SOURCE TEST REPORT

01-171

CONDUCTED AT

Inland Empire Composting
1951 W. Key Street
Colton, CA 92324

AMMONIA AND VOLATILE ORGANIC COMPOUND (VOC) EMISSIONS FROM A GREENWASTE COMPOSTING OPERATION

TESTED: September 27, 2001
                     & October 4, 2001

ISSUED:

REPORTED BY: Wayne A. Stredwick
                     Asst. Air Quality Engineer

REVIEWED BY:

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Michael Garibay
Senior Air Quality Engineer

MONITORING AND SOURCE TEST ENGINEERING BRANCH

MONITORING AND ANALYSIS

SUMMARY

a.	Firm and Mailing Address	Inland Empire Composting 1951 W. Key Street Colton, CA 92324
b.	Site Location	1951 W. Key Street Colton, CA
c.	Area Tested	Tipping Pile, Static Pile and Windrows
d.	Test Requested by	Alene Taber, Planning, (909) 396-3057
e.	Reason for Test Request	Information for Proposed Rule 1133
f.	Date of Test	September 27, & October 4, 2001
g.	Source Test Performed by	Ron Lem, Mei Wang, M. Garibay, C. Willoughby, Wayne Stredwick
h.	Test Arrangements Made through	Wilson E. Nolan, CEO Inland Compost, (909) 684-7336

RESULTS

Table 1 – Summer Greenwaste Tests

	Tipping Pile		Static, Fines, and ADC Piles		Windrows		Facility Total
Contaminant	lb/hr per 1000 ft^2 of Pile Surface Area	lb/hr	lb/hr per 1000 ft^2 of Pile Surface Area	lb/hr	lb/hr per 1000 ft^2 of Pile Surface area	lb/hr	lb/hr
Ammonia	0.091	10.1	0.071	8.91	0.004	0.22	19.2
Methane	0.079	8.79	0.024	3.01	0.005	0.31	12.1
VOC	0.368	40.8	0.226	28.4	0.079	4.41	73.6

- Surface Area Data - 110,906 ft^2 Tipping Pile, 125,513 ft^2 Static Pile, and 55,770 ft^2 Windrows.
- lb/hr-1000ft^2 = (Avg. lb/hr-ft.^{2}) * 1000
- lb/hr = (lb/hr-ft^2) * (Pile Surface Area)
- ton/year = lb/hr * 24 hr * 365 day/year * ton/2000 lb
- lb/ton greenwaste = (lb/hr *24 hr/day) / 350 ton/day

Table 2 - Total Facility Emissions

Contaminant	lb/hr	lb/ton of Greenwaste
Ammonia	19.2	1.32
Methane	12.1	0.83
VOC	73.6	5.05

**Table 3 – Data Quality Checks Using VOC Emissions vs. FID Reading
and Internal Compost Temperature**

Location	Avg. FID Reading (ppm)	Avg. Internal Temperature (^{o}F)	VOC Emissions (lb/hr-1000 ft^{2})
Tipping	113	147	0.368
Static	45	138	0.226
Windrows	13	122	0.079

INTRODUCTION

On September 27, 2001 and November 4, 2001, personnel from the South Coast Air Quality Management District (SCAQMD) conducted source tests at Inland Empire Composting. The tests were intended to measure emissions from the greenwaste composting process. The tests were conducted on the three areas of Inland's processing: tipping pile, static pile and windrows. Testing on up to ten (10) positions at each area was conducted to obtain composite samples. Composite samples were then used to obtain emission factors for each area of the composting process.

The testing was requested by the SCAQMD Planning Division in order to assist in the development of Proposed Rule (PR) 1133 (Emission Reductions from Composting and Related Operations). Previously the District only had an emission factor for digested sludge (biosolids) composting operations in the South Coast District. Inland Empire Composting suggested that a different emission factor should be used for green waste composting and volunteered their Colton facility for purposes of determining green waste emission factors.

The SCAQMD is currently in the process of developing emissions inventories for various types of composting operations. These emissions inventories are to be used in evaluating the emissions impact and cost effectiveness of control techniques for SCAQMD PR1133. The SCAQMD has performed source testing at various types of biosolid and manure composting facilities using the EPA Emissions Isolation Flux Chamber approach, but has not until recently, conducted testing on a purely greenwaste composting facility. The necessity for obtaining emissions information has become a priority in the rule development process in order to investigate whether greenwaste composting can be assumed to exhibit similar emissions characteristics as the biosolids and manure facilities that were tested. This issue has further significance when considering the current greenwaste diversion programs at local landfills.

EQUIPMENT AND PROCESS DESCRIPTION

Composting is a natural biological degradation process that is controlled and accelerated at a composting facility. Under ideal conditions, composting is the transformation of biologically decomposable material through a controlled process of biooxidation that results in the release of carbon dioxide, water and minerals, and in the production of stabilized organic matter (compost) that is biologically active.

