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ANALYSIS OF FACTORS AFFECTING METHANE GAS RECOVERY FROM SIX LANDFILLS

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16. ABSTRACT The report gives results of a pilot study of six U.S. landfills that have methane (CH_4) gas recovery systems. (NOTE: The study was a first step in developing a field testing program to gather data to identify key variables that affect CH_4 generation and to develop an empirical model of CH_4 generation based on those variables. The field test program development, in turn, is part of EPA/AEERL's research program aimed at improving global landfill CH_4 emissions estimates.) To evaluate the effects of climate on CH_4 production and recovery, the six sites represented a variety of moisture and temperature patterns (i.e., hot and wet, cool and wet, hot and dry). Landfill gas was tested at each landfill to evaluate the quality of the gas recovery data available at each. The testing included assessing the adequacy of on-site instrumentation and scanning the landfill surfaces for organic vapors that would indicate emissions of CH_4. In addition, information on waste composition and landfill characteristics was sought for each landfill. Except for flow measurements, the test procedures selected were well suited to the types of gas recovery installations encountered at the landfills visited. Based on comparisons between EPA Reference Method 3C and instrument analyses of the landfill gas composition, all on-site analysis instruments appeared to be operating with reasonable accuracy.

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ABSTRACT

In 1990, EPA's Air and Energy Engineering Research Laboratory (AEERL) began a research program with the goal of improving global landfill methane (CH_4) emissions estimates. Part of AEERL's program includes developing a field testing program to gather data to identify key variables that affect methane generation and to develop an empirical model of methane generation based on those variables.

The first step in developing the field testing program was a pilot study of six U.S. landfills that have CH_4 gas recovery systems. Landfill gas testing was conducted at each of the six landfills to evaluate the quality of the gas recovery data available at each site. The testing program included assessing the adequacy of on-site instrumentation and scanning the landfill surfaces for the presence of organic vapors that would indicate emissions of CH_4. In addition, information on waste composition and landfill characteristics was sought for each landfill. In order to evaluate the effects of climate on CH_4 production and recovery, the sites were chosen to represent a variety of moisture and temperature patterns (i.e., hot and wet, cool and wet, hot and dry).

With the exception of flow measurements, the test procedures selected for this project were well suited to the types of gas recovery installation encountered at the landfills visited. Based on comparisons between the RM 3C and instrument analyses of the landfill gas composition, all on-site analysis instruments appeared to be operating within reasonable accuracy ranges. Review of calibration procedures and records indicate that long-term instrument accuracy should be comparable to the accuracies noted during on-site testing. A negative correlation between refuse age and CH_4 recovery per ton was found; a weak positive correlation was found for normal annual precipitation and CH_4 recovery per ton. The results of this small study are sufficiently encouraging to warrant further data gathering and analyses.

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1.0 INTRODUCTION

1.1 BACKGROUND

In response to concerns about global warming, the U.S. Environmental Protection Agency's (EPA's) Office of Research and Development (ORD) has initiated a program to characterize the causes and effects of global climate change, and to identify and quantify emission sources of greenhouse gases. To assist in this undertaking, EPA's Air and Energy Engineering Research Laboratory (AEERL) has begun research to improve emissions inventories of greenhouse gases in the United States and throughout the world.

One greenhouse gas of particular concern is methane (CH_4). Methane's radiative-forcing potential is thought to be much greater than that of carbon dioxide (CO_2). Although the major sources of CH_4 emissions are known, there is considerable uncertainty about the quantitative emissions from each source. However, as much as 15 percent of all CH_4 generated annually is thought to come from landfills (Thorneloe and Peer, 1990). One of AEERL's goals is to develop a database that can be used to accurately estimate CH_4 emissions from landfills on a global basis.

In 1990, AEERL began a research program with the goal of improving global landfill CH_4 emissions estimates (Thorneloe and Peer, 1990). This work began with a review of the currently available models and data (Peer et al., 1991). It was determined that current methodologies could be improved using available data or data from research currently underway. One important limitation of global emissions methodologies is the lack of data sufficient to model the effects of climate, refuse composition, and refuse age on methane generation in landfills. Theoretical models and laboratory experiments have been used to estimate the methane production in individual landfills, but methane recovery systems in landfills are generally collecting less than predicted.

In order to determine the factors that affect CH_4 generation in landfills on a global basis, a model is needed that is responsive to a wide range of climates and types of waste. Understanding the effects of climate on CH_4 production is especially important to climate modelers who are studying feedback effects of global climate change. Part of AEERL's program to create a CH_4 landfill emissions database, therefore, includes developing a field testing program to gather data to:

(1) Identify key variables that affect methane generation; and

(2) Develop an empirical model of methane generation based on those variables.

From the literature review, several variables were identified as potentially important. These include refuse moisture content, refuse composition, refuse age, pH, and a variety of other variables related to landfill characteristics and waste-handling practices. However, the global scope of this database effort limits the number and type of variables that can be considered.

Landfills with gas recovery systems offer unique opportunities for studying methane production from landfills. The landfill gas is being collected and measured by the gas recovery operators; if those data can be verified to be reasonably accurate, and if sufficient data are available on the landfill itself, the landfill gas measurements collected over several years may be used to estimate total methane generation. If sufficient sites are available to provide a representative sample of current U.S. landfills, then an empirical model may be developed using data from these sites. Eventually, this model can be expanded to model landfills globally. Gas recovery systems are being used widely in Europe, and are beginning to be more common in other parts of the world. They represent an important source of data for estimating global landfill CH_4 emissions, and may be used to calibrate the model.

1.2 OBJECTIVES

The first step in developing the field testing program was a pilot study of six U.S. landfills that have CH_4 gas recovery systems. The objectives of the pilot study were to:

(1) Determine the types and quality of landfill data on CH_4 recovery rates, gas composition, and refuse characteristics available at landfills with gas recovery systems;

(2) Use these data to determine trends in the effects of climate, refuse age, and landfill characteristics on CH_4 recovery; and

(3) Use the results of the emissions testing and data analysis to assess the relationship between gas recovery and gas generation, and assess the feasibility of expanding the study to include other sites.

To meet these objectives, a pilot study of six sites chosen to represent a range of climates was undertaken. The general procedures and methodologies planned were:

- Identify potential sites;
- Visit the landfills to collect data records from the facility;
- Independently measure landfill gas flow;
- Assess accuracy and adequacy of the data; and
- Develop statistical methods for analysis of the data.

Although the CH_4 content of the landfill gas is of most importance at this time, other constituents were also measured (carbon dioxide, oxygen, nitrogen, and nonmethane organic compounds). Eventually, this inventory development program may be extended to include other gases. The procedures and results of the pilot study are described in this report.

2.0 SITE SELECTION AND DESCRIPTION

2.1 SITE SELECTION

The pilot study included visits to six landfills in the United States to gather data on CH_4 recovery rates and factors thought to influence these rates. The primary criterion in selecting a landfill for study was that it have a gas recovery system in place. The recovery system needed to be well-controlled (i.e., operating under good engineering practices to minimize leaks and maximize CH_4 recovery) so that the CH_4 recovery data would be useful in estimating total CH_4 production at the site. In addition, well-maintained records on routine monitoring for possible gas migration at the perimeter and surface of the landfill were needed.

In order to evaluate the effects of climate on CH_4 production and recovery, sites were sought in geographic regions representing a variety of moisture and temperature patterns (i.e., hot and wet, cool and wet, hot and dry). Initial recommendations provided by landfill gas recovery experts in the United States were used to identify potential sites. Final site selection was largely influenced by:

- Assurance that long-term gas production and refuse composition data were available at the site;
- Suitability of the site for sample acquisition; and
- The landfill operator's willingness to cooperate in the study.

A Landfill Survey Form (Appendix A) was sent to the operators of the selected sites prior to visiting the landfills so that they could begin gathering the records. Site visits took place between August 6 and August 24, 1990.

2.2 SITE DESCRIPTIONS

The following paragraphs briefly describe each of the landfills selected for the pilot study. The monthly precipitation normals (30-year) for each site are shown in Figure 2-1; the monthly mean temperature normals are shown in Figure 2-2. (Climate data sources and statistical methodology are described in Section 5.0.) More detailed descriptions of the sites are presented in Appendix B1.

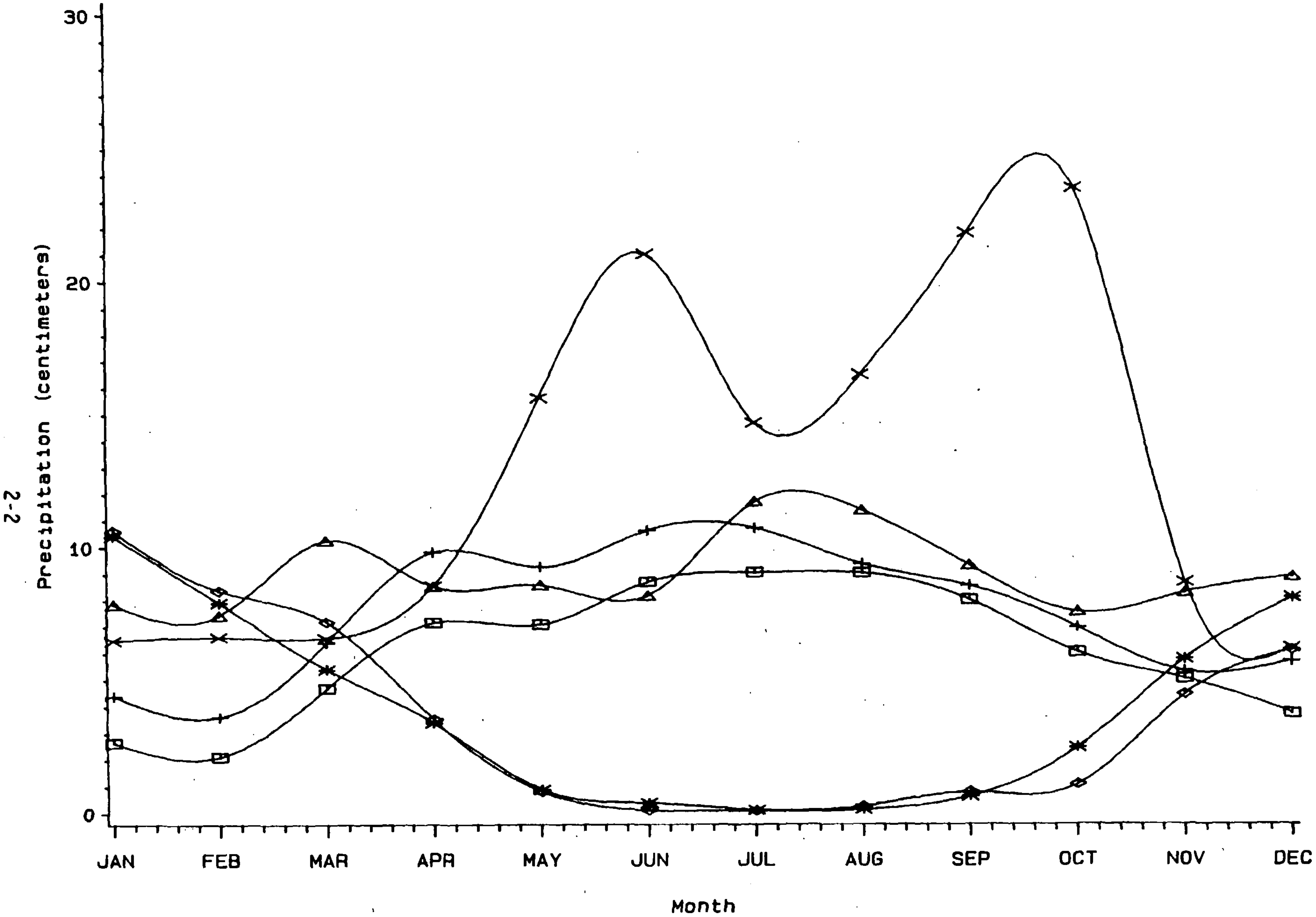

Figure 2-1. Precipitation normals (30-year) for the landfill sites

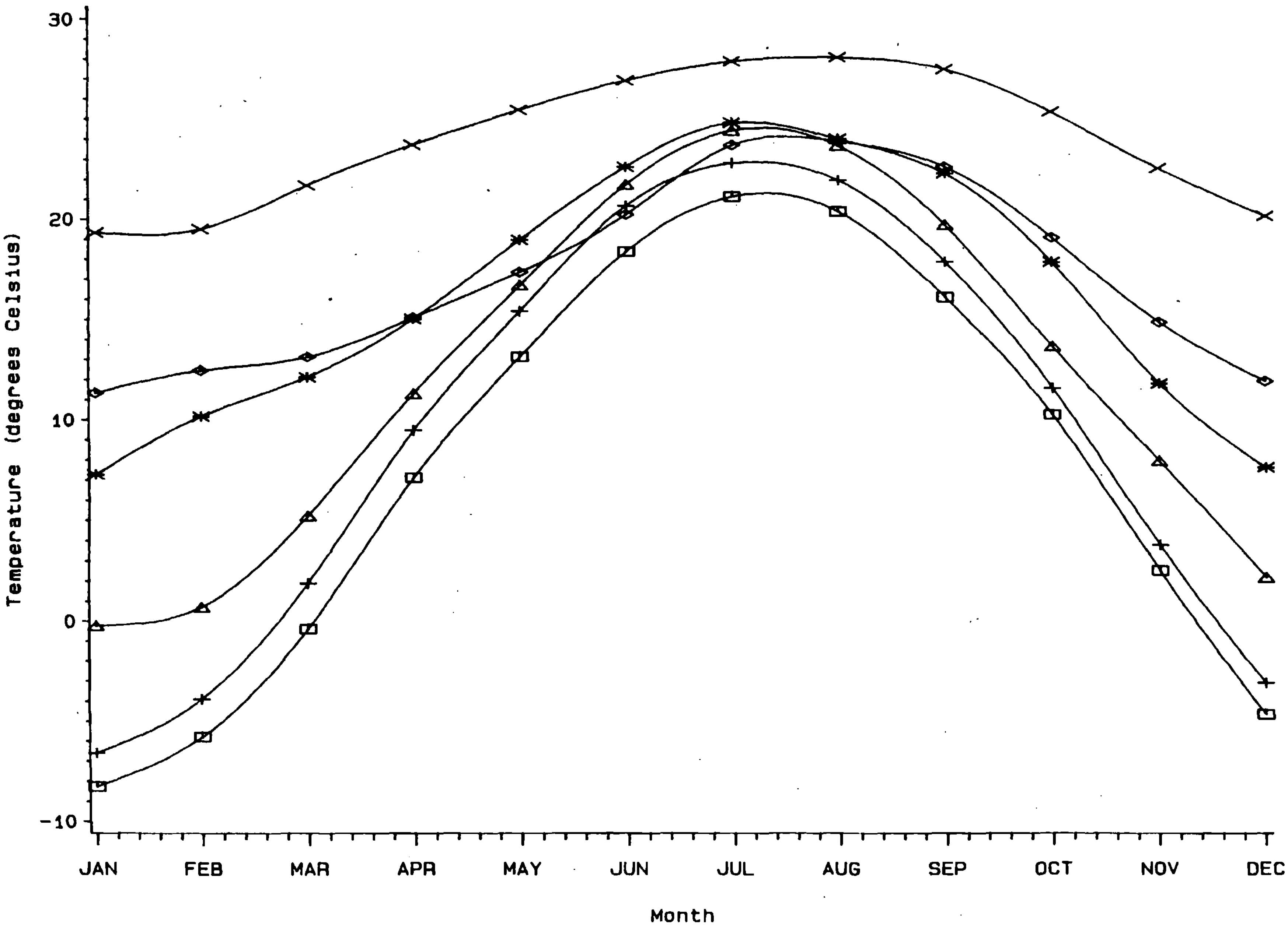

Figure 2-2. Mean temperature normals for the landfill sites.

Landfill 1 is located in Wisconsin. The site is considered representative of a cool, wet climate. The 35-hectare landfill was closed in 1989. Cap thickness is reported to be at least 1.5 meters.

Refuse was placed at this site beginning in the 1950s; hazardous waste was also accepted (and placed in separate cells) until the early 1980s. An estimated 9 to 11 million cubic meters, or 6.3×10^6 Mg, of refuse are in place at the landfill. Gas recovery began on December 31, 1985. As of July 1, 1990, 1.8×10^8 cubic meters of gas had been recovered (approximately 162,823 cubic meters per day). At the time of the study, 45 wells were in place, and three Solar Centaur turbines were in place and operating full time.

Landfill 2 is located in Illinois and also represents a cool, wet climate. Gas is being recovered from approximately 54 hectares: An older closed section of the landfill encompasses 26 hectares, and a newer closed section covers 28 hectares. The original owners were very inconsistent in cap placement and thickness, and the surface of the older section varies from 0.15 to 2.4 meters. The cap thickness on the newer section of the site averages 0.9 meters.

Refuse was first placed on the older section in 1968. Refuse acceptance at the newer section began in November 1982. A Solar Centaur turbine was installed in January 1989, and a Solar Saturn turbine was slated to go on-line in the fall of 1990. Sixty-five wells were on-line at the time of the study. Total combined gas recovery from both sections of the landfill is about 56,600 cubic meters per day.

Landfill 3 is located in Pennsylvania. Like Landfills 1 and 2, it represents a cool, wet climate. Gas is recovered from a 51-hectare portion that began accepting refuse in 1970 and was essentially closed in 1988, although refuse is still being added in small amounts as settling occurs. Hazardous wastes were accepted until 1981, and make up about 1 percent of total refuse. An estimated 8.4×10^6 cubic meters of refuse are currently in place. The clay cap averages 0.6 meters in thickness.

Gas was originally vented to the atmosphere to prevent off-site migration. A Solar Centaur turbine was installed in January 1988, and a second one was added in June 1989. At the time of the pilot study, both turbines were operating full time. There are a total of 31 wells on-site. An estimated 1.2×10^5 cubic meters of gas are recovered daily.

Landfill 4, located in Florida, represents a hot, wet climate. Gas is recovered from a closed portion of the landfill that covers about 57 hectares. Average refuse height in this portion is 56 meters above sea level including a 0.5-meter cap on the uppermost 16 hectares. (The landfill is shaped like a pyramid.) Refuse acceptance began in 1971 and ceased in 1989. Portions of the landfill accepted and continue to accept sludge from a nearby wastewater treatment plant. Most (94 percent) of the compacted 13.8 x 10^6 Mg of refuse estimated in place at the closed portion is thought to be CH_4-producing.

Final cover on the closed areas of the landfill is 45.7 cm of topsoil, 45.7 cm of clay (rock tailings), and 45.7 cm of sand. The cover is very permeable to rainfall and this permeability limits the amount of vacuum that can be applied.

This landfill has 111 wells in place; five Solar turbines were started up in 1989. Four turbines are currently in continuous operation at 95 percent capacity. At the time the study was conducted, the maximum gas recovery rate attained was 293,170 cubic meters per day, but recovery had leveled off to about 156,000 cubic meters per day.

Landfill 5, located in southern California, was the only site in a hot, dry climate. Gas is being recovered in a closed portion covering 32 hectares. Refuse acceptance began in 1952. The closed portion of the landfill has approximately 11 x 10^6 Mg of refuse in place, of which approximately 8.7 x 10^6 Mg are decomposable. Reinjection of condensate to boost moisture in the refuse was permitted until 1985. Since this practice ceased, however, there has been no appreciable drop in either gas or condensate production.

At the time of the study, the closed portion of the landfill did not have a final cover in place, although one was scheduled to be installed in the fall of 1990. The area is currently covered with a permeable silty sand and is not vegetated. Refuse moisture content is estimated to be 12 percent.

There are a total of 102 wells on site. Gas collection began in 1976, originally using either an internal combustion engine or flaring the gas. Currently, a Solar skid is used for gas compression prior to flaring, and condensate is treated in an oil/water separator.

Landfill 6 is located in north central California, another relatively hot and dry climate. Gas is recovered from closed portions of the landfill. This landfill was the only one visited where gas recovery and refuse composition data could be gathered for three separate portions within the landfill. Area 1 covers 27 hectares and contains about 1.74 x 10^6 Mg of refuse; Area 2 covers 10 hectares and contains 5.8 x 10^5 Mg of refuse; and Area 3 covers 3 hectares and contains 2.5 x 10^5 Mg of refuse.* The final covers on Areas 1 and 2 and part of Area 3 consist of a 1.2-meter clay cap and a 0.3-meter soil cover, with vegetation established. Parts of Area 3 had not yet been seeded with vegetation.

Information on refuse was gathered for the entire site. Refuse was accepted at different times in different areas between 1975 and 1989. Average moisture content of the refuse is reported to be 23 percent, with paper waste comprising about 46 percent (wet weight) of the total waste.

Gas recovery began at this site in 1988. The current system consists of three internal combustion engines and a backup flare. The flare burns constantly (fueled with propane and a small stream of CH_4) and on-site personnel indicated that the amount of CH_4 burned in the flare has been steadily decreasing over time. Of the 68 wells located on site, 47 are in Area 1, 17 in Area 2, and 4 in Area 3. The estimated landfill gas flow for the entire site is 40,766 cubic meters per day, with 50 to 52 percent CH_4.

*This area does not include the 6.7 hectares and 11 wells brought on line in May 1990.

3.0 LANDFILL GAS TEST PROCEDURES

Landfill gas testing was conducted at each of the six landfills in the pilot study in order to evaluate the quality of the gas recovery data available at each site. The testing program included assessing the adequacy of on-site instrumentation and scanning the landfill surfaces for the presence of organic vapors that would indicate emissions of CH_4.

This section of the report identifies the methods used in the testing program and describes the site-specific testing procedures used at each of the landfills visited. A more detailed description of the test methods, site-specific procedures, and laboratory analyses are given in Appendix C. The program's quality assurance procedures are presented in Appendix D.

3.1 GENERAL TEST PROCEDURES

3.1.1 Methane, Carbon Dioxide, Oxygen, and Nitrogen Test Method

The EPA Reference Method (RM) 3C (U.S. EPA, 1991a) was used to determine the composition of the landfill production gas. This method was developed and proposed for use at municipal landfills for determining CH_4, CO_2, nitrogen (N_2), and oxygen (O_2) levels. Figure 3-1 shows a diagram of the RM 3C sampling system.

3.1.2 Nonmethane Organic Compounds Test Method

Nonmethane organic compounds (NMOC) in the landfill gas were determined using EPA RM 25C (U.S. EPA, 1991b). Samples were taken using the same procedures as for RM 3C (Figure 3-1). After a 5-minute leak check procedure, starting vacuum pressures were recorded and samples were extracted into evacuated stainless steel canisters. Canisters were shipped off-site for GC analysis.

3.1.3 Moisture Test Methods

Moisture content of the landfill gas was determined using EPA RM 4 (U.S. EPA, 1989a). This method uses a chilled impinger train to condense and trap water from the landfill gas. The water is then weighed and related to the volume of gas sampled. Figure 3-2 shows a diagram of the RM 4 sampling system.

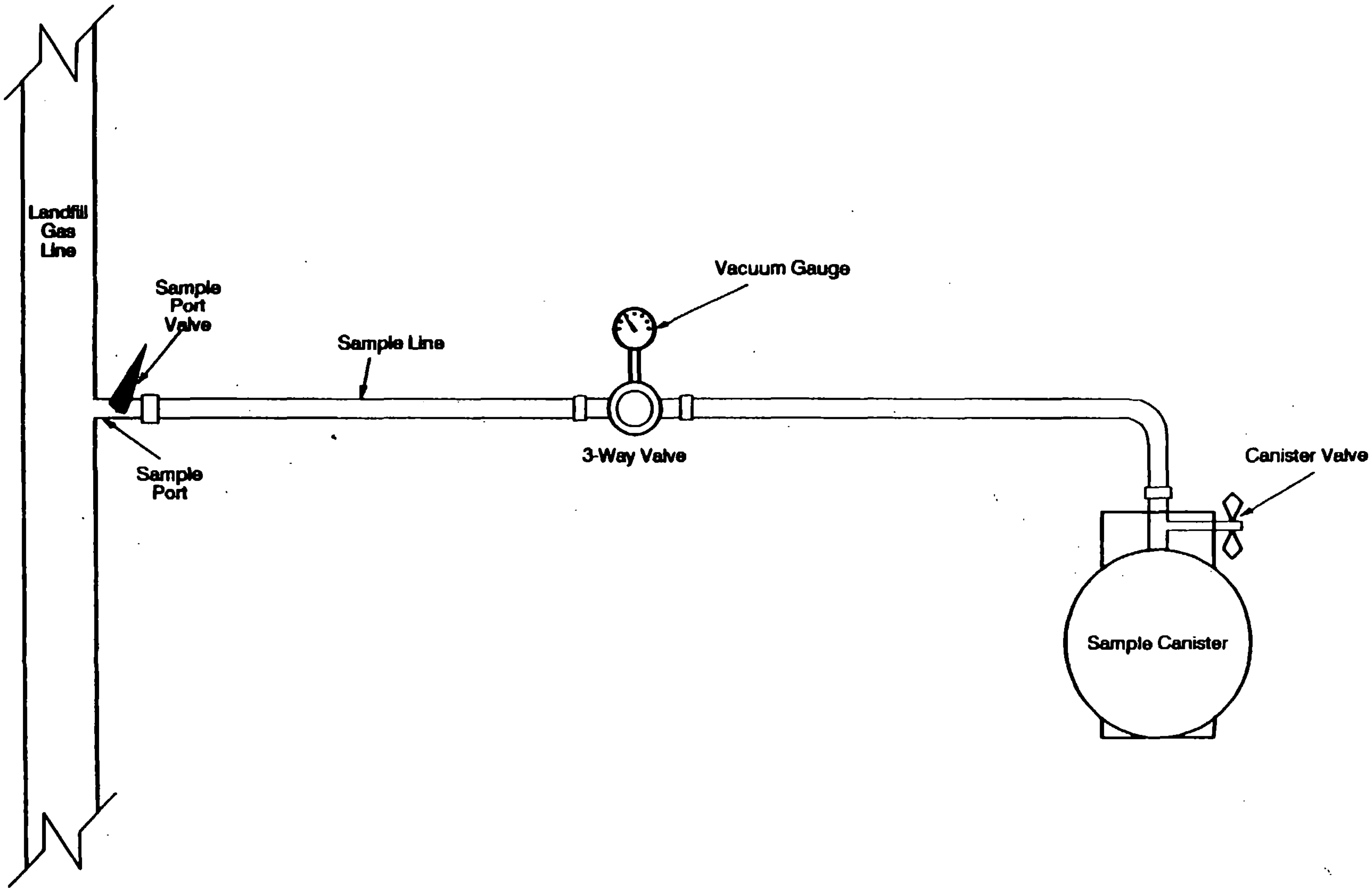

Figure 3-1. Sampling System for Reference Methods 3C and 25C

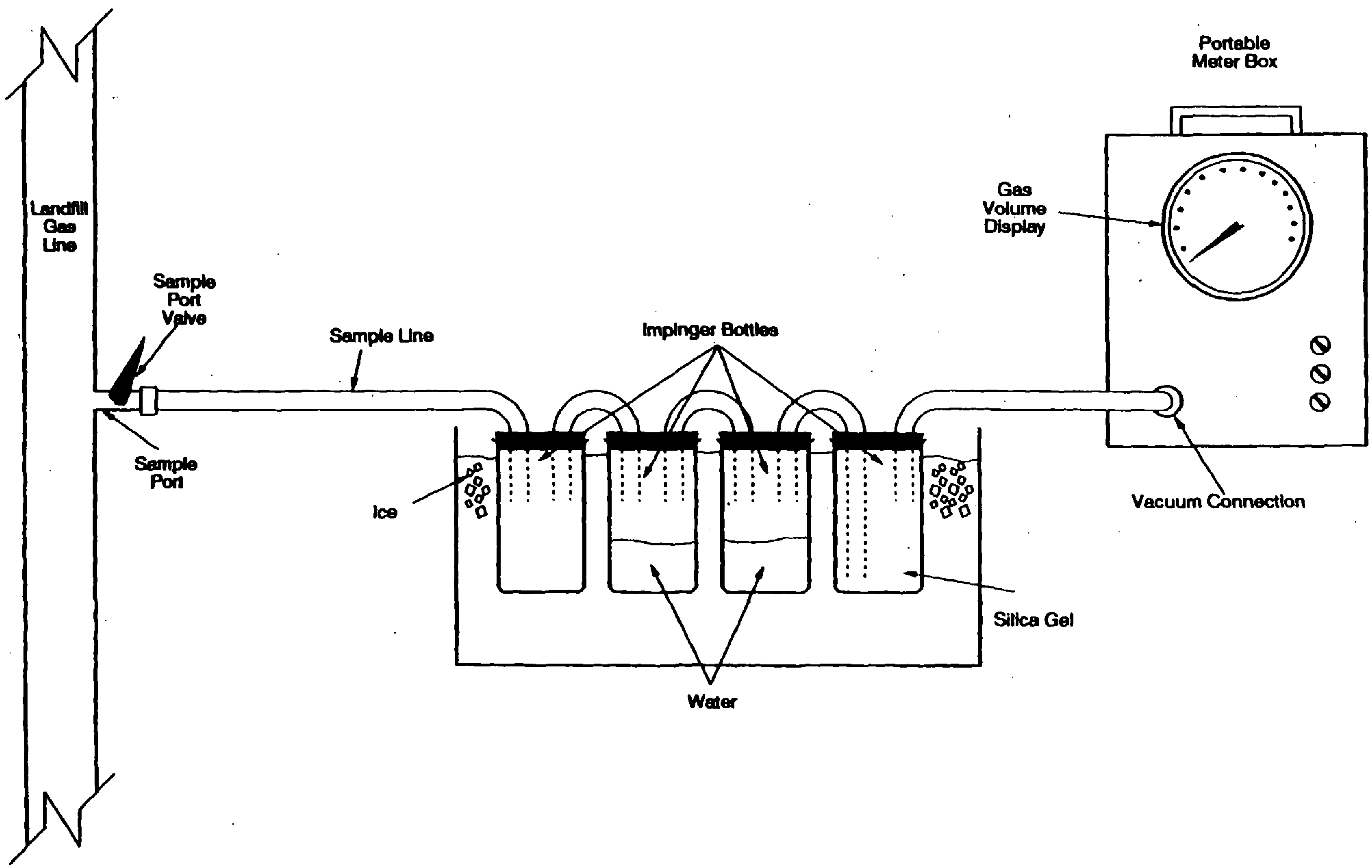

Figure 3-2. Sampling System for Reference Method 4

3.1.4 Volumetric Gas Flow Rate Test Method

Initially, the volumetric flow rates of the landfill gas production were to be measured using EPA RM 2 (U.S. EPA, 1989b). This method requires that a pitot tube with a diameter of about 0.5 to 1.0 cm be inserted into the gas transport pipe. At the landfills visited, however, there were no sample ports on the gas transport pipes large enough to insert a pitot tube. Therefore, field measurement for gas flow rate was not possible. In lieu of this test, copies of recent calibration records of on-site flow measurement instruments were obtained for three of the six landfills.

