IMPACTS OF LANDFILL NEW SOURCE PERFORMANCE STANDARDS

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ABSTRACT

On May 30, 1991, the United States Environmental Protection Agency (EPA) proposed a Rule to control landfill gas (LFG) emissions under the authority of the Clean Air Act (CAA). Since that time the Rule has been modified significantly, with an emphasis on regulating large U.S. landfills. To date, landfill owners and operators have not been affected by this new CAA regulation. However, with the Rule promulgated in early 1996 and its subsequent implementation by the states to follow by the end of the year, landfill owners and operators need to understand these new requirements and their associated costs. To this end, the goal of this paper is to provide insight into the impacts of the Rule on individual landfill sites. By performing the emission analyses specified in the Rule on actual landfills, and comparing these sites to others, an understanding can be gained on the potential impacts of the NSPS Rule's requirements on individual landfills.

INTRODUCTION

On May 30, 1991, the United States Environmental Protection Agency (EPA) proposed a Rule to control landfill gas (LFG) emissions under the authority of the Clean Air Act (CAA). Since that time, the Rule has been modified significantly, with an emphasis on regulating large U.S. landfills. The goal of this paper is to provide insight into the impacts of the Rule on individual landfill sites. By performing the emission analyses specified in the Rule on actual landfills, and comparing these sites to others, an understanding can be gained on the potential impacts of the NSPS Rule's requirements on individual landfills.

OVERVIEW OF THE NSPS RULE

The proposed Rule was published in the Federal Register on May 30, 1991 (pp. 24468 - 24526). The proposed Rule amends 40 CFR Parts 51, 52 and 60. The purpose of the Rule is to control LFG emissions. The target pollutants are non-methane organic compounds (NMOCs) and methane. NMOCs contribute to smog formation and some are known or suspected carcinogens. Methane emissions may contribute to global warming as a greenhouse gas. In addition, landfill emissions can cause odor problems. The Rule seeks to limit LFG emissions by adopting NMOC emissions guidelines and performance standards, and requiring LFG emission control at landfills which exceed these guidelines and standards. By controlling NMOC emissions, methane emissions also are controlled.

The Rule consists of two parts: The Guidelines under Section 111(d) (Guidelines) of the CAA pertaining to emission standards for existing landfills, and the New Source Performance Standards under Section 111(b) (NSPS) of the CAA pertaining to emission standards for new landfills. Other areas of the CAA (including mobile sources, hazardous air pollutants, permits, etc.), and other parts of the CAA amendments pertaining to solid waste facilities (i.e., incinerators, etc.) are not considered in this discussion.

Applicability

The NSPS Rule requires LFG emission control at landfills that meet all of the following conditions:

- Landfills that receive municipal solid waste (MSW). The Rule does not address other landfills, including hazardous waste sites and construction/demolition debris landfills.
- MSW landfills that received waste after November 8, 1987. The NSPS apply to all MSW landfills that began construction, re-construction, or accepting wastes for the first time, on or after the date of publication of the proposed Rule (May 30, 1991). The Guidelines for existing landfills apply to all sites that accepted wastes on or after November 8, 1987, whether they continued to accept wastes after May 30, 1991 or not. States may have more flexibility in how they choose to implement the Rule at sites subject to the Guidelines than they have at sites subject to the NSPS.
- Landfills that exceed a maximum permit design capacity of 2,500,000 metric tons (i.e., megagrams [Mg], 1.0 Mg is approximately 1.1 imperial tons).
- Landfills that exceed a maximum NMOC emission rate of 50 Mg per year (approximately 56 imperial tons per year). Landfills will have to demonstrate that this emission limit will not be exceeded to avoid installation of an LFG control system.

Emissions Testing

To assess whether a landfill meets the fourth condition, the Rule requires a calculation of the landfill's NMOC emission rate. These calculations may be performed using a three tiered system. The decision tree for the three tier system is shown in Figure 1. Each of the three tiers is described below:

- Tier One — This desktop calculation uses an EPA LFG emissions model with prescribed default values. These default values allow the landfill owner to calculate an estimated emission rate based on several parameters. To "pass" Tier One, calculated NMOC emissions must be less than 50 Mg per year (Mg/yr). The default values for the U.S. EPA model are as follows:

  — LFG generation rate (k) = 0.05 per year.

  — Methane generation potential (Lo) = 170 cubic meters (m^3) of methane per Mg of refuse, based on waste receipts.

