LESSONS LEARNED FROM THE FIRST TWO YEARS OF COMPLIANCE WITH THE FEDERAL GHG MANDATORY REPORTING RULE

Patrick S. Sullivan, C.P.P.
SCS Engineers
Sacramento, California

Raymond H. Huff
SCS Engineers
Long Beach, California

Cassandra B. Drotman
SCS Engineers
Long Beach, California

ABSTRACT

For the past two years, the solid waste industry has been required to report greenhouse gas (GHG) emissions to the U.S. Environmental Protection Agency (U.S. EPA) under the federal GHG reporting rule. During this time, landfills with methane generation greater than 25,000 metric tons of carbon dioxide equivalent ($MTCO_2e$) have been reporting data and information to U.S. EPA. An analysis of the lessons learned during the first two years of mandatory reporting will shed light on the issues that have arisen and what the solid waste industry believes are necessary modifications to the rule subpart for landfills (40 Code of Federal Regulations [CFR] Part 98, Subpart HH).

This paper details elements in the rule which could affect the municipal solid waste (MSW) industry. Specifically, this paper will assess the following rule elements: an analysis of sensitive variables for the various GHG calculation equations and models in Subpart HH; the impact of whether the first-order decay landfill gas (LFG) generation model is a single year or historical model; analysis of confidential business information (CBI) and its influence on results; assessment of unanticipated scenarios in reporting systems; choices in variables within Subpart HH; impact of waste averaging versus tonnage inputs on 2010 and 2011 reporting results; consideration of the impact of unknown/fact gathering components of Subpart HH and what the U.S. EPA does with the information; and an analysis of publically posting GHG data on the U.S. EPA database. In addition, the paper includes a more detailed site report analysis, which is not publicly available, for select landfills.

Using the data analysis described above, this paper will draw conclusions on issues that affect the industry, lessons learned, and changes that should requested in the regulation to remedy the problems discovered.

Specifically, this paper assesses solid waste industry's review of possible means to lessen the regulatory burden while making reported data more accurate and representative.

INTRODUCTION

After the promulgation and implementation of the federal GHG Mandatory Reporting Rule (MRR or Rule), the solid waste industry has gained insight on the U.S. EPA's requirements as well as started an effort to lessen the regulatory burden. In regard to the MRR, the solid waste industry has gained a better understanding of the impacts of the federal GHG reporting rule on landfills, assessed the current reporting methodologies which may have resulted in unnecessary burden on reporters, discovered industry-wide lessons that have been learned during the first two years of the program, and assessed ways to make the reported data more accurate and less burdensome for the solid waste industry.

BACKGROUND

Over the last ten years, GHG has come to the forefront of the environmental movement. The United Nation's Intergovernmental Panel on Climate Change (IPCC) has indicated that a concerted and coordinated effort must be made to limit the effects of global warming.

The United Nations Framework Convention on Climate Change (UNFCCC) has combatted global warming with the goal of achieving "stabilization of GHG concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UNFCCC, 2005). The Kyoto Protocol established the following six substances as recognized GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluoro-carbons (PFCs), and sulfur hexafluoride (SF_6). Of these six gases, anthropogenic methane from LFG is the driver that brings landfills to the forefront of federal climate change legislation and regulation.

The Final U.S. EPA MRR was signed on September 22, 2009, and was published in the Federal Register (FR) as 40 Code of Federal Regulations (CFR) Parts 86, 87, 89, et al., "Mandatory Reporting of Greenhouse Gas; Final Rule," on October 30, 2009. The MRR affects GHG sources with over 25,000 $MTCO_2e$. In addition to the 25,000 $MTCO_2e$ applicability threshold, the Rule includes reporting requirements and methodologies for 31 source categories, including landfills.

The Rule requires the reporting of GHG emissions from all sectors of the economy in the U.S. The Rule requires that specific industries/source categories report, along with any facility that emits 25,000 $MTCO_2e$ from stationary combustion. All facilities which are required to report their emissions are required to report all stationary combustion emissions in addition to sector specific emissions. Specified sectors, such as landfills, are required to report additional fugitive and process emissions as specified by the Rule. The gases a facility is required to report may vary by sector and can include the six internationally recognized GHGs from the Kyoto Protocol and other fluorinated gases, including nitrogen tirifluoride (NF_3) and hydrofluorinated ethers (HFEs). The Rule does not impose a cap or require control or destruction of GHGs; rather, it requires only that sources above certain threshold levels monitor and report emissions.