The composting process occurs in two major phases. In the first stage, microorganisms decompose the composing feedstock into simpler compounds, producing heat as a result of their metabolic activities. The size of the composting pile is reduced during this stage. In the second stage, the compost product is "cured" or finished. Microorganisms deplete the supply of readily available nutrients in the compost, which in turn slows their activity. As a result, heat generation gradually diminishes and the compost becomes dry and crumbly in texture. When the curing stage is complete, the compost is considered "stabilized" or "mature". Any further microbial decomposition will occur very slowly.

During the actual composting process, bacteria are generally allowed to decompose the mixture in a combination of aerobic and anaerobic activity. Airborne by-products of the anaerobic activity, which are largely reduced compounds, include relatively large amounts of methane, hydrocarbons, ammonia, and relatively smaller amounts of amines, hydrogen sulfide, and other reduced sulfur compounds. The anaerobic activity is less desirable due to emissions of toxic and odor-causing compounds. Fugitive dust can be a direct source of PM-10 emissions, particularly during periods of high temperatures, high wind and low humidity.

The heat generated by the exothermic reaction raises the compost's internal temperature to 120-160°F. The heat also serves the purpose of reducing pathogenic activity. Compost composition is thought to have an impact on emissions since the process is dependent on microbiological activity and oxygen availability.

The following is a list of operating conditions that were encountered during the testing:

Greenwaste Throughput - 350 ton/day
Tipping Pile Age - 2 days from arrival at facility
Static Pile Age - 7 days in static pile (9 - 14 days total at facility)
Windrow Ages - 7 days and 30 days in windrows (40 – 45 days and 65 – 70 days total at facility)
Pile Dimensions - (refer to Figure A in Appendix and Calculations section)
Compost Composition - (refer to compost analysis in Appendix)

The composting process at Inland Empire Composting can be characterized by the following process flow diagram.

SAMPLING AND ANALYTICAL PROCEDURES

EPA Emission Isolation Flux Chamber

The procedure for measuring emissions from the compost pile surfaces is a modified form of the procedures found in the US Environmental Protection Agency's (EPA) *Measurement of Gaseous Emission Rates from Land Surfaces Using an Emission Isolation Flux Chamber User's Guide.* The modifications are detailed in the following section.

Under the EPA procedures, gaseous emissions from surface migration are collected from an isolated surface area with an enclosure device called an emission isolation flux chamber. A sweep gas is introduced to the flux chamber at a fixed, controlled rate (5.0 lit/min recommended) as a carrier where it mixes with the contaminants from the surface migration. The flux chamber encompasses a fixed surface area (1.4 ft^2), and is designed to isolate the surface from phenomena that can influence the air surface interface such as wind speed, other meteorological conditions, or properties of the waste itself. The flux chamber is sunk to a depth of one inch into the surface in order to create a seal between the flux chamber and the surface. The flux chamber and sweep air system is designed such that the contents are well mixed and no internal stratification exists. A probe is located in the flux chamber to extract a gaseous sample for subsequent analysis. The probe is of such a design that the sample represents a composite of various altitudes from within the flux chamber. Sampling is conducted at a rate of lesser than or equal to the sweep air rate. The remainder of the flux chamber contents is allowed to vent through a small opening located strategically on the flux chamber dome. For measuring flux chamber internal temperature, a thermocouple is also located within the flux chamber. Refer to Figure 1 for specifications and exact dimensions of the flux chamber design.

Modifications to the Flux Chamber Method

The Flux Chamber procedure is intended primarily for surface migration from landfills, hazardous waste treatment facilities, and hazardous spill remediation covered under the RCRA and CERCLA acts. The procedure assumes that gaseous emissions from the surface within the chamber area are much less than that of the sweep air rate. Under this assumption, mass emissions of a given contaminant are a product of the measured sample concentration and sweep air rate and reported per unit of surface area. Upon field evaluation of the flux chamber, it was discovered that the surface flux migration rate was more appreciable for composting applications and could not be ignored as compared to the sweep air rate. The calculation of mass emissions of a given contaminant thus becomes a product of the measured sample concentration, sweep air rate, and surface migration rate. This surface migration rate would also include the effect of air entering the flux chamber due to wind induced leaks at the flux chamber to surface seal. Furthermore this migration rate could not be directly measured due to the discovery that any attempt to employ a measuring device resulted in impedance of the surface migration.

As an amendment to the EPA procedure, the surface migration rate must be determined in order to obtain accurate emissions measurements. A procedure for calculating surface migration employs a material balance and concentrations taken from the sample analysis of an inert known component initially mixed into the sweep gas (refer to material balance section). For this reason, the sweep gas is composed of 10% helium (balance ultra-pure grade air) as a component to perform the analysis and material balance.

