



# **Mandatory Greenhouse Gases Reporting Rule: Subpart HH - MSW Landfills**

**for LMOP Conference  
January 13, 2010**

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# Which landfills must report?



- **Municipal solid waste landfills**
  - Definition in 40 CFR 98.6
  - Excludes C&D, industrial, and hazardous waste landfills
  - Industrial landfills may be added to the rule for future years
- **Accepted waste since January 1, 1980**
  - Covers both open and closed MSW landfills
- **Methane generation  $\geq 25,000$  metric tons CO<sub>2</sub>e/yr**
  - Applicability based on generation, not actual emissions

# How do I determine applicability?



- EPA on-line Applicability tool
  - <<http://www.epa.gov/climatechange/emissions/GHG-calculator/index.html>>
    - Includes a simplified calculator for screening purposes
- If methane generation is close to 25,000 metric tons CO<sub>2</sub>e for 2010, perform more detailed calculations
  - Use equations in the rule
  - Use available data as input to the equations to estimate 2010 generation.

# Which equations do I use to determine applicability



Landfills without gas collection systems (GCS)	Combination of Eq. HH-1 (Gas generation model equation similar to LandGEM) AND Eq. HH-5 (Adjusts HH-1 modeled generation for soil oxidation)
Landfills with GCS Use 2 methods. If <b>either</b> result exceeds threshold, the landfill must report	Method 1. Same as above
	Method 2. Combination of Eq. HH-4 (calculates methane recovery from measured GCS flow and CH <sub>4</sub> concentration) AND Eq. HH-7 (calculates generation using methane recovery from HH-4 and assumed gas collection efficiency, and adjusts for soil oxidation)

**Note:** IPCC model or LandGEM can be used to calculate Eq. HH-1 using site-specific annual waste quantities and default values from Table HH-1.

# GHGs to report



- Report 3 items:
  - CH<sub>4</sub> generation and emissions from the landfill (HH)
  - CH<sub>4</sub> destruction from collection and combustion (HH)
  - CH<sub>4</sub>, CO<sub>2</sub> and N<sub>2</sub>O from combustion devices (reported under subpart C)
- What do I report for landfill flares?
  - Subpart HH calculations and reporting includes CH<sub>4</sub> destruction in flares and CH<sub>4</sub> emitted from flares
  - CO<sub>2</sub> and N<sub>2</sub>O from flares is not reported under HH or C

# Who reports emissions from LFG-fired engines, boilers, etc.?



- “Facility” = contiguous or adjacent property under common ownership or common control (see full definition in 98.6)
- If the landfill and combustion devices are part of a single “facility”, submit single report with:
  - CH<sub>4</sub> generation and emissions from the landfill (including CH<sub>4</sub> emitted by combustion devices)
  - CH<sub>4</sub> destruction from gas collection and combustion system
  - CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions from combustion devices under subpart C. (CO<sub>2</sub> and N<sub>2</sub>O for LFG, all 3 pollutants for fossil fuels)

# Who reports emissions from LFG-fired engines, boilers, etc. (continued)?



- If the landfill and the combustion devices are at separate facilities:
  - Landfill facility reports CH<sub>4</sub> generation and emissions from the landfill; CH<sub>4</sub> destruction (For gas sent off-site for destruction, assume DE=1).
  - Facility with the combustion devices reports emissions of CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O using subpart C methods *if* their facility is subject to the rule. (Can use table C-1 “biogas” default factors for LFG.)

# How do I calculate emissions if I don't have a gas collection system?



**Landfills without GCS use Eq. HH-5:**

$$\text{Methane emissions and methane generation} = G_{CH_4} \text{ (modeled methane generation from Eq. HH-1)} \times (1 - OX)$$

Where OX = 10% soil oxidation factor

**Eq. HH-1. First order decay model**

$$G_{CH_4} = \left[ \sum_{x=S}^{T-1} \left\{ W_x L_{0,x} \left( e^{-k(T-x-1)} - e^{-k(T-x)} \right) \right\} \right]$$

**If waste composition is known, calculate using material specific  $L_0$  and  $k$ . Otherwise, use bulk waste factors in rule table HH-1.**