UNDERSTANDING OF FEDERAL GHG REPORTING RULE FOR LANDFILLS

MSW landfills are directly regulated under 40 CFR Part 98, Subpart HH. Landfills accepting only hazardous waste, industrial waste, and construction and/or demolition wastes are exempt from reporting under Subpart HH. MSW landfills which accepted waste after 1980 and generate over 25,000 $MTCO_2e$, must report methane generation and emissions from the landfill, methane destruction resulting from LFG collection and combustion systems, and CO_2, CH_4, and N_2O from all regulated general stationary fuel combustion sources, expect flares which are omitted from reporting. The 25,000 $MTCO_2e$ generation threshold equates to landfills that generate approximately 270 standard cubic feet (scf) of LFG at 50% CH_4.

Subpart HH created new monitoring requirements at landfills subject to the Rule. Requirements include continuous monitoring of LFG flow and continuous or weekly testing of methane content. Flows must be adjusted to standard conditions to account for pressure, moisture content, and temperature. When calculating fugitive emissions from LFG, the U.S. EPA emission calculation methods and site-specific information are required. A monitoring plan is required in addition to these new monitoring requirements.

Subpart HH breaks the Rule down into three main components: applicability, monitoring, and reporting.

Applicability

The MRR applicability assessment for MSW landfills is contained in Subpart HH §98.340 through §98.341 and are summarized below.

- MSW landfills that generate methane in amounts equivalent to 25,000 $MTCO_2e$ or more per year
- MSW landfills which accepted waste after January 1, 1980.
- This source category does not include hazardous waste landfills, construction and demolition landfill, or industrial landfills.
- This source category consists of the following sources at MSW landfills: Landfills, LFG collection systems, and LFG destruction devices (including flares).

Landfills which meet the above criteria and collect about 185 scfm or more LFG at 50 percent methane will be subject to the MRR unless they can demonstrate LFG collection efficiency greater than 75 percent. Landfills which generate approximately 270 scfm of LFG at 50 percent methane per the U.S. EPA gas generation model will be subject to the MRR. The U.S. EPA methane generation calculations/modeling requires the use of a conservative 10 percent factor to account for methane oxidation as LFG crosses a landfill cover.

Monitoring

Monitoring Requirements are reviewed in Section §98.344 of Subpart HH of the MRR and are discussed below:

- Waste disposal amounts (scale house).
- Continual gas flow monitoring.
- Gas flow correction for temperature, pressure, and moisture.
- Methane monitoring:
    - Continuous, or
    - At least weekly.
- The owner or operator shall document the procedures used to ensure the accuracy of the estimated of disposal quantities and, if applicable, gas flow rate, gas composition, temperature, and pressure measurements.

The MRR provides instructions for missing data points, and includes calibration requirements. All sites must use the U.S. EPA model to estimate gas generation. Landfills that have gas collection and control system (GCCS) must also evaluate methane generation based on methane recovery for both reporting and determining applicability.

Reporting

Reporting requirements for MSW landfills are reviewed below for §98.346 in Subpart HH of the MRR.

- Landfill operations (open/closed/year).
- Waste disposal calculations.
- Waste composition.
- Modeling parameters.
- Methane data.
- Landfill area.
- Cover types by area.
- Cover material by area.
- Oxidation fractions.
- Methane generation and methane emissions from landfills modeling.
- Sites must also report under Subpart C the emissions of CO_2, CH_4, and N_2O from each stationary combustion unit, including comfort heating and LFG to energy combustion, following the requirements of Subpart C.

The MRR prescribes specific modeling coefficient values, which are different than the *Compilation of Air Pollutant Emission Factors* (AP-42) and New Source Performance Standards (NSPS) values. All MSW Landfills must use a mathematical model to estimate gas generation. As such, facilities cannot rely on existing site gas models done for landfill NSPS compliance or for LFG recovery projection to determine applicability. Landfills with GCCS systems must also calculate the landfill methane generation using a calculation based on methane recovery.

Working within the confines of these three components, applicability, monitoring, and reporting, the solid waste industry has been complying with Part 98 as well as evaluating ways to lessen the regulatory burden while making reported data more accurate and representative.

For the first two years of reporting, landfills were required to exclude information required by the Rule that had been designated by the U.S. EPA as CBI from their submittals to the U.S. EPA. The U.S. EPA designated any input used to calculate reported GHG emissions as CBI. The deferral was intended to give the U.S. EPA time to determine whether any of the data qualified for confidential treatment. U.S. EPA concluded that none of the deferred information for landfills was CBI and that all inputs would have to be reported.

