Calculating Your Landfill’s NMOC Emission Rate

SUMMARY: The process of calculating your landfill’s NMOC emission rate is a three-step process. The steps are called ‘Tier 1’, ‘Tier 2’, and ‘Tier 3’. The steps are in order of increasing precision and complexity.

- Tier 1 calculations are done using your landfill’s year-to-year solid waste acceptance rate along with standardized factors for methane generation rate and NMOC concentration.
- Tier 2 is done using your landfill’s year-to-year solid waste acceptance rate, a standardized rate for methane generation, and a unique NMOC concentration determined by sampling landfill gas from your landfill.
- Tier 3 is done using your landfill’s year-to-year solid waste acceptance rate, the unique NMOC concentration determined by the Tier 2 sampling of landfill gas from your landfill, and a site-specific methane generation rate determined by drilling holes into the landfill and measuring the methane generation rate.

An engineer can do the calculations required for Tier 1, or you can use EPA’s LandGEM software\(^1\) to calculate these emissions. Tiers 2 and 3 require the assistance of a qualified testing company.

APPLICABLE REGULATORY TEXT

§60.752(b) Each owner or operator of an MSW landfill having a design capacity equal to or greater than 2.5 million megagrams and 2.5 million cubic meters, shall either comply with paragraph (b)(2) of this section or calculate an NMOC emission rate for the landfill using the procedures specified in §60.754. The NMOC emission rate shall be recalculated annually, except as provided in §60.757(b)(1)(ii) of this subpart. The owner or operator of an MSW landfill subject to this subpart with a design capacity greater than or equal to 2.5 million megagrams and 2.5 million cubic meters is subject to part 70 or 71 permitting requirements.

§60.754 Test methods and procedures.

§60.754(a)(1) The landfill owner or operator shall calculate the NMOC emission rate using either the equation provided in paragraph (a)(1)(i) of this section or the equation provided in paragraph (a)(1)(ii) of this section. Both equations may be used if the actual year-to-year solid waste acceptance rate is known, as specified in paragraph (a)(1)(i), for part of the life of the landfill and the actual year-to-year solid waste acceptance rate is unknown, as specified in paragraph (a)(1)(ii), for part of the life of the landfill. The values to be used in both equations are 0.05 per year for \(k\), 170 cubic meters per megagram for \(L_O\), and 4,000 parts per million by volume as hexane for \(C_{NMOC}\). For landfills located in geographical areas with a thirty year annual average precipitation of less than 25 inches, as measured at the nearest representative official meteorologic site, the \(k\) value to be used is 0.02 per year.

(i) The following equation shall be used if the actual year-to-year solid waste acceptance rate is known.

\[
M_{\text{NMOC}} = \sum_{i=1}^{N} 2k L_o M_i (e^{-kt})(C_{\text{NMOC}})(3.6 \times 10^{-9})
\]

where,

\[M_{\text{NMOC}} = \text{Total NMOC emission rate from the landfill, megagrams per year}\]

\[k = \text{methane generation rate constant, year}^{-1}\]

\[L_o = \text{methane generation potential, cubic meters per megagram solid waste}\]

\[M_i = \text{mass of solid waste in the } i^{th} \text{ section, megagrams}\]

\[t_i = \text{age of the } i^{th} \text{ section, years}\]

\[C_{\text{NMOC}} = \text{concentration of NMOC, parts per million by volume as hexane}\]

\[3.6 \times 10^{-9} = \text{conversion factor}\]

The mass of nondegradable solid waste may be subtracted from the total mass of solid waste in a particular section of the landfill when calculating the value for \(M_i\) if documentation of the nature and amount of such wastes is maintained.