3.1.5 Landfill Surface Organic Vapor Testing

Tests for the presence of organic vapors near the landfill surface were conducted using an organic vapor analyzer (OVA). An OVA basically consists of a sample probe, a vacuum pump to draw the sample through the analyzer, a flame ionization detector, and a display that indicates the concentration in parts per million (ppm) of organic vapors.

Prior to surface testing at each site, the OVA was calibrated using three calibration standards, with air containing (1) 0 ppm organic vapor; (2) 100 ppm CH_4; and (3) 500 ppm CH_4. Field tests were conducted by sampling at various points in the landfill at a distance of about 10 cm above the surface. Areas of vegetative stress were sampled, as well as any cracks or fissures in the landfill surface. As each point was tested, its location, a brief description of the surface characteristics, and the organic vapor concentration measured were recorded in the project notebook.

3.2 SITE-SPECIFIC TEST PROCEDURES

3.2.1 Test Procedures at Landfills 1 through 4

Landfills 1, 2, 3, and 4 have very similar landfill gas recovery and electrical generation equipment. Figure 3-3 shows a schematic diagram of the gas recovery and electric generation process.

At Landfills 1 through 4, RM 3C (CH_4, CO_2, N_2, and O_2) samples were taken from a sample port on the landfill gas line that feeds the gas turbine. This port corresponds to sample port A on Figure 3-3. At this point, the landfill gas has been processed to remove condensate and particulate. The sample port is also on the same line from which samples are withdrawn by the on-site automatic gas analyzer.

Landfills 1 through 4 all have an automatic GC analyzer that periodically samples and analyzes the composition of the gas entering the turbines. The

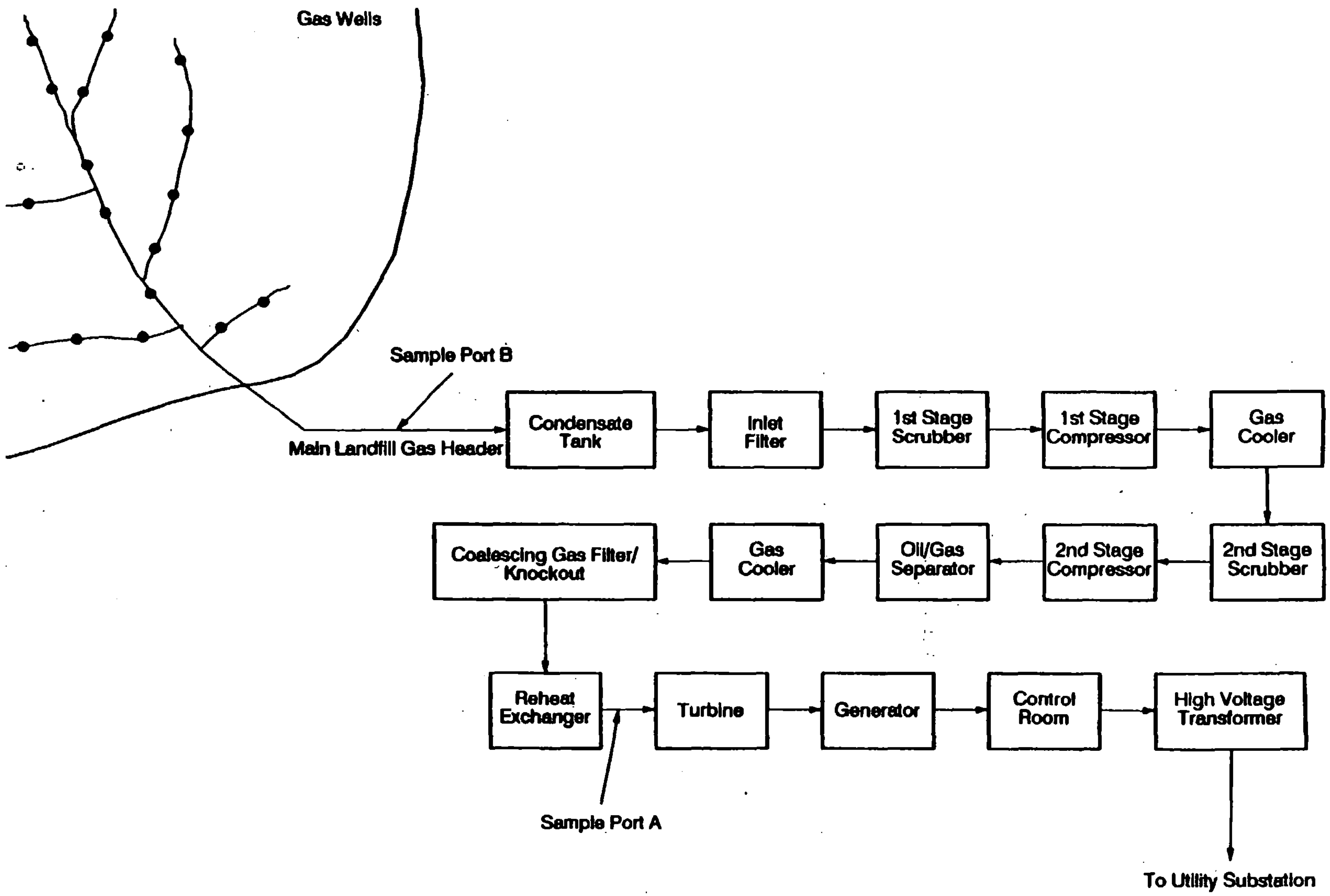

Figure 3-3. Landfills 1-4: Gas Recovery and Turbine Electrical Generation Process Flow Diagram

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analyzer determines the percentage of CH_4, CO_2, O_2, and N_2 in the gas. Sample frequency is computer controlled, and samples are taken every 3 minutes.

Six RM 3C samples were taken at each of the landfills. Each sample was extracted over a period of 10 to 20 minutes, and total sampling time for all six samples was 1.5 to 2 hours. After RM 3C field testing was complete, gas composition data printouts generated by the automatic analyzer during field testing were obtained from the gas plant operator. These gas composition data would be compared to the composition determined from laboratory analysis of the field samples.

Reference Method 25C (NMOC) samples from Landfills 1 through 4 were taken from the main gas header as far upstream from gas conditioning equipment as possible. The sampling point for RM 25C corresponds to sample port B on Figure 3-3. It should be noted, however, that at Landfill 1, the first sample port on the main leader was located downstream from a condensate collection tank, and no sample could be taken further upstream. For Landfills 2, 3, and 4, there was no treatment of the gas upstream of the sampling point.

At each of the sites, six RM 25C samples were taken. Each sample was extracted over a period of about 10 to 20 minutes, and collection of all six samples required 1.5 to 2 hours.

Reference Method 4 (moisture) samples were taken from the same sample port that the RM 25C samples were taken from (sample port B on Figure 3-3). Six samples were taken at each of the landfills. Each RM 4 sample was collected over a period of about 20 minutes. Total sampling time at each landfill for the six moisture samples was 3 to 4 hours.

Organic vapor analysis testing was performed at only Landfills 2 and 4. At Landfill 2, landfill personnel were asked to point out locations on the landfill where there were known vegetative stress problems, and OVA tests were performed at these locations. At Landfill 4, there were no specific gas migration problem areas, and tests were performed at random locations on the landfill surface. Organic vapor analysis testing was not performed at Landfills 1 and 3 because high winds were continually sweeping over the landfill surfaces, removing any buildup of organic vapor that might have been detectable.

3.2.2 Test Procedures at Landfill 5

At Landfill 5, there are two separate gas collection systems. An interior gas collection system collects the landfill production gas, and a perimeter collection system collects gas that migrates to the perimeter of the landfill. Figure 3-4 shows a diagram of the gas recovery and treatment processes at Landfill 5.

Reference Method 3C samples were taken from the perimeter collection main header. The sampling point corresponds to sample port A on Figure 3-4. Landfill gas from the perimeter wells is not treated prior to combustion in the flare.

Routine on-site gas composition testing by landfill personnel is performed by taking grab samples in Tedlar bags and analyzing the samples with a GC located in the gas plant control room. For this test program, field sampling for RM 3C was coordinated with on-site sampling and analysis. Reference Method 3C sampling by the field team and grab sampling by a landfill employee were performed alternately. A total of six RM 3C samples were extracted. The grab samples were then analyzed by landfill personnel, and the results were given to the field team. Therefore, the RM 3C results obtained through laboratory analysis can be compared to the results of on-site testing.

Reference Method 25C samples were taken from the main header serving the interior production gas wells. Samples were taken upstream of any gas treatment. The sample point for RM 25C sampling corresponds to sample port B on Figure 3-3. A total of six RM 25C samples were extracted.

Moisture samples were also taken from the main production gas header at the same point as the RM 25C samples (sample port B on Figure 3-3). A total of three moisture samples were taken.

Organic vapor analysis was performed at Landfill 5. Surface test readings were taken from several points at the perimeter of the landfill as well as from the surface of the interior production portion of the landfill.

3.2.3 Test Procedures at Landfill 6

There are three separate gas collection areas at Landfill 6. These three areas were filled with refuse and capped at different times. Separate headers carry landfill gas from each of these areas to one main header which then transports the gas to the gas recovery plant. Figure 3-5 shows a flow diagram of the landfill gas recovery and electrical generation process at Landfill 6.

Reference Method 3C samples were collected from each of the three separate landfill areas. The sample points correspond to test ports A, B, and C on Figure 3-5. Landfill personnel routinely test for methane concentration at these three ports using a hand-held methane analyzer.

A total of nine RM 3C samples were taken at Landfill 6, three samples from each area. A landfill employee performed methane testing using the

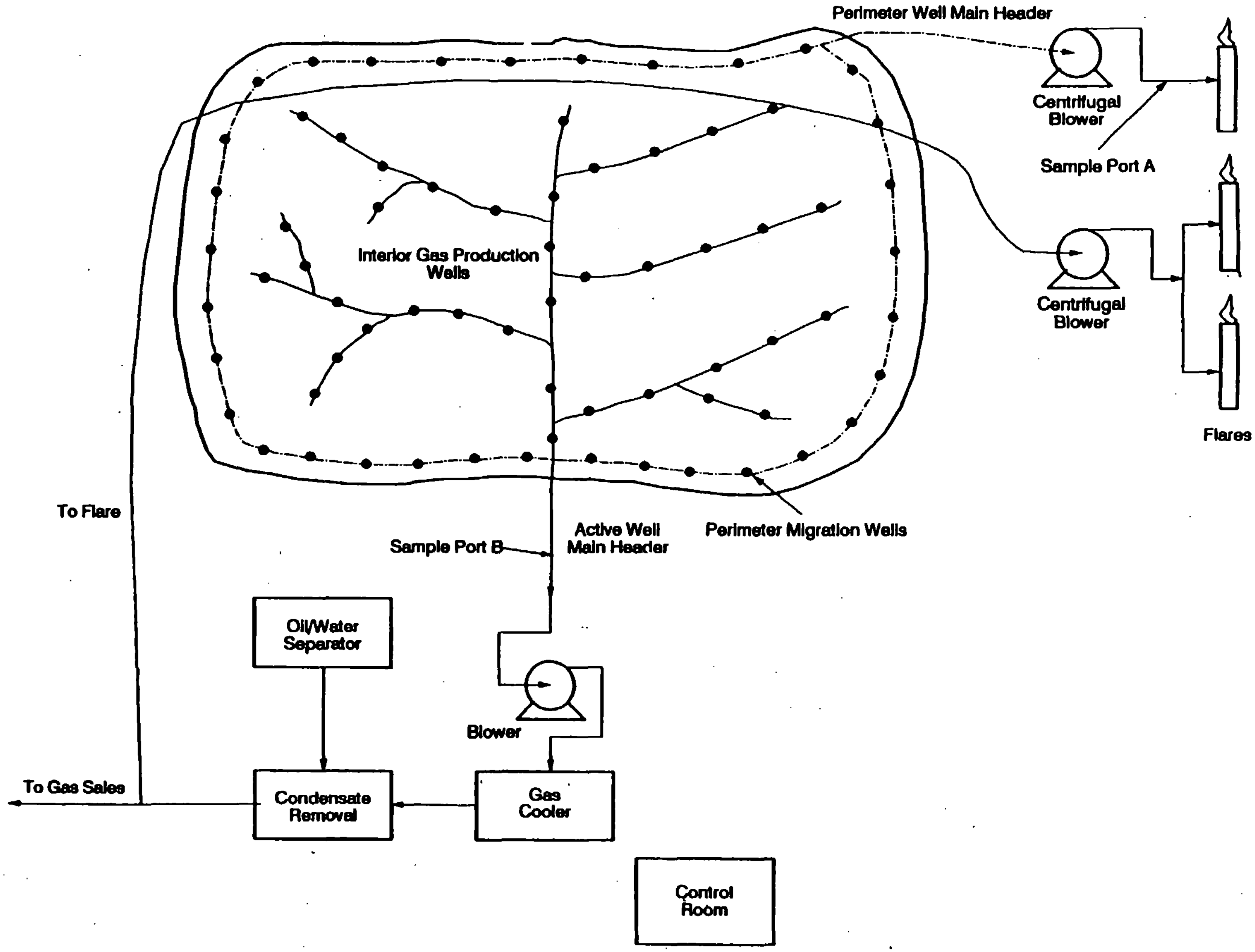

Figure 3-4. Landfill 5: Gas Recovery Process Flow Diagram

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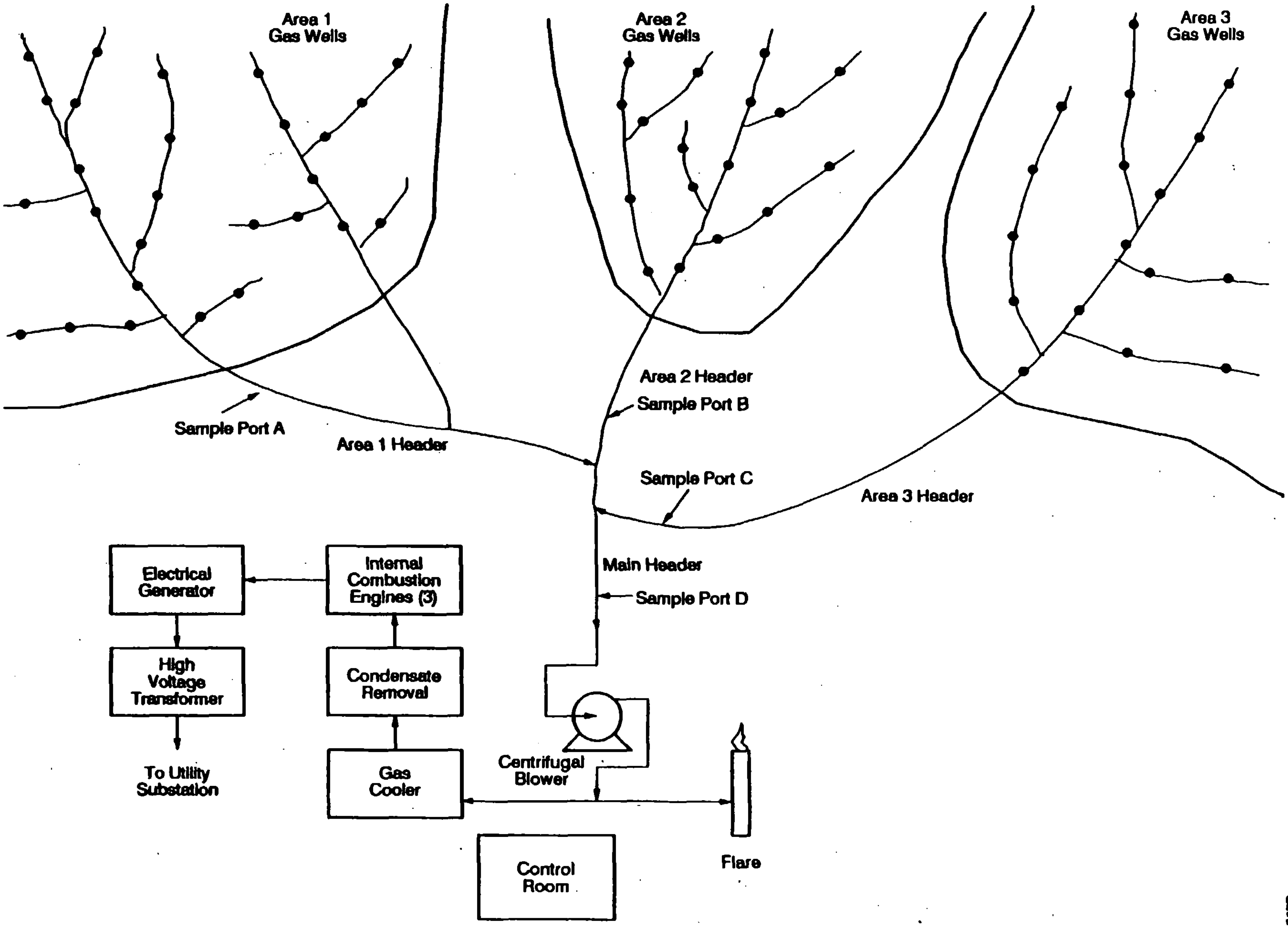

Figure 3-5. Landfill 6: Gas Recovery and Internal Combustion Engine Electrical Generation Process Flow Diagram

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hand-held analyzer prior to extraction of each of the RM 3C field samples. The results from the laboratory analyses of the field samples can then be correlated with the methane concentration results recorded during routine on-site testing.

It should be noted that for Area 1, the sample port on the Area 1 header (sample port A) is located upstream from the junction of a pipe carrying landfill gas from one section of Area 1. This port is used for routine sampling by landfill personnel, and the data obtained is integrated into the historical gas production data for Landfill 6. However, landfill gas from a segment of Area 1 is not represented in test results obtained from sample port A or in the data collected routinely by landfill personnel.

Reference Method 25C samples were taken in the same manner as RM 3C samples above. A total of nine samples were taken, three from each of Areas 1, 2, and 3 (sample ports A, B, and C on Figure 3-5).

Moisture samples were taken from the main landfill gas header that transports gas from all three areas to the gas plant. Samples were taken upstream of any gas treatment. The sample point for the moisture testing corresponds to sample port D on Figure 3-5. A total of three moisture samples were taken at Landfill 6.

Organic vapor analysis testing was performed on Area 1 of Landfill 6. Several areas in the landfill surface had fissures 3 to 4 cm wide and about a meter deep. These fissures were tested for organic vapor.

4.0 TEST RESULTS

This section presents the results of the comparative testing between the source operated analysis equipment and EPA reference methods. These comparisons are made for composition monitoring only due to problems encountered with the velocity testing sites. A discussion of these problems is presented later in this section. Field data sheets are included in Appendix D.

4.1 METHANE AND CARBON DIOXIDE

Table 4-1 presents the results of the RM 3C tests of CH_4 and CO_2 from each of the six landfills. (Note that the sums of CH_4 and CO_2 are less than 100 percent due to the presence of other constituents in the gas stream.) Sample locations for the RM 3C testing were selected to acquire a gas composition value which would be representative of the landfill gases collected from the site as monitored and recorded by the site operators. The procedures described in Section 3.1.1 were used to collect the samples for analysis by GC. Samples for Landfills 1 through 4 were collected at the gas line feeding the power turbines. This location was adjacent to the sampling point used by the on-site analyzers, and provided the ability to acquire concurrent samples with the site analyzers for subsequent accuracy evaluations. Gas samples for CH_4 and CO_2 analysis from Landfills 5 and 6 were collected from the locations normally used by site personnel for the routine checks made of composition. Sampling for gas composition at these two sites is performed manually and arrangements were made to collect samples concurrently for later accuracy comparisons.

On-site analysis of the landfill gas composition was made by an automated GC system obtaining a sample from one location at Landfills 1 through 4. Landfill 5 employed manual sample collection from a number of locations for operational data to maintain control of fugitive emissions as well as measurement of production gas compositions. Samples collected during the course of the day were analyzed using a GC operated in a manual batch processing mode. Gas composition measurements at Landfill 6 are made at various locations to permit balancing of the gas collection system. Samples are analyzed using a combustibles analyzer.

Table 4-1

RM 3C Test Results

Sample I.D.	CO2 (vol %)	CH4 (vol %)
Landfill 1		
4T42*	45.30	60.81
4T64	36.81	49.81
4T50	37.83	52.27
4T57	33.52	44.90
4T21	36.48	51.48
343	34.53	47.50
Landfill 2		
4T54	35.70	50.78
4T56	31.36	46.35
4T28	37.09	52.72
4T5	39.29	56.49
4T48	35.92	51.47
4T8	35.73	54.29
Landfill 3		
4T52	38.29	51.46
6156	37.82	51.13
6148	38.20	51.91
6103	38.34	52.78
6177	38.62	52.26
6181	36.81	50.10

Sample I.D.	CO2 (vol %)	CH4 (vol %)
Landfill 4		
39	44.97	53.38
45	43.44	54.47
150	44.82	53.35
175	46.24	53.76
70*	44.91	55.28
89	44.21	52.73
Landfill 5		
102	31.89	30.73
179	31.00	30.60
109	24.38	23.89
Landfill 6		
57	37.10	47.21
181	38.58	46.49
142	39.88	47.97
87	36.40	46.30
156	39.62	48.68
183	39.93	50.02
126	44.34	51.16
108	43.43	51.17

*The sum of CH_4 and CO_2 is greater than 100% -- results are attributed to sampling error.

Accuracy evaluations of the on-site instrumentation was performed similarly to the procedures established by EPA to assess continuous emission monitoring systems. This evaluation process involves determining the actual gas species concentration simultaneously with the instrument under scrutiny. The two resulting emission values are then compared and the differences between the reference method (in this instance RM 3C) and the analyzer are recorded. From this group of differences between the instrument and the reference method a confidence level is assessed and an accuracy value relative to the emission rate is calculated. (More detailed discussion of the calculation procedures is contained in Appendix B of 40 CFR 60, "Performance Specifications for Continuous Emission Analyzers.") Tables 4-2 through 4-7 present the results of the comparisons between CH_4 and CO_2 concentrations measured and those of the on-site analyzers. (Landfill 6 did not perform analysis of CO_2 at the time of testing, so CO_2 accuracy calculations were not possible.) The relative accuracy of each instrument, determined using the procedures listed in 40 CFR 60, Appendix B, are also presented in these tables.

There are currently no evaluation criteria established for accuracy of this type of instrumentation, so the following observations are made based on experience with other types of analyzers. In general, all of the instruments were observed to be operating in manner consistent with good operating practices. Calibration of the analyzers is performed by landfill personnel on a routine basis, and the instruments appeared to be included in a regular maintenance program. Three CH_4 analyzers exhibited relative accuracies better than 10% (Landfills 3, 4, and 6), and 5 of the 6 were within about 12%. Three of the five CO_2 instruments tested were found to have relative accuracies better than 15% (Landfills 1, 4, and 5). (An instrument is considered to be more accurate as the relative accuracy approaches zero.)

4.2 NONMETHANE ORGANIC COMPOUNDS

Results of the NMOC tests are presented in Table 4-8. Sample points for Landfills 1 through 4 were located as close as practicable to the collection field. At these sites however, this location was downstream of condensate collection tanks. It is not known to what extent NMOC concentrations may be reduced by these collection tanks. Samples collected at Landfills 5 and 6 were acquired before any gas cleaning took place, and should be representative

Table 4-2
Relative Accuracy Results for Landfill 1

Sample ID	Reference Method CO2 (vol %)	Reference Method CH4 (vol %)	Site Analyzer CO2 (vol %)	Site Analyzer CH4 (vol %)	Difference CO2 (vol %)	Difference CH4 (vol %)
4T42	45.30	60.81	39.39	51.78	*	*
4T64	36.81	49.81	39.33	51.78	2.52	1.97
4T50	37.83	52.27	39.41	51.81	1.58	-0.46
4T57	33.52	44.90	39.36	51.83	5.85	6.94
4T21	36.48	51.48	39.35	51.83	2.87	0.35
343	34.53	47.50	39.33	51.81	4.80	4.30
avg =	35.83	49.19		avg =	2.94	2.18
				sum x =	17.63	13.10
				sum x^2 =	74.35	70.81
sd = standard deviation				sd =	1.75	2.91
CC = confidence coefficient				CC =	2.17	3.61
RA = relative accuracy				RA =	14.25	11.77

* - since the sum of the reference method analyses was greater than 100% this test was not used in the calculations

Table 4-3
Relative Accuracy Results for Landfill 2

Sample ID	Reference Method CO2 (vol %)	Reference Method CH4 (vol %)	Site Analyzer CO2 (vol %)	Site Analyzer CH4 (vol %)	Difference CO2 (vol %)	Difference CH4 (vol %)
4T54	35.70	50.78	39.13	53.29	3.43	2.51
4T56	31.36	46.35	39.12	53.28	7.77	6.93
4T28	37.09	52.72	39.13	53.30	2.04	0.57
4T5	39.29	56.49	39.11	53.31	-0.18	-3.18
4T48	35.92	51.47	39.11	53.30	3.19	1.82
4T8	35.73	54.29				
avg =	35.87	51.56		avg =	3.25	1.73
				sum x =	16.25	8.65
				sum x^2 =	86.49	68.03
				sd =	2.90	3.64
sd = standard deviation				CC =	3.60	4.52
CC = confidence coefficient						
RA = relative accuracy				RA =	19.10	12.12

Table 4-4
Relative Accuracy Results for Landfill 3

Sample ID	Reference Method CO2 (vol %)	Reference Method CH4 (vol %)	Site Analyzer CO2 (vol %)	Site Analyzer CH4 (vol %)	Difference CO2 (vol %)	Difference CH4 (vol %)
4T52	38.29	51.46	43.39	55.11	5.10	3.65
6156	37.82	51.13	43.40	55.10	5.59	3.97
6148	38.20	51.91	43.40	55.10	5.20	3.19
6103	38.34	52.78	43.40	55.10	5.06	2.32
6177	38.62	52.26	43.40	55.11	4.77	2.85
6181	36.81	50.10	43.41	55.10	6.59	5.00
avg =	38.01	51.61		avg =	5.39	3.50
				sum x =	32.31	20.98
				sum x^2 =	176.13	77.78
				sd =	0.65	0.94
sd = standard deviation				CC =	0.68	0.98
CC = confidence coefficient						
RA = relative accuracy				RA =	15.95	8.68

Table 4-5
Relative Accuracy Results for Landfill 4

Sample ID	Reference Method CO2 (vol %)	Reference Method CH4 (vol %)	Site Analyzer CO2 (vol %)	Site Analyzer CH4 (vol %)	Difference CO2 (vol %)	Difference CH4 (vol %)
39	44.97	53.38	43.37	53.67	-1.60	0.29
45	43.44	54.47	43.37	53.65	-0.07	-0.82
150	44.82	53.35	43.36	53.62	-1.46	0.27
175	46.24	53.76	43.35	53.63	-2.89	-0.14
70	44.91	55.28	43.34	53.62	-1.57	-1.65
89	44.21	52.73	43.36	53.61	-0.85	0.88
avg =	44.76	53.83		avg =	-1.41	-0.20
				sum x =	-8.45	-1.17
				sum x^2 =	16.26	4.35
				sd =	0.94	0.91
sd = standard deviation				CC =	1.06	1.03
CC = confidence coefficient						
RA = relative accuracy				RA =	5.51	2.28

Table 4-6
Relative Accuracy Results for Landfill 5

Sample ID	Reference Method CO_2 (vol %)	Reference Method CH_4 (vol %)	Site Analyzer CO_2 (vol %)	Site Analyzer CH_4 (vol %)	Difference CO_2 (vol %)	Difference CH_4 (vol %)
102	31.89	30.73	29.66	29.76	-2.23	-0.97
179	31.00	30.60	28.81	28.91	-2.19	-1.69
109	24.38	23.89	29.06	29.14	*	*
115	46.53	55.29	44.29	49.11	-2.24	-6.18
135	48.23	56.54	44.86	48.50	-3.37	-8.04
900	47.37	55.67	44.84	48.64	-2.53	-7.03
avg =	41.00	45.77		avg =	-2.51	-4.78
				sum x =	-12.56	-23.91
				sum x^2 =	32.53	156.04
				sd =	0.50	3.23
sd = standard deviation				CC =	0.62	4.01
CC = confidence coefficient						
RA = relative accuracy				RA =	7.64	19.21

* - this test was not used in the calculations because there is a greater than 20% difference between the values from this test and the average values from the previous two tests.