ASSESSMENT OF CURRENT REPORTING METHODOLOGIES

Sensitive Variables for Various GHG Calculations in Subpart HH

Landfills, which must comply with the MRR, are required to report annual modeled methane generation as well as report the annual quantity if methane collected. The calculation methodologies and variables used for the various GHG calculations may fluctuate greatly depending on the landfills. Calculating methane generation and methane emissions using measured methane recovery and estimated gas collection efficiency depends on multiple sensitive variables, including the fraction of hours the destruction device was operating (F_{rec}) and collection efficiency estimated at the landfill (CE).

The use of F_{rec} infers that fugitive emissions increase in proportion to the amount of time that a GCCS is not operating (i.e., all uncollected gases are fugitive). Landfill operators maintain a GCCS to operate at a maximum efficiency both to control fugitive emissions and to optimize the operation of the destruction device onsite. In order to optimize a GCCS, an operator takes into account the LFG generation, waste information, and system history. As such, most GCCS are not intended to operate with one hundred percent uptime. Operating a GCCS at a site with gas generation insufficient to maintain a flare with 100 percent uptime is impossible. Operating a GCCS for 100 percent uptime when the gas generation does not support it would be detrimental to the landfill and GCCS, and could potentially have dangerous impacts for the facility such as a landfill fire caused by oxygen intrusion into the refuse mass from "over-pulling" on a GCCS. There is not a direct correlation between fugitive emissions and collected emission at a landfill, which F_{rec} assumes. Many site specific factors, including but not limited to landfill cover, oxidation in the soil, waste types, LFG produced, GCCS operating/downtown time and LFG previously collected, all effect fugitive emission generation and venting to the atmosphere when the GCCS is down. By assuming that the fugitive emissions are directly related to GCCS downtimes, the Rule overestimates GHG emissions. For most sites, the difference is only a few percent of total GHG emissions, but for sites with intermittent emissions, the difference can be 100 percent or greater.

The collection efficiency is estimated at the landfill, taking into account system coverage, and cover type (i.e. daily, intermediate, or final cover). All of the factors used to determine collection efficiency are sensitive to change and day to day operations at a site. Especially for active landfills, the collection system may vary greatly over the course of a calendar year. The approach was derived from SWICS, but removes qualitative analysis to make it more appropriate for compliance. However, every landfill is unique, and by removing the qualitative analysis used to determine collection efficiency and using defaults may reduce accuracy of reported emissions. Removing the qualitative element does not impact industry-wide emissions because a similar amount of sites would likely use the lower end of the collection efficiency range as compared to the higher end, but individual site emissions may be vary significantly. Furthermore, the removal of the qualitative element severely limits the ability of a site to reflect improved GHG management techniques in the reported inventory.

Calculating waste disposal quantities, as opposed to having historical measured values, can cause drastic variances in emissions. Subpart HH provides three methods to calculate the quantity of waste disposed, as detailed in §98.341(a)(3)(i) through §98.341(a)(3)(iii). The first method assumes all prior year waste disposal quantities are the same as the waste quantity in the first reporting year. The second method to calculate waste in place is by using equation HH-2 with several variables (estimating the population served by the landfill [POP_x], average per capita waste generation by city [WGR_x], and the percent of waste generated subsequently managed in solid waste disposal sites by year [%SWDS]). The third method is to calculate waste in place via waste averaging, a methodology that is discussed in greater detail below. The first method only takes into account one year of data and can skew emissions to be over reported because annual waste placement generally increases at active landfills. The second method takes into account national statistics and does not take into account actual landfill practices. Due to the variation of methods on how to calculate W_x, the reported emissions could vary greatly depending on the choice of equation. Both the first and second methods are unpopular with the solid waste industry and are not believed to be used for reporting purposes to any significant degree. The first method (assuming historical waste placement at current rates) is inaccurate and would typically result in somewhat higher calculated GHG emissions. Equation HH-2 is burdensome and documentation is frequently unavailable to use the method, though it may increase the accuracy of modeled emissions slightly.

In addition to sensitive input variables to MRR equations, methane oxidation (OX) provides an example of a sensitive variable that is not allowed to be input, i.e., it is a default value only (OX is set at 10% for equations HH-5 through HH-8). At its surface, the reporting regulation and the calculations/data requested for reporting contained within it are seemingly structured and written as though the oxidation rate was intended to vary from site to site.
A primary example of this is that the reporting regulation requires the reporting of soil cover materials, which is consistent with the approach proposed by the Solid Waste Industry for Climate Solutions (SWICS) for calculating site-specific methane oxidation. This information, which was originally deferred from reporting due to its CBI status, may hold the key to future modifications to the OX rate as the SWICS report as well as the technical literature show that actual OX rates are generally higher than 10% and vary site-by-site based on cover materials in place and the methane flux at the surface of the landfill.