(ii) The following equation shall be used if the actual year-to-year solid waste acceptance rate is unknown.

\[
M_{\text{NMOC}} = 2L_o R (e^{-kt})(C_{\text{NMOC}})(3.6 \times 10^{-9})
\]

Where:

\[M_{\text{NMOC}} = \text{mass emission rate of NMOC, megagrams per year}\]

\[L_o = \text{methane generation potential, cubic meters per megagram solid waste}\]

\[R = \text{average annual acceptance rate, megagrams per year}\]

\[k = \text{methane generation rate constant, year}^{-1}\]

\[t = \text{age of landfill, years}\]

\[C_{\text{NMOC}} = \text{concentration of NMOC, parts per million by volume as hexane}\]

\[c = \text{time since closure, years; for active landfill } c = 0 \text{ and } e^{-kc}\]

\[3.6 \times 10^{-9} = \text{conversion factor}\]

The mass of nondegradable solid waste may be subtracted from the total mass of solid waste in a particular section of the landfill when calculating the value of \(R\), if documentation of the nature and amount of such wastes is maintained.
§60.754(a)(2) **Tier 1.** The owner or operator shall compare the calculated NMOC mass emission rate to the standard of 50 megagrams per year.

(i) If the NMOC emission rate calculated in paragraph (a)(1) of this section is less than 50 megagrams per year, then the landfill owner shall submit an emission rate report as provided in §60.757(b)(1), and shall recalculate the NMOC mass emission rate annually as required under §60.752(b)(1).

(ii) If the calculated NMOC emission rate is equal to or greater than 50 megagrams per year, then the landfill owner shall either comply with §60.752(b)(2), or determine a site-specific NMOC concentration and recalculate the NMOC emission rate using the procedures provided in paragraph (a)(3) of this section.

§60.754(a)(3) **Tier 2.** The landfill owner or operator shall determine the NMOC concentration using the following sampling procedure. The landfill owner or operator shall install at least two sample probes per hectare of landfill surface that has retained waste for at least 2 years. If the landfill is larger than 25 hectares in area, only 50 samples are required. The sample probes should be located to avoid known areas of nondegradable solid waste. The owner or operator shall collect and analyze one sample of landfill gas from each probe to determine the NMOC concentration using Method 25 or 25C of appendix A of this part. Method 18 of appendix A of this part may be used to analyze the samples collected by the Method 25 or 25C sampling procedure. Taking composite samples from different probes into a single cylinder is allowed; however, equal sample volumes must be taken from each probe. For each composite, the sampling rate, collection times, beginning and ending cylinder vacuums, or alternative volume measurements must be recorded to verify that composite volumes are equal. Composite sample volumes should not be less than one liter unless evidence can be provided to substantiate the accuracy of smaller volumes. Terminate compositing before the cylinder approaches ambient pressure where measurement accuracy diminishes. If using Method 18, the owner or operator must identify all compounds in the sample and, as a minimum, test for those compounds published in the most recent Compilation of Air Pollutant Emission Factors (AP-42), minus carbon monoxide, hydrogen sulfide, and mercury. As a minimum, the instrument must be calibrated for each of the compounds on the list. Convert the concentration of each Method 18 compound to $C_{\text{NMOC}}$ as hexane by multiplying by the ratio of its carbon atoms divided by six. If more than the required number of samples are taken, all samples must be used in the analysis. The landfill owner or operator must divide the NMOC concentration from Method 25 or 25C of appendix A of this part by six to convert from $C_{\text{NMOC}}$ as carbon to $C_{\text{NMOC}}$ as hexane. If the landfill has an active or passive gas removal system in place, Method 25 or 25C samples may be collected from these 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. For active collection systems, samples may be collected from the common header pipe before the gas moving or condensate removal equipment. For these systems, a minimum of three samples must be collected from the header pipe.

(i) The landfill owner or operator shall recalculate the NMOC mass emission rate using the equations provided in paragraph (a)(1)(i) or (a)(1)(ii) of this section and using the average NMOC concentration from the collected samples instead of the default value in the equation provided in paragraph (a)(1) of this section.