Table 4-7
Relative Accuracy Results for Landfill 6

Sample ID	Reference Method CO_2 (vol %)	Reference Method CH_4 (vol %)	Site Analyzer CO_2 (vol %)	Site Analyzer CH_4 (vol %)	Difference CO_2 (vol %)	Difference CH_4 (vol %)
57	37.10	47.21		51.00		3.79
181	38.58	46.49		51.00		4.51
142	39.88	47.97		51.00		3.03
87	36.40	46.30		48.50		2.20
156	39.62	48.68		51.00		2.32
183	39.93	50.02		52.00		1.98
126	44.34	51.16		51.00		-0.16
108	43.43	51.17		51.00		-0.17
avg =	38.59	47.78		avg =		2.97
				sum x =		17.83
				sum x^2 =		58.03
				sd =		1.62
sd = standard deviation				CC =		1.35
CC = confidence coefficient						
RA = relative accuracy				RA =		8.45

Table 4-8
Nonmethane Organic Compounds Test Results

Sample Identification	Total Gaseous Nonmethane Organics (mg C/m^3)
Landfill 1	
	951
	1463
	805
	679
	802
	620
Average =	886.7
Landfill 2	
	841
	491
	771
	547
	555
	563
Average =	628.0
Landfill 3	
	1316
	1288
	2130
	765
	665
	1226
Average =	1231.7

Sample Identification	Total Gaseous Nonmethane Organics (mg C/m^3)
Landfill 4	
	902
	933
	1019
	888
	726
	1166
Average =	939.0
Landfill 5	
	2712
	2736
	2741
Average =	2729.7
Landfill 6	
	503
	384
	408
	405
	642
	461
	601
Average =	486.3

of total landfill NMOC's generated. A wide range of the NMOC concentrations were noted at the six sites (486 mg C/m^3 to 2730 mg C/m^3).

The large degree of variability between the NMOC results for the six sites may be caused by several factors. The primary influence is most likely the differences in landfill composition. Of a secondary, but potentially significant impact, is the use of condensate collection tanks at sites 1 through 4. It is suspected that these tanks, located prior to the sampling locations, may remove a certain amount of NMOC's from the landfill gas.

4.3 LANDFILL GAS FLOW RATE

During the test program development, measurement of total landfill gas flow rate was believed to be possible utilizing EPA Reference Method 2. Due to various operating conditions and constraints encountered in the field, it was not possible to perform velocity measurements for eventual comparisons to site instrumentation. The two principal constraints on using RM 2 for determining gas flow rates were the lack of sample ports adjacent to the on-site flow monitors and operational and safety considerations relating to the working pressures at the monitoring site.

At Landfills 1 through 4 the flow monitor (an orifice and differential pressure monitor) was located in the high pressure exhaust line of the gas compressor. Working pressures at this location were typically between 150 and 170 psi, precluding use of standard test equipment. Also, the only access for sampling would have been through one of the pressure tap ports of the differential pressure gauge, effectively disabling the flow monitor during the test. At Landfills 4 and 5 the problem encountered was one of limitations based upon site operational constraints. The available sample ports were located in the vacuum side of the gas collection lines. Insertion of the pitot tube in the ports would have caused significant air infiltration into the gas supply lines, causing problems with operating equipment. It was not the intention of this test program to impose any adverse or potentially dangerous operating conditions on any of the sites, so testing was not performed. Because no pre-site visit was possible before selecting a test method, there was no contingency plan for alternative sampling procedures.

An alternative approach was taken to assess the accuracy of the flow monitors used by the sites to record total gas flow from the landfills. The landfill operators were asked to describe the calibration procedures used for routine checks of the differential pressure gauges used at their landfill.

Each site routinely calibrates the differential pressure gauge against a standard reference. These procedures, as well as the frequency of calibration, were evaluated to determine if it would be possible to qualitatively identify the relative accuracy of the flow monitors. Based on the information supplied by the landfill operators, the flow monitors appeared to be reasonably accurate. Given the calibration procedures and instrument types, the expected accuracy of the flow monitors is about 10%.

5.0 STATISTICAL METHODS DEVELOPMENT

The ultimate objective of this research program is to determine which variables relating to refuse characteristics, landfill characteristics, or climate are significant determinants of gas production. This pilot study addressed a small number of sites and the results were not intended to be representative of all landfills. Rather, the study was intended to provide the basis for development of statistical methods for use in a larger study, to identify data quality issues, and to look for trends. This section describes the landfill and climatological data, the statistical methods used, and the results of the analysis.

The data obtained from each landfill consisted of computer printouts or handwritten data sheets listing total gas flow, percent CH_4 composition of the total gas flow, and other information applicable to the individual landfills. The data were usually in the form of daily averages of hourly flow rates, and were reported for each on-line gas recovery unit.

The descriptive data for each landfill are summarized in Table 5-1. The average CH_4 flow in standard cubic feet per minute (CFM)** was calculated from daily averages supplied by site operators. Although the between-landfill variation is large, ranging from 590 CFM to 3477 CFM (16.71 to 98.47 m^3/min), the day-to-day variability is relatively small, as shown by the coefficients of variation, which were generally below 10% except for Landfill 6 (12.4%). Data sources, limitations, and preparation are described in the next two sections.

5.1 DESCRIPTION OF DATA

5.1.1 Landfill CH_4 Data

Data were reported and summarized for each of the three on-line turbines at Landfill 1; for one on-line turbine at Landfill 2; for each of the two turbines at Landfill 3; and for each of the five turbines at Landfill 4. Applicable data for these four landfills include daily averages of total gas flow in cubic feet per hour and percent CH_4 composition of the gas streams for each turbine. Other available data include percent composition of other gases, temperature, pressure, run time, and other parameters.

**Flow rate at 25°C and 1 atmosphere.

TABLE 5-1. SUMMARY STATISTICS FOR EACH LANDFILL CALCULATED FROM DAILY CH_4 AND WEATHER DATA

Parameter	Landfill 1	2	3	4	5	6
Analysis Period	5/89 to 4/90	10/89 to 7/90	8/89 to 7/90	7/89 to 6/90	1/90 to 8/90	5/89 to 4/90
Number of wells	45	65 (44 VA)*	31	111	102	68
Average well depth (meters)	14	14	23	21	34	10
Number of hectares	35	55	51	57	32	40
Refuse mass (10^6 Mg)	6.3	6.1	7.3	13.8	10.9	2.6
Average landfill depth (meters)	67	26	66	56	46	10
1990 average age (years)	8	10	10	9.50	15	7
Total Methane Flow						
Number of days	194	302	314	85	209	37
Mean (m^3/min) (CFM)	55.36 (1955)	18.04 (637)	40.07 (1415)	98.47 (3477)	24.86 (878)	16.71 (590)
Standard deviation	2.12	1.19	2.32	1.33	1.70	2.07
Coefficient of variation (%)	3.80	6.60	5.80	1.40	6.80	12.40
Temperature						
Mean (°C) during analysis period	7.34	7.67	10.51	24.96	16.12	16.57
30-year normal	7.51	9.28	12.23	23.96	17.12	16.18
Precipitation						
Total (cm) during analysis period	80.52	86.36	111.51	101.6	22.86	42.16
30-year normal	73.15	90.42	107.7	156	43.18	45.5

*VA = very active; other wells were primarily for odor control.

Data from Landfill 5 were reported and summarized for each well type. Wells at this site are classified as either "production" or "perimeter" wells. Applicable data include production and perimeter well gas flows, total CH_4 sold, and percent CH_4 composition of the production and perimeter well gas flows. The gas flow and gas sales data were all reported as daily averages in CFM.

Data from Landfill 6 were reported and summarized for each of five specific areas. Applicable data include daily averages of total gas flow in CFM and percent CH_4 composition for each area. Other data available at Landfill 6 include daily averages of CH_4 flow in CFM per refuse wet weight per year for each area.

5.1.2 Weather Data

Daily temperature and precipitation data were obtained from the State Climatologist's Office in each respective state for a cooperative National Weather Service (NWS) station nearest each landfill. In most cases, the State Climatologist made copies of the appropriate pages from Climatological Data (U.S. Department of Commerce, 1989-1990). At the time of this study, the current issue of Climatological Data was June 1990; thus, daily weather data were available for most of the same time period as the available CH_4 data.

In addition to the daily weather data, 30-year averages of monthly and annual temperature and precipitation were obtained for the NWS stations (U.S. Department of Commerce, 1982). These 30-year averages are referred to as the "normal" values.

Weekly values of the Palmer Drought Severity Index (PDSI), which are reported by climatic division within a state, were obtained for all reporting weeks in 1989 and 1990 from the Weekly Weather and Crops Bulletin (NOAA/USDA Joint Agricultural Weather Facility). The PDSI reflects the long-term moisture balance, which affects groundwater volume. The PDSI is generally reported every other week between April and October.

5.2 DATA PREPARATION

5.2.1 Landfill CH_4 Data

Because the landfill CH_4 data arrived in the form of paper printouts, the data applicable to this study were first entered into computer files for further processing. Exploratory data analysis was then performed for total gas flow and percent CH_4 composition on a turbine-by-turbine basis for Landfills 1 through 4, on a well type (i.e., producing wells versus migration collection wells) basis for Landfill 5, and on an area-by-area basis for Landfill 6. This exploratory analysis consisted primarily of summary statistics, including a listing of the five largest and smallest extreme values, and time series plots of the data. The intent of the exploratory analysis was to remove outliers and any other data deemed unrepresentative of the true population.

No rigid procedure was adopted for outlier removal because outliers were very obvious. However, in removing outliers, two general steps were followed. In the first step, any of the five largest or smallest extreme values that were obviously different from the other extreme values, or that were obviously far from the bulk of the data (as indicated by Box plots) were removed. In the second step, the remaining data were plotted in time series fashion. Any data points that were located outside the region of general variability of the majority of the data were removed. Most of the points removed in the second step were associated with periods leading to downtimes, with periods beginning from start-up times, or when there were other problems with the gas collection system. For borderline data points, landfill operators were sometimes contacted to verify that problems existed at the time data were collected.

After the outliers and questionable data were removed, CH_4 flow rates were calculated for each turbine, well type, or area by multiplying the total gas flow rate by the percent CH_4 composition. Because landfill parameters were unknown for individual turbines, well types, or areas at most landfills, a total CH_4 flow rate for each landfill was calculated by summing the CH_4 flow from all gas recovery systems. These sums were calculated only when all systems were operating, or when data were reported from all well types or areas. When necessary, total CH_4 flow rates were converted to CFM for between-landfill comparisons.

Time series plots were then made of the total CH_4 flow rates for each landfill. Because the total CH_4 was calculated only when all turbines, well types, or areas were reporting, there were gaps in the plots at each landfill. Thus, it was decided to further analyze only the one-year span that contained the most complete data.

The time series plot for Landfill 2 revealed noticeably different CH_4 flow rates before September 1989 compared to those after September 1989. The landfill operator was contacted and it was found that 30 additional wells were brought on-line in September 1989. Thus, data before and after that time were not comparable and a one-year period of comparable data did not exist. The period between September 1989 and July 1990 was selected for further analysis.

5.2.2 Weather Data

The daily weather data for all but one site also arrived in the form of paper copies from Climatological Data (U.S. Department of Commerce, 1989-90). As with the landfill CH_4 data, the weather data were entered into computer files for further processing. However, the only screening necessary for the weather data was a quality check to ensure that the correct numbers had been entered from the printouts. Data in Climatological Data publications have already been screened for accuracy and are officially certified.

The monthly normals of the weather data and the weekly PDSI data originated from paper copies and were also entered into computer files for further processing. As with the daily weather data, no additional screening was necessary, except for ensuring that the numbers had been entered correctly.

5.3 STATISTICAL METHODS AND RESULTS

One objective of this study was to determine if sufficient data were available for a time series analysis of methane emission rates from individual landfills. Methane recovery is a relatively new process, and none of these landfills had records for methane emissions of sufficient length (several years) and completeness for time series analysis. It is highly probable that emissions are autocorrelated so that any attempt to find correlations between methane recovery and weather data on a daily or monthly basis is likely to be confounded by autocorrelations in the data. Since the strength of autocorrelation decreases with averaging period, only annual averages were used in the statistical analysis of the relationship between long-term CH_4 emissions and weather data between landfills. The annual CH_4 averages were correlated to annual averages of temperature and precipitation obtained from 30 years of data, as well as to other landfill parameters.

Table 5-2 shows the Pearson correlation coefficients between annual CH_4 flow rates and CH_4 flow rates per unit mass with the annual and long term (normal) weather data and other landfill parameters for the six landfills. Only two correlations with CH_4 flow rate were found to be significant at the 95 percent confidence level and no correlation coefficients were significant with the CH_4 flow rate per unit mass. The low number of significant correlations can be attributed, at least in part, to the low number of

TABLE 5-2. CORRELATION COEFFICIENTS OF CH_4 RECOVERY VARIABLES WITH LANDFILL PARAMETERS AND SUMMARIZED WEATHER DATA (n=6)

	Dependent Variables	
	Annual Methane Recovery Rate	Annual Methane Recovery Rate per Unit Mass
Independent Variables		
Annual temperature (1989-1990)	0.56	0.12
Normal annual temperature	0.51	0.01
Annual precipitation (1989-1990)	0.55	0.33
Normal annual precipitation	0.81*	0.25
1990 mean age of landfill	-0.15	-0.80**
Number of wells	0.37	-0.15
Tons of refuse	0.71	-0.18
Mean depth of landfill	0.62	0.26
Area of landfill	0.37	-0.04
Volume of landfill	0.74*	0.24
Mean well depth	0.10	-0.58

*Correlation coefficient significant at 95 percent confidence level.

**Correlation coefficient significant at 90 percent confidence level.

observations. The normal annual precipitation correlated fairly well with the one-year annual mean CH_4 flow rate, and even though it was not significant for the CH_4 flow rate per unit mass, it had the largest positive correlation coefficient. The correlation coefficient for refuse mass with CH_4 flow rate was just under the cutoff point for significance at the 95 percent confidence level, but its value of 0.71 suggests that perhaps with more data it would be significant.

Figure 5-1 shows the scatter plot of mean annual CH_4 flow rate per unit mass versus 30-year annual mean precipitation for the six landfills (as numbered). The least squares regression line is also shown to indicate the trend. With only six data points, it is impossible to determine any significant relationship.

5.4 DISCUSSION

These comparisons yielded promising results and are worth pursuing further. The strongest correlation was the positive relationship between CH_4 flow rate and weight of refuse in place--not a surprising result. Variability of flow rate data appears to increase with larger landfills, but this effect needs to be analyzed further. It is possible that larger landfills vary more in depth than smaller ones, which may affect production rates. However, this is not likely to be important for estimating global emissions.

The CH_4 flow correlated well with landfill volume, land area, and other measures of size. For global CH_4 estimation, refuse mass is the only relevant size variable and, fortunately, CH_4 flow appears to be a linear function of mass. In order to determine the effects of climate on CH_4 production, the effect of mass needs to be removed. Therefore, results that relate to CH_4 per total refuse weight in place were the most pertinent for estimating global CH_4 production.

Three variables are of particular interest: normal annual mean ambient temperature, normal annual precipitation, and age of refuse. The production of CH_4 per ton of refuse is expected to show a lag in the early years, rise fairly rapidly to a maximum, and then to decline slowly with age of the refuse. The length of the lag can be very short, particularly under optimal conditions. Since the population of landfills within a country represent the entire range of ages, all that is of interest, ultimately, is the average annual CH_4 produced per ton of refuse. However, since refuse age does appear to have a strong effect, it needs to be included in the analysis.

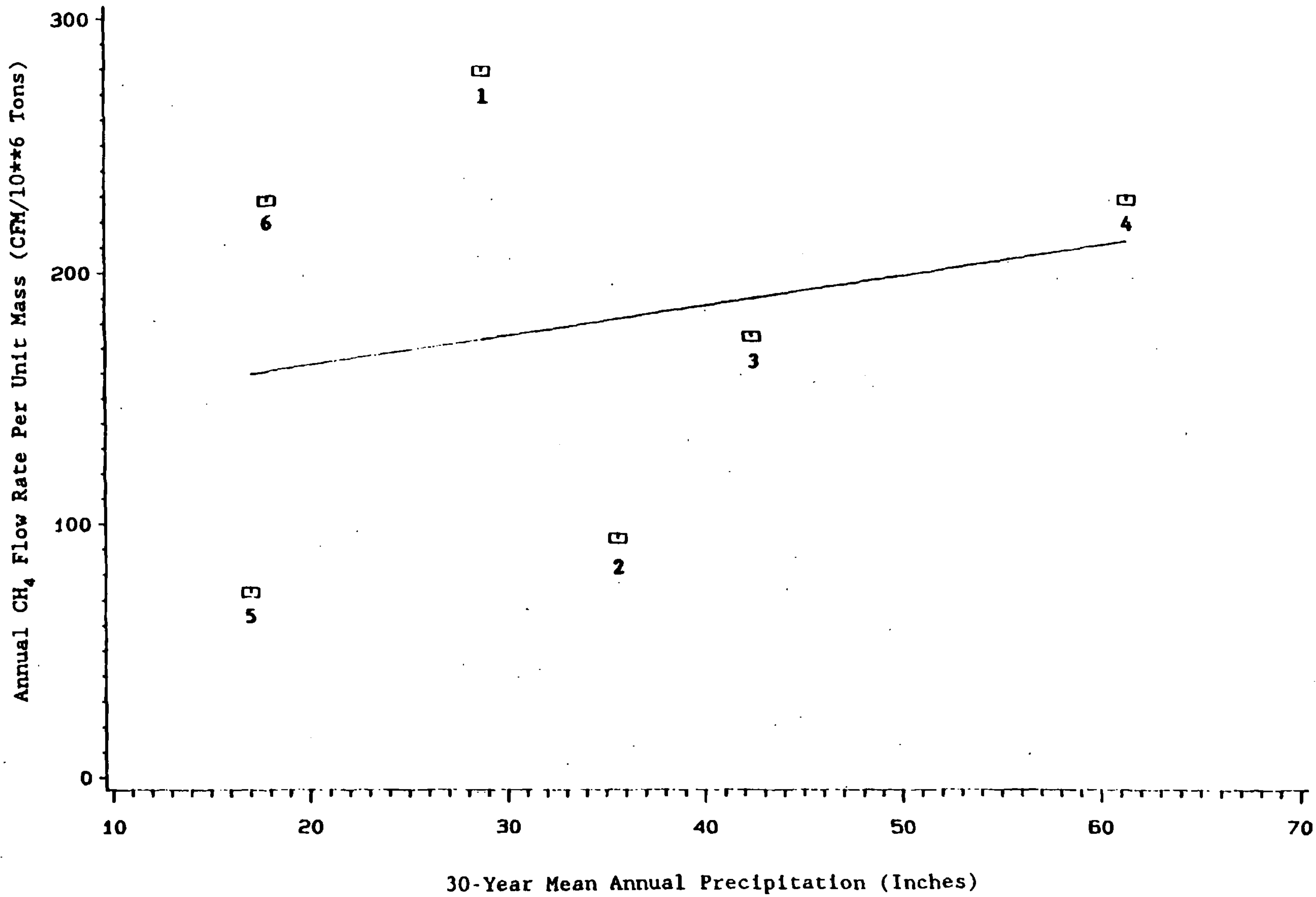

Figure 5-1. Annual CH_4 Flow Rate per Tons of Refuse Versus Normal Precipitation.

To accurately quantify the effects of climate on the rate of CH_4 production, interactions between refuse age or landfill characteristics and climatic effects need to be identified.

It is likely that long-term (normal) precipitation affects methane production. Although a cap may impede rainfall infiltration, some rainfall may enter before the final cap is in place. When a site is open and refuse is being added, precipitation can accumulate. The patchiness of moisture in landfills is borne out by the boring logs of two of the landfills in the study. A well dug at one location in a landfill found very dry conditions, with little or no degradation of the waste; another well in a different location within the same landfill found saturated conditions, with completely decayed wastes. These difference may be due, in part, to the moisture in the waste itself, but it is more likely that they are the result of whether or not it was raining the day the refuse was put in place and covered.

6.0 CONCLUSIONS

With the exception of flow measurements, the test procedures selected for this project were well suited to the types of gas recovery installations encountered at the landfills visited. Alternative flow measurement methods that are more appropriate to the site conditions must be identified if flow measurements are desired in the future. Since all sites record flow data, however, a quality assurance program could be used to determine the acceptability of the on-site data.

Based on comparisons between the RM 3C and instrument analyses of the landfill gas composition, all on-site analysis instruments appeared to be operating within reasonable accuracy ranges. Review of calibration procedures and records indicate that long-term instrument accuracy should be comparable to the accuracies noted during on-site testing.

NMOC results for the sites exhibited moderate to significant variability. The NMOC data variability is most likely due to differences in waste composition. Of a secondary, but potentially significant impact, is the use of condensate collection tanks upstream of sample collection points at some of the sites. The method used for these tests requires extensive field collection, analytical, and data reduction time. Should further NMOC measurements be needed in the future, alternative methods are available that will improve turn-around of results with very little, if any, loss in data accuracy.

Although the results of this small study are sufficiently encouraging to warrant further data gathering and analyses, some limitations need to be recognized. The main problem was that the collection efficiencies of the CH_4 recovery systems were not known. Where emission control was one (or the only) reason for the collection system's existence, efficiency appeared to be high. However, this is a qualitative assessment based on visual inspection of the landfills and an assessment of operating practices at the landfills. Perhaps landfills where CH_4 recovery systems are used for emissions control can be used as the benchmark, if enough of them can be found. Again, the end-use of the gas should be part of the site selection process.

One key piece of information is missing from most landfills: the average composition of the refuse. Not only would it be useful to know the total percent of the refuse that is biodegradable, it would also help to know the percentage of putrescibles (i.e., rapidly decomposing garbage such as kitchen wastes), paper and textiles, and slowly decomposing organics such as leather and wood. Waste composition undoubtedly contributes to data variability but, unfortunately, it is not possible to get composition information for most landfills in the United States.

Also, it is impossible to fully account for differences in the structure and operating characteristics of landfills. All of these unknowns contribute to the variability of the CH_4 flow rate data. Although it should be possible to explain some of the variability, a certain amount will always remain.

It is likely that the functional relationships between CH_4 per ton of refuse and age and climate are nonlinear, or that interactions between these variables produce nonlinearities. With a larger sample size, it may be possible to identify these nonlinearities, and fit the data to the appropriate model.

Finally, these analyses illustrate the importance of carefully selecting study sites. By chance, the larger landfills in the pilot study were located in regions with the highest precipitation. This resulted in a strong positive correlation between precipitation and tons of refuse. While this relationship can be removed to a large extent by using CH_4 per ton of refuse as the dependent variable, it makes identification of possible interactions between precipitation and landfill size impossible. In the next phase of the study, as much data as possible on physical characteristics and operating procedures should be gathered to facilitate site selection. An equal number of large and small landfills should be chosen from wet and dry regions. A greater proportion of the sites should be from extremely wet or dry climates. This will make it more likely that significant effects are detected, if they exist.

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APPENDIX A

LANDFILL SURVEY FORM

Call Made By ______________________________ Date Call Made ______________
Landfill Facility Name: ______________________________
Address: ______________________________
____
____

Contact at Landfill: ______________________ Phone Number: ______________

Please provide the following information for only that portion of your landfill where methane is being recovered. Please provide this information for the period of time that data has been collected. For items such as the number of wells that may have changed over time, please provide the current information.

PRIORITY DATA

Active Landfill? ______________________________
Date Waste Acceptance Began ______________________________
Date Waste Acceptance Ceased ______________________________
Date Methane Recovery Began ______________________________
Gas End Use ______________________________
Annual Methane Production Rate ______________________________
Tons of Refuse in Place ______________________________
Age of the Refuse ______________________________
Number of Acres ______________________________

ADDITIONAL INFORMATION (provide as necessary)

Number of Active Wells (Regular- or High-Flow Wells) ______________________________
Number of Low-Flow Wells ______________________________
Depth of Active Wells: Minimum __________ Average __________ Maximum __________
Depth of Low-Flow Wells: Minimum __________ Average __________ Maximum __________
Depth of Landfill: Minimum __________ Average __________ Maximum __________
Methane Recovery System (i.e., turbine, IC engine, other): ______________________________
Landfill Design (i.e., cell, canyon, trench, or other) ______________________________
Cap Composition ______________________ Cap Thickness ______________
Cap Permeability ______________________________
No. of Flares (if applicable) ______________________________
Acceptance Rate of Waste by Year ______________________________
Total Capacity (by weight): ______________________________

[If capacity is provided by volume, what is the average refuse density?]

____

Daily Soil Cover Information (does volume number include ALL refuse or soil and refuse?)

____

Results of Routine Testing for Surface or Perimeter Leaks ______________________________
Any other data available on:

Refuse Composition? ______________________________
Gas Composition? ______________________________
Moisture Content of Refuse? ______________________________
Compliance Testing of Power Generation or Control Equipment Exhaust?

____

APPENDIX B1
LANDFILL CHARACTERISTICS

The following discussion will present a brief description of each landfill tested. Following these descriptions will be a general discussion of the type of information gathered at each site. Historical refuse composition data of interest includes the age, acceptance rates, the type of refuse in place (preferably as shown on a map of the landfill), and any history of hazardous waste codisposal. Other information of interest includes the groundwater proximity to the refuse in place, rainfall patterns, cap permeability, and leachate collection (to give some indication of refuse moisture content and any changes in conditions).

Landfill 1

The first landfill was visited August 6, 1990. Located in Wisconsin, this site is considered to be representative of sites in cool, wet climates.

The landfill covers about 35 hectares, with a refuse height of 67 meters. Refuse was originally placed at this site in the 1950s. The original owners filled approximately three cells. The site also accepted hazardous waste until the early 1980s (placed in separate cells). The current owners purchased this site in 1972. Refuse acceptance ceased June 1989, and the landfill was closed.

An estimated 9 to 11 x 10^6 cubic meters of refuse are in place at this site. On-site personnel at Landfill 1 do not typically report refuse by weight, but the Corporate Office stated that a total of 6.3 x 10^6 Mg of refuse are in place.

Cap thickness on the landfill is reported to be at least 1.5 meters; rainfall percolation through the cap is estimated by on-site personnel to be less than 2.5 cm/yr.

Gas recovery began at this site December 31, 1985. Three Solar Centaur turbines are currently in place and operating full time (at 3,300 kW/turbine). Forty-five wells are in place, 25 along the perimeter of the site that were installed in 1985 and 20 on the interior portion of the site that were added in 1987. Six wells are over the refuse placed by the original owner, and average well depth is 12 to 15 meters. The wells installed most recently are 24 to 27 meters deep.

As of July 1, 1990, 1.8 x 10^8 cubic meters have been recovered (producing 141,202,025 kW-hrs of energy). The Corporate Office stated that 162,823 cubic meters are recovered per day.

On-site personnel estimate leachate production (primarily due to rainfall) to range from 1.5 to 1.7 x 10^6 liters/month.

Landfill personnel do not routinely monitor for surface or perimeter leaks. Problem areas are usually identified by visual inspection of the surface for vegetative stress. Once a problem area is identified, the decision is made as to whether or not to install a new well. They are currently dealing with a problem area that shows methane levels of 20 to 30 percent (no details provided on the size of this area).

Except for roadbeds, the entire surface was seeded with grass. The only fissures noted in landfill surface appeared to be due to water erosion. On the day of the site visit, it was too windy to detect gas odor or conduct OVA sampling.

Landfill 2

The second landfill tested (August 7, 1990) is located in Illinois. Gas is being recovered from the two closed sections of Landfill 2. The oldest closed section of the recovery area covers about 28 hectares, and the average refuse height is about 30 meters. The newer closed section of the landfill covers about 26 hectares, and the average height is also about 30 meters. Refuse was first placed in the older section of the landfill in 1968, and the previous owner filled about 8 hectares. The current owner took over the site in 1980. Refuse acceptance at the newer section of the landfill began November 1982.

Approximately 3.6 x 10^6 Mg of refuse are in place in the older closed section, and 2.5 x 10^6 Mg in place in the newer closed section.

The original owners were very inconsistent in cap placement and cap thickness. Cap thickness in the older section varies from 0.15 to 2.4 meters. The newer section of the site has an average clay cap thickness of 0.9 meters. The current owner uses visual vegetation inspection and routine surface monitoring to identify areas that need to have a new or a thicker clay cap installed.

The current owners of this facility installed a flare system in 1988, and converted to Solar turbines in January of 1989. The facility has two turbines manufactured by Solar, but only the Centaur (3,300 kW) is currently active.

The other turbine, a Saturn (933 kW), is slated to go on-line after more wells are installed in the fall of 1990.

There are 65 wells currently on-line (72 wells total). Of the 65 wells on-line, 45 are considered very active and 17 are "tubed" (very low flow, installed primarily to control odors). The oldest section of the landfill has 40 wells in place, and the other 30 are on the newer section.

Total combined gas recovery from both sections of the landfill is about 56,600 cubic meters per day.

The oldest section of the landfill produces from 19,000 to 30,000 liters of leachate per week. The leachate and the landfill gas condensate are transported by truck to a local wastewater treatment plant. The newer section of the landfill produces a much smaller quantity of leachate (not quantified, however).

Routine gas monitoring reports of permanent probe testing for pressure, percent methane, and water levels are prepared by landfill personnel. Wells are added as needed to improve gas recovery. The landfill operators place a great emphasis on controlling any gas migration problems to prevent odor complaints and vegetative stress.

A visual inspection of the vegetation growing on the landfill surface revealed only one area with vegetative stress; a well had already been installed to correct the problem, but it was not under a vacuum yet. Gas was bubbling through the water that had collected in the bottom of the well. No odors were detected in any other parts of the collection area. Although gusting winds were present at the time of the site visit, OVA tests for ambient methane were conducted. The only location at which measurable concentrations could be found was within a new well enclosure. No other significant leaks were found.

<u>Landfill 3</u>

Landfill 3, in Pennsylvania, was visited August 9, 1990. Gas is recovered from the closed portion of Landfill 3, which covers about 51 hectares. The active portion covers about 24 hectares, and will also have gas recovery. The height of the closed portion is about 66 meters, with no refuse below ground level. Refuse acceptance began in 1970 and essentially ceased in 1988 for the portion of the landfill with gas recovery. The original owner placed refuse on about 21 hectares (lined with 1.6 cm thick asphalt). Hazardous wastes were accepted until 1981, and make up about 1% of the total refuse. The current owner took over the site in 1981. Refuse is still being added in small amounts to the closed portion as settling occurs.

Annual refuse intake can only be estimated for the previous owner's years of operation; the current estimate is that a total of 8.4 x 10^6 Mg are in place (29,000 Mg/month). Average clay cap thickness is 0.6 meters.