Modified Bulk DOC

When modeling methane generation using Equation HH-1, reporters are allowed three options for determining the degradable organic carbon (DOC) and k (decay rate) values. Reporters may use bulk waste, modified bulk MSW, or waste composition methods. The bulk waste option allows all waste to use a bulk waste k and DOC factors. In the modified bulk MSW option, waste is classified as bulk MSW (excluding inerts and construction & demolition [C&D] waste), C&D waste, and inerts (e.g., glass, plastics, metal, concrete, etc.). The waste composition method is rarely used, as site specific data are typically unavailable, and the factors are not agreed upon by the landfill sector.

The bulk waste option uses a DOC value of 0.20, which works well for landfills that do not accept additional, segregated C&D and inert waste streams, and is equivalent to a methane generation potential (L_0) value of 100 cubic meters per megagram of waste (m^3/Mg), the value from the U.S. EPA's AP-42 document.

The modified bulk MSW option uses a significantly higher DOC of 0.31. Based on review of supporting documentation, it can be inferred, the higher DOC is based on an assumption that the C&D and inert waste streams are removed from a bulk MSW waste stream, thus increasing the average degradable fraction of the residual waste stream. However, most MSW landfill facilities do not segregate and record only the C&D and inert materials that are brought to the facility as part of the MSW stream. Instead, these sites generally take separate C&D and inert waste streams *in addition* to a non-segregated bulk MSW waste stream. A typical MSW waste stream includes approximately 30 percent inert materials such as plastics, glass, and concrete. The C&D and inert waste streams are separate from their generation to the landfill, and the use of 0.20 DOC would be appropriate for all sites which accept a non-segregated MSW waste stream.

The problem of the high DOC for the modified bulk MSW stream is made worse by the requirement of 98.343(a)(2), which requires reporters use material-specific waste quantity data when those data are available, forcing reporters into using the higher DOC even when it is not appropriate for sites that take separate classifiable waste streams in addition to non-segregated MSW.

It may be possible to argue that even when a site tracks MSW, C&D, and inert waste separately, the non-separated MSW does not match the modified bulk MSW in the regulation; therefore, the waste is not characterized sufficiently to use any factors other than the bulk MSW factor of 0.20 for all waste, but U.S. EPA's stance on this position is not known.

Re-Consideration vs. Acceptance of the First-Order Decay Rate LFG Generation Model as just a Single-Year Model

Subpart HH of 40 CFR Part 98 requires that landfills model methane generation using a first order decay (FOD) model described in Equation HH-1. This methodology is similar to the calculation of emissions using the Landfill Gas Emission Model (LandGEM), which is used to calculate LFG generation for regulatory and inventory purposes. Equation HH-1 replaces the L_0 value used by LandGEM with several variables (methane correction factor [MCF], DOC, fraction of DOC dissimilated [DOC_f], 16/12 [the ratio of the weight of methane to carbon], and the volumetric fraction of methane in the LFG generated [F]).

$$G_{CH4} = \sum_{x=S}^{T-1} \left\{ W_x \times MCF \times DOC \times DOC_F \times F \times \frac{16}{12} \times \left(e^{-k(T-x-1)} - e^{-k(T-x)} \right) \right\} \quad \text{(Eq. HH-1)}$$

Where:

G_{CH4} = the modeled methane generation;
x = the year in which waste was disposed;
S = the starting year of calculations;
T = the year in which emissions are calculated;
W_x = the mass of waste accepted in year x;
MCF, DOC, DOC_f, 16/12, and F are described above;
k = the decay rate constant.

The regulation allows the use of measured values in place of regulatory defaults for many of these parameters, including MCF, DOC, and F. MCF is an attribute of the waste stream and should remain static from year to year. MCF typically only varies in the case of waste aeration, a relatively rare practice. U.S. EPA has indicated that the use of the measured fraction of methane in the recovered LFG is site specific data for F. The fraction of methane in recovered LFG can vary from year to year, leading to changes in the modeled methane generation calculated using HH-1.

Changes in the recovered methane content can create unexpected results. For example, a closed landfill should expect to see smaller methane generation from year to year, but if the recovered methane content increases, the methane generation calculated using Equation HH-1 can increase. Increased methane generation and the resulting GHG emissions from Equation HH-1 should even be expected when a closed site adds final cover, leading to higher methane content in the recovered LFG. Conversely, methane generation calculated using Equation HH-8 can be expected to decrease with the addition of final cover.