For the purposes of this test, the flux chamber's shell and sample path was constructed entirely of non-reactive materials. The following sampling specifications were used during testing:

> Sweep Air Type - 10% Helium, 20.9% Oxygen, balance Nitrogen (99.999 % purity)
> Sweep Air Rate - 5.0 lit/min
> Ammonia Sampling Rate – 1.0 lit/min

Each sampling run was integrated over several points to insure a representative sample. In order to account for general spatial variability, the flux chamber samples were drawn and integrated over several points around the piles for an averaging effect. For the Windrow samples, the sampling was composited over both a newly formed windrow and an older windrow for an averaging effect.

Modifications to the Flux Chamber Method (Con't.)

This is also known as composite sampling. A evaluation of methane migration was conducted using a portable Flame Ionization Detector (FID) to determine spatial variations in emissions from the compost (Refer to Table 4). The FID was also used to determine flux chamber period of equilibration with surface emissions for each sampling point. A steady plateau in the methane readings indicated equilibration.

A small mixing fan is mounted within the flux chamber to ensure complete mixing within the flux chamber and allow for a homogeneous sample. The fan speed was set at approximately 110 rpm during all sampling and equilibration periods. A bench-top smoke study revealed that at 110 rpm, the fan could perform adequate mixing within the chamber without affecting vertical surface migration.

Results are reported as concentration (ppm by volume) in the flux chamber and emission rates are calculated in lb/hr-ft^2 of surface area. Final mass emission rates are reported on a facility wide basis using the entire compost surface area within the facility for each of the three types of piles that were tested. The number of sampling points used in each run, real time FID readings, and other raw data at each sampling point are presented in Table 4. The FID readings were used primarily to indicate steady state and degree of point to point variability. For quantification purposes, the FID readings are considered to be less accurate than the sampling methods that are described in the following section.

<u>Ammonia Sampling</u>

An ammonia sample was collected during each sampling run from the flux chamber sample line using Draft SCAQMD Method 207.1. The midget sampling train consisted of two midget impingers each filled with 15 ml of 0.1N Sulfuric Acid, an empty bubbler, and a bubbler filled with tared silica gel, as shown in Figure 2. A minimal amount of condensation was observed in the sample line leading to the ammonia train. The impingers and bubblers were contained in an ice bath to condense ammonia, water vapor, and other condensable matter present in the sample stream.

The samples from the Tipping and Static piles were collected from sampling ten (10) points on each pile at a sampling rate of 1.0 lit/min. The samples taken from the Windrows were each collected from eight sampling points at a sampling rate of 1.0 lit/min. The samples were collected for six minutes at each sampling point.

The SCAQMD laboratory analyzed for ammonia deposited in the impingers as ammonium by ion chromatography. Moisture gain was determined volumetrically in the impingers, and gravimetrically in the silica gel. Ammonia concentration in the flux chamber was determined using the ammonia content collected in the impingers, along with the sampling rate and net elapsed sampling time.

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VOC by SCAQMD Method 25.3

Duplicate integrated gas samples were taken from each pile using SCAQMD Method 25.3. The apparatus was connected to the flux chamber sampling line with an 18 inch length of 0.125 inch o.d. Perfluoroalkoxy (also known as PFA, a type of Teflon) line for connection to a small glass impinger. The PFA tubing extended to the impinger tip as one continuous piece. The connecting tubing was not heated. Condensation was observed forming in this area during sampling due to the moisture present in the samples.

A small amount of hydrocarbon free de-ionized water was initially placed into the traps as a heat transfer medium. The impinger was immersed in an ice water bath with the outlet connected to a six liter summa polished canister as shown in Figure 3. The ice bath height was adjusted so that the water level did not exceed the level of any impinger connection as to avoid potential contamination. A constant sampling rate was maintained by using a small orifice flow controller. The impinger is of such a design that the impinger body also acts as a vial that can be capped and sealed before sampling and for sample storage. The sampling flow rate is driven by an initial 30 inches Hg vacuum in the canister and regulated by the constant flow controlling orifice. The flow controllers are designed and pre-tested to draw at a steady sampling rate from between the full 30 inches of vacuum down to 10 inches.

The sample canisters were checked for leaks by observing the internal vacuum gauges over a period of several hours. An observation of a zero loss in vacuum indicated an acceptable canister leak check. The remainder of the sampling apparatus was checked for leaks both before and after sampling by blocking the flow at the connector line end with a clean cap and introducing a portion of the tank vacuum into the remainder of the sampling system. An observation of the resulting stabilization in the gauge for a period of one minute indicated an acceptable leak check.

After the post-test leak check, the PFA lines were disconnected from the probes. The condensates present in the lines (not including the flux chamber lines) were rinsed into the impingers with hydrocarbon free water. This was accomplished by introducing a small amount of remaining tank vacuum to each line while dipping the open end of the line into the water of an extra sample vial. After a minimum of two separate one inch plugs of water were passed through the line and into the impingers, the lines were capped, sealed, and sent to the SCAQMD laboratory for purging.