Gas was originally vented to the atmosphere to control off-site migration. Gas recovery began with the installation of a Solar Centaur turbine (3,300 kW) in January 1988. A second Centaur turbine was added June 1989. Both turbines are currently operating full time.

A total of 31 wells are on the site, with an average well depth of 100 feet. The Corporate Office estimates that this site recovers 1.2 x 10^5 cubic meters of gas per day.

Landfill personnel estimate that approximately 132,000 liters of liquid are collected each month. Included in this estimate are about 19,000 liters condensate generated each week.

Landfill personnel report that they are encountering problems on the eastern slope of the recovery area, with organic vapor surface probe readings of 25 to 48 percent as methane. One suspected reason for this problem is the fact that this slope has several leachate manholes that are not tied into the gas collection system. They are currently trying to address this problem.

There were a few areas with sparse vegetation, but it could not be concluded that these areas had migration problems because the topsoil applied to the site was very poor quality (very rocky), and there had been a 6-week period with very little rain. On the eastern slope, there was a very strong gas odor in at least five separate areas (even with a brisk wind), but there were no signs of vegetative stress. Most of these areas, however, were probably located near leachate manholes. On the day of the site visit it was too windy to attempt OVA sampling.

Landfill 4

During the second week of testing, a landfill in Florida was visited (August 20, 1990). This climate is considered representative of hot, wet areas. Gas is recovered from the closed portion of Landfill 4. Another portion of the landfill is currently accepting refuse. The average refuse height on the closed portion is 56 meters above sea level, including a 0.5 meter thick cap on the uppermost 16 hectares. The closed portion covers about 57 hectares and is shaped like a pyramid. Refuse acceptance began in

1971 and ceased in April 1989. The next portion was then opened. Portions of the landfill also accepted sludge from a nearby wastewater treatment plant in the past and continue to do so.

The total volume of the part of the landfill with gas recovery is 14 x 10^6 cubic meters. Using a compacted density of 889 to 1,067 kg/cubic meters, there are 12.5 to 15.0 x 10^6 Mg of refuse in place. Monthly gate receipt information was gathered for 1987 through July 1990. This information shows both cubic meters (yard waste and construction and demolition debris) and Mg (garbage) brought to the landfill. On-site personnel recommended that a conversion factor of 237 kg/cubic meter be used for the refuse measured in cubic meters, and indicated that construction and demolition debris account for about 15.5% of the cubic meters reported. After converting cubic meters to Mg, it appears that construction and demolition debris make up from 5.5 to 6% of the total volume. Given an average compacted refuse density of 978 kg/cubic meter, of the 13.8 x 10^6 Mg of refuse in place in the closed portion of the landfill, 5.75% (793,553 Mg) can be assumed to be construction and demolition debris. Removing this non-organic fraction yields an estimated methane producing total tonnage of 13 x 10^6 Mg.

Final cover on the closed areas of Landfill 4 is 45.7 cm of topsoil, 45.7 cm of clay (rock tailings), and 45.7 cm of sand. This cover is very permeable to rainfall and the permeability also limits the amount of vacuum that can be applied.

Landfill 4 currently has 111 wells in place. Average well depth is 21 meters, with depths ranging from 18 to 46 meters. Five Solar turbines (each with a rated capacity of 300 kW) were installed and brought on-line during March and April of 1989. Official start-up began July 1989. Previous to this time, recovered gas was processed in a former gas plant and/or flared. Currently, the facility is continuously operating four turbines at 95% capacity. At the time the study was conducted, the maximum gas recovery rate attained was 283,170 cubic meters per day, but recovery had leveled off to about 156,000 cubic meters per day. The Plant Manager hopes to increase recovery by installing eight new deep wells. There are also plans to tie the other closed cells into the gas recovery system. Gas recovery in closed areas can begin 6 months after construction is started.

The Plant Manager estimated leachate collection to range up to 5.3 million liters/month, depending on rainfall. Because the cap is so permeable, the amount of leachate produced will be greatly affected by rainfall amounts. Leachate and condensate from the area currently accepting waste are shipped off site to a wastewater treatment facility. The portion of the landfill with gas recovery does not have a true leachate collection system.

Permanent bore holes have not been installed for routine perimeter gas migration monitoring. Buildings near the perimeter of the site (up to 305 meters from the landfill) are routinely tested for gas levels.

Organic vapor analyzer measurements were restricted due to gusting wind conditions. During close visual inspection of the vegetative stress areas, OVA readings up to 400 ppm were noted. Due to the variable wind conditions, it is not known if this was a peak concentration or not.

On-site personnel indicated that when vegetation stress is identified, they first try to adjust the vacuum on nearby wells. If required, a decision is made as to whether a new well should be added to alleviate the vegetative stress. Soil dehydration due to lateral gas lines may also result in vegetative stress.

Landfill 5

Landfill 5, located in southern California, was the only site in a hot, dry climate, tested (August 23, 1990). Gas is being recovered from the closed portions of the landfill. The refuse was (and still is) placed in the pit left from a gravel mining operation. The average refuse height is 46 meters, with a maximum of 76 meters. No refuse will be placed above grade. The closed portion of the landfill is about 32 hectares. Refuse acceptance began at this site in 1952, and there is no known history of co-disposal of hazardous waste. During the 1950s and 1960s, the site primarily received inert waste, but at that time the waste also contained a high proportion of orange trees. The very center portion of the landfill reportedly contains a high proportion of construction and demolition debris, but there is still some gas produced at wells in this area. Reinjection of condensate to boost moisture in the refuse was permitted by the local authorities until 1985. Landfill personnel note, however, that since this practice ceased, there has not been any appreciable drop in either gas or condensate production.

The closed portion of the landfill has approximately 11×10^6 Mg of refuse in place, and the active portion of the site accepts another 1.4×10^6 Mg each year. Total capacity of the site is permitted to be 23×10^6 Mg tons over 122 hectares. Examination of gate receipt records for

1987 through February 1989 shows a breakout of solid waste (Class 3 decomposable waste) and inert wastes. On the average, inert wastes account for approximately 20% of the total wastes received. Much of these inert wastes are debris from the adjacent gravel mining operation. Thus, it may be estimated that of the 11 x 10^6 Mg of refuse in place, approximately 8.7 x 10^6 Mg are decomposable waste.

A 1984 report on gas production at this facility indicates that at that time, 8 x 10^6 Mg of refuse were in place, of which inerts accounted for 10% of the total.

The closed portion of the landfill does not have a final cover in place yet (will be installed Fall 1990). The area is currently covered with a permeable silty sand and is not vegetated. Landfill personnel estimate the moisture content of the refuse in place to be 12%.

Gas collection first began at this site in 1976; the previous owners periodically used an internal combustion engine to produce energy or flared the gas. The site was purchased by the current owners in 1987.

The closed portion of this landfill has a total of 102 wells. These wells are divided as interior (42) and perimeter (60) wells. Orifice plates are used on each well to measure and control gas flow. The lines connecting these two well systems are kept separate and lead to flares on the perimeter of the site. There are three flares at the site, one for each well system and one for backup use only. The interior wells are better producers than the perimeter wells, with high gas flow and higher methane content of the gas (48 vs 32%). The depth of the interior wells ranges from 46 to 76 meters, while the perimeter wells, designed primarily for migration control, are much shallower.

A Solar skid is used for gas compression prior to flaring, and condensate is treated in an oil-water separator. Landfill personnel estimate that hydrocarbons account for 1% of the condensate. The water is transported to an off site wastewater treatment facility, and the hydrocarbon fraction is handled as a hazardous waste and burned off site as kiln fuel.

There is currently only a sporadic market for gas sales at this facility. Local regulations often limit customer use of landfill gas. Operators of this facility are optimistic that gas sales will increase in the future, and predict that as waste acceptance rates increase, gas recovery rates will also increase.

Because of the age of this landfill, there is currently no leachate collection system in places where gas is being collected.

Perimeter gas migration is controlled by the 60 shallow perimeter wells that encircle the closed portion of the landfill. Monthly surface test data (2.5 samples/hectare) typically indicate organic vapor readings below 50 parts per million.

No measurable organic vapors levels were detected. Vegetation has not been established on any portion of the landfill.

Landfill 6

Landfill 6, located in northern California, was visited August 24, 1990. This landfill was the only one visited where gas recovery and refuse composition data could be gathered for separate portions of the landfill. As shown in Figure 3-5, three portions of the landfill had separate gas recovery lines. The dates of refuse acceptance at these three areas were estimated through discussions with landfill personnel.

Gas is recovered from the closed portions of the landfill (Areas 1, 2, and 3). Refuse is currently being placed in another area. The acreage and the estimated volume of refuse in place for each of the closed units are shown below:

- Area 1: 27 hectares, 1.74 x 10^6 Mg refuse;
- Area 2: 10 hectares, 5.8 x 10^5 Mg refuse; and
- Area 3: 3 hectares, 2.5 x 10^5 Mg refuse.*

There are an estimated total of 2.6 x 10^6 Mg of refuse over 40 hectares at this site.

Refuse was first accepted at this site in 1975. The refuse placement dates for the closed portions of this site are:

- Area 1: 1975-1983, 1987, 1988;
- Area 2: 1983-1986; and
- Area 3: 1984-1986, 1989.

*This area does not include the 6.7 hectares and 11 wells brought on-line May 1990.

Area 1 did not accept any refuse from approximately 1983 through 1986. After this period, landfill personnel decided to add another 4.6 meters of compacted refuse to the top of Area 1 units, and this addition was completed in 1988. The height of the refuse placed on the 3 areas ranges from 9.7 to 13.7 meters, all above ground level. The final cover on Areas 1 and 2 and part of Area 3 consists of a 1.2-meter clay cap, a 0.3-meter soil cover, with vegetation established. Parts of Area 3 have not been seeded with vegetation yet.

Information was also gathered on the refuse composition for the entire site. The average refuse moisture content is reported to be 23%, and the composition is listed below by wet weight percent:

Component	Percent
Paper Waste	46
Garden Waste	13
Glass/Ceramics	10
Food Waste	10
Metals	9
Plastics/Rubber	8
Textiles	2
Wood	1
Ash/Dirt/Rock	1
Total	100

Gas recovery began at this site in August of 1988. The current system consists of three internal combustion engines and a backup flare that is used if one of the engines fails. This flare is constantly burning, and normally runs on propane (with only a small stream of recovered methane). On-site personnel indicate that the amount of methane burned in the flare has been steadily decreasing over time. Gas is collected from the closed portions of the landfill from three separate areas. These areas correspond to the acres listed for Areas 1 through 3 as shown above. All header and subheader lines are on the surface of the fill areas. There are a total of 68 wells, and the number of wells in each unit is listed below:

- Area 1: 47;
- Area 2: 17; and
- Area 3: 4.

The estimated landfill gas flow for this entire site is 40,766 cubic meters per day, with 50 to 52% methane. Gas is cooled to about 34°F prior to entering the internal combustion engines. This pretreatment of the gas results in the formation of a thick sludge (3.8 to 7.6 liters/8 hours). On-site personnel indicated that this sludge will be tested for its toxicity and the sludge will be landfilled, if it is permissible.

Condensate collected at the well heads is fed back into the fill area. Condensate collected at the gas recovery plant is combined with the leachate collected from the landfill and transferred to one of two surface collection ponds. The liquid is then allowed to stand until it reaches a solids to liquid ratio of 50:50. After testing the mixture's toxicity, it is placed in the landfill if permitted.

Information received from the County Environmental Health group, the party responsible for gas migration testing, showed that there are no areas with any significant gas migration problems.

At the time of year this testing was performed, all vegetation was dry and in a generally dormant condition. Visual inspection indicated one small area (~28 m^2) of possible distress during the last growing season. The cap is full of large cracks, caused by excessive dryness of the soil. Use of the OVA in the larger cracks did not indicate leaks, however.

APPENDIX B2

SUMMARY OF INFORMATION GATHERED

The amount of information obtained from the landfills varied from one landfill to another and is summarized below. This information is best used when examining the gas recovery variances. The recent waste composition data gathered may be useful in predicting future methane rates. In addition, the topographic site maps can be used to estimate the amount of refuse in place if a compacted refuse density is available. These estimates could then be compared to the amount of refuse in place provided by the landfill operators.

Landfill 1

Refuse Filling Plans - 1985 through 1989:

These give projected volumes of waste to be landfilled, the portion of the landfill to be filled, and the type of cover for each of the above years. These also contain brief discussions of gas well installation plans. Refuse composition is not discussed in any of these plans.

Waste Acceptance Data - 1985 through 1989:

All total cubic yard data is listed by month from 1/85 to 6/90. It is also broken down as loose, packed, roll-off, compacted, loads, demolition, and miscellaneous. The break-out categories change from year to year and are not consistent over the 5-year period.

Calibration Data:

Four sets of calibration reports for flow, temperature, and pressure instruments were obtained. Calibrations are done quarterly and dates are 3/89, 6/89, 9/89, and 1/90.

Gas Composition Data:

Daily average gas composition data (CH_4, CO_2, N_2, O_2) are listed for 5/89 through 7/90. One month, 9/89, seems to be missing. There are gaps of several days during most months where data was not collected. These must be days when the turbine was down. These data sheets also contain values for Btu, pressure, temperature, and gravity.

Site Maps:

These accompany the refuse filling plans.

Landfill 2

Waste Acceptance Data:

Have data for the period of 1/90 to 7/90. Cubic yards are broken out by loose, compacted, contaminated soil, sludge, industrial waste, and asbestos. Older data was not available.

Calibration Data:

Have Quarterly calibration reports for temperature, flow, and pressure were obtained. Report dates are for 4/89, 8/89, 11/89, 2/90, and 5/90.

Gas Composition Data:

Daily average gas composition data is listed for each month from 1/89 to July 1990. No gaps in data (except for downtimes).

Perimeter Gas Migration Data:

Monitoring data for the perimeter gas wells is included for years 1985 to 1990. The 1985 report is not an official report or data sheet, but the others are. Gas monitoring was also performed in area buildings. Figures are included that show the locations of the wells and buildings.

Leachate Data:

One report (1984) of leachate chemical analysis was provided.

Recovery Well Boring Logs:

Provides information on borings for the gas wells. Information includes degree of decomposition, qualitative moisture content, waste composition, and temperature at various drilling depths.

Landfill 3

Gas Production Data:

Annual gas production and refuse-in-place data are listed for 1970 to 1989.

Gas Composition Data:

Data for CH_4, N_2, CO_2, O_2, pressure, temperature, gravity, and Btu are listed daily for each month from 5/88 through 7/90. Data for 8/88, 9/88, and 1/89 are missing.

Gas Migration Data:

1989 and 1990 reports of perimeter gas well and building monitoring are included. These also contain figures showing the locations of the sample locations.

Recovery Well Boring Logs:

There are several reports describing well installation and drilling data.

Site Closure Plans:

Describes different landfill sections, sizes, liners, leachate collection, and cover plans.

Calibration Data:

Calibration reports for the pressure transmitters and the flow computer are included for 3/89, 7/89, 10/89, 1/90, and 3/90.

Site Maps:

Two site maps were provided by landfill personnel.

Landfill 4

Waste Acceptance Data:

Monthly cubic yardage and tonnage data for waste accepted (1/87 to 7/90) is listed along with calculations showing the percent of construction and demolition debris. The amount of sludge received is broken out separately for each month from 1986 to 1989.

Gas Production Data:

Give total gas production and use for the whole plant (and by turbine) for each month from 7/89 to 7/90. Condensate and leachate (total liquid volume) are also provided for each month.

Gas Composition Data:

Average monthly values for CH_4, N_2, O_2, and CO_2 for the period 8/89 to 6/90 are provided. Weekly average values are listed over the period 4/10/90 to 8/21/90.

Gas Production Data Sheet:

Gives total annual refuse and gas production for the years 1971 to 1989.

Site Map:

A site map was provided that shows current and past fill areas.

Ambient Temperature Data:

Shows monthly average temperatures for 1989.

Landfill 5

Waste Acceptance Data:

Daily weight records (tonnage) for waste received is listed for each month from 8/88 to 7/90. Also provided total amount of refuse in place.

Flare Exhaust Reports:

These give the composition of the flare inlet gas and the exhaust gas from flares 1 and 2 (one sample from each flare).

Gas Production and Composition Data:

Describes composition of gas, gas plant, and gas quantities.

Sampling Results:

From 4/89 to 6/90, the following data are summarized:

- Integrated surface sampling analyses (methane, non-methane hydrocarbons, total organic compounds, and toxic contaminants).
- Landfill gas (CH_4, CO_2, NMOC, toxics).
- Perimeter samples (CH_4, CO_2, NMOC, TOC, toxics).
- Ambient air (CH_4, NMOC, TOC, toxics).

Gas Production Data:

Daily gas production (sales gas and migration collection) is listed for each month from 1/90 to 8/90. It is broken down into the following categories: CH_4 concentration, Btu's, flare CFM, CFM sold, and total CFM. Other data may be sent on historical gas production, if found. These data may not have been complete in the past.

Landfill 6

Waste Acceptance Data:

Total tonnage values are listed for years 1976 to 1989. Monthly values are given for 1/88 through 6/90.

Waste Composition Data:

A 1990 breakdown of average waste composition and moisture content is given. About 10 waste types are listed.

Gas Flow and Composition Data:

Gas flow and methane composition data are listed for areas 1 through 3 for the period 8/88 to 8/90. About two to three samples are taken per week. Samples are not taken every day of the week. This data sheet also includes total refuse volume and depth for the three landfill areas.

Site Map:

A site map was provided that indicates gas recovery lines, surface elevations, and past and current fill areas.

APPENDIX C

TEST PROCEDURES AND LABORATORY ANALYSIS

Methane, Carbon Dioxide, Oxygen, and Nitrogen Test Method

Environmental Protection Agency (EPA) Reference Method (RM) 3C was used for determining the composition of the landfill production gas. This method has been developed and proposed for use at municipal landfills for determination of methane, carbon dioxide (CO_2), nitrogen (N_2), and oxygen (O_2) levels. Landfill gas samples are taken using evacuated leak-free stainless steel canisters. Sampling lines are securely connected to the landfill gas line sample port and the sample canister. A three-way valve and a vacuum gauge are connected in the sampling line. Prior to extracting the sample gas, a leak check is performed. The three-way valve is positioned to isolate the sampling line between the vacuum gauge and the sample canister. The sample canister valve is then opened, and the vacuum pressure is noted. After 5 minutes, the vacuum pressure is noted again. If the vacuum pressure has not changed during this time, the canister is leak-free, and the gas sampling is initiated.

To begin sampling, the starting vacuum pressure is recorded, and the three-way valve is positioned to open the line between the gas sample port and the sample canister. The valve is adjusted such that the sample gas is extracted slowly and evenly over a period of 10 to 20 minutes. When the vacuum gauge pressure drops to zero, sample extraction is complete. The three-way valve is then positioned to shut off the flow of sample gas to the canister, and the canister valve is closed. A cover nut is attached to the canister sample connection to protect and securely seal the canister. Sample canisters were shipped for laboratory analysis using gas chromatography (GC).

Nonmethane Organic Carbon Test Method

Nonmethane organic carbon (NMOC) in the landfill gas was determined using EPA Reference Method 25C. Samples were taken using the same procedures as for Reference Method 3C. After a 5-minute leak check procedure, starting vacuum pressures were recorded and samples were extracted into evacuated stainless steel canisters. Canisters were then shipped for GC analysis.

Moisture Test Methods

Moisture content of the landfill gas was determined using EPA Reference Method 4. This method uses a chilled impinger train to condense and trap water from the landfill gas; the water is then weighed and related to the volume of gas sampled. To collect gas for moisture analysis, the sample line is connected to the landfill gas sample port and to a gas volume meter box. The meter box contains a vacuum pump which draws the sample through a chilled impinger train consisting of four impinger bottles submerged in ice. The first impinger bottle is empty, the second two contain measured volumes of water, and the fourth contains a known weight of dry silica gel.

Prior to gas sampling, the sampling train is checked for leaks. The vacuum pump is started with the landfill gas sample port valve closed. If the gas meter shows no gas flow after evacuation of sample lines and impinger bottles, the sample train contains no leaks, and gas sampling can begin.

To begin sampling, the starting gas meter reading is recorded and then the sample port valve is opened to allow landfill gas to be drawn through the sampling train. Sampling is conducted for 20 minutes per sample. Impinger temperature, sample gas temperature, and gas meter readings are recorded every 5 minutes. At the end of 20 minutes, the sample valve is closed, the vacuum pump is stopped, and the final gas meter reading is recorded. The first three impinger bottles are then emptied into a graduated cylinder and the volume of water is recorded. The silica gel from the fourth bottle is emptied into a tared sample bottle, to be weighed at a later time.

Moisture in the gas is determined by relating the increased volume of water in the first three impinger bottles and the increased weight of the silica gel to the volume of landfill gas extracted through the sample train.

Volumetric Gas Flow Rate Test Method

The volumetric flow rates of the landfill gas production at the six landfills were to be measured using EPA Reference Method 2. This method requires that a pitot tube with a diameter of about 0.5 to 1.0 centimeters (cm) be inserted into the gas transport pipe. At the landfills visited, however, there were no sample ports on the landfill gas transport pipes large enough to insert a pitot tube. Therefore, field measurement for gas flow rate was not possible. In lieu of this test, for three of the six landfills copies of recent calibration records of the on-site flow measurement instruments were obtained.

Landfill Surface Organic Vapor Testing

Tests for the presence of organic vapors near the landfill surface were conducted using an organic vapor analyzer (OVA). An OVA basically consists of a sample probe, a vacuum pump to draw sample through the analyzer, a flame ionization detector, and a display that indicates the concentration in parts per million (ppm) of organic vapors.

Prior to surface testing at each of the landfill sites, the OVA was calibrated using three calibration standards with air containing: 1) 0 ppm organic vapor; 2) 100 ppm methane; and 3) 500 ppm methane. Field tests were conducted by sampling at various points on the landfill surface at a distance of about 10 cm above the surface. Areas of vegetative stress were sampled, as well as any cracks or fissures in the landfill surface. As each point was tested, its location, a brief description of the surface characteristics, and the organic vapor concentration measured were recorded in the project notebook.

LABORATORY ANALYSES

Methane, Carbon Dioxide, Oxygen, and Nitrogen

Determination of CO_2, CH_4, O_2, and N_2 concentrations of the landfill gases was performed using proposed Reference Method 3C (RM 3C). As described by RM 3C, sample analysis is conducted using a GC with a thermal conductivity detector. For this project, a Shimadzu Model GC3-B GC, associated automatic integrator, and column supplied by Alltech Inc. were utilized to analyze the landfill gas samples. Calibration of the GC was performed by injecting replicate samples of a gas mixture containing known concentrations of the three gases of interest. To establish a calibration curve, three different concentrations covering the expected range of landfill gas concentrations were used. Calibrations were repeated at regular intervals to detect instrument drift.

The sample is analyzed by injecting a known aliquot (1-mL total volume) into the GC column. The column separates the sample constituents, which are eluted at different rates depending on the chemical characteristics of the column and the specific gas. After being separated, the sample passes through a thermal conductivity detector. The resulting output of the detector is recorded on an integrating recorder for determination of the concentration of the gas. Samples were analyzed a minimum of three times.

Nonmethane Organic Carbon

Measurement of Nonmethane Organic Carbon (NMOC) concentrations in the landfill gas was performed using proposed EPA Reference Method 25C. This method utilizes evacuated canisters to collect a sample for subsequent analysis. After sample collection was completed, the canisters were returned to Radian for recovery and analysis. The Radian laboratories are not currently performing RM 25C analyses on a routine basis, so Research Triangle Laboratories, Inc. were used to insure timely turn around of sample results.

The sample tank is analyzed by injecting an aliquot via a 1-mL sample loop into a GC column, which is maintained at a constant 85°C. Methane and then CO_2 elute through the column to an oxidation catalyst, reduction catalyst, and finally to a flame ionization detector (FID). The column is then backflushed to elute the organic fraction, which is analyzed in a similar fraction. Triplicate injections are made for all samples. The NMOC analysis system is calibrated frequently to insure proper operation.

APPENDIX D

Quality Assurance Project Plan
for
Field Testing Air Emissions From Municipal Solid Waste Landfills

EPA Project Officer:

Susan A. Thorneloe

Contract No.: 68-02-4288

Task No.: 52

Prepared by:
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Approvals:

Walter Gray Radian Project Director	Signature Date
Susan Thorneloe EPA Project Director	Signature Date
Judy Ford AEERL Quality Assurance Officer	Signature Date

1.0 PROJECT DESCRIPTION

In response to concerns about global warming, the U.S. Environmental Protection Agency's (EPA) Office of Research and Development (ORD) has initiated a program to characterize the effects of global climate change. The program includes identifying and quantifying emission sources of greenhouse gases. As part of this effort, EPA's Air and Energy Engineering Research Laboratory (AEERL) has begun research to improve emissions inventories for the United States and the world.

Methane (CH_4) is of particular concern because its radiative forcing potential is thought to be much greater than that of carbon dioxide (CO_2). Although the major sources of CH_4 are known qualitatively, considerable uncertainty exists about the quantitative emissions from each source. One of the goals of AEERL's global climate research program is to develop a more accurate inventory for CH_4 emissions from landfills.

As part of the ORD Global Climate Change program, AEERL is developing a database that can be used to estimate CH_4 emissions from landfills. This effort began with an analysis of available models that estimate CH_4 production and an assessment of the data available to parameterize the models (Peer et al., 1990). Available models were found to be very simplistic. These models use the CH_4 potential of the refuse (which is a function of its organic content) and the age of the landfill to predict annual emissions. The best available models were designed to predict emissions from a single landfill. One of these, the Landfill Air Emissions Estimation Model, which is based on the Scholl Canyon model, was developed for use by regulatory agencies for estimating landfill air emissions. The rate constant in this model was chosen by fitting best estimates of CH_4 emissions from approximately 50 landfills in the United States.

In order to determine the factors that affect CH_4 production in landfills on a global basis, a model that is more responsive to the wide range of climates and wastes found throughout the world is needed. Understanding climatic effects is considered especially important to climate modelers who are studying feedback effects of global climate change. To this end, the AEERL is developing a field testing program to gather data that can be used to create a model that demonstrates the relationship between climatic and landfill characteristics and CH_4 production.

The project is divided into the following subtasks:

- Task 1: Project Management
- Task 2: Site Selection
  - Develop selection and evaluation criteria,
  - Complete preliminary screening of potential sites,
  - Select final list of candidate facilities, and
  - Contact facilities and obtain permission for testing.
- Task 3: Test Plan/Quality Assurance Project Plan Development
  - Prepare Test Plan for landfill gas composition and flow rate measurements, and
  - Develop Category II QA project plan for testing program to be performed under this work assignment.
- Task 4: Landfill Emission Testing and Instrument Evaluation
  - Perform landfill gas composition and flow rate measurements,
  - Collect historical operations data, and
  - Complete all sample analysis and preliminary data reduction.
- Task 5: Data Analysis and Report Preparation
  - Compile historical data into a format compatible with model requirements,
  - Complete model runs using historical data,
  - Assess accuracy and precision of site determined composition and flow data,
  - Compare emission rates predicted by model with observed emission rates, and
  - Prepare a report assessing site selection criteria, test methods, and test results.

The field testing to be completed in Task 4 includes the following:

- Landfill Gas Composition: expected concentrations are 40 to 50% methane, 40 to 45% carbon dioxide (CO_2), 5 to 15% water vapor, 0.5 to 1% nonmethane organic compounds, and balance nitrogen.
- Landfill Gas Production Rate: rates may vary from 28,317 standard cubic meters per day to 240,694 standard cubic meters per day.

The specific sites have not yet been selected so only a generic description can be presented at this time. At each site a number of collection wells have been constructed based upon the size and configuration of the landfill. These wells collect the methane, CO_2, and other generated gases and direct them to a common manifold. This manifold feeds either an energy recovery facility or control device (such as a flare). Sampling would be performed in the manifold at existing test ports.

This Quality Assurance Project Plan (QAPP) details the methods which will be used by Radian Corporation to assure that quality data are collected during the field program. Table 1-1 lists the measurements to be performed by Radian personnel. In addition to these measurements, information from each site will be collected regarding: 1) past gas production, 2) waste composition, and 3) historical meteorological data required by the model.

This QAPP has been prepared in accordance with AEERL quality assurance procedures specified in the document "AEERL Quality Assurance Procedures for Contractors and Financial Assistance Recipients." The emissions testing and data validation conform to Category II requirements. Radian is committed to implementing this QAPP and conducting the testing portion of this program in a fashion which will generate quality data.

TABLE 1-1. EMISSION MEASUREMENTS

Gas species	Methodology	Number of tests
Methane	EPA Reference Method-3C	6
Nonmethane organic carbon	EPA Reference Method-25	6
Carbon dioxide	EPA Reference Method-3C	6
Oxygen	EPA Reference Method-3C	6
Moisture	EPA Reference Method-4	6
Velocity	EPA Reference Method-2C	6

2.0 PROJECT ORGANIZATION

The Program Organization is shown in Figure 2-1. Mr. Clint Burklin is the Radian Program Manager and Mr. Walter Gray is the technical Project Director for Radian. The Radian QA/QC officer is Ms. Linda Brown. Administratively, Ms. Brown is independent of the technical project management. For the purposes of this project she will coordinate her activities through the Project Director and report her findings to him at appropriate intervals.

As task leaders for the on-site testing program and the data analysis, Mr. Walter Gray and Ms. Darcy Campbell will be responsible for implementing the task specific quality control (QC) activities. They will conduct any needed training sessions and proficiency evaluations, schedule QC activities, establish sampling/analytical protocols, insure that all equipment calibrations are completed, and coordinate record keeping and data review/validation.

As Project Director Mr. Gray is responsible for the overall technical effort. This includes responsibility for the timely, cost-effective execution of all project activities. He will also coordinate preparation of a final data quality report.

This organization of QA/QC has proven effective in past Radian sampling/analysis programs. As problem areas and/or project priorities arise, the field team members who execute daily QC efforts bring them to the attention of the field task leaders for appropriate action. The QA officer provides independent review of QC activities and independent performance checks through QA audits.