The way methane can vary from year to year requires that U.S. EPA and industry assess whether Equation HH-1 is intended to be a multi-year model with a methane value associated with each year that remains unchanged going forward, or whether the equation is intended to reflect methane generation for a given year and historical conditions are not considered.

Impact of Waste Averaging vs. Tonnage Input Reporting

The impact of waste averaging versus actual tonnage inputs has vast impacts on the GHG emissions estimates for a landfill. The waste input into the methane generation model will result in dramatically different emissions by year, then what actually occurred. The age, quantity, and decomposition of waste all have a huge impact on the amount of methane generation. Waste averaging, as prescribed under Subpart HH of 40 CPR Part 98, allows landfills to use Equation HH-3. Conversely, for regulatory and inventory purposes, landfills use calculations methods, such as LandGEM and tonnage inputs, to calculate LFG generation.

Typically using the annual average waste (W_x) drives emissions for a landfill early in its history by loading one end with higher emissions and lowers emissions at the opposite end. Equation HH-3 takes the landfills capacity currently used (LFC) over time.

$$W_x = \frac{LFC}{(YrData - YrOpen + 1)} \quad \text{(Eq. HH-3)}$$

YrData = the year the landfill last received waste, or for operating landfills, the year prior to the first reporting year when waste disposal data is first available;
YrOpen = the year the landfill first received waste;
W_x and LFC are described above.

Waste averaging especially effects older landfills and landfills which initially accepted smaller quantities of waste in the beginning of their lifespan and gradually increased over time. For example, landfills which opened prior to 1970 never expected the tonnage of waste they receive annually to exponentially increase at such a dramatic rate towards the end of the century. Waste averaging disproportionally over loads a landfill with greater emissions towards the beginning of a landfill's lifespan and may lower GHG emissions estimates towards the end of a landfill's lifespan.

Waste averaging creates issues within equation HH-1 as it assumes equal waste per year from the time the year the landfill was opened until the year it last received waste or the year prior the first reporting year when waste disposal data are first available. Not only does the average waste method assume the landfill is receiving consistent tonnages year by year, it assumes that the landfill never temporarily closed or stop receiving waste for a period of time. The landfill industry considers waste averaging an appropriate balance of burden and accuracy to calculate emissions compared to using the current waste placement for historical waste placement or the historical population served, even with the shortcomings.

Using actual tonnage inputs in methane generation models provides a more accurate image of a LFG generation when available. It allows a landfill to predict the amount of methane generation over time and helps a site maintain optimal GCCS operation.

MRR Burden

Landfills are already a highly regulated industry, the federal MRR added many additional monitoring and reporting requirements and costs. Many of the methodologies prescribed in the Rule are being transposed to the state and local level. Many states are requiring the submission of federal GHG reports or imposing that the same calculation methodologies be used with some modification. Fugitive landfill emissions being reported under the federal GHG reporting rule are therefore being reported at the state level. However, landfills are already reporting significantly different data to the states and U.S. EPA through Title V and NSPS annual and semi-annual reporting, as well as for the few states with GHG regulation that differ from the federal government. It is challenging and consuming for landfills to tracking and reporting similar fugitive emissions reports.

For example, the Rule provides a requirement for methane to be monitored on a weekly basis. This weekly requirement is over and above federal NSPS requirements for monthly monitoring. Industry analysis has shown that the methane content of LFG is not subject to as much fluctuation as would warrant an additional three rounds of data collection per month, as is required for the current weekly requirement. Statistically, weekly methane data does not change the calculated methane emissions enough to warrant such frequency as compared to monthly testing. Clearly, if wellhead monitoring under the NSPS is sufficient on a monthly basis, then monthly MRR sampling should be as well.

In addition, many of the requirements and default variables under the MRR are very complex, ridged, costly, and under investigation. Direct measurement methods and historical models used to estimate do not have enough flexibility. The landfill industry already used other available tools, site-specific factors, and national/regulatory defaults, such as the SWICS method, for other regulatory reporting. The use of these factors would provide some flexibility and reduce the burden and inaccuracies in reporting.

INDUSTRY-WIDE LESSONS AND IMPACTS

Unanticipated Scenarios/Loopholes in the Reporting System

Following implementation of the MRR, many unanticipated scenarios arose which created non-uniform methods of reporting and ultimately confusion between landfills, reporters, and the U.S. EPA.