Upon submittal of the samples to the laboratory for analysis, the canister pressures were obtained using a calibrated manometer. The canisters were then reassembled to the remainder of the

sampling assemblies. The sample lines were connected to a source of ultra pure grade inert gas and introduced to a slight positive pressure at the ultra pure gas source. The sampling canister valves were opened and the pure gas was allowed to purge through the assemblies and into the canisters for a period of 10 minutes. The pure gas valves were closed and the lines depressurized before closing the canister valves to avoid back flushing the impinger assemblies. The glass vials were then disconnected, capped, sealed, and stored at approximately 35 ^{o}F until analysis.

The liquids within the impingers were analyzed with an infrared total carbon analyzer. The contents of the canisters were analyzed using SCAQMD Method 25.1 by the total combustion analysis (TCA) technique using a flame ionization detector (FID). Results were reported as the sum of those measured in the impingers and the canisters as Non-Methane Non-Ethane Organic Compounds (NMNEOC).

Compost Internal Temperature

Compost was monitored with a type "K" thermocouple at each sampling point. Results were reported as the temperature encountered approximately two feet below the surface at each location.

TEST CRITIQUE

The test was conducted under normal operating conditions on a pre-arranged basis.

The test represents emissions as measured on the days that the testing was conducted. The operating conditions as encountered during testing were recorded and presented in this test report. The discussion of the representativeness of these operating conditions as relating to the facility's seasonal operations or facility to facility variations is left as outside the scope of the tests report. For this reason, this report, which is the first of the SCAQMD greenwaste test is considered as a screening test. More specifically, the results, although not proven to encompass all types of greenwaste emissions, can be used as part of an evaluation which attempts to do so.

Contrary to that which was experienced in the previous biosolids testing, emissions sampling using the flux chamber approach at the greenwaste facilities was complicated to a small extent by the inherent properties of the material and the manner in which the material is processed. More specifically, the coarseness of the material makes the flux chamber's seal onto the material less effective, while the non-uniformity of the material along with larger pile dimensions and extra processing steps required large number of sampling points to achieve representation of the emissions. This coarseness of the material can be seen in Figure 4. Despite these difficulties, the testing is thought to have been quite successful in measuring emissions from the facility throughout the range of emission rates encountered. The testing was successful in differentiating between the highest emissions from the tipping area to the lowest emissions in the windrows. The trend in measured emissions was also consistent with key operational data and screening tests as shown in the results in Table 3.

In evaluating the accuracy of the test results, it should be noted that the reported test results represent a conservative estimate of the emissions. Because of this, it can be assured that on the test days, the emissions were at least that which were reported. The reason for the low bias is that due to logistical constraints, certain issues that relate to the manner in which the testing was conducted, inherently allow a low bias in the measured emissions. These issues are listed as follows listed in order of greatest effect to least:

1. EPA reports a potential 20% low bias in the flux chamber method. The reason for this is largely due to the flux chamber's impedance of the surface emissions flux. When in place on the compost surface, the entire 1.4 ft^2 that the flux chamber encompasses, is forced to exit through a small 0.005 ft^2 (1" diameter) hole in the top of the chamber. The flux chamber was not specifically designed for measuring compost surface flux emissions which are much higher than design flow rates. For this reason, it is highly likely that much of the surface emissions are restricted by the flux chamber and simply by-pass the chamber. This theory is confirmed by the

observed surface flux velocities with the flux chamber removed verses measured flux velocities within the flux chamber in place. More specifically, it was observed that the velocity of the steam rising from the compost surface is on the order of several feet per minute, while the average flux velocity as measured by the flux chamber technique was less than one foot per minute. This visible steam can be seen in the photograph in Figure 5. In all likelihood, the reported emissions for this application are biased even lower than EPA's estimated 20%.

2. Both ammonia and VOC samples were extracted through an eight foot long 0.25 inch Teflon sampling line to facilitate sampling (Figure 6). This line was purged between sampling locations. Condensed moisture was observed in this line for all locations. Due to the soluble nature of the pollutants, it is likely that some loss occurred in this line. The extent of this loss in unknown.

3. During the time period required for composting, all of the material at the facility is moved several times by front-end loader, and also screened once or twice. Much of the material is also ground. The testing did not include measurements for emissions during any of these agitation events. These emissions could not be measured due to obvious limitations of the flux chamber approach for moving material. These emissions may simply accelerate the emissions rates temporarily, then return to a baseline emission rate. The exact overall effect of the agitation is unknown. The effect can be seen visually in the background in the photograph in Figure 5 as steam rising from the screening and material moving activities. Since the emissions specifically from these agitation events were not measured, the reported overall facility emissions may be understated.

4. The emissions from the facilities Fines and Alternative Daily Cover (ADC) product piles were not measured but assumed to be equal to that of the static pile. The material, which is sold to landfills as cover material, is similar in age to the static pile. The material, however, is thought to have higher emissions than the static pile since it is a finer and therefore less aerated material and was observed to be the greatest source of odors at the facility. Since the Fines and ADC surface area was included in the static pile surface area, its emissions were not ignored, but were likely to have been biased low.