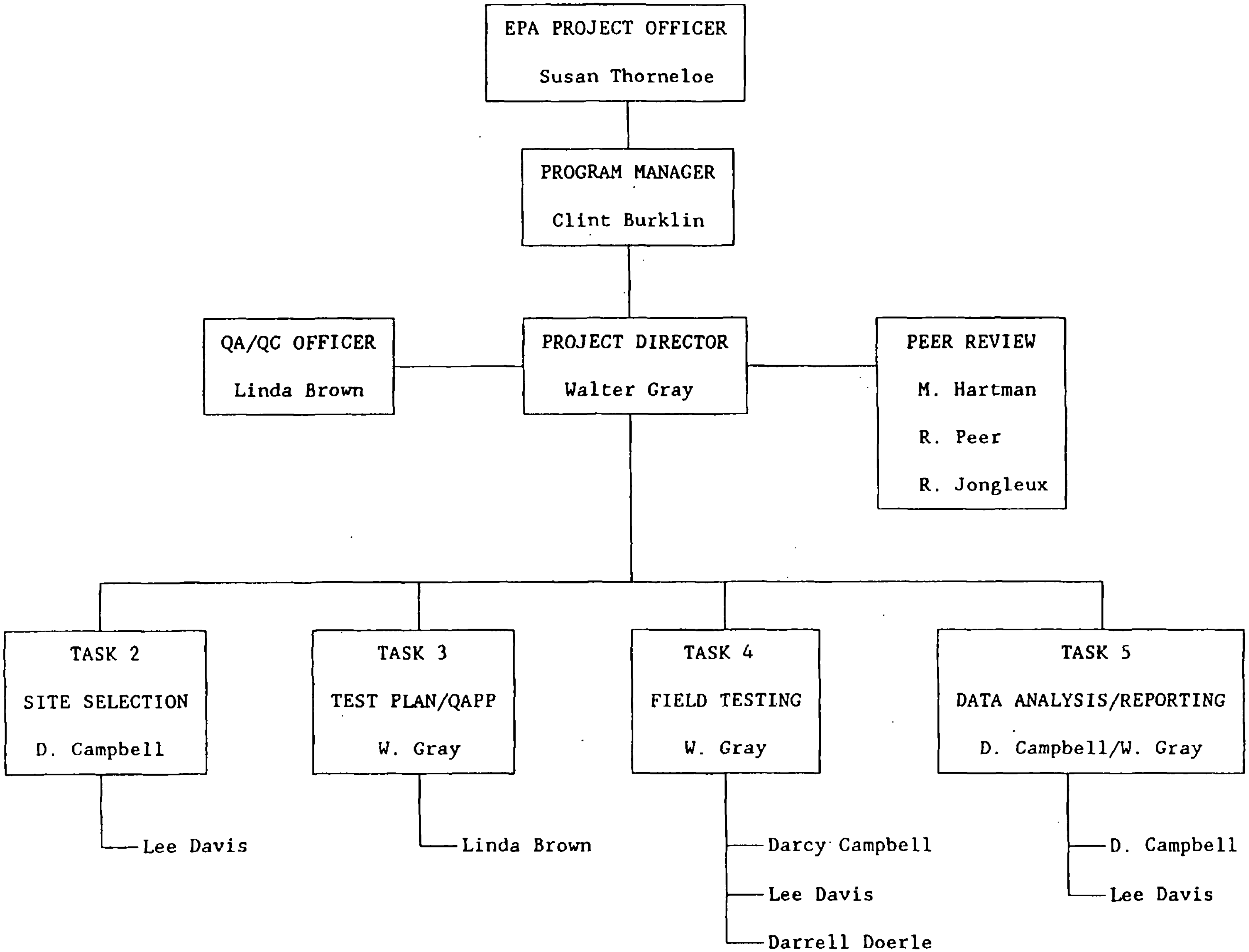

Figure 2-1. Project Organization

3.0 DATA QUALITY OBJECTIVES

The objectives of the quality assurance efforts for this program is to assess and document the precision, accuracy, and adequacy of the data collection systems including sample collection and laboratory analysis. Table 3-1 summarizes the QA objectives for each major measurement parameter. Data comparability will be achieved by using standard units of measure as specified in the methods indicated in Table 3-1.

At this time it is not possible to set Data Quality Objectives for the comparison of real (historical) emission data to predicted (modeled) emission data. The reasons for this include the following:

- The amount of historical data is not yet known.
- The quality of available historical data is unknown.
- Collection of historical data will be performed by facility operators or owners.
- Records verifying quality of the instrumental data may be incomplete or inadequate.

Each of these concerns may have an impact on the usefulness of data collected from the host facilities. It is not, however, within the scope of this project to determine what level of data quality is needed for comparison with the Scholl Canyon model. Rather, it is one of this project's goals is to determine what information is available and what the best methods of obtaining it are. Further assessments of the quality of data obtained from the host facilities will be made under a separate scope of work.

In selection of the types of test methods to be used and the number of test runs required, the following criteria were considered:

- Is there a current or proposed Reference Method for the parameter to be measured.
- Is the method selected appropriate for anticipated concentrations.

TABLE 3-1. DATA QUALITY INDICATORS

Parameter	Methodology	Precision[a] (%)	Accuracy[a] (%)
Volumetric flow rate	Reference Method 2C	6 %	±10
Methane, carbon dioxide, oxygen, nitrogen	Reference Method 3C	5 %[b]	±10
Moisture	Reference Method 4	20 %	±10
Nonmethane organic carbon	Reference Method 25	5 %	±10

[a]Based on EPA collaborative tests.
[b]Precision required by methodology.

- Can the selected method meet the required level of accuracy and precision.

- How much data is needed for the evaluation of facility operated instrumentation.

Each of the test methods selected for this project are either promulgated Reference Methods (40 CFR 60, Appendix A) or have been developed specifically for testing landfill emissions. The use of a standardized method is thus assured.

After selection of the test procedure, an assessment of the potential ranges of emission concentrations was made to determine if it was within the detection limits of the proposed method. In each case the method specified was either capable of measurements over the anticipated ranges or contained procedures to make the method applicable.

Accuracy and precision of the methods has been determined through collaborative tests sponsored by EPA. Since it is believed that order of magnitude comparisons will be made with data collected during this program the data quality goals set in Table 3-1 are more than adequate.

Selection of the number of test runs to perform used the requirements of 40 CFR 60, Appendix F "Quality Assurance Guidelines for Continuous Emission Monitors" for guidance. In this procedure a Relative Accuracy of the instrument in question is checked with either calibration gases or a comparison with a reference method value. A total of three comparisons is made by either method. For this test series six test runs were selected to guard against unforseen data loss and to provide a potential excess of data by which to evaluate the effectiveness of the procedures used.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

Included in this section are the sampling and analytical techniques to be used to characterize landfill emissions during this pilot program. Also is included a tentative test schedule and sampling matrix that will be used.

4.1 SITE DESCRIPTION

Sites for this program have not yet been selected. As such there are no specifics available for a discussion of the test locations.

4.2 TEST SCHEDULE AND SAMPLING MATRIX

The proposed sampling/analysis matrix for the emissions tests is presented in Table 4-1. The tentative test schedule is presented in Table 4-2.

4.3 VOLUMETRIC GAS FLOW RATE SAMPLING PROCEDURES

The volumetric gas flow rate of the landfill production gas will be determined using procedures described in EPA Reference Method 2. Based on this method, the volumetric flow rate is determined by measuring the cross-sectional area of the transport pipe and the average linear velocity of the gas stream.

The average gas velocity is calculated from the temperature, wet molecular weight, static pressure, and differential pressure induces in a pitot tube by the gas flow. The temperature and pressure profile will be obtained by traversing the pipe. The number of sampling points and distances from the pipe walls will be determined based on the configuration of the piping and the requirements of Reference Method 2.

Temperature and differential pressure profile data will be measured at each of the sampling points using an S-type pitot tube and K-type thermocouple. The static gas pressure will be measured at several points and averaged for a single value. An example of the data sheet used is presented in Figure 4-1.

TABLE 4-1

Sampling/Analysis Matrix

Parameter	Sampling Method	Analytical Method	Sampling Frequency
Flow rate	RM 2	pitot troverse	6 tests per site
Methane, carbon dioxide, oxygen, nitrogen	RM 3C (integrated grab sample)	GC with thermal conductivity sensor	6 tests per site
Moisture	RM 4	Analytical balance	6 tests per site
Non-Methane organic compounds	RM 25C (grab sample)	GC/FID	6 tests per site

TABLE 4-2. ITINERARY FOR LANDFILL FIELD TEST WORK*

Sunday, August 5	Travel to Wisconsin
Monday, August 6	Site visit/Field Test - Wisconsin Landfill Travel to Illinois
Tuesday, August 7	Site visit to Illinois Landfill
Wednesday, August 8	Travel to Pennsylvania
Thursday, August 9	Site visit to Pennsylvania Landfill
Friday, August 10	Travel Home
Monday, August 20	Travel to Florida
Tuesday, August 21	Site visit to Florida Landfill
Wednesday, August 22	Travel to Southern California
Thursday, August 23	Site visit to Southern California Landfill Travel to Northern California
Friday, August 24	Site visit to Northern California Landfill
Saturday, August 25	Travel Home

*These are proposed dates and are being confirmed with each site.

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VELOCITY TRAVERSE

PLANT ______________________
DATE ______________________
LOCATION ______________________
STACK I.D. ______________________
BAROMETRIC PRESSURE, in. Hg ______________________
STACK GAUGE PRESSURE, in. H_2O ______________________
OPERATORS ______________________

SCHEMATIC OF TRAVERSE POINT LAYOUT

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

EPA (Dur) 233
4/72

Figure 4-1. Velocity Traverse Data

4.4 METHANE, CARBON DIOXIDE, OXYGEN, AND NITROGEN SAMPLING/ANALYSIS PROCEDURES

The composition of the landfill production gas will be determined using proposed EPA Reference Method 3C. This method has been developed and proposed for use at municipal landfills for the determination of methane, carbon dioxide (CO_2), nitrogen (N_2), and oxygen (O_2). A sample of the landfill production gas is extracted into a leak-free stainless steel canister. This sample is collected (integrated) over a period contiguous with the other emission measurements.

Once the sample has been collected it is analyzed using a gas chromatograph (GC) with thermal conductivity (TC) detector. The analyzer is calibrated using three gas mixtures of known concentration to establish a calibration curve for the detector's response to gas constituents. A portion of the sample is injected into the GC and the response is recorded for calculation of the various component concentrations. Replicate analyses are performed until the average difference between values is less than or equal to five percent.

4.5 MOISTURE SAMPLING/ANALYSIS PROCEDURES

The moisture content of the landfill gas will be determined using EPA Reference Method 4. In this test method, a known volume of particulate-free gas is bubbled through a chilled impinger train. The quantity of condensed water is determined and related to the volume of gas sampled to determine the moisture content.

4.6 NONMETHANE ORGANIC COMPOUNDS SAMPLING/ANALYSIS PROCEDURES

Nonmethane organic compounds will be determined using EPA Reference Method 25C. This method utilizes a dry ice cooled trap and evacuated canister to collect the sample from the effluent stream. The trap and flask are then returned to the laboratory where the NMOC is flushed into an NMOC analyzer consisting of a GC equipped for back purging, an oxidation section, a reduction section, and a Flame Ionization Detector (FID).

Analysis of the sample begins by separating the NMOC components present in the trap and canister by using the GC system. Any NMOC species collected on the GC column are then flushed off into an intermediate collection vessel.

Next, the NMOC present in the sample is converted to CO_2 in the oxidizer section of the analyzer and is then quantitatively reduced to methane. This insures that the detector will give a consistent response for all species of NMOC present in the sample.

5.0 SAMPLE CUSTODY

Sample custody procedures for this program are based on EPA procedures recommended in "Quality Assurance Handbook for Air Pollution Measurements". Since samples will be analyzed both on and off site, the custody procedures emphasize: 1) careful documentation of sample collection, analytical, and quality control data, and 2) the use of chain-of-custody records for samples being transhipped.

All field data sheets will be completed at the end of each test run and will be initialed by the operator conducting the test and by the field team leader at the end of the day. All samples which are to be shipped will be clearly labeled and sealed prior to packing. An example of the sample labels and seals is presented in Figures 5-1 and 5-2. A sample chain-of-custody form will be completed for each sample as they are packaged for shipment. Examples of all data sheets to be used in this project are included as Figures 5-3 through 5-6.

All gas samples will be returned to the Radian laboratory and to Research Triangle Laboratory for analysis. All RM 3C samples will be analyzed at the Radian RTP facility within two weeks of collection. All RM 25C samples will be analyzed at the Research Triangle Laboratory facilities within two weeks of collection. Each sample canister will be shipped in its own individual box, and will be completely labelled before packaging by the field crew.

RADIAN
CORPORATION
900 Perimeter Park
Morrisville, NC 27560
(919)481-0212

PRELIM. NO: ____________

SAMPLE TYPE: ______________________________

LOCATION: ______________________________

DATE: ____________ CONTRACT: ______________

REMARK: ________________ FINAL WT: ________

TARE: ________

SAMPLE WT: ________

8-84-17483

Figure 5-1. Example Sample Label

ATTENTION:
BEFORE OPENING
NOTE IF BOTTLE WAS
TAMPERED WITH.

RADIAN
CORPORATION

Progress Center/3200 E. Chapel Hill Rd./
Nelson Highway/P.O. Box 13000
Research Triangle Park, NC 27709/(919)541-9100

SAMPLE CODE: ______________________________

ATTENTION:
BEFORE OPENING
NOTE IF BOTTLE WAS
TAMPERED WITH.

Figure 5-2. Example Sample Seal

RADIAN CORPORATION

VELOCITY TRAVERSE

PLANT ______________________
DATE ______________________
LOCATION ______________________
STACK I.D. ______________________
BAROMETRIC PRESSURE, in. Hg ______________________
STACK GAUGE PRESSURE, in. H_2O ______________________
OPERATORS ______________________

SCHEMATIC OF TRAVERSE POINT LAYOUT

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

EPA (Dur) 233
4/72

Figure 5-3. Method 2C Velocity Traverse

MOISTURE RECOVERY FORM FOR METHOD 4

Plant ______________________ Sample Identification Code: ______________

Date ______________________

Sampling location ______________________

Sample type ______________________

Run number ______________________

Sample box number ______________________

Clean-up person ______________________

Solvent rinses ______________________

Impinger Number	Impinger Solution	Amount of Solution (g)	Impinger Tip Configuration	Impinger Weight (grams) Final	Initial	Weight Gain
1						
2						
3						
4						
5						
6						
7						

Total Weight Gain (grams) ________

Figure 5-4. Moisture Recovery Form for Method 4

RADIAN
CORPORATION

Run Number____________________ DATE________________________

Samplers Initials______________

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	

NOTES:

Figure 5-5. Method 3C Field Sampling Data Sheet

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CORPORATION

Run Number_______________________ DATE____________________________

Samplers Initials_______________

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	

NOTES:

Figure 5-6. Method 25C Field Sampling Data Sheet

6.0 CALIBRATION PROCEDURES

Information is presented in this section pertaining to the calibration of both sampling and analytical systems. Included is a description of the procedure or reference to an applicable standard operating procedure, the frequency and the calibration standards to be used.

6.1 SAMPLING EQUIPMENT CALIBRATION PROCEDURES

The checkout and calibration of source sampling equipment is an important function in maintaining data quality. Referenced calibration procedures will be strictly followed when available and the results will be properly documented and retained. If a referenced calibration technique for a piece of equipment is not available, then a state-of-the-art technique will be used. Calibration requirements are summarized in Table 6-1.

6.1.1 Type-S Pitot Tube Calibration

EPA has specified guidelines concerning the construction and geometry of an acceptable Type-S pitot tube. If the specific design and construction guidelines are met, a pitot tube coefficient of 0.84 can be used. Information relating to the design and construction of Type-S pitot tubes is presented in detail in Section 3.1.1 of the EPA document "Quality Assurance Handbook for Air Pollution Measurements - Volume III" and in Section 2 of 40 CFR 60 Appendix A, Reference Method 2. Type-S pitot tubes not meeting referenced specifications will not be used during this project. Pitot tubes will be inspected and documented as meeting specifications prior to the field sampling. An example of the pitot specification sheet is shown as Figure 6-1.

6.1.2 Dry Gas Meter Calibration

Meter boxes will be used for RM 4 (moisture determination). The meter box houses a dry gas meter, sample pump, and flow metering/control hardware. Figure 6-2 shows the meter box calibration form used to check to inspect the operation of the components and to calibrate the dry gas meter. Space is provided for leak checks of the dry gas meter, calibration of vacuum gauges and flow meters, and for calibration of temperature sensors (thermometers or

TABLE 6-1. EQUIPMENT REQUIRING CALIBRATION

Equipment	Sampling Method	Calibration Data Sheets
Type S Pitot	Reference Method 2C	Figure 6-1
Meter Box	Reference Method 4	Figure 6-1

Date (DDMMYY): ____________

Initials of Calibrator: ________

Nozzle Identification No.	D_1 (inches)	D_2 (inches)	D_3 (inches)	Average Diameter (inches)

Note: The maximum acceptable difference between any two measurements is 0.004 inches. If this tolerance cannot be met, the nozzle should not be used.

Figure 6-1. Nozzle Calibration Data Sheet

DRY GAS METER CALIBRATION DATA

(English Units)

Pretest Post Teat

Calibration meter #:______________ Y = ______________

Barometric Pressure (in. Hg):______________

Dry Gas meter #:______________

Date:______________

Calib. by:______________

Orifice Manometer Setting ΔH in. H_2O	Manometer Pressure Cal. Meter in. H_2O	Gas Volume Calibration Meter V_M Cu. Ft.	Gas Volume Dry Gas Meter V_M Cu. Ft.	Temperature: Calibration Meter	In	Out	Temperature: Dry Gas Meter	In	Out	Time (min)	Y	ΔH (in. H_2O)
		final	final	initial			initial					
		initial	initial	mid			mid					
		total	total	final			final					
		final	final	initial			initial					
		initial	initial	mid			mid					
		total	total	final			final					
		final	final	initial			initial					
		initial	initial	mid			mid					
		total	total	final			final					
		final	final	initial			initial					
		initial	initial	mid			mid					
		total	total	final			final					
		final	final	initial			initial					
		initial	initial	mid			mid					
		total	total	final			final					
		final	final	initial			initial					
		initial	initial	mid			mid					
		total	total	final			final					
		final	final	initial			initial					
		initial	initial	mid			mid					
		total	total	final			final					
				avg			avg					
										avg		

Leak Test status: Front__________ Back__________

Pitot test status:______________

Vacuum Gauge Check:

3" Hg:______________

10" Hg:______________

15" Hg:______________

Thermocouple calibration

Inlet

Ice ______ ________

Room Temp ______ ________

Outlet

Ice ______ ________

Room Temp ______ ________

Figure 6-2. Meter Box Calibration Data Sheet thermocouples) at ice and ambient temperatures against an NBS traceable mercury-in-glass thermometer. The dry gas meter will be calibrated (documented correction factor at standard conditions) prior to the shipment of the equipment to the test site. A post-test calibration check will be performed as soon as possible after the equipment has returned to Radian/RTP. Pre- and post-test calibrations should agree within 5 percent. The same data form is used for both pre- and post-test calibrations.

Dry gas meters will be calibrated using the calibration system illustrated in Figure 6-3. Prior to calibration, a positive pressure leak-check of the system will be performed using the procedure outlined in the EPA Quality Assurance Handbook. The system is placed under approximately ten inches of water column pressure and a manometer is used to determine if a change in pressure occurs over a one minute period. If leaks are detected (indicated by a drop in pressure), corrective actions will be taken before calibrations are begun.

6.2 ANALYTICAL EQUIPMENT CALIBRATION

Chemical and physical characterization of field samples will require calibration of analytical instruments. Analytical calibration requirements are summarized in Table 6-2. Calibration procedures are briefly discussed below.

6.2.1 Analytical Balance Calibration

Analytical balances will be calibrated over the expected range of use with standard weights (NBS Class S). Measured values must agree within ±2 mg. The balances will be calibrated prior to the field measurement program and again at the completion of the program. Balance calibration data will be recorded in the laboratory and project notebooks.

6.2.2 Gas Chromatograph Calibration

Prior to analysis of any samples the gas chromatograph (GC) is setup based on manufacturer's specifications for temperature and carrier gas flow rates, and permitted to reach stable conditions. After the GC has stabilized (about 1 hour) the instrument is checked for linearity of response and calibration. Using three gas mixtures spanning the expected concentration range of the samples, verify the detector linearity for each gas component of

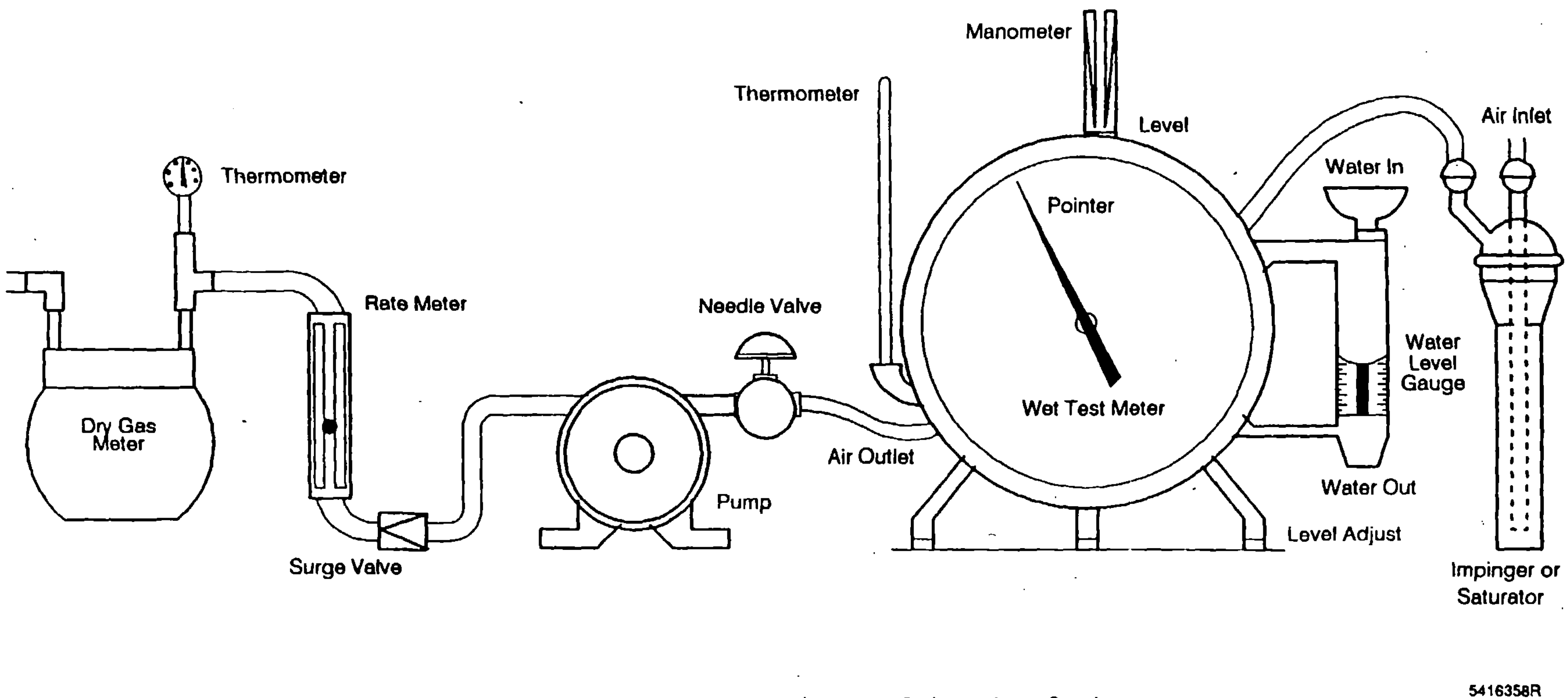

Figure 6-3. Meter Calibration System

TABLE 6-2. ANALYTICAL EQUIPMENT CALIBRATION

Equipment	Type of Calibration	Frequency
Analytical Balance	Multipoint	Semi-Annual
Gas Chromatograph	Multipoint	Daily
Non-methane Organic Analyzer	Multipoint	Daily

interest. This check also serves as the initial calibration of the GC. For this and all subsequent calibrations the carrier flow rates, instrument temperatures, injection times, component concentrations, and sample loop volumes will be recorded. Figure 6-4 presents an example of the calibration data sheet. A plot of peak height versus concentration will be prepared and used to determine proper operation of the instrument.

All samples will be analyzed in duplicate. Consecutive analyses of the same sample must agree within ±5%. If they do not agree, additional samples will be analyzed until consistent answers are obtained.

6.2.3 Nonmethane Organic Compounds Analyzer Calibration

Procedures for the initial performance check and calibration of the Nonmethane Organic Compounds analyzer are contained in 40 CFR 60 Appendix A, Section 5. Analyzer calibrations will be conducted each day (or for each set of samples analyzed, whichever is more frequent) and results will be recorded in the laboratory notebook. An instrument linearity check will also be performed before each set of samples are analyzed. Propane standards (specified in RM 25) will be used to assess instrument response over the expected concentration range of the sample. Analyzer linearity is acceptable if the response to each standard gas is ±5% of the average of the three replicate injections and the standard deviation is less than ±5%.

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Gas Chromatograph Calibration Data

mple Loop Volume (cc): ______________________ Carrier Flow (cc/min): ______________________

Temperature (deg F): ______________________ Carrier Gas: ______________________

Low			Mid			High		
Conc.	Inj. Time	Reponse	Conc.	Inj. Time	Reponse	Conc.	Inj. Time	Reponse

Figure 6-4. Gas Chromatograph Calibration Data Sheet

7.0 DATA REDUCTION, VALIDATION, AND REPORTING

Table 7-1 contains a list of data reduction, validation, and reporting tasks along with the individual(s) responsible for completion of that task. Also included in Table 7-1 are those individuals responsible for data review.

7.1 DATA REDUCTION

Calculations for determining flow rates, moisture contents, and emission concentrations are very repetitive in nature and have been converted into computerized data analysis programs. These programs use the calculation procedures specified in EPA Reference Methods 2, 3C, 4, and 25C. The program has been validated by independent checks and simplifies data review to verification of correct input values. Data are input to the program from field data sheets.

Examples of the calculations being performed are presented in Figures 7-1 through 7-4.

7.2 DATA VALIDATION

All measurement data will be validated based upon representative process conditions during sampling or testing, acceptable sample collection/testing procedures, consistency with expected and/or other results, adherence to prescribed QC procedures, and the specific acceptance criteria outlined in Section 6 for calibration procedures and in Section 8 for internal quality control procedures. Any suspect data will be flagged and identified with respect to the nature of the problem with validity. Suspected outliers will be tested using the Dixon Criteria at the five percent significant level.

Several of the data validation acceptable criteria presented in Sections 6 and 8 involve specific calculations. Representative examples of these are presented below.

7.2.1 Instrument Response Linearity

Acceptance criteria for instrument response linearity checks are based upon the correlation coefficient, r, of the best fit line for the calibration data points.

TABLE 7-1. SUMMARY OF DATA REDUCTION AND REVIEW RESPONSIBILITIES

Task	Data Reduction	Review and Validation	Reporting
Test Plan and QAPP		M. Hartman	W. Gray
Test Data Summaries	Test Team Members	Lee Davis	W. Gray
QC Data Summary	Test Team Members	D. Campbell	W. Gray
Final Data Summary		W. Gray	C. Burklin

$$V_s = K_p C_p \left(\sqrt{\Delta P} \right)_{avg} \sqrt{\frac{T_s\,(avg)}{P_s \quad M_s}}$$

$$Q_s = 3{,}600\ (1-B_w)\ V_s\ A \quad \frac{T_{std}}{T_s(avg)} \qquad \frac{Ps}{P_{std}}$$

Where: A = Cross sectional area, ft^2.

B_w = Water vapor in gas stream, fraction.

C_p = Pitot tube coefficient.

K_p = Pitot tube constant = 85.49.

M_s = Molecular weight of gas stream, wet basis.

P_s = Absolute gas pressure, in Hg.

P_{std} = Standard pressure, in Hg.

P = Velocity head of gas stream, in N_2O.

Q_s = Volumetric flow rate, dscf/hr.

T_s = Gas temperature, ^oR.

T_{std} = Standard temperature, ^oR.

Figure 7-1. RM2 Calculations.

$$B_w = \frac{P_w}{P_{bar}}$$

$$C = \frac{A}{R(1-B_w)}$$

Where:

A = GC Response (sample area).

B_w = Moisture content in the sample, fraction.

C = Component concentration, dry basis, ppm.

P_{bar} = Barometric pressure, mm Hg.

P_w = Vapor pressure of H_2O, mm Hg.

R = Mean calibration response factor for specific component, area/ppm.

Figure 7-2. RM3C Calculation.

$$V_{wc} = K_1 \ (V_{fi} - V_i)$$

$$V_{m_{std}} = K_2 \ Y \ \frac{V_m \ P_B}{T_m}$$

$$B_{ws} = \frac{V_{wc}}{V_{wc} + V_{m_{std}}}$$

Where: B_{ws} = Water content of gas stream, fraction.

K_1 = 0.04707

K_2 = 17.64

P_B = Barometric pressure, in Hg.

T_m = Temperature of meter, ^oR.

V_i = Initial volume of liquid in impinger.

V_f = Final volume of liquid in impinger.

V_{wc} = Standard volume of waer collected.

V_m = Actual volume of sample.

$V_{m_{std}}$ = Standard volume of sample collected.

Y = Dry gas meter coefficient.

Figure 7-3. RM 4 Calculations.

$$B_w = \frac{P_w}{P_{bar}}$$

$$C_t = \left[\frac{\frac{P_{tf}}{T_{tf}}}{\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}}} \right] \left[\frac{1}{(1-B_w)r} \sum_{J=1}^{r} C_{tm}(J) \right]$$

Where:

B_w = Moisture content in the sample, fraction.