(ii) If the resulting mass emission rate calculated using the site-specific NMOC concentration is equal to or greater than 50 megagrams per year, then the landfill owner or operator shall either comply
with §60.752(b)(2), or determine the site-specific methane generation rate constant and recalculate the NMOC emission rate using the site-specific methane generation rate using the procedure specified in paragraph (a)(4) of this section.

(iii) If the resulting NMOC mass emission rate is less than 50 megagrams per year, the owner or operator shall submit a periodic estimate of the emission rate report as provided in §60.757(b)(1) and retest the site-specific NMOC concentration every 5 years using the methods specified in this section.

§60.754(a)(4) Tier 3. The site-specific methane generation rate constant shall be determined using the procedures provided in Method 2E of appendix A of this part. The landfill owner or operator shall estimate the NMOC mass emission rate using equations in paragraph (a)(1)(i) or (a)(1)(ii) of this section and using a site-specific methane generation rate constant k, and the site-specific NMOC concentration as determined in paragraph (a)(3) of this section instead of the default values provided in paragraph (a)(1) of this section. The landfill owner or operator shall compare the resulting NMOC mass emission rate to the standard of 50 megagrams per year.

(i) If the NMOC mass emission rate as calculated using the site-specific methane generation rate and concentration of NMOC is equal to or greater than 50 megagrams per year, the owner or operator shall comply with §60.752(b)(2).

(ii) If the NMOC mass emission rate is less than 50 megagrams per year, then the owner or operator shall submit a periodic emission rate report as provided in §60.757(b)(1) and shall recalculate the NMOC mass emission rate annually, as provided in §60.757(b)(1) using the equations in paragraph (a)(1) of this section and using the site-specific methane generation rate constant and NMOC concentration obtained in paragraph (a)(3) of this section. The calculation of the methane generation rate constant is performed only once, and the value obtained from this test shall be used in all subsequent annual NMOC emission rate calculations.

§60.754(a)(5) The owner or operator may use other methods to determine the NMOC concentration or a site-specific k as an alternative to the methods required in paragraphs (a)(3) and (a)(4) of this section if the method has been approved by the Administrator.

§60.754(b) After the installation of a collection and control system in compliance with §60.755, the owner or operator shall calculate the NMOC emission rate for purposes of determining when the system can be removed as provided in §60.752(b)(2)(v), using the following equation:

\[ M_{NMOC} = 1.89 \times 10^{-3} Q_{LFG} C_{NMOC} \]

where,

\( M_{NMOC} \) = mass emission rate of NMOC, megagrams per year

\( Q_{LFG} \) = flow rate of landfill gas, cubic meters per minute

\( C_{NMOC} \) = NMOC concentration, parts per million by volume as hexane

§60.754(b)(1) The flow rate of landfill gas, \( Q_{LFG} \), shall be determined by measuring the total landfill gas flow rate at the common header pipe that leads to the control device using a gas flow measuring device calibrated according to the provisions of section 4 of Method 2E of appendix A of this part.
§60.754(b)(2) The average NMOC concentration, $C_{\text{NMOC}}$, shall be determined by collecting and analyzing landfill gas sampled from the common header pipe before the gas moving or condensate removal equipment using the procedures in Method 25C or Method 18 of appendix A of this part. If using Method 18 of appendix A of this part, the minimum list of compounds to be tested shall be those published in the most recent Compilation of Air Pollutant Emission Factors (AP-42). The sample location on the common header pipe shall be before any condensate removal or other gas refining units. The landfill owner or operator shall divide the NMOC concentration from Method 25C of appendix A of this part by six to convert from $C_{\text{NMOC}}$ as carbon to $C_{\text{NMOC}}$ as hexane.

§60.754(b)(3) The owner or operator may use another method to determine landfill gas flow rate and NMOC concentration if the method has been approved by the Administrator.

On the following page is a figure showing the process for determining NMOC rate using Tiers 1, 2, and 3.