  — NMOC concentration (C_{NMOC}) 4,000 parts per million (ppm) by volume.

- Tier Two — If the results from the Tier One analysis indicate NMOC emissions greater than 50 Mg/yr, the landfill owner may opt to either install an LFG emission control system or proceed with the Tier Two analysis. The Tier Two analysis uses actual NMOC concentrations derived from analysis of LFG samples collected from the landfill (instead of the default value of 4,000 ppm). These concentrations are measured from a shallow probes in the landfill, spaced at one probe per hectare. The LFG sampling and analysis procedures are defined in the regulations under Method 25C.

- Tier Three — If the Tier Two analysis yields NMOC emissions greater than 50 Mg/yr, landfill owners can opt to install an LFG emission control system or proceed with Tier Three analysis. The Tier Three analysis involves a pump test program using three to five extraction wells to estimate the LFG generation rate (k) for use in the model. The pump test procedures are defined in the regulations under Method 2E.

Performance and Design Requirements

LFG emission control system performance and design requirements are addressed in the Rule and its supporting Enabling Document. These requirements include:

- Design the collection systems to handle the maximum expected LFG flow from the entire area of the landfill that warrants control based on model results.

- Collect LFG from each area, cell, or group of cells in the landfill in which refuse has been placed for a period of 2 years or more; or a period of 5 years or more for areas closed or at final grade.

- Collect LFG at a sufficient extraction rate. Sufficient extraction rate is demonstrated by maintaining a vacuum at each well head. If a positive pressure is measured at a well head, valve adjustments shall be made or additional wells installed.

- Conduct quarterly surface emissions monitoring as a check for the adequacy of the LFG collection system. The gas extraction rate is considered adequate when instantaneous methane concentrations measured at the landfill surface (all points around the perimeter of the collection area and along a serpentine path spaced 30 meters apart throughout the landfill surface) are less than 500 ppm.

The above provisions can be accomplished through a vertical well extraction system, horizontal collection system, or passive collection system (which must direct all LFG to a treatment system(s) and can only be used for landfills that have both synthetic membrane bottom liners and caps). Regulations are geared towards vertical well systems and include compliance provisions for meeting the above-referenced design requirements.

To demonstrate that the system has been designed to handle the maximum expected LFG generation flow rate, a formula based on average waste receipts and the age of the landfill must be used. To assess compliance with the requirement that LFG be collected from all areas of the landfill, the area of influence of the system is calculated in accordance with Method 2E. Areas of the landfill exempt from collection system requirements include asbestos disposal areas, nondegradable waste areas, and areas with refuse less than 2 years old. Any nondegradable area of the landfill may be disallowed from collection, provided that the total of all excluded areas can be shown to contribute less than 1 percent of the total amount of emissions from the landfill.

The Rule's Enabling Document also includes specific design criteria for vertical well systems, such as well spacing, bore hole diameter, and bore hole depth. Well piping materials, perforations, and backfill specifications are also provided.

The NSPS Rule requires that the collected LFG be treated according to approved Best Demonstrated Technology (BDT). Three types of systems are defined at BDT:

- Open flares designed and operated in accordance with general performance requirements.

- Enclosed combustion units (e.g., enclosed ground flares, gas turbines, internal combustion engines, and boilers) capable of reducing the outlet NMOC concentration by 98 percent.