5. Method 25.3 is limited to VOC concentrations of 50 ppm. Since concentrations for the tipping and static piles were over 50 ppm, non-water soluble compounds may have been lost. Therefore results would be considered to be biased low. The method is considered, however, to be well
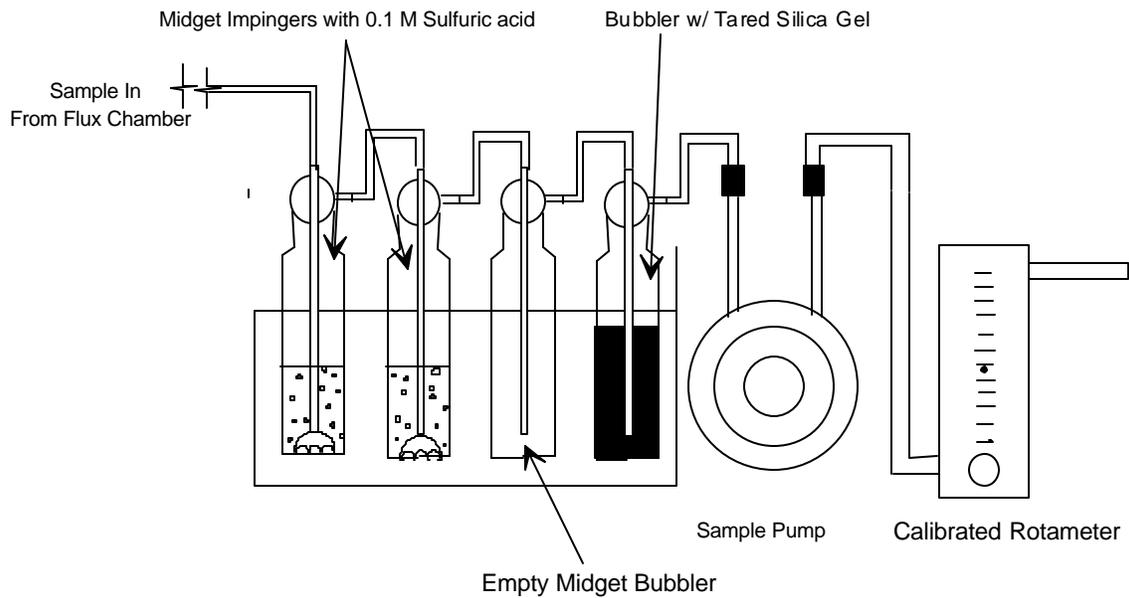
suited for this application where the condensable species are considered to be water-soluble. The extent of the low bias due to this effect is therefore thought to be least of all the biases discussed.
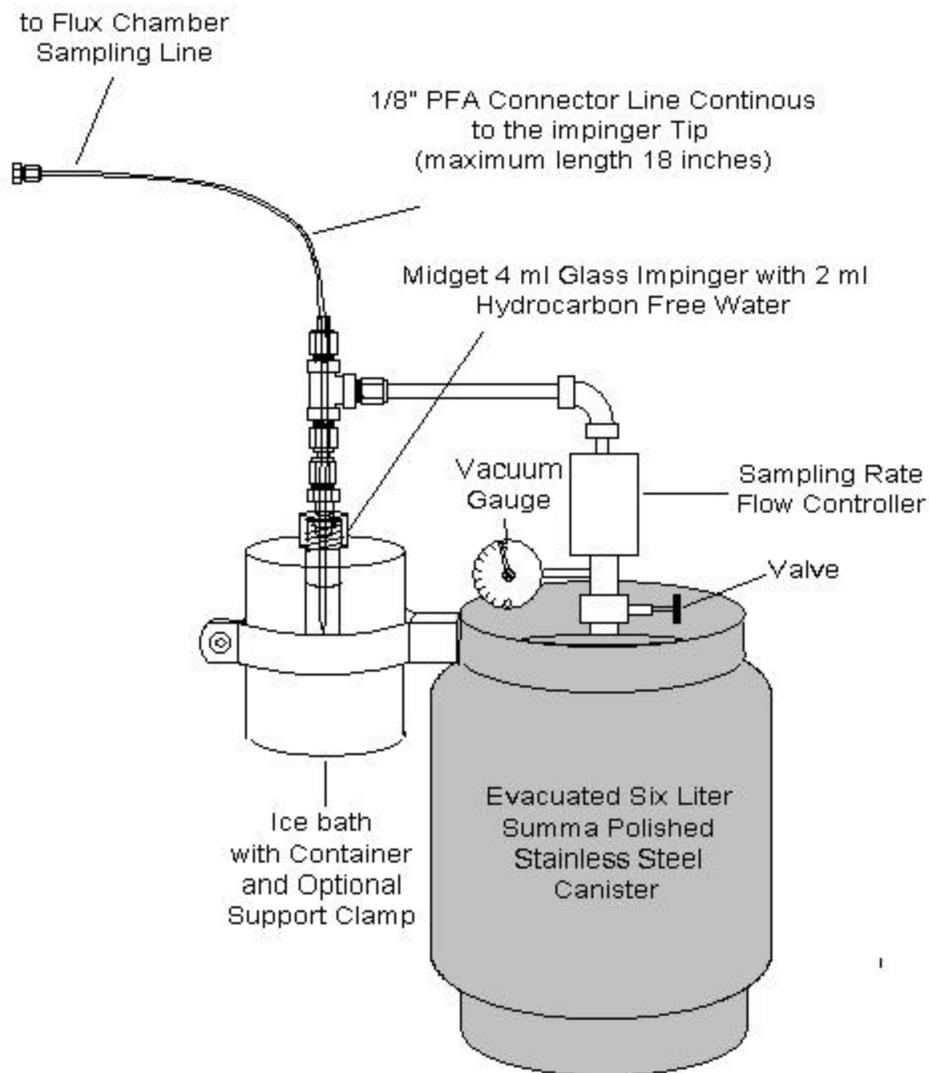