The current MRR calculations do not easily accommodate reporting/calculation of emissions from landfills with multiple destruction devices. When calculating methane emissions for a facility with multiple destruction devices, multiple variables require "pseudo-values" be entered. For example, a single variable needed to be created for the fraction of hours that multiple destruction devices associated with a landfill as if a single LFG measurement location were in operation while the GCCS was operating (F_{dest}) instead of one for each destruction device. Many landfills have multiple destruction devices (e.g. engines, turbines, flares, pipelines) pathways. This was such a significant issue for reporters that the U.S. EPA had to develop additional guidance in December 2011 on how to manipulate the variables, which go into equations HH-6, HH-7, and HH-8. When calculating emissions, a landfill with multiple destruction devices has the option to calculate from a central measurement location or from multiple locations.

Although not as common as multiple destruction devices, some landfills have multiple GCCSs. This scenario is generally a result of the merging of separate landfills as a single "facility" under the MRR definition of a facility. Presently, sites with multiple GCCSs are calculating emissions as if they only had one GCCS and using "pseudo-values" of values (e.g. F_{Dest}, F_{Rec}, etc.) as was discussed for multiple destruction devices with multiple flow and methane contents measured separately for each onsite GCCS.

A third unseen scenario was mixed on-site and off-site destruction devices. As many landfills will transport LFG off-site for use by third party parties, and will also require on-site destruction devices as back-up or additional on-site destruction devices for excess gas. Manipulated variables can be put into equations HH-6, HH-7, and HH-8 in order to report as accurately as possible. In these scenarios, the landfill can calculate emissions similarly as if they had multiple destruction devices onsite, but should use a destruction efficiency factor (DE) and a $f_{DEST,n}$ of 1 (DE=1 and $f_{DEST,n}=1$) for all off-site gas.

The computerized reporting format led to a limited explanation of complex systems (e.g. multiple devices, multiple GCCSs, on-site and off-site destruction devices, etc.) where a user only had a limited list of available choices and formats. For complex systems, as aforementioned, many landfills had to use independent "pseudo-variables" to report the methane generated at a single facility. Version 3 of the U.S. EPA reporting schema added in some flexibility for certain configurations which were difficult to report, however, there are still many situations which have not been worked out.

Another unanticipated scenario requires landfills to report the manufacturer of the GCCS onsite. Many landfills, especially old and/or large landfills, have GCCS that have several manufactures, builders, and contractors who have worked on the GCCS over multiple phases, and over multiple years. The U.S. EPA provided clarification; a landfill should report the entity who designed the GCCS and the entity who installed the GCCS, if the information is unknown, the landfill should report the manufacturer of the blower. However, this may change as destruction devices on site change. Ideally the landfill would have this information, however, for many sites there are a variety of answers, or none at all, when it comes to reporting the GCCS manufacturer information. In addition, the U.S. EPA's purpose for collecting this information is currently unknown. As a result, the data reported for this element is arbitrary and non-uniform.

Sensitive Variables within Subpart HH

Reporters have many options for variable selection within the confines of Subpart HH; some of which can significantly impact the resultant calculated GHG emissions from a site. One of the most sensitive of these variables is rainfall. Since the FOD model used in Eq. HH-1 uses average annual rainfall as an input, the selection of the rainfall value can significantly influence the generation model.

In addition, many of the variables used within Subpart HH have a substantially larger impact on reporting emissions than initially realized due to the multiple methods used to calculate individual variables. As discussed previously, the Rule was initially written for a landfill with a single GCCS and destruction device, and many variables had to be altered in order for landfills to report. The manipulation of these variables could cause drastically different emission estimates.

As discussed previously, the DOC value for modified bulk MSW in Table HH-1 is based on an incorrect assumption that when a landfill categorizes waste as MSW, C&D, and inert waste, the C&D and inert waste is removed from the MSW waste stream.

The equations used to calculate emissions in Subpart HH were written as though a site would operate a single LFG destruction device and a backup device. This assumption lead to the creation of values for the fraction of time a gas system operates (f_{Rec}), and a value for the fraction of time a destruction device operates (f_{Dest}). In the field, gas systems and destruction devices operate in many configurations to suit the widely varied needs of landfills. The values for f_{Rec} and f_{Dest} must be calculated using methods that account for multiple devices and potentially multiple gas collection systems.