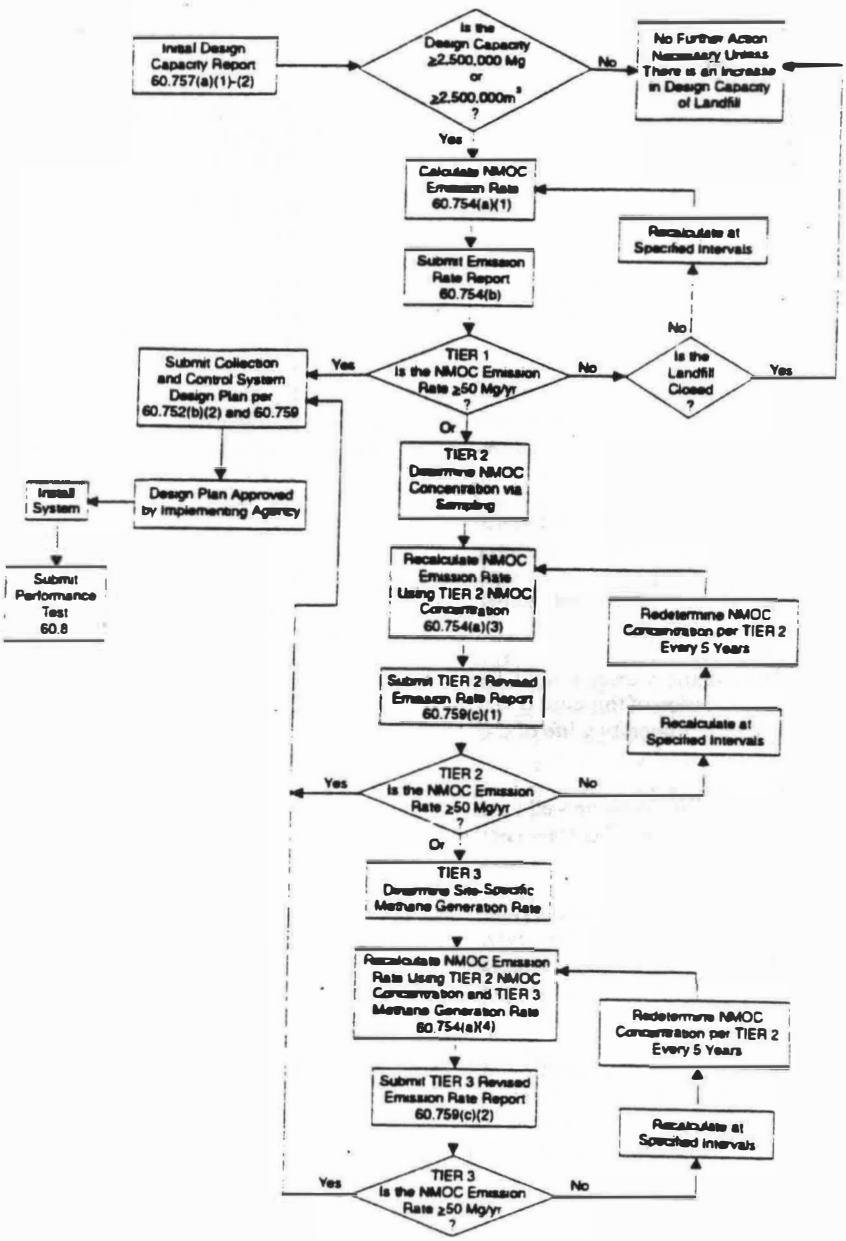

Figure 1. Overall Three-Tiered Approach for Determination of Control Requirements

Source: "Draft Enabling Document for the New Source Performance Standards and Emission Guideline for Municipal Solid Waste Landfills," Radian Corporation, August, 1995.

- Treatment systems that process the collected LFG for subsequent sale or use (e.g., sale to a utility as pipeline quality gas, conversion to a vehicle fuel, etc.). The sum of all NMOC emissions to the atmosphere from the LFG treatment system shall be reduced by 98 percent.

Recordkeeping And Reporting Requirements

Significant recordkeeping is required under the proposed Rule. These recordkeeping requirements include:

- Waste Volume Data. Both design and actual waste volume data must be presented; these are the most significant inputs to the annual emissions report prepared each year.

- Calculated Maximum Flow Rate for Extracted LFG. This is calculated for both designed and installed systems and compared against actual operating flow rates.

- Calculated Area of Influence. These values are derived from the Tier Three test program, or from the formula contained within the proposed Rule. The calculated area of influence is then reconciled against actual design.

- Well Head Pressures. Operational vacuums must be achieved at each well. Demonstration of this must occur on a monthly basis throughout the operating life of the collection system.

- Flow Volumes. Total volumes from the entire well field are to be measured before entry to the LFG treatment or processing system.

- Flare Combustion Temperature. Temperature monitoring of open flares is not required. However, temperature must be recorded frequently (at 15 minute intervals) for enclosed combustion units such as ground flares.

- NMOC Reduction. Ground flares or other sophisticated combustion devices must test NMOC destruction initially, and demonstrate achievement of 98 percent destruction efficiency thereafter through operational requirements.

- Performance and Down-Time Periods. Records must be kept to show operational periods of the LFG system, and to demonstrate that operational down-times have been minimal.