For the static pile samples, the results for Canister 5053 were not used due to a faster than anticipated sampling rate which filled the canister over the first few sampling points. By not using the results from this canister, a high bias is avoided since the first few sampling points have higher emissions as compared to the remaining points as indicated by FID readings. The large discrepancy between sampling pair results from the tipping pile samples is the result of a portion of the Vial 13 contents being pulled into Vial 14 during sampling through the tubing tee connected to the flux chamber sampling line. This would cause the results from Vial 14 to be biased high and the results from Vial 13 to be biased low. For purposes of calculating emissions, the results from the two samples were averaged. The net effect is to have no bias in the reported emissions as a result of this occurrence.
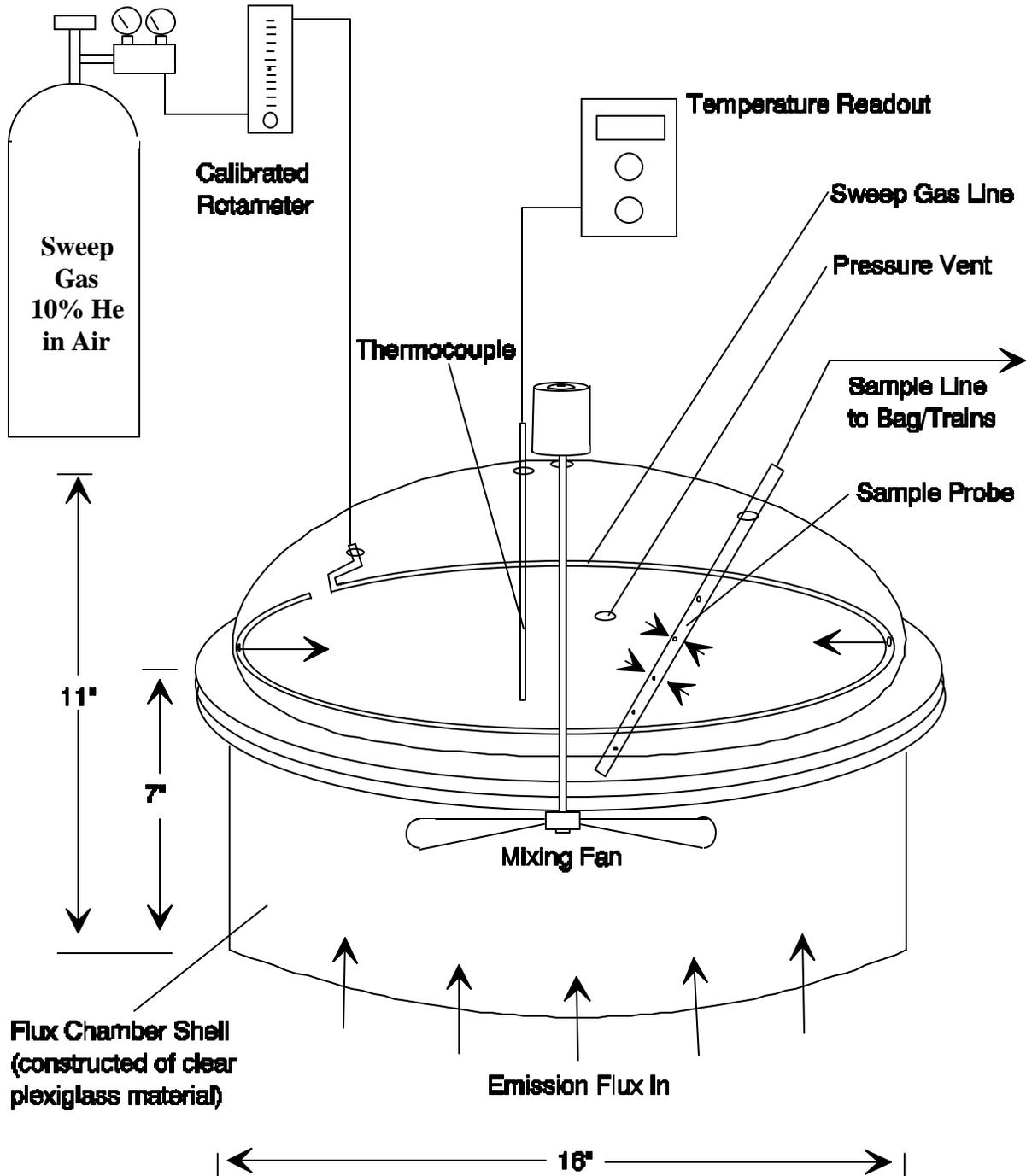
Figure 1 Emission Isolation Flux Chamber