Confidential Business Information Influence on Results

For the initial reporting years under Part 98, CBI was excluded from being reported to the U.S. EPA as data collected under the GHG Reporting Program must be made available to the public unless the data qualifies for confidential treatment. The U.S. EPA typically makes confidentiality determinations under the Clean Air Act on a case-by-case determination. However, due to the number of facilities reporting and the number of data elements, the U.S. EPA has determined through a series of rulemaking actions which categories of data elements will be protected as CBI. After three years of consideration, the U.S. EPA came out with the *Final Data Category Assignments and Confidentiality Determinations for Part 98 Reporting Elements* on April 29, 2011, also known as the Final CBI Rule. The U.S. EPA made their determination regarding previously unreported CBI information under Part 98 and proposed confidentiality status based on whether the data qualified as emissions data and whether the data that does not qualify as emissions data would qualify for confidential treatment (whether the information is "reasonably obtainable" and whether disclosure of the data in each category would be likely to cause "substantial harm to the business's competitive position").

In the case of Subpart HH, the U.S. EPA determined that none of the data elements were eligible for confidential treatment. The U.S. EPA also provided which emissions data will be made available to the public.

On December 17, 2012, the U.S. EPA finished evaluating the inputs whose reporting deadline was deferred until 2013 as outlined in the Final CBI Rule, and determined that no further action will be taken regarding 2013 inputs. Therefore, information which was deferred until 2013 must be reported to the U.S. EPA by April 1, 2013, for reporting years 2010, 2011, and 2012 as applicable. An update XML schema is expected to be provided by the U.S. EPA in February 2013.

While providing the previously designated CBI should not have any impact on the total GHG emissions results reports (since the CBI was used to perform Subpart HH calculations), it is anticipated that the availability of CBI to the U.S. EPA will bring several of the issues and inconsistencies identified in the paper to light.

Impact of Unknown/Fact Gathering Components of Subpart HH

Within Subpart HH, there are multiple required components which are required to be reported, either initially, or with the addition of the CBI information. Many of the reportable components appear to be for alternative calculation methodologies, which the landfill is not reporting, or may be used by U.S. EPA for other uses. The data reporting requirement section of Subpart HH, 40 CFR 98.346, include many of these additional requirements that appear to possibly be the basis for alternative calculations. Section 98.346(f) requires the reporting of surface area of the landfill containing waste, as well as the cover types (with surface area of each) applicable to the landfill. It currently is unclear what the U.S. EPA's intent is for collecting this information. However, as discussed previously, cover type information can, and has, been used to develop an oxidation fraction for each cover type at a landfill. As discussed previously, the aforementioned reporting components appear to be based on the SWICS oxidation calculation.

Many of the components are expected for general data gathering such as: permitted landfill closure year, years which waste placement was estimated using tipping receipts, number of LFG wells. These data elements are not used to calculate GHG and are only tangentially related to GHG emissions, but similar to GCCS manufacturer discussed previously, they impose a burdensome and possibly unnecessary reporting obligation to sites.

Impact of U.S. EPA Metrics

Following submittal of 2010 emissions reports in 2011, the U.S. EPA evaluated landfill emissions reports using metrics which contained expected emission ranges within which facility emissions were supposed to fall. Since the emissions context that CBI would provide was not available the U.S. EPA's metric-based emission ranges often were not comparable to actual reported emissions numbers. Thus, whenever a site was outside the expected emissions range, the U.S. EPA would automatically generate an email which was sent to all personnel associated with the site, which at times, included up to 10 people, but is only limited by the number of people affiliated with a particular site. The majority of the time, a site's response to the generated email was that the reported emissions are correct and have been checked. Each site which had emissions outside of the expected metrics had to respond individually, which created an undue and unnecessary burden.

Another issue was that the metrics' automatically-generated email would be generated months after the reporting deadline. Due to the time deadline of reporting, receiving an automatically generated response was an encumbrance, as reported information was not fresh to the reporter, new staff may be involved in the reporting, and a site would have to go back and review all of their submitted XML's as well backup data to find that everything had been reported correctly during the initial submission. This delay also created a burden for entities who reported correctly as well as those who owned multiple sites and had to submit an identical response for each facility the own/operate.

Further, it is uncertain where the metric values themselves originated, as the solid waste industry was not consulted on the development of these metrics. Thus, most of the metrics seem incorrect as each site is unique based on age, waste in place, climate, GCCS, and operations and maintenance. These U.S. EPA metrics created a "one size fits all" approach that added an unnecessary administrative burden to MRR reporting because many sites fell outside of U.S. EPA's norm, which was for all intent and purposes wrong. Without knowing the CBI, a vast majority of landfills will likely fall outside of the expected metric. Further, with the reporting of CBI, it is anticipated that a new set of metrics may be developed, which will result in an all-new learning curve for both the U.S. EPA and the solid waste industry in responding to U.S. EPA inquiries.