C_t = Calculated NMOC concentration, ppm C equivalent.

C_{tm} = Measured NMOC concentration, ppm C equivalent.

P_b = Barometric pressure, mm Hg.

P_{ti} = Gas sample tank pressure after evacuation, mm Hg absolute.

P_t = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.

P_{tf} = Final gas sample tank pressure after pessurizing, mm Hg absolute.

P_w = Vapor pressure of H_2O, mm Hg.

T_{ti} = Sample tank temperature at completion of sampling, ^oK.

T_t = Sample tank temperature at completion of sampling, ^oK.

T_{tf} = Sample tank temperature after pressurizing, ^oK.

r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1...r).

Figure 7-4. RM 25C Calculations.

The correlation coefficient reflects the linearity of response to the calibration gas mixtures and is calculated as:

$$r = \frac{n\,(\sum xy) - (\sum x)\,(\sum y)}{([n(\sum x^2) - (\sum x)^2]\,[n(\sum y^2) - (\sum y)^2])^{1/2}} \quad (7\text{-}1)$$

where:

x = calibration concentrations

y = instrument response (peak area)

n = number of calibration points (x,y data pairs)

7.2.2 Precision

Control limits for control sample analyses, acceptability limits for replicate analyses, and response factor agreement criteria specified in Sections 6 and 8 are based upon precision, in terms of the coefficient of variation (CV), i.e,. the relative standard deviation. The standard deviation of a sample set is calculated as:

$$S = \text{standard deviation} = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

where:

x = individual measurement

x = mean value for the individual measurements

n = number of measurements

The CV in percent is then calculated as:

$$CV = \frac{S}{\bar{x}} \times 100\%$$

$$\text{Pooled CV} = \frac{\sum_{i=1}^{K} CV_i\, DF_i}{\sum_{i=1}^{K} DF_i}$$

where:

CV_i = CV of data set i

nja.052

7.3 REPORTING

Reporting responsibilities for this project are outlined in Table 7-1. These include both formal reports (e.g., QA Project Plan, final reports, etc.) and internal reports (e.g., test data summaries, QC data summaries, etc.).

Upon completion testing, the Field Team Leaders will be responsible for preparation of a complete data summary including calculation results and raw data sheets. They will be assisted in this effort by other field team members. Following the performance and systems audits, the Project Director will prepare a summary audit report which details the audit activities and results. This summary report will be included as part of the final project report.

8.0 INTERNAL QUALITY CONTROL PROCEDURES

Prior to actual sampling on site, all of the applicable sampling equipment will be thoroughly checked to ensure that each component is clean and operable. Each of the equipment calibration data forms will be reviewed for completeness and adequacy to ensure the acceptability of the equipment. Each component of the various sampling systems will be carefully packaged for shipment, and upon arrival at the site, the equipment will be unloaded, inspected, and assembled for use.

General quality control procedures for flue gas sampling (i.e., EPA Methods 2C, 3C, 4, and 25C) will include the following:

- Each sampling train will be visually inspected for proper assembly before every use.

- All sampling data will be recorded on standard data forms.

- Any unusual conditions or occurrences will be noted during each run on the appropriate data form.

- Field sampling team leaders will review sampling data sheets daily.

In addition to the general QC procedures listed above, QC procedures specific to each sampling method will also be followed. These method-specific procedures are discussed below.

8.2.1 Quality Control Procedures for Velocity/Volumetric Flow Rate Determination

Data required to determine the volumetric gas flow rate will be collected using Method 2C. Quality control will focus on the following procedures:

- The S-type pitot tube will be visually inspected before sampling.

- Both the low pressure and high pressure legs of the pitot tube will be leak checked before sampling.

- The oil manometer or Magnehelic gauge used to indicate the differential pressure (ΔP) across the S-type pitot tube will be leveled and zeroed.

- The number and location of the sampling traverse points will be checked before taking measurements.

- The temperature measurement system will be visually checked for damage and operability by measuring the ambient temperature prior to each traverse.

- All sampling data and calculations will be recorded on preformatted data sheets.

8.2.2 Quality Control Procedures for CO_2, O_2, N_2, and Methane Determination

Data required to calculate molecular weight of the gas stream will be collected using EPA Method 3C. Quality control for Method 3C sampling will focus on the following:

- The sampling train will be leak-checked before and after each sampling run.

- A constant sampling rate (±10%) will be used in withdrawing a sample.

- The sampling train will be purged prior to sample collection.

- The sampling port will be properly sealed to prevent air in leakage.

Analytical quality control for Method 3C will include the following:

- Instrument will be set to manufacturer's specifications before use.

- Instrument linearity will be checked daily.

- Instrument calibration will be checked before and after each series of runs are completed.

8.2.3 Quality Control Procedures for Moisture Determination

The moisture content of the gas streams will be determined using the technique specified in Method 4. The following internal QC checks will be performed as part of the moisture determinations:

- Each impinger will be weighed to the nearest 0.02 grams before and after sampling.

- The sampling train, including impingers, will be leak-checked before and after each run.

- Ice will be maintained in the ice bath throughout the run.

- Dry gas meter readings will be made at the start and end of each sampling segment.

- The sampling train will be purged following each run.

- Sampling and impinger catch data will be recorded on preformatted data sheets.

8.2.4 Quality Control Procedures for NMOC Determination

Data required to calculate NMOC concentration of the effluent stream will be collected according to EPA RM 25C. Quality control for RM 25C sampling will include:

- The sampling train will be leak-checked before and after each sampling run.
- A constant sampling rate (±10%) will be maintained when collecting the sample.
- The sample train will be purged before sample collection.

Analytical quality control for Method 25C will include the following:

- Instrument will be set to manufacturer's specifications before use.
- Instrument linearity will be checked daily.
- Instrument calibration will be checked before and after each series of runs are completed.

9.0 PERFORMANCE AND SYSTEMS AUDITS

A quality assurance audit is an independent assessment of a measurement system. It typically includes performance evaluation using apparatus and/or standards that are different from those used in the measurement system. It also may include an evaluation of the potential of the system to produce data of adequate quality to satisfy the objectives of the measurement efforts. The independent, objective nature of the audit requires that the auditor be functionally independent of the sampling/analytical team.

Quality assurance audits play an important role in Radian's overall QA/QC program. This section describes the role of the QA auditor and the nature of both performance and systems audits.

9.1 AUDIT APPROACH

The QA Coordinator or her designee will perform an independent performance and systems audits. The function of the auditor will be to:

- Check and verify records of calibration,
- Assess the effectiveness of and adherence to the prescribed QC procedures,
- Review document control procedures,
- Identify and correct any weaknesses in the sampling/analytical approach and techniques, and
- Assess the overall data quality of the various sampling/analytical systems.

Generally, the role of the auditor is to observe and document the overall performance of each of the various sampling and analytical systems. Audit standards and test equipment which are traceable to acceptable reference standards may be used to assess the performance of each analytical method and/or measurement device (performance audit). Based on the audit results, the auditor may, as necessary, initiate corrective action at the project level, through the Program Manager or Project Director.

During the field testing portion of this program, an individual not directly involved with operation of the sampling equipment will periodically check the tester's compliance with all QA/QC functions appropriate for the testing. These observations will be recorded in a permanently bound notebook assigned specifically for this project.

In addition to the field QA/QC, all laboratory QA/QC activities will be similarly documented. An internal laboratory audit will also be performed to assess the effectiveness of the QA/QC program.

10.0 PREVENTIVE MAINTENANCE

The primary objective of a comprehensive preventive maintenance program is to help ensure the timely and effective completion of a measurement effort. Radian's preventive maintenance program is designed to minimize the downtime of crucial sampling and/or analytical equipment due to component failure. Details of the preventive maintenance efforts for this project are discussed below.

10.1 GENERAL

Prior to this field program, all sampling and analytical systems will be assembled and checked for proper operation. At this time, any worn or inoperative components will be identified and replaced.

The component parts of the sampling system will be checked on a daily basis to ensure that the equipment is operating properly. The checklists similar to those shown in Figure 10-1 will be used to document the daily system check and routine maintenance activities. Any major problems requiring unscheduled maintenance will be recorded in the field log, which will be a bound paginated laboratory notebook. Pertinent information to be recorded will include:

- name of operator,
- date,
- maintenance activity,
- problems encountered,
- cause of problem, and
- corrective actions taken.

All entries will be made in ink and signed. Any corrections will be made by drawing a single line through the improper entry and entering the correct information.

OPERATIONAL PARAMETERS: SAMPLING

TEST ID	DATE	TIME	PROBE PROPERLY LOCATED	SAMPLE LINE HEATING	GAS COND. BATH TEMP. (DEG. F)	AMPLE GAS COND. FLOW (SCFH)	INSTRUMENT AREA TEMP. (DEG. F)	BLOWBACK FREQUENCY (MINUTES)	EXCESS MANIFOLD FLOW

NOTES:

Figure 10-1. Example Operator Checklist.

10.2 SPARE PARTS

The maintenance activities described above, and an adequate inventory of spare parts will be required to minimize equipment downtime. This inventory will emphasize those parts (and supplies) which:

- are subject to frequent failure,
- have limited useful lifetimes, or
- cannot be obtained in a timely manner should failure occur.

11.0 ASSESSMENT OF PRECISION, ACCURACY, AND COMPLETENESS

The performance audits and QC analyses conducted during the testing program are designed to provide a quantitative assessment of the measurement system data. The two aspects of data quality which are of primary concern are precision and accuracy. Accuracy reflects the degree to which the measured value represents the actual or "true" value for a given parameter, and includes elements of both bias and precision. Precision is a measure of the variability associated with the measurement system. The completeness of the data will be evaluated based upon the valid data percentage of the total tests conducted.

11.1 PRECISION

Precision, by the definition presented in the EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I, Principles (EPA-600/9-76-005) is "a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions." Different measures of precision exist, depending upon these "prescribed similar conditions."

Quality control procedures, such as control sample analyses and replicate analyses, represent the primary mechanism for evaluating measurement data variability or precision. Replicate analyses will be used to define analytical replicability, while results for replicate samples may be used to define the total variability (replicability) of the sampling/analytical system as a whole.

Precision of the measurement data for this program will be based upon replicate analyses (replicability) and control sample analyses (repeatability). Variability will be expressed in terms of the coefficient of variation (CV) for the replicate and repeat analyses where,

$$\%CV = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

This term is independent of the error (accuracy) of the analyses and reflects only the degree to which the measurements agree with one another, not the degree to which they agree with the "true" value for the parameter measured. The CV is in units of percent since it is the standard deviation of the mean expressed as percent of the mean (relative standard deviation).

For the CEMS data, the daily drift checks will provide another means of controlling and assessing monitor data precision. These data will be summarized in terms of percent drift for each monitor as discussed in Section 8.0.

11.2 ACCURACY

Accuracy, according to EPA's definition is "the degree of agreement of a measurement (or an average of measurements of the sam thing), X, with an accepted reference or true value T." This definition actually encompasses two concepts, which creates a strong potential for confusion if the difference between the concepts is not clearly understood. The confusion arises due to the discrepancy between the concept of accuracy of individual measurements and the concept of accuracy of average values obtained from replicate or repeat measurements of a given parameter. In the case of accuracy of individual measurements, accuracy includes components of bias and precision (i.e., both systematic and random error). On the other hand, accuracy of the average of individual measurements equates accuracy with bias and represents an attempt to quantitate systematic error (bias) independent of random error (precision). Under this approach, a set of measurements could be said to the accurate without being precise. Under the other approach, where individual measurements are considered, precision is a requisite of accuracy since random variability is a component of the total measurement error and does not get "averaged out." The validity of significance of the estimate of bias is directly related to the number of individual measurements used to compute the average. It is based on the principle that as the number of individual measurements is increased indefinitely, the sample mean, X, approaches a definite value, u. The difference between u and the true value, T represents the magnitude of the measurement bias, or systematic bias plus random error due to imprecision.

Performance audits represent one mechanism for defining measurement system error. Typically, repeated measurements are made of the parameter of interest for the same audit sample or using additional samples at different levels, and the average error is calculated. As discussed above, this error value represents an estimate of measurement bias or systematic error, although it is often simply referred to as "accuracy." The significance of the bias estimate may be evaluated using confidence intervals. An approximate 95% confidence interval for the mean error (bias) can be calculated using:

$$\text{Mean}(X) \pm t_{.025,\ (n-1)} \frac{\text{Standard Deviation}}{(n)^{1/2}}$$

where n is the number of measurements used to compute the average and standard deviation and t is a table statistical value (.025 confidence level, n-1 degrees of freedom; when n is greater than 10, 5 approaches 2.0).

As an example, for a particular set of nine measurements, assume an overall mean of 20 ppm is reported, and the standard deviation of these data is 10 ppm. Also, assume that the true concentration is 30 ppm. For these measurements, the 95% confidence internal is:

$$20 \pm 2.3 \frac{10}{(9)^{1/2}} \qquad \text{or} \qquad 20 \pm 7.7$$

which is the interval (12,28). Since this interval does not include the true value, 30 ppm, a conclusion of bias is justified. The magnitude of this bias is between 2 and 18 ppm. The uncertainty in the estimate is due to variability arising from random error.

The choice of definitions of accuracy should be made based on the specific application. Regardless of the definition chosen, performance audit results provide only a point-in-time measure of accuracy, and actually reflect only the capability of the system. In most cases, the results provide some insight into the precision, as well as the bias of measurements. These data supplement data generated by the internal QC procedures. Extrapolation of the audit and QC data to actual samples and measurements provides the primary mechanism whereby error limits for various measurements may be estimated and the confidence in the measurement data defined.

Daily control samples analyses may be used to assess measurement bias. While performance audit results represent a point-in-time assessment of measurement error, the average degree of agreement between measured values and actual values for control samples provides a long-term, or average estimate of measurement bias, as well as precision (repeatability).

11.3 COMPLETENESS

Measurement data completeness is a measure of the extent to which the database resulting from a measurement effort fulfills objectives for the amount of data required. For this program, completeness will be defined as the valid data percentage of the total tests planned.

12.0 CORRECTIVE ACTION

During the course of the LIMB testing program, it will be the responsibility of the Field Task Leader and the sampling team members to see that all measurement procedures are followed as specified and that measurement data meet the prescribed acceptance criteria. In the event a problem arises, it is imperative that prompt action be taken to correct the problem(s). The Field Team Leaders will initiate corrective action in the event of QC results which exceed acceptability limits. Corrective action may also be initiated by the team leaders upon identification of some other problem or potential problem. Corrective action may be initiated by the QA Coordinator based upon QC data or audit results. The corrective action scheme is shown in the form of a flow chart in Figure 12-1. Acceptability limits and prescribed corrective action related to the various internal QC checks are discussed in Section 8 and are summarized in Table 8-1.

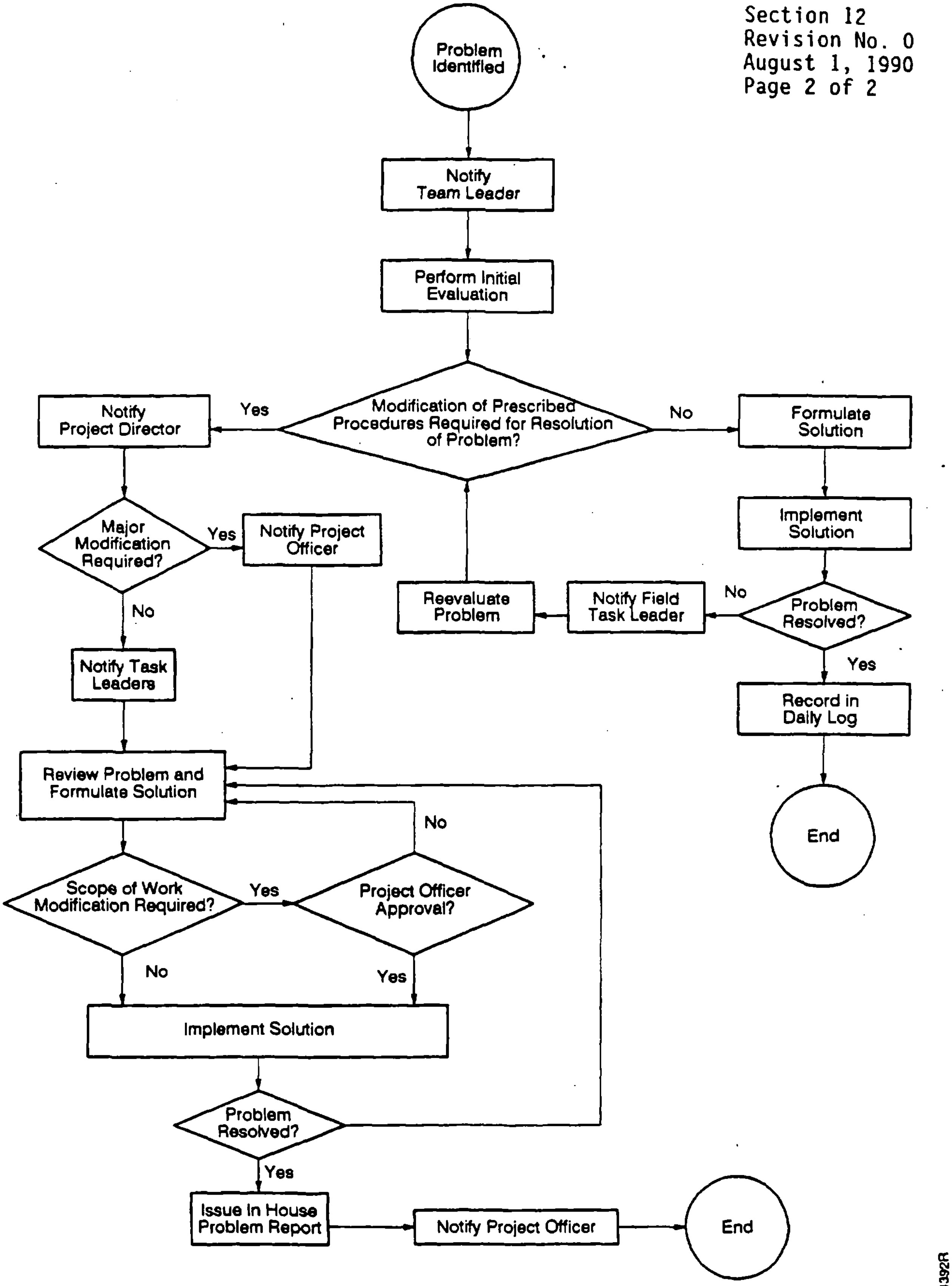

Figure 12-1. Corrective Action Flow Scheme

13.0 QUALITY ASSURANCE REPORTING

Effective management of a field sampling and analytical effort requires timely assessment and review of field activities. This will require effective interaction and feedback between the Field Team Leader, the Project Director and the QA Coordinator.

During the project, the Field Team Leader will be responsible for submitting QC reports to the EPA Project Manager, the Radian Project Director, and the Radian QA Coordinator(s). These monthly reports will address the following:

- summary of activities and general program status,
- summary of corrective action activities,
- assessment and summary of data completeness, and
- summary of any significant QA/QC problems and recommended and/or implemented solutions not included above.

The QA Coordinator (or her designee) will prepare an audit report following the performance and systems audits. The audit report will address data accuracy, the qualitative assessment of overall system performance. This report will be submitted to the Project Director. The project final report will include a separate QA/QC section which summarizes the audit results, as well as the QC data collected throughout the duration of the program.

Problems requiring swift resolution will be brought to the immediate attention of the Project Director via the malfunction reporting/corrective action scheme discussed in Section 12.0.

14.0 REFERENCES

1. "Handbook: Continuous Air Pollution Source Monitoring Systems," United States Environmental Protection, EPA 625/6-79-005. Technology Transfer, Cincinnati, Ohio. June 1979, pp. 11-16 to 11-19.

2. U. S. Environmental Protection Agency, "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods," EPA 600-4-77-027 b, Research Triangle Park, North Carolina. August 1977.

3. U.S. Environmental Protection Agency "AEERL Quality Assurance Procedures for Contractors and Financial Assistance Recipients", Research Triangle Park, North Carolina. May 1988.

4. U.S. Environmental Protection Agency. 1989a. EPA Reference Method 4: Determination of Moisture Content in Stack Gases; 40 CFR Pt. 60, Appendix A, pp. 676-685.

5. U.S. Environmental Protection Agency. 1989b. EPA Reference Method 2: Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube); 40 CFR Pt. 60, Appendix A, pp. 641-659.

6. U.S. Environmental Protection Agency. 1991a. EPA Reference Method 3C (Proposed): Determination of Carbon Dioxide, Nitrogen, and Oxygen from Stationary Sources. Proposed in the U.S. EPA's Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Solid Waste Landfills.

7. U.S. Environmental Protection Agency. 1991b. EPA Reference Method 25C (Proposed): Determination of Nonmethane Organic Compounds (NMOC) in Landfill Gases. Proposed in the U.S. EPA's Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Solid Waste Landfills.

APPENDIX E

Field Data Sheets

(Appendix E sheets are numbered to correspond with site numbers; e.g., sheet E1-1 is for run No. 1 and sheet E2-1 is for run No. 2. The gas analysis reports for Sites 2 and 4 were retyped due to poor copy quality of the originals.)

RADIAN
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Run Number Site 1 DATE Aug 6, 1990

Samplers Initials WCG

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	1410	6191	84		16.5		30.2		
2	1420	87	83		16.8				
3	1537	16	79		16.8				
4	1605	225	78		15.6				

NOTES:

Method 25C Field Sampling Data Sheet

RADIAN
CORPORATION

Run Number Site 1 DATE 8-6-90

Samplers Initials WCG

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
5	1618	46	78		16.8				
6	1627	6101	79		16.8				

NOTES:

Method 25C Field Sampling Data Sheet

RADIAN CORPORATION

Run Number: Site 1 **DATE** Aug 6, 1990

Samplers Initials wcg

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	1225	4T42	87		17				~~1225~~
2	1238	4T64	89		16.8				
3	1251	4T50	90		16.5				
4	1306	4T57	96		16.9				

NOTES:

Method 3C Field Sampling Data Sheet

RADIAN
CORPORATION

Run Number Site 1 DATE Aug 6, 1990

Samplers Initials WCG

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
5	1320	4T21	100		16.5				
6	1330 ~~343~~	343	102		16.5				

NOTES:

Method 3C Field Sampling Data Sheet

E1-5

RADIAN CORPORATION

FIELD DATA

PLANT Site 1
DATE 8-6-90
SAMPLING LOCATION comp. inlet
SAMPLE TYPE H_2O
RUN NUMBER 1
OPERATOR WCS
AMBIENT TEMPERATURE 74
BAROMETRIC PRESSURE 30.2
STATIC PRESSURE, (P_s) -60" H_2O
FILTER NUMBER (s) ~

γ = 1.0016

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER γ

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ____ MINUTES

154

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1445	429.885					76.1	79			50
	1450	430.675					77.	79			50
	1455	433.36					83	80			50
	1500	435.60					88	78.7			52
	1505	437.475					89	81.			52
											100
											+
											100

COMMENTS

1

EPA (Dur) 235

RADIAN CORPORATION

FIELD DATA

PLANT Site 1
DATE 8-6-90
SAMPLING LOCATION Comp. inlet
SAMPLE TYPE H_2O
RUN NUMBER 2
OPERATOR WCG
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_s) 30.15 -55" H_2O
FILTER NUMBER (s)

γ = 1.0016

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER γ 206

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

gas Temp 83 °F

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-h CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1515	437.582					81	79			58
	1521	439.4					84	80			60
	1526	440.9					84	83			60
	1530	442.1					84	80			60
	1535	443.360					84	80			
											100
											+
											100

COMMENTS:

EPA (Dur) 235

E1-6

E1-7

RADIAN
CORPORATION

FIELD DATA

PLANT: Site 1
DATE: 8-6-80
SAMPLING LOCATION:
SAMPLE TYPE: H2O
RUN NUMBER: 3
OPERATOR: WCG
AMBIENT TEMPERATURE:
BAROMETRIC PRESSURE: 30.1
STATIC PRESSURE, (P_s):
FILTER NUMBER (s):

PROBE LENGTH AND TYPE:
NOZZLE I.D.:
ASSUMED MOISTURE, %:
SAMPLE BOX NUMBER:
METER BOX NUMBER:
METER $\Delta H_@$:
C FACTOR:
PROBE HEATER SETTING:
HEATER BOX SETTING:
REFERENCE Δp:

SCHEMATIC OF TRAVERSE POINT LAYOUT

METER #:

READ AND RECORD ALL DATA EVERY ____ MINUTES

216

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
				DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	1642	443.509					81	80			60
	1647	445.9					86	81			60
	1652	448.8					92	82			60
	1657	451.4					92	82			61
	1702	454.269					91	81			61
	1710	469.3					93	84			62
											100
											+
											106

COMMENTS

EPA (Dur) 235
4 72

RADIAN CORPORATION

FIELD DATA

PLANT Site 1
DATE 8-6-90
SAMPLING LOCATION comp inlet
SAMPLE TYPE H_2O
RUN NUMBER 4
OPERATOR
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE 30.1
STATIC PRESSURE (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER γ

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

218

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-h CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1620	454.615					78	79			50
	1636	457.5					83	81			56
	1645	459.1					84	82			58
	1650	461.9					88	83			60
	1651	461.730					89	89			
		469.									
											108
											+
											108

COMMENTS

EPA (Dur) 235
4 72

E1-8

RADIAN CORPORATION

FIELD DATA

PLANT Site 1
DATE 8-6-90
SAMPLING LOCATION comp inlet
SAMPLE TYPE
RUN NUMBER 5
OPERATOR
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE 30.1
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER γ 226

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 h CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1655	462.181					84	82			60
	1200	464.4					89	83			60
	1705	466.7					91	83			63
	1710	469.3					93	84			64
	1715	471.620					93	83			62
											109
											109

COMMENTS:

EPA (Dec) 72

E1-9

RADIAN CORPORATION

FIELD DATA

PLANT Site 1
DATE 8-6-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 6
OPERATOR
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE 30.1
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER Y 233

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1720	471.717					86	84			62
	1726	473.8					89	84			60
	1730	475.6					89	84			59
	1735	477.5					91	85			59
	1740	479.575					92	86			57
											113
											+
											113

COMMENTS

EPA (Dur) 235
9 77

ANALYSIS

DATE: 08/06/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 12
TIME: 12:21 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 0 MODE: RUN CYCLE START TIME: 12:18

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.484	0.00	0.6000
OXYGEN	116	0.592	0.00	0.0065
NITROGEN	114	8.339	0.00	0.0807
METHANE	100	51.586	522.05	0.2857
TOTALS		100.000	522.05	0.9729

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 523.6
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 514.5
REAL SPECIFIC GRAVITY = 0.9753
UNNORMALIZED TOTAL = 99.77

ANALYSIS

DATE: 08/06/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 12
TIME: 12:24 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 0 MODE: RUN CYCLE START TIME: 12:21

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.386	0.00	0.5985
OXYGEN	116	0.554	0.00	0.0061
NITROGEN	114	8.308	0.00	0.0804
METHANE	100	51.752	523.73	0.2867
TOTALS		100.000	523.73	0.9716

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 525.3
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 516.1
REAL SPECIFIC GRAVITY = 0.9740
UNNORMALIZED TOTAL = 99.77

ANALYSIS

DATE: 08/06/90	ANALYSIS TIME: 165	STREAM SEQUENCE: 12
TIME: 12:27	CYCLE TIME: 180	STREAM#: 1
ANALYZER#: 0	MODE: RUN	CYCLE START TIME: 12:24

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.396	0.00	0.5986
OXYGEN	116	0.549	0.00	0.0061
NITROGEN	114	8.319	0.00	0.0805
METHANE	100	51.736	523.57	0.2866
TOTALS		100.000	523.57	0.9717

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 525.1
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 516.0
REAL SPECIFIC GRAVITY	= 0.9741
UNNORMALIZED TOTAL	= 99.57

ANALYSIS

DATE: 08/06/90	ANALYSIS TIME: 165	STREAM SEQUENCE: 12
TIME: 12:30	CYCLE TIME: 180	STREAM#: 1
ANALYZER#: 0	MODE: RUN	CYCLE START TIME: 12:27

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.433	0.00	0.5992
OXYGEN	116	0.541	0.00	0.0060
NITROGEN	114	8.266	0.00	0.0799
METHANE	100	51.759	523.81	0.2867
TOTALS		100.000	523.81	0.9718

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 525.4
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 516.2
REAL SPECIFIC GRAVITY	= 0.9742
UNNORMALIZED TOTAL	= 99.42

ANALYSIS

DATE: 08/06/90		ANALYSIS TIME:	165	STREAM SEQUENCE: 12	
TIME: 12:33		CYCLE TIME:	180	STREAM#: 1	
ANALYZER#:	0	MODE:	RUN	CYCLE START TIME: 12:30	

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.345	0.00	0.5978
OXYGEN	116	0.547	0.00	0.0060
NITROGEN	114	8.316	0.00	0.0804
METHANE	100	51.793	524.14	0.2869
TOTALS		100.000	524.14	0.9712

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 525.7
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 516.5
REAL SPECIFIC GRAVITY = 0.9736
UNNORMALIZED TOTAL = 99.47

ANALYSIS

DATE: 08/06/90		ANALYSIS TIME:	165	STREAM SEQUENCE: 12	
TIME: 12:36		CYCLE TIME:	180	STREAM#: 1	
ANALYZER#:	0	MODE:	RUN	CYCLE START TIME: 12:33	

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.340	0.00	0.5978
OXYGEN	116	0.550	0.00	0.0061
NITROGEN	114	8.332	0.00	0.0806
METHANE	100	51.779	524.00	0.2868
TOTALS		100.000	524.00	0.9712

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 525.6
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 516.4
REAL SPECIFIC GRAVITY = 0.9736
UNNORMALIZED TOTAL = 99.41

ANALYSIS

DATE: 08/06/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 12
TIME: 12:39 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 0 MODE: RUN CYCLE START TIME: 12:36