Figure 2 Ammonia Midget Sampling Train

to Flux Chamber
Sampling Line

1/8" PFA Connector Line Continous
to the impinger Tip
(maximum length 18 inches)

Midget 4 ml Glass Impinger with 2 ml
Hydrocarbon Free Water

Vacuum
Gauge

Sampling Rate
Flow Controller

Valve

Ice bath
with Container
and Optional
Support Clamp

Evacuated Six Liter
Summa Polished
Stainless Steel
Canister

Figure 3 – VOC Sampling Apparatus

Figure 4 – Photos of Tipping Pile (top) and Static Pile (bottom)

Figure 5 – Photo of Steam from Tipping Pile and Screening

Figure 6 – Photo of Tipping Pile and Flux Chamber

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Table 4 - Number of Sampling Points, Compost Temp. and FID Readings at Each Sampling Point

Tipping Pile			Static Pile			Windrows		
Sampling Point Zone #	FID Reading (ppm)	Internal Temp. (^{O} F)	Sampling Point Zone #	FID Reading (ppm)	Internal Temp. (^{O} F)	Sampling Point Zone #	FID Reading (ppm)	Internal Temp. (o F)
1	255	156	1	46	160	1	8	138
2	16	125	2	143	152	2	9	138
3	64	152	3	30	144	3	10	132
4	70	119	4	90	164	4	16	132
5	48	169	5	90	161	5	23	112
6	115	150	6	20	133	6	15	104
7	113	148	7	15	81	7	10	110
8	206	164	8	9	114	8	9	109
9	115	140	9	5	141			
10	130	143	10	6	136			

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SOURCE TEST CALCULATIONS

Material Balance for Compost Surface Migration Rate

For calculating the compost surface migration rate, a helium material balance was performed around the flux chamber. Helium was the chosen constituent because of inert properties and its ease of accurate analysis. The material balance is derived as follows:
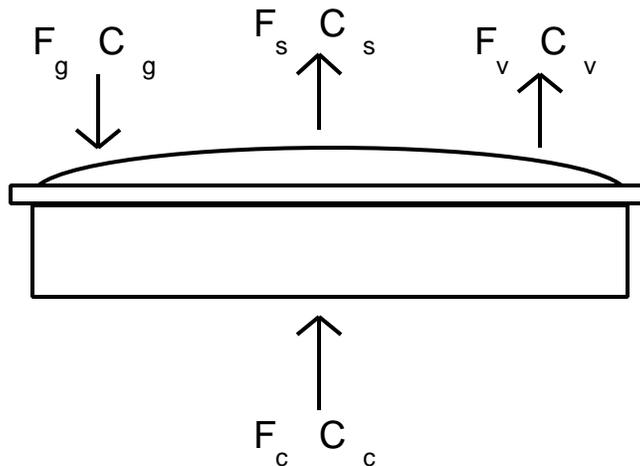
Where:

F_g = Sweep Gas Flow Rate (measured)

C_g = Sweep Gas Helium Concentration (analyzed)

F_S = Sample Flow Rate (measured)

C_S = Sample Helium Concentration (analyzed)

F_V = Vent Flow Rate (unknown)

C_V = Vent Helium Concentration (assume = C_s)

F_C = Compost Surface Migration Flow Rate (unknown and includes dilution air)

C_C = Compost Surface Migration Helium Concentration (assumed zero)

Flow Balance:

$$F_V = F_C + F_g - F_S$$

Material Balance for Compost Surface Migration Rate (continued)

Helium Balance:

$$F_cC_c + F_gC_g = F_sC_s + F_vC_v$$

Substitute:

$$C_c = 0$$

$$C_v = C_s$$

$$F_v = \text{Flow Balance}$$

then:

$$F_gC_g = F_sC_s + (F_c + F_g - F_s)C_s$$

$$F_gC_g - F_cC_s = F_sC_s + F_gC_s - F_sC_s$$

$$F_cC_s = F_gC_g - F_gC_s$$

$$F_c = \frac{F_g(C_g - C_s)}{C_s}$$

EMISSION ESTIMATION CALCULATIONS

Emissions are based on the surface area of the piles and the results of the flux chamber sampling reported per unit of surface area. The facility wide emissions do not include arbor waste; wood waste, palm waste or tree stumps and is calculated using the contributions of the tipping, ADC, static, and windrow piles.