# Data needed for Eq. HH-1 (modeled methane generation):



Must determine or measure	In units of	Using the following methods
S = Start year of calculation (year LF opened or 50 yrs ago)	NA	Available records
W <sub>x</sub> = quantity of waste disposed in year X (for each year since start year of calc)	Metric tons, as received (wet waste)	For years prior to 2010, use tipping fee receipts or other records. For prior years for which quantities not available, estimate W <sub>x</sub> using one of 3 methods: <ol style="list-style-type: none"> <li>1) Assume all prior years are the same as the first year for which waste data are available</li> <li>2) Eq. HH-2: calc for each year based on population served, per capita waste generation, and percent landfilled</li> <li>3) Eq. HH-3: use a constant annual average calculated from landfill capacity and number of years waste was received</li> </ol>
	For 2010 and future years	Use mass measurement equipment meeting the requirements for commercial weighing equipment as described in NIST Handbook 44.
L <sub>0</sub> = CH <sub>4</sub> generation potential	Metric tons CH <sub>4</sub> /metric ton waste	Use default for bulk waste in table HH-1 OR calculate for material-specific L <sub>0</sub> values from MCF (methane correction factor), DOC (degradable organic carbon from Table HH-1) and Fraction by volume of CH <sub>4</sub> in landfill gas (as measured or assume 0.5)
k = Rate constant	Yr <sup>-1</sup>	Use bulk waste or material-specific default values from table HH-1 (unless measured values are available)

# How do I calculate emissions if I have a gas collection system?



- Calculate emissions in two ways and report *both* results:
  1. Calculate modeled CH<sub>4</sub> generation the same way as landfills without GCS, subtract the amount of CH<sub>4</sub> recovered by the GCS, and adjust for destruction efficiency of collected gas and soil oxidation of uncollected gas.
  2. Determine CH<sub>4</sub> recovered by the GCS, apply a gas collection efficiency to account for emissions of uncollected gas, and adjust for destruction efficiency of collected gas and soil oxidation of uncollected gas.

# Inputs needed for the two emission calculation methods



Method 1: Subtract recovery from CH<sub>4</sub> generation

**Eq. HH-6 to  
calculate  
emissions**

- **Modeled methane generation from Eq. HH-1, (use recovery from Eq. HH-4 if it is larger)**
- **Methane recovered by GCS from Eq. HH-4**
- **Destruction efficiency**
- **Soil oxidation factor**

Method 2: Determine recovery and apply collection efficiency

**Eq. HH-8 to  
calculate  
emissions**

- **Methane recovered by GCS from Eq. HH-4**
- **CE from table HH-3 or 0.75**
- **Destruction efficiency**
- **Soil oxidation factor**

# Measuring CH<sub>4</sub> recovered



- CH<sub>4</sub> recovered by GCS must be determined for both emission calculation methods
  - Continuously monitor gas flow
  - Monitor CH<sub>4</sub> concentration continuously OR measure weekly (allows use of handheld meters)
  - Adjust measurements for temperature, pressure, and moisture
  - See 98.343(b) & Eq. HH-4 for details
- Measure in GCS header prior to destruction device or treatment equipment
  - knockout pots, compressors, blowers, etc are not treatment
- Measure CH<sub>4</sub> concentration near the flow monitor or at a location representative of flow monitor location.

# Measuring CH<sub>4</sub> recovered - details



<b>Must determine or measure</b>	<b>In units of</b>	<b>Using the following methods and calibration</b>
Volumetric flow rate of LFG recovered and routed to destruction device	acfm per day (per week if measuring CH <sub>4</sub> weekly rather than continuously)	Continuous gas flow monitor that meets the 5% accuracy specified in 98.3 (i) of subpart A. Calibrate using methods in 98.344(c) or manufacturer's specified methods.
Temperature, pressure (if flow monitor doesn't automatically correct for these)	See Eq. HH-4 term descriptions	Type of monitor not specified, but must meet 5% accuracy specified in 98.3(i). Calibrate as specified by manufacturer and document procedures used to ensure accuracy and document estimated accuracy per 98.344(d) and (e)
Methane concentration	Volume percent [if CH <sub>4</sub> conc. and flow are measured on different bases (wet vs dry) then correct for moisture]	<ol style="list-style-type: none"> <li>1. If you have a continuous CH<sub>4</sub> monitor, you must use it and compute daily average CH<sub>4</sub> concentrations. Monitor must use one of the analysis methods in 98.344(b) and be calibrated per 98.344(b).</li> <li>2. Otherwise, meter the CH<sub>4</sub> concentration at least weekly at a location near or representative of the flow monitor location per 98.343(b)(2)(ii).</li> </ol>

# Determining destruction efficiency



- Destruction efficiency must be determined for both emission calculation methods.
  - Use combustion device manufacturer's specified destruction efficiency or 0.99 (whichever is less)
  - If gas is transported off-site for destruction, use 1.0. This is because none of the recovered gas is emitted at the landfill.