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.323	0.00	0.5975
OXYGEN	116	0.553	0.00	0.0061
NITROGEN	114	8.353	0.00	0.0808
METHANE	100	51.771	523.93	0.2868
TOTALS		100.000	523.93	0.9712

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 525.5
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 516.3
REAL SPECIFIC GRAVITY = 0.9735
UNNORMALIZED TOTAL = 99.35

ANALYSIS

DATE: 08/06/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 12
TIME: 12:52 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 0 MODF: RUN CYCLE START TIME: 12:39

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.406	0.00	0.5988
OXYGEN	116	0.533	0.00	0.0059
NITROGEN	114	8.247	0.00	0.0798
METHANE	100	51.814	524.36	0.2870
TOTALS		100.000	524.36	0.9714

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 525.9
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 516.8
REAL SPECIFIC GRAVITY = 0.9738
UNNORMALIZED TOTAL = 99.47

ANALYSIS

DATE: 08/06/90		ANALYSIS TIME:	165	STREAM SEQUENCE:	12
TIME:	13:16	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	0	MODE:	RUN	CYCLE START TIME:	13:13

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.382	0.00	0.5984
OXYGEN	116	0.523	0.00	0.0058
NITROGEN	114	8.226	0.00	0.0796
METHANE	100	51.869	524.91	0.2873
TOTALS		100.000	524.91	0.9711

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 526.5
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 517.3
REAL SPECIFIC GRAVITY	= 0.9734
UNNORMALIZED TOTAL	= 99.43

ANALYSIS

DATE: 08/06/90		ANALYSIS TIME:	165	STREAM SEQUENCE:	12
TIME:	13:19	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	0	MODE:	RUN	CYCLE START TIME:	13:16

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.340	0.00	0.5978
OXYGEN	116	0.538	0.00	0.0059
NITROGEN	114	8.323	0.00	0.0805
METHANE	100	51.800	524.21	0.2869
TOTALS		100.000	524.21	0.9711

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 525.8
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 516.6
REAL SPECIFIC GRAVITY	= 0.9735
UNNORMALIZED TOTAL	= 99.27

ANALYSIS

DATE: 08/06/90	ANALYSIS TIME: 165	STREAM SEQUENCE: 12
TIME: 13:22	CYCLE TIME: 180	STREAM#: 1
ANALYZER#: 0	MODE: RUN	CYCLE START TIME: 13:19

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.361	0.00	0.5981
OXYGEN	116	0.532	0.00	0.0059
NITROGEN	114	8.271	0.00	0.0800
METHANE	100	51.836	524.58	0.2871
TOTALS		100.000	524.58	0.9711

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 526.1
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 517.0
REAL SPECIFIC GRAVITY	= 0.9735
UNNORMALIZED TOTAL	= 99.29

ANALYSIS

DATE: 08/06/90	ANALYSIS TIME: 165	STREAM SEQUENCE: 12
TIME: 13:25	CYCLE TIME: 180	STREAM#: 1
ANALYZER#: 0	MODE: RUN	CYCLE START TIME: 13:22

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.337	0.00	0.5977
OXYGEN	116	0.533	0.00	0.0059
NITROGEN	114	8.296	0.00	0.0802
METHANE	100	51.833	524.55	0.2871
TOTALS		100.000	524.55	0.9710

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 526.1
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 517.0
REAL SPECIFIC GRAVITY	= 0.9733
UNNORMALIZED TOTAL	= 99.38

ANALYSIS

DATE: 08/06/90		ANALYSIS TIME:	165	STREAM SEQUENCE:	12
TIME:	13:28	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	0	MODE:	RUN	CYCLE START TIME:	13:25

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.345	0.00	0.5978
OXYGEN	116	0.530	0.00	0.0059
NITROGEN	114	8.309	0.00	0.0804
METHANE	100	51.816	524.38	0.2870
TOTALS		100.000	524.38	0.9711

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 525.9
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 516.8
REAL SPECIFIC GRAVITY	= 0.9735
UNNORMALIZED TOTAL	= 99.23

ANALYSIS

DATE: 08/06/90		ANALYSIS TIME:	165	STREAM SEQUENCE:	12
TIME:	13:31	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	0	MODE:	RUN	CYCLE START TIME:	13:28

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.328	0.00	0.5976
OXYGEN	116	0.536	0.00	0.0059
NITROGEN	114	8.307	0.00	0.0803
METHANE	100	51.829	524.51	0.2871
TOTALS		100.000	524.51	0.9709

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 526.1
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 516.9
REAL SPECIFIC GRAVITY	= 0.9733
UNNORMALIZED TOTAL	= 99.27

ANALYSIS

DATE: 08/06/90		ANALYSIS TIME:	165	STREAM SEQUENCE:	12
TIME:	13:34	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	0	MODE:	RUN	CYCLE START TIME:	13:31

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.319	0.00	0.5975
OXYGEN	116	0.543	0.00	0.0060
NITROGEN	114	8.319	0.00	0.0805
METHANE	100	51.819	524.41	0.2870
TOTALS		100.000	524.41	0.9709

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 526.0
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 516.8
REAL SPECIFIC GRAVITY	= 0.9733
UNNORMALIZED TOTAL	= 99.23

ANALYSIS

DATE: 08/06/90		ANALYSIS TIME:	165	STREAM SEQUENCE:	12
TIME:	13:37	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	0	MODE:	RUN	CYCLE START TIME:	13:34

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.347	0.00	0.5979
OXYGEN	116	0.534	0.00	0.0059
NITROGEN	114	8.344	0.00	0.0807
METHANE	100	51.775	523.97	0.2868
TOTALS		100.000	523.97	0.9713

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 525.5
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 516.4
REAL SPECIFIC GRAVITY	= 0.9736
UNNORMALIZED TOTAL	= 99.15

ANALYSIS

DATE: 08/06/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 12
TIME: 12:55 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 0 MODE: RUN CYCLE START TIME: 12:52

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	39.413	0.00	0.5989
OXYGEN	116	0.537	0.00	0.0059
NITROGEN	114	8.248	0.00	0.0798
METHANE	100	51.802	524.24	0.2869
TOTALS		100.000	524.24	0.9715

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 525.8
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 516.6
REAL SPECIFIC GRAVITY = 0.9739
UNNORMALIZED TOTAL = 99.29

RADIAN CORPORATION

Run Number Site 2 DATE 8-7-90

Samplers Initials ALD

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	1116	151	86		14.5		30.17		
2	1131	47	86		14.8		"		
3	1146	115	86		14.8		"		
4	1329	202	83		14.8		30.18		

NOTES:

Method 25C Field Sampling Data Sheet

RADIAN
CORPORATION

Run Number Site 2 DATE 8-7-90

Samplers Initials ACO

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
5	1344	193	83		14.8		30.18		
6	1359	351	83		14.8		"		

NOTES:

Method 25C Field Sampling Data Sheet

RADIAN CORPORATION

Run Number Site 2 DATE 8-7-90

Samplers Initials WCG

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	0954	4T54	83		14.9		30.15		
2	1002	4T56	86		14.8		"		
3	1010	4T28	86		14.8		"		
4	1020	4T5	86		14.9		"		

NOTES:

Method 3C Field Sampling Data Sheet

RADIAN
CORPORATION

Run Number Site 2 DATE 8-7-90

Samplers Initials ______________

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
5	1036	4T48	88		14.9		30.15		
6	1049	4T8	88		14.9		"		

NOTES:

Method 3C Field Sampling Data Sheet

RADIAN CORPORATION

FIELD DATA

PLANT Site 2
DATE 8-7-90
SAMPLING LOCATION comp inlet
SAMPLE TYPE
RUN NUMBER 1
OPERATOR WCG
AMBIENT TEMPERATURE 78
BAROMETRIC PRESSURE 30.18
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER γ 201

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
				DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	1157	491.795					92	94			65
	1202	494.4					106	95			72
	1207	498.8					109	95			72
	1212	502.8					113	95			72
	1217	506.572					111	97			

stack temp 63°F

100
+
100

COMMENTS:

EPA (Dur) 235

RADIAN CORPORATION

FIELD DATA

PLANT Site 2
DATE 8-7-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 2
OPERATOR
AMBIENT TEMPERATURE 79
BAROMETRIC PRESSURE 30.18
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER γ

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

201

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 h CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1222	506.601					101	92			70
	1227	511.0					107	94			75
	1232	515.0					109	94			75
	1237	518.9					111	94			72
	1242	522.8					111	95			
										101	
										+	
										100	

COMMENTS

EPA (Dur) 235

RADIAN
CORPORATION

FIELD DATA

PLANT Site 2
DATE 8-7-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 3
OPERATOR
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE 30.17
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

SCHEMATIC OF TRAVERSE POINT LAYOUT

METER γ

READ AND RECORD ALL DATA EVERY ______ MINUTES

204

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-h CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1246	522.875					103	95			68
	1251	527.0					108	95			68
	1258	531.1					109	95			62
	1303	535.3					109	96			60
	1306	538.400					107	95			58
										101	
										+	
										100	

COMMENTS:

EPA (Dur) 235
4-72

RADIAN CORPORATION

FIELD DATA

PLANT Site 2
DATE 8-7-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 4
OPERATOR
AMBIENT TEMPERATURE 83
BAROMETRIC PRESSURE 30.18
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER γ 206

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-h CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1417	539.405					99	97			45
	1422	543.3					108	97			47
	1427	547.3					113	98			49
	1432	551.0					114	99			48
	1437	554.307					115	99			73
											102
											+
											102

COMMENTS

EPA (Dur) 235
1 73

RADIAN CORPORATION

FIELD DATA

PLANT Site 2
DATE 8-7-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 5
OPERATOR
AMBIENT TEMPERATURE 83
BAROMETRIC PRESSURE 30.18
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER # 208

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1442	554.402					109	100			77
	1447	558.8					114	99			65
	1452	563.0					116	101			56
	1457	566.9					118	101			53
	1502	570.507					118	102			52
											103
											+
											102

COMMENTS:

EPA (Dur) 235

E2-9

RADIAN CORPORATION

FIELD DATA

PLANT Site 2
DATE 8-7-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 6
OPERATOR
AMBIENT TEMPERATURE 83
BAROMETRIC PRESSURE 30.18
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

SCHEMATIC OF TRAVERSE POINT LAYOUT

METER γ

READ AND RECORD ALL DATA EVERY ____ MINUTES

212

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-h CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1505	570.605					117	102			68
	1510	574.0					117	102			64
	1515	577.9					119	104			50
	1520	581.6					119	105			47
	1525	585.104					120	106			46
											104
											+
											104

COMMENTS:

EPA (Dec) 235
4-72

ANALYSIS

DATE:	08/07/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	09:46	CYCLE TIME:	180	STREAM#:	1
ANALYZER:	72092	MODE:	RUN	CYCLE START TIME:	09:43

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.121	0.00	0.5944
OXYGEN	116	0.131	0.00	0.0014
NITROGEN	114	7.475	0.00	0.0723
METHANE	100	53.273	539.13	0.2951
TOTALS		100.000	539.13	0.9633

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 540.7
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 531.3
REAL SPECIFIC GRAVITY	= 0.9657
UNNORMALIZED TOTAL	= 99.62

ANALYSIS

DATE:	08/07/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	09:49	CYCLE TIME:	180	STREAM#:	1
ANALYZER:	72092	MODE:	RUN	CYCLE START TIME:	09:46

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.111	0.00	0.5943
OXYGEN	116	0.131	0.00	0.0014
NITROGEN	114	7.508	0.00	0.0726
METHANE	100	53.250	538.89	0.2950
TOTALS		100.000	538.89	0.9633

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 540.5
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 531.1
REAL SPECIFIC GRAVITY	= 0.9657
UNNORMALIZED TOTAL	= 99.56

ANALYSIS

DATE: 08/07/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 09:52 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 72092 MODE: RUN CYCLE START TIME: 09:49

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.118	0.00	0.5944
OXYGEN	116	0.130	0.00	0.0014
NITROGEN	114	7.470	0.00	0.0723
METHANE	100	53.282	539.21	0.2951
TOTALS		100.000	539.21	0.9632

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 540.8
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 531.4
REAL SPECIFIC GRAVITY	= 0.9656
UNNORMALIZED TOTAL	= 99.56

ANALYSIS

DATE: 08/07/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 09:55 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 72092 MODE: RUN CYCLE START TIME: 09:52

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.138	0.00	0.5947
OXYGEN	116	0.129	0.00	0.0014
NITROGEN	114	7.417	0.00	0.0717
METHANE	100	53.317	539.56	0.2953
TOTALS		100.000	539.56	0.9632

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 541.2
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 531.8
REAL SPECIFIC GRAVITY	= 0.9656
UNNORMALIZED TOTAL	= 99.64

ANALYSIS

DATE: 08/07/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 09:58 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 72092 MODE: RUN CYCLE START TIME: 09:55

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.127	0.00	0.5945
OXYGEN	116	0.129	0.00	0.0014
NITROGEN	114	7.480	0.00	0.0724
METHANE	100	53.263	539.02	0.2950
TOTALS		100.000	539.02	0.9633

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 540.6
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 531.2
REAL SPECIFIC GRAVITY = 0.9657
UNNORMALIZED TOTAL = 99.51

ANALYSIS

DATE: 08/07/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 10:01 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 72092 MODE: RUN CYCLE START TIME: 09:58

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.120	0.00	0.5944
OXYGEN	116	0.130	0.00	0.0014
NITROGEN	114	7.467	0.00	0.0722
METHANE	100	53.284	539.23	0.2951
TOTALS		100.000	539.23	0.9632

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 540.8
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 531.4
REAL SPECIFIC GRAVITY = 0.9656
UNNORMALIZED TOTAL = 99.53

ANALYSIS

DATE: 08/07/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 10:04 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 72092 MODE: RUN CYCLE START TIME: 10:01

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.119	0.00	0.5944
OXYGEN	116	0.130	0.00	0.0014
NITROGEN	114	7.468	0.00	0.0722
METHANE	100	53.283	539.22	0.2951
TOTALS		100.000	539.22	0.9632

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 540.8
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 531.4
REAL SPECIFIC GRAVITY = 0.9656
UNNORMALIZED TOTAL = 99.59

ANALYSIS

DATE: 08/07/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 10:07 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 72092 MODE: RUN CYCLE START TIME: 10:04

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.126	0.00	0.5945
OXYGEN	116	0.130	0.00	0.0014
NITROGEN	114	7.466	0.00	0.0722
METHANE	100	53.278	539.17	0.2951
TOTALS		100.000	539.17	0.9633

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 540.8
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 531.4
REAL SPECIFIC GRAVITY = 0.9657
UNNORMALIZED TOTAL = 99.48

ANALYSIS

DATE: 08/07/90 | ANALYSIS TIME: 165 | STREAM SEQUENCE: 1
TIME: 10:10 | CYCLE TIME: 180 | STREAM#: 1
ANALYZER: 72092 | MODE: RUN | CYCLE START TIME: 10:07

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.105	0.00	0.5942
OXYGEN	116	0.129	0.00	0.0014
NITROGEN	114	7.477	0.00	0.0723
METHANE	100	53.288	539.28	0.2952
TOTALS		100.000	539.28	0.9631

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 540.9
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 531.5
REAL SPECIFIC GRAVITY	= 0.9655
UNNORMALIZED TOTAL	= 99.53

ANALYSIS

DATE: 08/07/90 | ANALYSIS TIME: 165 | STREAM SEQUENCE: 1
TIME: 10:13 | CYCLE TIME: 180 | STREAM#: 1
ANALYZER: 72092 | MODE: RUN | CYCLE START TIME: 10:10

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.128	0.00	0.5945
OXYGEN	116	0.128	0.00	0.0014
NITROGEN	114	7.403	0.00	0.0716
METHANE	100	53.341	539.81	0.2955
TOTALS		100.000	539.81	0.9630

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 541.4
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 532.0
REAL SPECIFIC GRAVITY	= 0.9654
UNNORMALIZED TOTAL	= 99.60

ANALYSIS

DATE:	08/07/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	10:16	CYCLE TIME:	180	STREAM#:	1
ANALYZER:	72092	MODE:	RUN	CYCLE START TIME:	10:13

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.139	0.00	0.5947
OXYGEN	116	0.134	0.00	0.0015
NITROGEN	114	7.509	0.00	0.0726
METHANE	100	53.219	538.58	0.2948
TOTALS		100.000	538.58	0.9636

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 540.2
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 530.8
REAL SPECIFIC GRAVITY	= 0.9660
UNNORMALIZED TOTAL	= 99.39

ANALYSIS

DATE:	08/07/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	10:19	CYCLE TIME:	180	STREAM#:	1
ANALYZER:	72092	MODE:	RUN	CYCLE START TIME:	10:16

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.119	0.00	0.5944
OXYGEN	116	0.128	0.00	0.0014
NITROGEN	114	7.427	0.00	0.0718
METHANE	100	53.326	539.65	0.2954
TOTALS		100.000	539.65	0.9630

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 541.3
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 531.9
REAL SPECIFIC GRAVITY	= 0.9654
UNNORMALIZED TOTAL	= 99.60

ANALYSIS

DATE: 08/07/90	ANALYSIS TIME:	165	STREAM SEQUENCE: 1		
TIME: 10:22	CYCLE TIME:	180	STREAM#: 1		
ANALYZER: 72092	MODE:	RUN	CYCLE START TIME: 10:19		

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.106	0.00	0.5942
OXYGEN	116	0.130	0.00	0.0014
NITROGEN	114	7.496	0.00	0.0725
METHANE	100	53.268	539.08	0.2951
TOTALS		100.000	539.08	0.9632

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 540.7
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 531.3
REAL SPECIFIC GRAVITY	= 0.9656
UNNORMALIZED TOTAL	= 99.53

ANALYSIS

DATE: 08/07/90	ANALYSIS TIME:	165	STREAM SEQUENCE: 1		
TIME: 10:25	CYCLE TIME:	180	STREAM#: 1		
ANALYZER: 72092	MODE:	RUN	CYCLE START TIME: 10:22		

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.094	0.00	0.5940
OXYGEN	116	0.129	0.00	0.0014
NITROGEN	114	7.468	0.00	0.0722
METHANE	100	53.309	539.49	0.2953
TOTALS		100.000	539.49	0.9630

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 541.1
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 531.7
REAL SPECIFIC GRAVITY	= 0.9654
UNNORMALIZED TOTAL	= 99.58

ANALYSIS

DATE: 08/07/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 10:28 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 72092 MODE: RUN CYCLE START TIME: 10:25

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.109	0.00	0.5943
OXYGEN	116	0.129	0.00	0.0014
NITROGEN	114	7.449	0.00	0.0721
METHANE	100	53.313	539.52	0.2953
TOTALS		100.000	539.52	0.9630

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 541.1
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 531.7
REAL SPECIFIC GRAVITY = 0.9654
UNNORMALIZED TOTAL = 99.65

ANALYSIS

DATE: 08/07/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 10:31 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 72092 MODE: RUN CYCLE START TIME: 10:28

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.119	0.00	0.5944
OXYGEN	116	0.128	0.00	0.0014
NITROGEN	114	7.433	0.00	0.0719
METHANE	100	53.320	539.59	0.2953
TOTALS		100.000	539.59	0.9631

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 541.2
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 531.8
REAL SPECIFIC GRAVITY = 0.9654
UNNORMALIZED TOTAL = 99.56

ANALYSIS

DATE:	08/07/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	10:34	CYCLE TIME:	180	STREAM#:	1
ANALYZER:	72092	MODE:	RUN	CYCLE START TIME:	10:31

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.107	0.00	0.5942
OXYGEN	116	0.128	0.00	0.0014
NITROGEN	114	7.426	0.00	0.0718
METHANE	100	53.339	539.79	0.2954
TOTALS		100.000	539.79	0.9629

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 541.4
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 532.0
REAL SPECIFIC GRAVITY	= 0.9653
UNNORMALIZED TOTAL	= 99.62

ANALYSIS

DATE:	08/07/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	10:37	CYCLE TIME:	180	STREAM#:	1
ANALYZER:	72092	MODE:	RUN	CYCLE START TIME:	10:34

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.115	0.00	0.5944
OXYGEN	116	0.129	0.00	0.0014
NITROGEN	114	7.489	0.00	0.0724
METHANE	100	53.266	539.05	0.2950
TOTALS		100.000	539.05	0.9633

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 540.7
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 531.3
REAL SPECIFIC GRAVITY	= 0.9656
UNNORMALIZED TOTAL	= 99.58

ANALYSIS

DATE: 08/07/90	ANALYSIS TIME:	165	STREAM SEQUENCE: 1
TIME: 10:40	CYCLE TIME:	180	STREAM#: 1
ANALYZER: 72092	MODE:	RUN	CYCLE START TIME: 10:37

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.103	0.00	0.5942
OXYGEN	116	0.129	0.00	0.0014
NITROGEN	114	7.470	0.00	0.0723
METHANE	100	53.298	539.38	0.2952
TOTALS		100.000	539.38	0.9631

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 541.0
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 531.6
REAL SPECIFIC GRAVITY	= 0.9654
UNNORMALIZED TOTAL	= 99.51

ANALYSIS

DATE: 08/07/90	ANALYSIS TIME:	165	STREAM SEQUENCE: 1
TIME: 10:43	CYCLE TIME:	180	STREAM#: 1
ANALYZER: 72092	MODE:	RUN	CYCLE START TIME: 10:40

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.104	0.00	0.5942
OXYGEN	116	0.129	0.00	0.0014
NITROGEN	114	7.476	0.00	0.0723
METHANE	100	53.292	539.31	0.2952
TOTALS		100.000	539.31	0.9631

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 540.9
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 531.5
REAL SPECIFIC GRAVITY	= 0.9655
UNNORMALIZED TOTAL	= 99.56

ANALYSIS

DATE: 08/07/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 10:46 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 72092 MODE: RUN CYCLE START TIME: 10:43

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	39.135	0.00	0.5947
OXYGEN	116	0.128	0.00	0.0014
NITROGEN	114	7.406	0.00	0.0716
METHANE	100	53.331	539.71	0.2954
TOTALS		100.000	539.71	0.9631

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0030
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 541.3
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 531.9
REAL SPECIFIC GRAVITY = 0.9655
UNNORMALIZED TOTAL = 99.57

E3-1

RADIAN CORPORATION

Run Number Site 3 **DATE** 8/9/90

Samplers Initials ALD

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	1005	31	76		16.3		30.1		
2	1019	134	76		16.4		"		
3	1035	133	76		16.4		"		
4	1214	84	76		16.7		"		

NOTES:

Method 25C Field Sampling Data Sheet

RADIAN
CORPORATION

Run Number Site 3 DATE 8/9/90

Samplers Initials ALD

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
5	1230	222			16.6		30.1		
6	1243	79			16.5		"		

NOTES:

Method 25C Field Sampling Data Sheet

RADIAN CORPORATION

Run Number Site 3

DATE 8/9/90

Samplers Initials ALD

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	14:20	4752	79		15.4		30.1		
2	14:31	6156	"		16.1		"		
3	14:42	6148	"		16.1		"		
4	14:53	6103	"		16.3		"		

NOTES:

Method 3C Field Sampling Data Sheet

RADIAN
CORPORATION

Run Number Site 3 DATE 8/9/90

Samplers Initials ALD

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
5	15:02	6177	79		16.3		30.1		
6	15:14	6181	79		16.4		"		

NOTES:

Method 3C Field Sampling Data Sheet

RADIAN
CORPORATION

FIELD DATA

PLANT Site 3
DATE 8/9/90
SAMPLING LOCATION Compressor Inlet
SAMPLE TYPE
RUN NUMBER 1
OPERATOR
AMBIENT TEMPERATURE 76
BAROMETRIC PRESSURE 30.1
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER γ 108

SCHEMATIC OF TRAVERSE POINT LAYOUT

gas temp 85°F

READ AND RECORD ALL DATA EVERY ____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET $(T_{m\,in})$, °F	DRY GAS METER TEMPERATURE OUTLET $(T_{m\,out})$, °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	10:54	586.407					82	80			56
	10:59	589.6					87	81			56
	11:04	592.4					89	82			56
	11:09	595.0					90	82			62
	11:14	598.101					88	82			
										100	

COMMENTS

EPA (Dur) 235
4/72

RADIAN CORPORATION

FIELD DATA

PLANT Site 3
DATE 8/9/90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 2
OPERATOR
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE 30.1
STATIC PRESSURE (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER γ

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
										115	
	11:20	598.103					85	81			64
	11:27	604.4					91	82			78
	11:30	607.0					93	82			73
	11:35	610.3					92	83			72
	11:40	614.103					92	82			68
										108	

COMMENTS:

EPA (Dur) 235
4-72

RADIAN CORPORATION

FIELD DATA

PLANT: Site 3
DATE: 8/9/90
SAMPLING LOCATION:
SAMPLE TYPE:
RUN NUMBER: 3
OPERATOR:
AMBIENT TEMPERATURE:
BAROMETRIC PRESSURE:
STATIC PRESSURE, (P_s):
FILTER NUMBER (s):

PROBE LENGTH AND TYPE:
NOZZLE I.D.:
ASSUMED MOISTURE, %:
SAMPLE BOX NUMBER:
METER BOX NUMBER:
METER $\Delta H_@$:
C FACTOR:
PROBE HEATER SETTING:
HEATER BOX SETTING:
REFERENCE Δp:
METER γ:

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

125

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	11:45	614.203					86	81			70
	11:50	618.0					91	83			65
	11:55	621.1					92	84			54
	12:00	624.5					90	82			50
	12:05	627.091					91	84			49
											115

COMMENTS:

EPA (Dur) 235
4/72

E3-7

RADIAN
CORPORATION

FIELD DATA

PLANT Site 3
DATE 8-9-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 4
OPERATOR
AMBIENT TEMPERATURE 78
BAROMETRIC PRESSURE 30.1
STATIC PRESSURE (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER ΔH@
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER Y

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ____ MINUTES

135

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1249	627.400					83	80			34
	1254	631.0					74	81			42
	1259	634.7					100	83			48
	1304	638.5					102	81			48
	1309	642.473					101	80			48
										12.5	

COMMENTS

EPA (Dec) 235

RADIAN CORPORATION

FIELD DATA

PLANT Site 3
DATE 8-5-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 5
OPERATOR
AMBIENT TEMPERATURE 75
BAROMETRIC PRESSURE 30.0
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER Y

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

144

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
		1314	643.600					91	80			55
		1319	646.3					95	79			58
		1324	649.6					97	79			50
		1329	652.9					97	80			48
		1334	656.347					96	79			
											135	

COMMENTS

EPA (Dur) 235
6 72

RADIAN CORPORATION

FIELD DATA

PLANT Site 3
DATE 8-9-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 6
OPERATOR
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE 30.0
STATIC PRESSURE, (P_s) 74
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

SCHEMATIC OF TRAVERSE POINT LAYOUT
METER γ

READ AND RECORD ALL DATA EVERY ______ MINUTES

151

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1337	656.400					98	80			
	1342	659.9					97	79			62
	1347	662.8					96	79			56
	1352	665.6					95	78			50
	1357	668.439					93	78			

144

COMMENTS:

EPA (Dur) 235

E3-10

ANALYSIS

DATE: 08/09/90 | ANALYSIS TIME: 165 | STREAM SEQUENCE: 1

TIME: 14:24 | CYCLE TIME: 180 | STREAM#: 1

ANALYZER#: 51386 | MODE: PGM | CYCLE START TIME: 14:22

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.384	0.00	0.6592
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.412	0.00	0.0137
METHANE	100	55.115	557.76	0.3053
TOTALS		100.000	557.76	0.9791

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033

DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 559.6

SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 549.9

REAL SPECIFIC GRAVITY = 0.9819

UNNORMALIZED TOTAL = 98.43

ANALYSIS

DATE: 08/09/90 | ANALYSIS TIME: 165 | STREAM SEQUENCE: 1

TIME: 14:27 | CYCLE TIME: 180 | STREAM#: 1

ANALYZER#: 51386 | MODE: PGM | CYCLE START TIME: 14:24

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.400	0.00	0.6595
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.405	0.00	0.0136
METHANE	100	55.107	557.68	0.3052
TOTALS		100.000	557.68	0.9793

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033

DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 559.5

SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 549.3

REAL SPECIFIC GRAVITY = 0.9820

UNNORMALIZED TOTAL = 98.60

ANALYSIS

DATE: 08/09/90		ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	14:30	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	14:27

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.390	0.00	0.6593
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.411	0.00	0.0136
METHANE	100	55.110	557.71	0.3053
TOTALS		100.000	557.71	0.9792

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.6
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.8
REAL SPECIFIC GRAVITY	= 0.9820
UNNORMALIZED TOTAL	= 98.52

ANALYSIS

DATE: 08/09/90		ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	14:33	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	14:30

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.388	0.00	0.6593
OXYGEN	116	0.090	0.00	0.0010
NITROGEN	114	1.413	0.00	0.0137
METHANE	100	55.109	557.71	0.3052
TOTALS		100.000	557.71	0.9792

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.6
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.8
REAL SPECIFIC GRAVITY	= 0.9819
UNNORMALIZED TOTAL	= 98.48

ANALYSIS

DATE: 08/09/90		ANALYSIS TIME:	165	STREAM SEQUENCE: 1	
TIME: 14:36		CYCLE TIME:	180	STREAM#: 1	
ANALYZER#: 51386		MODE:	PGM	CYCLE START TIME: 14:33	

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.422	0.00	0.6598
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.407	0.00	0.0136
METHANE	100	55.082	557.43	0.3051
TOTALS		100.000	557.43	0.9795

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.3
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.5
REAL SPECIFIC GRAVITY	= 0.9823
UNNORMALIZED TOTAL	= 98.5[illegible]

ANALYSIS

DATE: 08/09/90		ANALYSIS TIME:	165	STREAM SEQUENCE: 1	
TIME: 14:39		CYCLE TIME:	180	STREAM#: 1	
ANALYZER#: 51386		MODE:	PGM	CYCLE START TIME: 14:36	

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.402	0.00	0.6595
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.411	0.00	0.0136
METHANE	100	55.098	557.60	0.3052
TOTALS		100.000	557.60	0.9793