Six separate reports are required under the Rule. These reports and their submittal conditions are:

- Initial Design Capacity Report — This report must be prepared once for any MSW landfill operational after November 8, 1987. This report must state the intended capacity of the landfill. If this is less than 2,500,000 Mg total capacity, no further reports are required. If current or proposed capacity exceeds this value, annual NMOC emission reports must be compiled and submitted as per below.

- Amended Design Capacity Report — This report would be prepared only if the expected design capacity changes from that stated initially. An amended design capacity report is required whenever the ultimate capacity increases. This may occur through horizontal or vertical expansion, a change in refuse in-place density, etc.

- NMOC Emission Report — This report is required for those MSW landfills having an ultimate design capacity in excess of 2,500,000 Mg that have not installed an LFG control system. These reports are to be submitted at annual intervals or less frequently. If waste volumes can be estimated for an ensuing 5 year term, they may be submitted to cover the current year and the following 4 years. However, if actual waste receipts exceed the expected receipts during this term, an amended report must be submitted.

- Landfill Closure Report — Any landfill having a capacity in excess of 2,500,000 Mg must submit a closure report. Landfill closure reports are required at the time the landfill stops receiving wastes permanently. This report is required regardless of whether an LFG collection system has been installed or not.

- Equipment Removal Report — An LFG collection system must remain operational until:

  — The landfill is closed from further operation.

  — The actual measured NMOC emission rate reduces to less than 50 Mg/yr (demonstrated by performance of three successive tests).

  — The LFG collection system has been operational for a minimum 15 year term.

  If all three above conditions are met, the LFG collection system may be disconnected, and equipment removed. A report verifying LFG system removal must be submitted.

- Collection and Control System Operations Report — A control operations report containing LFG system operational data is to be submitted at 6 month intervals. Contents of the report are to include information on well head vacuums, total LFG flows, flare performance, etc.

Status of the Rule

The NSPS Rule will be promulgated in early 1996. At this writing, the exact date is not known. Assuming Rule promulgation in February, affected landfills have 90 days to submit the NMOC Emission Report, after which there is a 3-year

compliance period. This schedule would result in a requirement for sites that exceed the 50 Mg/yr NMOC emission limit to have an operational LFG emission control system by November 1998, with supporting documentation due 180 days later.

Several states expect to pass more stringent requirements under their procedures to implement the NSPS Rule. In some cases, the 50 Mg/yr NMOC emission limit may be lowered, and in others the schedule for compliance and ultimate installation of an operational LFG control system will be advanced.

IMPACTS OF THE NSPS RULE

The EPA estimated that about 400 to 600 of the approximately 6,000 existing active landfills (in 1990) would have to control LFG emissions. The reality is that every landfill that has accepted wastes since November 8, 1987 will be affected to some degree. For example, all landfills will have to at least file an Initial Capacity Report. If a site contains more than 2,500,000 Mg of refuse, then other requirements and other costs will be incurred. The various requirements and their estimated costs are presented in Table 1.

Although we cannot tell you what impacts to expect for your landfill without performing a site-specific NMOC Emission Analysis, we can describe the potential impacts the Rule would have on selected landfills for which SCS Engineers has completed Tier One Emission Analyses. To evaluate potential impacts on your site, you may compare your landfill to the several listed in Table 2.

Tier One Emission Analyses for Selected Landfills

The Tier One Emission Analyses results for 20 landfills are discussed below. The sites are identified as Landfills A, B, C, and so on. Information on each landfill, including the calculated 1996 NMOC emissions rate, is presented in Table 2.

As shown in Table 2, all 20 of the sites analyzed exceeded the 50 Mg/yr NMOC emission limit. However, some of the sites would not be subject to the NSPS Rule due to design capacity tonnage. That is, 5 of the 20 landfills report design capacities less than the 2,500,000 mg threshold (i.e., landfills A, B, K, M, and O_1). These 5 sites would have to submit an Interim Design Capacity report; no further reporting would be required under the Rule.

The remaining sites would have to either install an LFG emission control system or proceed to Tier Two.

Potential Results of Tier Two Emission Analyses

The expected NMOC concentration which would be obtained from a Tier Two sampling program is unknown. At this time, a national data base of field-measured NMOC values (per EPA Method 25C) does not exist. NMOC testing has been performed by a variety of analytical methods over the years. A limited data base was developed through a EPA pilot study at six landfills throughout the United States. The data were obtained from existing LFG collection systems using the Method 25C analysis. Three to seven LFG samples were analyzed from each site. The results are summarized in Table 3. As evidenced by these results, the 4,000 ppm NMOC concentration default value used in the Tier One Emission Analysis appears to be extremely conservative; approximately an order of magnitude higher than the average NMOC concentration (428 ppm) from the EPA study.