# Determining soil oxidation



- Soil oxidation factor must be determined for both emission calculation methods
- Default value of 10% must be used

# Determining Collection Efficiency



- Collection efficiency must be determined for the second emission calculation method (collection efficiency is applied to CH<sub>4</sub> recovered to account for uncollected gas)
- Select collection efficiency (CE) from Table HH-3 based on landfill cover type and presence of active collection system
  - If areas within the landfill differ in terms of cover type or presence of collection system, determine CE for each area and determine overall weighted CE for landfill per equation in Table HH-3)
- If area by cover type is not available, use  $CE = 0.75$

# Missing data calculation procedures



- CH<sub>4</sub> content and gas flow rate
  - Average of QA'd values immediately before and after missing data period
  - If no “after” value by end of year, use “before” value
  - If no “before” value available, use first QA'd value measured after the missing data period
- For missing daily waste disposal quantity
  - Average value for that day of the week as measured the week before and after the missing daily data.

# What must be reported by all landfills?



- Information required by 98.3(c) of subpart A
- Whether landfill is open or closed
- First year it accepted waste
- Last year it accepted waste or planned closure year
- Capacity
- Whether leachate is recirculated
- Waste disposal quantity for each year
- Method used to determine waste disposal quantity
- Waste composition: municipal; biosolids or sludge; more refined waste categories (materials) if available

# What must be reported by all landfills (continued)?



- For each waste type used to calculate generation in HH-1, report degradable organic fraction (DOC) and rate ( $k$ )
- Fraction of  $\text{CH}_4$  in landfill gas and how it was determined
- Surface area containing waste
- Cover types
- Surface area associated with each cover type
- Modeled methane generation rate (Eq. HH-1)

# What else do landfills without gas collection systems report?



- Annual methane emissions, metric tons (from Eq. HH-5)

# What else do landfills with gas collection systems report?



- Total flow of landfill gas collected for destruction
- CH<sub>4</sub> concentration of gas collected for destruction
- Monthly average temperature and pressure (or statement monitor internally corrects for these)
- Whether destruction occurs at the landfill facility or off-site. If at landfill, operating hours of primary destruction device and backup device and DE used
- Annual quantity of methane recovered (Eq. HH-4)

# What else do landfills with gas collection systems report (cont)?



- Description of gas collection system
  - Manufacturer, capacity, number of wells
  - Surface area, waste depth, and cover type for areas within the landfill (as specified in Table HH-3)
  - Estimated gas collection efficiency
  - Annual operating hours of collection system
- Methane generation calculated two ways:
  - Modeled CH<sub>4</sub> generation adjusted for soil oxidation (Eq. HH-5)
  - CH<sub>4</sub> generation calculated from methane recovered and collection efficiency (Eq. HH-7)

# What else do landfills with gas collection systems report (cont)?



- Generation value used as input to methane emission calculation in Eq. HH-6 and how it was determined (e.g., from Eq. HH-1 or HH-4)
- Methane emissions calculated using Eq. HH-6 (CH<sub>4</sub> generation minus CH<sub>4</sub> recovered, adjusted for soil oxidation and destruction efficiency)
- Methane emissions calculated using Eq. HH-8 (based on CH<sub>4</sub> recovered and collection efficiency, adjusted for soil oxidation and destruction efficiency)

# What must be recorded?



- Information required by 98.3(g) of subpart A
- Calibration records for all monitoring equipment
- Methods or manufacturers specifications used for calibrations

# Schedule for Monitoring and Reporting



<b>1/1/10</b>	<b>Start collecting data using best available monitoring methods</b>
<b>1/28/10</b>	<b>Deadline for submitting application to extend use of best available monitoring methods</b>
<b>3/31/10</b>	<b>Monitors installed and calibrated Begin using required monitoring methods (if extension not obtained)</b>
<b>12/31/10</b>	<b>Complete 2010 data collection</b>
<b>1/30/11</b>	<b>Submit certificate of representation</b>
<b>3/31/11</b>	<b>Submit GHG report for 2010</b>
<b>Ongoing</b>	<b>Submit corrected report 45 days after each discovery</b>
<b>Ongoing</b>	<b>Submit annual reports on 3/31 each year</b>

# When Can I Stop Annual Reporting?



- If annual reports demonstrate CO<sub>2</sub>e <25,000 metric tons/yr of emissions for 5 consecutive years.
- If annual reports demonstrate CO<sub>2</sub>e <15,000 metric tons/yr of emissions for 3 consecutive years.
- Must meet these levels using both emissions equations (HH-6 and HH-8)
- Note: Applicability for MSW landfills is based on methane generation. These provisions are based on emissions.

