste is not yet generating large quantities of LFG

Probe Versus Gas System
- Probe samples draw from upper portion of waste (newer)
  - Likely to be higher concentration
- Gas system installed across waste profile (new and old)
  - Better composite of gas profile?

NMOCs are a function of type of waste accepted, not a primary product of LFG generation!
### Results still vary!

<table>
<thead>
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<th>Site</th>
<th>Year</th>
<th>Method</th>
<th>NMOC Concentration (ppmv)</th>
<th>NMOC Emission Rate (Mg/yr)</th>
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<td>Probes</td>
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<td>Active System</td>
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<tr>
<td></td>
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<td>Active System</td>
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<td>Active System</td>
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<td>Probes</td>
<td>161</td>
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</table>

Many factors impact NMOC concentration and emission rate!
Questions

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