A Tier Two Analyses for the 15 remaining landfills in Table 2 can be illustrated using the lower NMOC value of 428 ppm. Recalculation of the NMOC emissions indicates that 3 landfills would "pass" Tier Two; namely landfills E, G, and O_2. These sites reported design capacities ranging from 3.9 to 6.3 million tons. The remaining 12 sites would have to either install a LFG control system or proceed to Tier 3.

CONCLUSIONS

Under the NSPS Rule, all MSW landfills with a design capacity of 2,500,000 Mg or greater that have accepted wastes since November 8, 1987, will have to conduct the Tier One Emissions Analysis. Based on the Rule's default values for the Tier One analysis, it appears that most landfills will fail Tier One, and will be required to install an LFG emission control system, or conduct a Tier Two Emission Analysis.

If the average NMOC concentrations reported in EPA's study hold true, it is likely that some sites will pass Tier Two and, therefore, not be required to install an LFG emission control system. However, NMOC concentrations may be highly variable from site to site, and there is no guarantee that your site will be "average," or even that the "average" will not change once data from more sites are available. In addition, some states likely will impose more stringent requirements than the EPA Rule, in some cases requiring that LFG systems be installed in advance of actual NMOC emissions exceeding the 50 mg/yr threshold.

You should remember that if your site passes Tier Two once, you will still be required to conduct a Tier One analysis and submit a report annually, as well as conduct a new Tier Two sampling program every 5 to 10 years.

Because the states have the option to make the Rule's requirements more stringent, we recommend that landfill owners explore what form the Rule will take in their state prior to making major decisions regarding LFG emissions control. However, if there is a need to know now, or in the near future, the potential impacts on your site for planning and/or budgeting purposes, you may want to proceed with Tier One and Two analyses. The information developed in these analyses should still prove useful even if the landfill NSPS requirements change.

Table 1. Landfill NSPS Requirements and Estimated Costs

NSPS REQUIREMENT	COST
Initial Design Capacity Report (Once)	$5,000
Amended Design Capacity Report (As Needed)	$5,000
NMOC Emission Reports	
-- Tier One (Annually)	$5,000-$10,000
-- Tier Two (Every 5 to 10 Years)	$7,500-$25,000
-- Tier Three (Once, if Conducted)	$120,000-$200,000*
Closure Report (Once)	$5,000
Equipment Removal Report (Once)	$5,000
Operations Report (Annually)	$5,000
Install System (Once?)**	$500,000-$3,000,000
Operate and Maintain System (Annually)	$50,000-$300,000

* May not cover full cost of LFG test wells and monitoring probes covered under "Install System" below.

** The system may need to be installed in sections over a period of time.

Table 2. Tier One Emission Results for Selected U.S. Landfills

Landfill	Design Capacity (tons)	Operational Dates	1996 NMOC Emissions (Mg/Yr)
A	1,456,320	1985 - 1996	251
B	1,061,360	1980 - 1992	132
C	5,000,000	1973 - 1996	655
D	17,069,550	1974 - 1995	2,156
E	3,910,530	1974 - 1993	434
F	21,100,000	1978 - 2030	1,061
G	5,596,558	1964 - 1993	426
H	7,190,580	1982 - 1995	1,163
I	8,690,605	1982 - 1992	1,252
J	7,660,962	1968 - 2020	499
K	1,008,332	1960 - 1988	80
L	79,840,000	1981 - 2008	4,026
M	1,443,000	1973 - 1993	175
N	13,286,700	1973 - 2005	1,252
O_1	1,570,000	1969 - 1976	106
O_2	6,330,000	1975 - 1994	832
P_1	11,500,000	1948 - 1993	1,145
P_2	15,500,000	1955 - 1992	1,788
P_3	44,000,000	1961 - 2009	2,709
P_4	95,000,000	1948 - 2015	5,155

Table 3. NMOC Concentrations Measured at Six Landfills Using Method 25C

Landfill	NMOC Concentration (ppm)
1	330
2	234
3	458
4	350
5	1,016
6	181
Average	428

Source: "Analysis of Factors Affecting Methane Gas Recovery from Six Landfills," U.S. EPA, September, 1991.