U.S. EPA Updates to Reporting Schema

The U.S. EPA is in the process of revising the Part 98 electronic reporting format (schema). All calculation inputs that were deferred from reporting until 2013 (as part of the U.S. EPA's CBI deferral) will need to be included in a revised schema. To assist in a smooth implementation of this new schema, U.S. EPA is working with industry during the revision process.

An example of the modifications being made to the schema includes the change in on- and off-site destruction. In the initial GHG reporting schema, reporters were limited to reporting whether LFG was destroyed on-site or off-site. It is not uncommon for LFG to be destroyed both on-site and off-site. Industry has pointed out the shortcoming of the schema to the U.S. EPA, and they have since revised the schema to allow reporters to indicate that destruction occurred both on-site and off-site. Similar modifications of the reporting schema have been made by the U.S. EPA for other reported elements based in industry feedback, such as standardization of reporting schema format.

SUMMARY

Landfills are essential public services, which are not only one of the most regulated industries in the U.S. but also one of the only industry sectors which have reduced their emissions footprint way beyond 1990 levels. Many MSW landfills already have active GCCS which destroys GHG emissions under current regulations that are imposed by local air districts, states, and the federal government. The landfill industry is currently the only sector under U.S. EPA federal GHG reporting required to report fugitive emissions. Despite existing stringent regulations, the landfill industry was hit harder than any other industry under the federal MRR, with almost 1,600 landfills reporting. Only the power plants and the oil and gas sector have more reporters.

With two years of Federal GHG reporting complete, the U.S. EPA had collected a vast array of data from for designated sectors and qualified facilities which produce over 25,000 $MTCO_2e$. Subpart HH of the MRR mandates how landfills shall report, but does not set limits on emissions. Although the landfill industry and the U.S. EPA are working towards solving many of the issues which have arose for reporting, but MRR reporting is still a costly burden put on landfills.

Some of the issues identified previously, like sensitive variables, types of modeling, modified bulk DOC, and waste averaging, are still topics being evaluated as to the best methods to use going forward.

Some of the impacts of the past two years have been identified, played out and remedied, while others are not unknown. For example, there is no way to know how the U.S. EPA will use the data reported to them. The fear in industry is that MRR data will be used to justify further regulation of specific source categories for GHGs. Also, by allowing public access to data, the GHG information can be used in a variety of ways to be critical of landfills, particularly if taken out of context.

Many of the unanticipated scenarios have been answered in frequently answered questions (FAQs) and additional clarification issued by the U.S. EPA, to the point that the FAQs are cited regularly as a component of the MRR itself. In addition, many landfills have had to work around the system and use pseudo-variables and alternatives to report. Additional reporting requirements have been added with the reporting of CBI starting in 2013 for all reported calendar years. As the U.S. EPA is in the process of revising and modifying Part 98, the landfill industry will have to wait and see if the requirements become less burdensome or more arduous.

GHG reporting is still in its infancy in the U.S. and many states have already adopted many of the requirements of the federal MRR. And there is also uncertainty associated with what U.S. EPA plans to do with all of the reported information and whether it will result in future command-and-control regulations for landfills, resulting from and to further control the reported methane emissions.

REFERENCES

SCS Engineers, 2012, "SWICS 2.2 Methane Oxidation Addendum 2012."

SCS Engineers, 2008, "Current MSW Industry Position and State-of-the-Practice on LFG Collect ion Efficiency, Methane Oxidation, and Carbon Sequestration in Landfills."

U.S. Environmental Protection Agency, 1999, "Federal Register, 40 CFR Parts 51, 52, and 60. Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Solid Waste Landfills," Vol 61, No 49, pp.9905-9944.

U.S. Environmental Protection Agency, 2010, "Mandatory Reporting of Greenhouse Gases Rile New Frequently Asked Questions: Subpart HH, Landfills."

U.S. Environmental Protection Agency, 2009, "Federal Register, 40 CFR Parts 86, 87, 89 et al. Mandatory Reporting of Greenhouse Gases; Final Rule," Vol 74, No 209, pp.56475-56481.

U.S. Environmental Protection Agency, 2012, "Final Confidentiality Determinations for Regulations Under the Mandatory Reporting of Greenhouse Gases Rule," Vol 77, No 156, pp.48072-48089.

U.S. Environmental Protection Agency, 2009, "Technical Support Document for the Landfill Sector: Proposed Rule for Mandatory Reporting of Greenhouse Gases."

U.S. Environmental Protection Agency, 1995, "Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources," Section 2.4 on Landfills.