The following data was used for the calculations:
Pile Surface Area – 110,906 ft^2 (Tipping Pile), 125,513 ft^2 (Static Pile), 55,770 ft^2 (Windrows)
Avg. Daily Composting – 350 Tons (from Inland Empire Composting Sept. 2001, Greenwaste only)

ESTIMATING TIPPING PILE DIMENSIONS

Tipping pile dimensions were determined using the scale plot drawing prepared by Inland Empire Compost (Figure A in the Appendix). From the drawing it was determined that the tipping pile occupied a ground level cross-section of a 350' X 375' right triangle. A "surface area correction factor" of 1.3 was applied to the two dimensional triangular cross section to approximate the total surface area of the three dimensional pile. The "surface area correction factor" accounts for both the height of the pile and its un-even surface. The "surface area correction factor" was determined on 12/26/01 using a wheel type measuring device over the pile surface as compared to the corresponding measured linear distance on the ground.

The total surface area of the tipping pile was calculated as:

$A = 1/2 \ (350' \ X \ 375') \ X \ 1.3^2 = 110,906 \ ft^2$

ESTIMATING STATIC PILE & FINES DIMENSIONS

Static pile dimensions were determined using the scale plot drawing prepared by Inland Empire Compost (Figure A). From the drawing it was determined that the static pile occupied a ground level cross-section of two rectangles with dimension of 150' X 175' and 100' X 170'. The surface area of the fines piles were determined in the same way as the static pile as two rectangles with dimensions of 75' X 200' and 50' X 100'. The surface area of the ADC blend occupied 7 foot high pyramid shape long windrows, with a base of 37.5 feet. From these measurements a cross dimensional surface area of 40 feet was determined. The cross dimensional area was then multiplied by the total length of the ADC piles (550 ft). There was no "surface area correction factor" used to determine the ADC surface area, after it was determined that the ADC piles had an even surface. The area of the static piles was then added to the surface area of the fines piles and the ADC blend to determine a total surface area.

The total surface area of the static, fines and ADC piles was calculated as:

$$A = ((150' \times 175') + (100' \times 150') + (75' \times 200') + (50' \times 100')) \times 1.3^2 + (40' \times 550') = 125{,}513 \ ft^2$$

ESTIMATING WINDROWS DIMENSIONS

Windrows pile dimensions were determined using the scale plot drawing prepared by Inland Empire Compost (Figure A). The surface area of the Windrows occupied a 7 foot high pyramid shape, with a base of 25 feet. From these measurements, a cross dimensional surface area of 28.6 feet was determined. The cross dimensional area was then multiplied by the length of the Windrows (1950 ft). There was no "surface area correction factor" used to determine the Windrows surface area, after it was determined that the Windrows had an even surface.

The total surface area of the Windrows was calculated as:

$A = (28.6' \times 1950') = 55,770 \text{ ft}^2$

Windrows Configuration

14.3 ft

14.3 ft

7 ft

25 ft
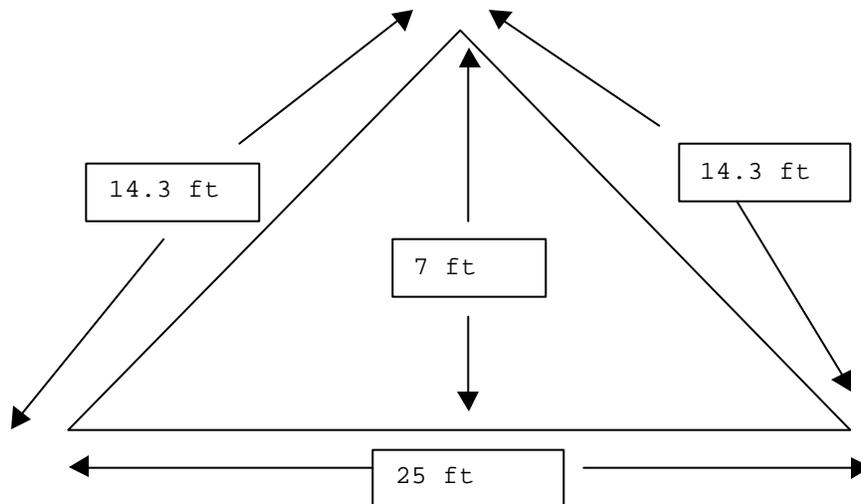
Appendix
Emissions Calculations and Laboratory Results