# Electronic Data Reporting System



- Electronic format and system under development
- Web-based system
  - Will guide reporters through data entry and submission for each subpart
  - Built-in default values and emissions calculations
- Mechanism to submit file directly using standard format (e.g., XML)

# Additional Information



- [www.epa.gov/climatechange/emissions/ghgrulemaking.html](http://www.epa.gov/climatechange/emissions/ghgrulemaking.html)
  - Preamble and rule
  - Technical background documents on source categories
  - Comment response documents
  - Link to rulemaking docket
  - Technical assistance materials (info sheets, checklists)
  - Frequently asked questions
- Email: [GHGMRR@epa.gov](mailto:GHGMRR@epa.gov) (hotline) with questions



# **Back-up Slides**

## **Frequently Asked Topics**

# Definition of Facility



- §98.6: Facility means any physical property, plant, building, structure, source, or stationary equipment located on one or more contiguous or adjacent properties in actual physical contact or separated solely by a public roadway or other public right-of-way and under common ownership or common control, that emits or may emit any greenhouse gas.
- Example of a landfill and LFGTE facility
  - If meet definition of facility (common ownership or control) then determine applicability and report together
  - If does not meet definition, determine applicability and report (if meet threshold) separately. Landfill reports under HH, LFGTE facility reports under C and any other applicable subpart
- Title V definition of facility is not appropriate for this rule.

# Models to Use



- **IPCC Waste Model**
- **LandGEM**
  - Designed for bulk waste
  - If using material-specific waste types, need to do separate runs for each waste type
- **EPA is looking for the web-based reporting tool to walk reporters through all required calculations including for Equation HH-1**

# Monitoring Equipment



- All monitoring equipment must meet the accuracy requirements of 98.3(i)
- Methods are listed in 98.344(b) for gas composition and 98.344(c) for methane flow
  - Use calibration recommended by the manufacturer if none of the listed methods apply
- Portable monitors are OK for gas composition
- Also OK are thermal mass flow meters, anubar/v cone/ averaging pitot tube meters
- There is not an approved list of monitors/meters

# Scales Are Required



- January 1, 2010 and after must use scales according to the 2009 NIST Handbook 44
  - Previous versions are not OK, but they are probably the same
- BAMM apply here too
- Before purchasing scales, makes sense to determine if your facility meets the threshold for applicability
- Do not have to track material-specific waste quantities, may use bulk waste values in Table HH-1
- For estimating waste quantities prior to 2010, can use company records, tipping receipts, or most appropriate of the three methods listed in 98.343(a)(3)

# Treatment Equipment



- “Treatment equipment” means the destruction device
- Knock-out boxes, compressors, blowers, etc., are not considered “treatment equipment”
- With regard to measurement location:
  - Measurements should be taken at the same relative location of this equipment – either all before or all after.

# Moisture Content



- Called for in HH-4
  - Need to correct for moisture content when CH<sub>4</sub> flow and CH<sub>4</sub> concentration are measured on a different basis – i.e. when one is done wet and the other dry.
  - If both are measured wet or both dry, then no correction is needed
- Rule text states value must be “determined,” however, measured values are preferred.
  - Methodology for measurement is not delineated
  - Variety of techniques are available: EPA standard Method 4; wet bulb-dry bulb techniques (note, moisture content is vol% measure of water per wet air), drying tube and condensation techniques
  - Moisture content is not the same as relative humidity or mass of water per mass dry air that is read from the psychometric chart.
- Determination/measurement must be done weekly (interpreted as once each calendar week with a minimum of 3 days between measurements)
- **EPA is looking to clarify the rule**
  - **to require that moisture content be measured, as pressure and temperature are now.**
  - **to make clear when moisture correction factor is needed.**

# Inert Wastes



- Clarification on what was provided to Waste Management, et al
- Default values for bulk MSW waste include consideration of all waste including some C&D and inerts (glass, plastic, metal, cement, etc.) If bulk waste values are used, the waste disposal quantities should include all types of waste being disposed of in the landfill including C&D and inerts.
- If material specific values are being used, inerts can be accounted for by using the value of zero for the DOC value.
  - EPA is looking to clarify the rule to add two lines to Table HH-1: a DOC for inerts and a k value for inerts.