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.5
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.7
REAL SPECIFIC GRAVITY	= 0.9821
UNNORMALIZED TOTAL	= 98.47

ANALYSIS

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 14:42 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 14:39

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.394	0.00	0.6594
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.406	0.00	0.0136
METHANE	100	55.112	557.73	0.3053
TOTALS		100.000	557.73	0.9792

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 559.6
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 549.9
REAL SPECIFIC GRAVITY = 0.9820
UNNORMALIZED TOTAL = 98.48

ANALYSIS

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 14:45 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 14:42

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.412	0.00	0.6596
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.406	0.00	0.0136
METHANE	100	55.093	557.54	0.3052
TOTALS		100.000	557.54	0.9794

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 559.4
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z) = 549.7
REAL SPECIFIC GRAVITY = 0.9821
UNNORMALIZED TOTAL = 98.49

ANALYSIS

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 14:43 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 14:45

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.403	0.00	0.6591
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.409	0.00	0.0136
METHANE	100	55.099	557.60	0.3052
TOTALS		100.000	557.60	0.9793

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.5
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.7
REAL SPECIFIC GRAVITY	= 0.9821
UNNORMALIZED TOTAL	= 98.50

ANALYSIS

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 14:51 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 14:48

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.389	0.00	0.6593
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.406	0.00	0.013[illegible]
METHANE	100	55.116	557.78	0.3053
TOTALS		100.000	557.78	0.9792

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.6
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.9
REAL SPECIFIC GRAVITY	= 0.9819
UNNORMALIZED TOTAL	= 98.54

ANALYSIS

DATE:	08/09/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	14:54	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	14:51

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.399	0.00	0.6595
OXYGEN	116	0.088	0.00	0.0010
NITROGEN	114	1.400	0.00	0.0135
METHANE	100	55.112	557.73	0.3053
TOTALS		100.000	557.73	0.9792

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.6
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.9
REAL SPECIFIC GRAVITY	= 0.9820
UNNORMALIZED TOTAL	= 98.51

ANALYSIS

DATE:	08/09/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	14:57	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	14:54

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.408	0.00	0.6596
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.405	0.00	0.0136
METHANE	100	55.098	557.59	0.3052
TOTALS		100.000	557.59	0.9793

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.4
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.7
REAL SPECIFIC GRAVITY	= 0.9821
UNNORMALIZED TOTAL	= 98.44

ANALYSIS

DATE: 08/09/90		ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	15:00	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	14:57

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.400	0.00	0.6595
OXYGEN	116	0.090	0.00	0.0010
NITROGEN	114	1.410	0.00	0.0136
METHANE	100	55.100	557.62	0.3052
TOTALS		100.000	557.62	0.9793

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.5
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.7
REAL SPECIFIC GRAVITY	= 0.9821
UNNORMALIZED TOTAL	= 98.47

ANALYSIS

DATE: 08/09/90		ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	15:03	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	15:00

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.406	0.00	0.6596
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.406	0.00	0.0135
METHANE	100	55.099	557.60	0.3052
TOTALS		100.000	557.60	0.9793

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.5
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.7
REAL SPECIFIC GRAVITY	= 0.9821
UNNORMALIZED TOTAL	= 98.60

ANALYSIS

DATE:	08/09/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	15:06	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	15:03

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.387	0.00	0.6593
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.406	0.00	0.0136
METHANE	100	55.118	557.79	0.3053
TOTALS		100.000	557.79	0.9791

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.6
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.9
REAL SPECIFIC GRAVITY	= 0.9819
UNNORMALIZED TOTAL	= 98.48

ANALYSIS

DATE:	08/09/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	15:09	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	15:06

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.392	0.00	0.6593
OXYGEN	116	0.090	0.00	0.0010
NITROGEN	114	1.407	0.00	0.0136
METHANE	100	55.111	557.72	0.3053
TOTALS		100.000	557.72	0.9792

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.6
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.8
REAL SPECIFIC GRAVITY	= 0.9820
UNNORMALIZED TOTAL	= 98.50

ANALYSIS

DATE: 08/09/90		ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	15:12	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	15:09

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.400	0.00	0.6595
OXYGEN	116	0.090	0.00	0.0010
NITROGEN	114	1.407	0.00	0.0136
METHANE	100	55.103	557.65	0.3052
TOTALS		100.000	557.65	0.9793

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.5
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.3
REAL SPECIFIC GRAVITY	= 0.9820
UNNORMALIZED TOTAL	= 98.53

ANALYSIS

DATE: 08/09/90		ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	15:15	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	15:12

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.409	0.00	0.6596
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.400	0.00	0.0135
METHANE	100	55.102	557.63	0.3052
TOTALS		100.000	557.63	0.9793

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 559.5
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	= 549.8
REAL SPECIFIC GRAVITY	= 0.9821
UNNORMALIZED TOTAL	= 98.53

ANALYSIS

DATE: 08/09/90		ANALYSIS TIME:	165	STREAM SEQUENCE: 1	
TIME: 15:18		CYCLE TIME:	180	STREAM#: 1	
ANALYZER#: 51386		MODE:	PGM	CYCLE START TIME: 15:15	

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.388	0.00	0.6593
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.404	0.00	0.0136
METHANE	100	55.119	557.81	0.3053
TOTALS		100.000	557.81	0.9791

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	=	1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	=	559.7
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	=	549.9
REAL SPECIFIC GRAVITY	=	0.9819
UNNORMALIZED TOTAL	=	98.55

ANALYSIS

DATE: 08/09/90		ANALYSIS TIME:	165	STREAM SEQUENCE: 1	
TIME: 15:21		CYCLE TIME:	180	STREAM#: 1	
ANALYZER#: 51386		MODE:	PGM	CYCLE START TIME: 15:18	

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR.*
C O 2	117	43.419	0.00	0.6591
OXYGEN	116	0.089	0.00	0.0010
NITROGEN	114	1.405	0.00	0.0136
METHANE	100	55.087	557.48	0.3051
TOTALS		100.000	557.48	0.9795

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	=	1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	=	559.3
SAT B.T.U. @ 14.730 PSIA & 60 DEG. F CORRECTED FOR (1/Z)	=	549.6
REAL SPECIFIC GRAVITY	=	0.9822
UNNORMALIZED TOTAL	=	98.44

ANALYSIS RAW DATA

DATE: 08/09/90 | ANALYSIS TIME: 165 | STREAM SEQUENCE: 1
TIME: 14:23 | CYCLE TIME: 180 | STREAM#: 1
ANALYZER#: 51386 | MODE: PGM | CYCLE START TIME: 14:22

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	43.9	1.81748 E+07	237861
2	90.1	60549.0	834.375
3	100.5	907074	10183.1
4	124.7	3.07438 E+07	166088

GRI	PAZ
0	205
1	206
5	206
62	820

ANALYSIS RAW DATA

DATE: 08/09/90 | ANALYSIS TIME: 165 | STREAM SEQUENCE: 1
TIME: 14:26 | CYCLE TIME: 180 | STREAM#: 1
ANALYZER#: 51386 | MODE: PGM | CYCLE START TIME: 14:24

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	44.0	1.82116 E+07	237871
2	90.1	60585.0	833.922
3	100.5	903834	10153.5
4	124.7	3.07907 E+07	166300

GRI	PAZ
0	205
5	206
12	206
66	821

ANALYSIS RAW DATA

DATE:	08/09/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	14:29	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	14:27

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	44.0	1.81930 E+07	237687
2	90.1	60576.0	835.672
3	100.5	907356	10180.2
4	124.7	3.07684 E+07	166235

GRI	PAZ
0	206
4	206
8	206
71	821

ANALYSIS RAW DATA

DATE:	08/09/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	14:32	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	14:30

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	44.0	1.81842 E+07	237613
2	90.1	61095.0	838.922
3	100.5	908073	10195.8
4	124.7	3.07541 E+07	166082

GRI	PAZ
0	206
0	206
4	206
61	820

ANALYSIS RAW DATA

DATE:	08/09/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	14:35	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	14:33

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	43.9	1.82026 E+07	237874
2	90.1	60288.0	832.250
3	100.5	904689	10166.2
4	124.7	3.07453 E+07	166100

GRI	PAZ
0	205
1	206
5	206
63	821

ANALYSIS RAW DATA

DATE:	08/09/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	14:38	CYCLE TIME:	180	STREAM#:	1
ANALYZER#:	51386	MODE:	PGM	CYCLE START TIME:	14:36

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	44.0	1.81888 E+07	237881
2	90.1	60330.0	830.047
3	100.5	906879	10183.6
4	124.7	3.07461 E+07	166039

GRI	PAZ
0	205
1	206
4	206
62	821

ANALYSIS RAW DATA

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 14:41 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 14:39

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	44.0	1.81874 E+07	237860
2	90.1	60390.0	833.922
3	100.5	903531	10159.5
4	124.7	3.07571 E+07	166145

GRI	PAZ
0	205
1	206
5	206
62	820

ANALYSIS RAW DATA

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 14:44 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 14:42

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	44.0	1.81961 E+07	237951
2	90.1	60366.0	829.922
3	100.5	904041	10159.8
4	124.7	3.07480 E+07	166096

GRI	PAZ
0	205
1	206
4	206
61	820

ANALYSIS RAW DATA

DATE: 08/09/90 | ANALYSIS TIME: 165 | STREAM SEQUENCE: 1
TIME: 14:47 | CYCLE TIME: 180 | STREAM#: 1
ANALYZER#: 51386 | MODE: PGM | CYCLE START TIME: 14:45

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	43.9	1.81942 E+07	237610
2	90.1	60174.0	829.375
3	100.5	905835	10172.1
4	124.7	3.07547 E+07	166160

GRI	PAZ
0	206
4	206
12	206
66	821

ANALYSIS RAW DATA

DATE: 08/09/90 | ANALYSIS TIME: 165 | STREAM SEQUENCE: 1
TIME: 14:50 | CYCLE TIME: 180 | STREAM#: 1
ANALYZER#: 51386 | MODE: PGM | CYCLE START TIME: 14:48

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	44.0	1.81967 E+07	237628
2	90.1	60588.0	834.805
3	100.5	904206	10146.3
4	124.7	3.07789 E+07	166259

GRI	PAZ
0	206
5	206
8	206
70	820

ANALYSIS RAW DATA

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 14:53 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 14:51

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	43.9	1.81948 E+07	237616
2	90.1	60174.0	829.375
3	100.5	900294	10118.1
4	124.7	3.07656 E+07	166150

GRI	PAZ
0	206
0	206
4	206
62	821

ANALYSIS RAW DATA

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SIQUINCI: 1
TIME: 14:56 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 14:54

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	43.9	1.81861 E+07	237620
2	90.1	60438.0	830.500
3	100.5	902964	10140.6
4	124.7	3.07370 E+07	166035

GRI	PAZ
0	206
0	206
4	206
62	821

ANALYSIS RAW DATA

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 14:59 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 14:57

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	43.9	1.81870 E+07	237863
2	90.1	61005.0	839.625
3	100.5	905940	10172.3
4	124.7	3.07455 E+07	166099

GRI	PAZ
0	205
1	206
5	206
62	820

ANALYSIS RAW DATA

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 15:02 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 15:00

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	44.0	1.82150 E+07	237626
2	90.1	60864.0	840.500
3	100.5	904485	10163.6
4	124.7	3.07880 E+07	166295

GRI	PAZ
0	206
4	206
12	206
65	821

ANALYSIS RAW DATA

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 15:05 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 15:03

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	43.9	1.81838 E+07	237363
2	90.1	60660.0	835.375
3	100.5	903912	10138.3
4	124.7	3.07592 E+07	166065

GRI	PAZ
0	206
4	206
8	206
69	820

ANALYSIS RAW DATA

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 15:08 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 15:06

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	44.0	1.81896 E+07	237612
2	90.1	60957.0	838.922
3	100.5	904692	10157.0
4	124.7	3.07613 E+07	166207

GRI	PAZ
0	206
5	206
8	206
71	820

ANALYSIS RAW DATA

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 15:11 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 15:09

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	44.0	1.81994 E+07	237616
2	90.1	61026.0	842.375
3	100.5	904914	10162.9
4	124.7	3.07684 E+07	166224

GRI	PAZ
0	206
4	206
8	206
70	820

ANALYSIS RAW DATA

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 15:14 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 15:12

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	44.0	1.82126 E+07	237686
2	90.1	60891.0	837.375
3	100.5	900534	10119.6
4	124.7	3.07833 E+07	166355

GRI	PAZ
0	206
5	206
9	206
70	820

ANALYSIS RAW DATA

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 15:17 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 15:15

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	44.0	1.81980 E+07	237616
2	90.1	60369.0	832.805
3	100.5	902871	10131.9
4	124.7	3.07829 E+07	166310

GRI	PAZ
0	206
5	206
9	206
71	821

ANALYSIS RAW DATA

DATE: 08/09/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 15:20 CYCLE TIME: 180 STREAM#: 1
ANALYZER#: 51386 MODE: PGM CYCLE START TIME: 15:18

PEAK #	RETENTION TIME	PEAK AREA	PEAK HEIGHT
1	43.9	1.81895 E+07	237628
2	90.1	60483.0	832.805
3	100.5	902901	10139.8
4	124.7	3.07285 E+07	166055

GRI	PAZ
0	206
-1	206
3	206
60	820

E4-1

RADIAN
CORPORATION

Run Number Site 4 **DATE** 8-21-90

Samplers Initials WCG

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	1105	155	89		27.5		30.15		
2	1125	122	90		27.5		"		
3	1243	068	87		26.5		30.15		
4	1302	019	89		25.9		"		

NOTES:

Method 25C Field Sampling Data Sheet

RADIAN CORPORATION

Run Number Site 4

DATE 8-21-90

Samplers Initials AKD

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
5	1317	038	90		25.8		30.15		
6	1330	147	"		26.8		"		

NOTES:

Method 25C Field Sampling Data Sheet

RADIAN
CORPORATION

Run Number Site 4

DATE 8/21/90

Samplers Initials ALD

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	1012	039	90		29.2		30.15		
2	1025	045	"		25.0		"		
3	1034	150	"		29.3		"		
4	1046	175	"		29.1		"		

NOTES:

Method 3C Field Sampling Data Sheet

RADIAN
CORPORATION

Run Number Site 4

DATE 8/21/90

Samplers Initials ALD

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
5	1055	070	90		29.0		30.15		
6	1109	089	"		25.2		"		

NOTES:

Method 3C Field Sampling Data Sheet

RADIAN
CORPORATION

FIELD DATA

PLANT: Site 4
DATE: 8-21-90
SAMPLING LOCATION: inlet
SAMPLE TYPE: N_xO
RUN NUMBER: 1
OPERATOR: WCG
AMBIENT TEMPERATURE: 94
BAROMETRIC PRESSURE: 30.15
STATIC PRESSURE, (P_s): -4
FILTER NUMBER (s):

PROBE LENGTH AND TYPE:
NOZZLE I.D.:
ASSUMED MOISTURE, %:
SAMPLE BOX NUMBER:
METER BOX NUMBER:
METER $\Delta H_@$:
C FACTOR:
PROBE HEATER SETTING:
HEATER BOX SETTING:
REFERENCE Δp:
METER γ: 0.978

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1138	158.485					94			92	66
	1143	158.66					94				66
	1150	158.85					95				66
	1153	158.98					95				66
	1159	159.17					95				63
	1203	159.325					95				61

100 ml
lost sample

COMMENTS

EPA (Dur) 235

RADIAN
CORPORATION

FIELD DATA

PLANT: Site 4
DATE: 8-21-90
SAMPLING LOCATION:
SAMPLE TYPE:
RUN NUMBER: 2
OPERATOR:
AMBIENT TEMPERATURE:
BAROMETRIC PRESSURE:
STATIC PRESSURE, (P_s):
FILTER NUMBER (s):

PROBE LENGTH AND TYPE:
NOZZLE I.D.:
ASSUMED MOISTURE %:
SAMPLE BOX NUMBER:
METER BOX NUMBER:
METER $\Delta H_@$:
C FACTOR:
PROBE HEATER SETTING:
HEATER BOX SETTING:
REFERENCE Δp:
METER γ: 102

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
				DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	1208	159.335					95				63
	1213	159.54					95				62
	1218	159.71					93				62
	1223	159.85					92				61
	1229	160.07					90				57
	1234	160.272					90				56
										100 ml	

COMMENTS

EPA (Dur) 235

RADIAN CORPORATION

FIELD DATA

PLANT Site 1
DATE 8-21-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 3
OPERATOR
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE 30.15
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER Y

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

104

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1345	160.382					90				45
	1350	160.57					90				47
	1355	160.80					90				48
	1400	161.150					90				48
	1405	161.50					91				48
	1410	161.831					91				46
										102	

COMMENTS:

EPA (Dur) 235

E4-7

RADIAN CORPORATION

FIELD DATA

PLANT: Site 4
DATE: 8-21-90
SAMPLING LOCATION: ____
SAMPLE TYPE: ____
RUN NUMBER: 4
OPERATOR: ____
AMBIENT TEMPERATURE: ____
BAROMETRIC PRESSURE: 30.13
STATIC PRESSURE, (P_s): ____
FILTER NUMBER (s): ____

PROBE LENGTH AND TYPE: ____
NOZZLE I.D.: ____
ASSUMED MOISTURE, %: ____
SAMPLE BOX NUMBER: ____
METER BOX NUMBER: ____
METER $\Delta H_@$: ____
C FACTOR: ____
PROBE HEATER SETTING: ____
HEATER BOX SETTING: ____
REFERENCE Δp: ____

SCHEMATIC OF TRAVERSE POINT LAYOUT

METER γ: ____

READ AND RECORD ALL DATA EVERY ____ MINUTES

104

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
		1417	161.865					91				67
		1422	162.12					91				68
		1432	162.70					91				55
		1437	163.020					91				48
											104	

COMMENTS

EPA (Dur) 235

RADIAN
CORPORATION

FIELD DATA

PLANT: Site 4
DATE: 8-21-90
SAMPLING LOCATION:
SAMPLE TYPE:
RUN NUMBER: 5
OPERATOR:
AMBIENT TEMPERATURE:
BAROMETRIC PRESSURE: 30.13
STATIC PRESSURE, (P_s):
FILTER NUMBER (s):

PROBE LENGTH AND TYPE:
NOZZLE I.D.:
ASSUMED MOISTURE, %:
SAMPLE BOX NUMBER:
METER BOX NUMBER:
METER $\Delta H_@$:
C FACTOR:
PROBE HEATER SETTING:
HEATER BOX SETTING:
REFERENCE Δp:
METER γ: 106

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
		1441	163.058					90				64
		1446	163.27					90				66
		1451	163.53					90				64
		1456	163.78					90				60
		1501	164.02					90				58
		1506	164.253					90				54
											104	

COMMENTS:

EPA (Dur) 235
4 72

RADIAN
CORPORATION

FIELD DATA

PLANT Site 4
DATE 8-21-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 6
OPERATOR
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE 30.13
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER ΔH@
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER γ

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1510	164.281					89				68
	1515	164.48					89				67
	1520	164.75					89				62
	1525	164.95					89				60
	1530	165.20					89				55
	1535	165.381					89				54
										106	

COMMENTS

EPA (Dur) 235

ANALYSIS

DATE: 08/21/90 | ANALYSIS TIME: 165 | STREAM SEQUENCE: 1
TIME: 10:12 | CYCLE TIME: 180 | STREAM#: 1
ANALYZER: 802903 | MODE: RUN | CYCLE START TIME: 10:09

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.385	0.00	0.6592
OXYGEN	116	0.485	0.00	0.0054
NITROGEN	114	2.452	0.00	0.0237
METHANE	100	53.678	543.22	0.2973
TOTALS		100.000	543.22	0.9856

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 545.0
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 535.5
REAL SPECIFIC GRAVITY = 0.9884
UNNORMALIZED TOTAL = 99.08

ANALYSIS

DATE: 08/21/90 | ANALYSIS TIME: 165 | STREAM SEQUENCE: 1
TIME: 10:15 | CYCLE TIME: 180 | STREAM#: 1
ANALYZER: 802903 | MODE: RUN | CYCLE START TIME: 10:12

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.353	0.00	0.6588
OXYGEN	116	0.483	0.00	0.0053
NITROGEN	114	2.496	0.00	0.0241
METHANE	100	53.667	543.11	0.2973
TOTALS		100.000	543.11	0.9855

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.9
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 535.4
REAL SPECIFIC GRAVITY = 0.9882
UNNORMALIZED TOTAL = 99.12

ANALYSIS

DATE:	08/21/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	10:18	CYCLE TIME:	180	STREAM#:	1
ANALYZER:	802903	MODE:	RUN	CYCLE START TIME:	10:15

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.373	0.00	0.6591
OXYGEN	116	0.480	0.00	0.0053
NITROGEN	114	2.490	0.00	0.0241
METHANE	100	53.656	543.00	0.2972
TOTALS		100.000	543.00	0.9856

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 544.8
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 535.3
REAL SPECIFIC GRAVITY	= 0.9884
UNNORMALIZED TOTAL	= 99.10

ANALYSIS

DATE:	08/21/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	10:21	CYCLE TIME:	180	STREAM#:	1
ANALYZER:	802903	MODE:	RUN	CYCLE START TIME:	10:18

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.356	0.00	0.6588
OXYGEN	116	0.481	0.00	0.0053
NITROGEN	114	2.490	0.00	0.0241
METHANE	100	53.673	543.17	0.2973
TOTALS		100.000	543.17	0.9855

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 545.0
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 535.5
REAL SPECIFIC GRAVITY	= 0.9882
UNNORMALIZED TOTAL	= 99.30

ANALYSIS

DATE: 08/21/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 10:24 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 802903 MODE: RUN CYCLE START TIME: 10:21

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.371	0.00	0.6590
OXYGEN	116	0.482	0.00	0.0053
NITROGEN	114	2.504	0.00	0.0242
METHANE	100	53.643	542.87	0.2971
TOTALS		100.000	542.87	0.9857

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.7
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 535.2
REAL SPECIFIC GRAVITY = 0.9884
UNNORMALIZED TOTAL = 99.29

ANALYSIS

DATE: 08/21/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 10:27 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 802903 MODE: RUN CYCLE START TIME: 10:24

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.375	0.00	0.6591
OXYGEN	116	0.482	0.00	0.0053
NITROGEN	114	2.488	0.00	0.0241
METHANE	100	53.655	542.98	0.2972
TOTALS		100.000	542.98	0.9857

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.8
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 535.3
REAL SPECIFIC GRAVITY = 0.9884
UNNORMALIZED TOTAL = 99.29

ANALYSIS

DATE:	08/21/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	10:30	CYCLE TIME:	180	STREAM#:	1
ANALYZER:	802903	MODE:	RUN	CYCLE START TIME:	10:27

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.365	0.00	0.6589
OXYGEN	116	0.480	0.00	0.0053
NITROGEN	114	2.511	0.00	0.0243
METHANE	100	53.644	542.87	0.2971
TOTALS		100.000	542.87	0.9857

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 544.7
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 535.2
REAL SPECIFIC GRAVITY	= 0.9884
UNNORMALIZED TOTAL	= 99.19

ANALYSIS

DATE:	08/21/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	10:33	CYCLE TIME:	180	STREAM#:	1
ANALYZER:	802903	MODE:	RUN	CYCLE START TIME:	10:30

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.369	0.00	0.6590
OXYGEN	116	0.483	0.00	0.0053
NITROGEN	114	2.501	0.00	0.0242
METHANE	100	53.647	542.91	0.2972
TOTALS		100.000	542.91	0.9857

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 544.7
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 535.2
REAL SPECIFIC GRAVITY	= 0.9884
UNNORMALIZED TOTAL	= 99.14

ANALYSIS

DATE: 08/21/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 10:36 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 802903 MODE: RUN CYCLE START TIME: 10:33

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.364	0.00	0.6589
OXYGEN	116	0.480	0.00	0.0053
NITROGEN	114	2.511	0.00	0.0243
METHANE	100	53.645	542.89	0.2971
TOTALS		100.000	542.89	0.9856

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.7
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 535.2
REAL SPECIFIC GRAVITY = 0.9884
UNNORMALIZED TOTAL = 99.27

ANALYSIS

DATE: 08/21/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 10:39 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 802903 MODE: RUN CYCLE START TIME: 10:36

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.355	0.00	0.6588
OXYGEN	116	0.486	0.00	0.0054
NITROGEN	114	2.549	0.00	0.0246
METHANE	100	53.610	542.54	0.2969
TOTALS		100.000	542.54	0.9857

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.3
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 534.8
REAL SPECIFIC GRAVITY = 0.9885
UNNORMALIZED TOTAL = 99.21

ANALYSIS

DATE: 08/21/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 10:42 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 802903 MODE: RUN CYCLE START TIME: 10:39

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.355	0.00	0.6588
OXYGEN	116	0.482	0.00	0.0053
NITROGEN	114	2.531	0.00	0.0245
METHANE	100	53.632	542.75	0.2971
TOTALS		100.000	542.75	0.9857

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.5
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 535.1
REAL SPECIFIC GRAVITY = 0.9884
UNNORMALIZED TOTAL = 99.16

ANALYSIS

DATE: 08/21/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 10:45 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 802903 MODE: RUN CYCLE START TIME: 10:42

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.351	0.00	0.6587
OXYGEN	116	0.483	0.00	0.0053
NITROGEN	114	2.562	0.00	0.0248
METHANE	100	53.604	542.48	0.2969
TOTALS		100.000	542.48	0.9857

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.3
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 534.8
REAL SPECIFIC GRAVITY = 0.9885
UNNORMALIZED TOTAL = 99.08

ANALYSIS

DATE:	08/21/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	10:48	CYCLE TIME:	180	STREAM#:	1
ANALYZER:	802903	MODE:	RUN	CYCLE START TIME:	10:45

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.347	0.00	0.6587
OXYGEN	116	0.483	0.00	0.0053
NITROGEN	114	2.542	0.00	0.0246
METHANE	100	53.628	542.71	0.2970
TOTALS		100.000	542.71	0.9856

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 544.5
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 535.0
REAL SPECIFIC GRAVITY	= 0.9884
UNNORMALIZED TOTAL	= 99.23

ANALYSIS

DATE:	08/21/90	ANALYSIS TIME:	165	STREAM SEQUENCE:	1
TIME:	10:51	CYCLE TIME:	180	STREAM#:	1
ANALYZER:	802903	MODE:	RUN	CYCLE START TIME:	10:48

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.361	0.00	0.6589
OXYGEN	116	0.484	0.00	0.0053
NITROGEN	114	2.514	0.00	0.0243
METHANE	100	53.641	542.85	0.2971
TOTALS		100.000	542.85	0.9856

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z)	= 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 544.6
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z)	= 535.2
REAL SPECIFIC GRAVITY	= 0.9884
UNNORMALIZED TOTAL	= 99.27

ANALYSIS

DATE: 08/21/90   ANALYSIS TIME: 165   STREAM SEQUENCE: 1
TIME: 10:54   CYCLE TIME: 180   STREAM#: 1
ANALYZER: 802903   MODE: RUN   CYCLE START TIME: 10:51

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.342	0.00	0.6586
OXYGEN	116	0.489	0.00	0.0054
NITROGEN	114	2.564	0.00	0.0248
METHANE	100	53.606	542.49	0.2969
TOTALS		100.000	542.49	0.9857

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.3
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 534.8
REAL SPECIFIC GRAVITY = 0.9884
UNNORMALIZED TOTAL = 99.04

ANALYSIS

DATE: 08/21/90   ANALYSIS TIME: 165   STREAM SEQUENCE: 1
TIME: 10:57   CYCLE TIME: 180   STREAM#: 1
ANALYZER: 802903   MODE: RUN   CYCLE START TIME: 10:54

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.341	0.00	0.6586
OXYGEN	116	0.479	0.00	0.0053
NITROGEN	114	2.531	0.00	0.0245
METHANE	100	53.649	542.93	0.2972
TOTALS		100.000	542.93	0.9855

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.7
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 535.2
REAL SPECIFIC GRAVITY = 0.9882
UNNORMALIZED TOTAL = 99.26

ANALYSIS

DATE: 08/21/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 11:00 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 802903 MODE: RUN CYCLE START TIME: 10:57

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.350	0.00	0.6587
OXYGEN	116	0.484	0.00	0.0054
NITROGEN	114	2.558	0.00	0.0247
METHANE	100	53.607	542.51	0.2969
TOTALS		100.000	542.51	0.9857

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.3
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 534.8
REAL SPECIFIC GRAVITY = 0.9885
UNNORMALIZED TOTAL = 99.17

ANALYSIS

DATE: 08/21/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 11:03 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 802903 MODE: RUN CYCLE START TIME: 11:00

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.341	0.00	0.6586
OXYGEN	116	0.488	0.00	0.0054
NITROGEN	114	2.568	0.00	0.0248
METHANE	100	53.603	542.46	0.2969
TOTALS		100.000	542.46	0.9857

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.2
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 534.8
REAL SPECIFIC GRAVITY = 0.9884
UNNORMALIZED TOTAL = 99.14

ANALYSIS

DATE: 08/21/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 11:06 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 802903 MODE: RUN CYCLE START TIME: 11:03

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.344	0.00	0.6586
OXYGEN	116	0.482	0.00	0.0053
NITROGEN	114	2.547	0.00	0.0246
METHANE	100	53.627	542.70	0.2970
TOTALS		100.000	542.70	0.9856

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.5
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 535.0
REAL SPECIFIC GRAVITY = 0.9883
UNNORMALIZED TOTAL = 99.01

ANALYSIS

DATE: 08/21/90 ANALYSIS TIME: 165 STREAM SEQUENCE: 1
TIME: 11:09 CYCLE TIME: 180 STREAM#: 1
ANALYZER: 802903 MODE: RUN CYCLE START TIME: 11:06

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.364	0.00	0.6589
OXYGEN	116	0.490	0.00	0.0054
NITROGEN	114	2.545	0.00	0.0246
METHANE	100	53.601	542.44	0.2969
TOTALS		100.000	542.44	0.9858

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.2
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 534.8
REAL SPECIFIC GRAVITY = 0.9886
UNNORMALIZED TOTAL = 99.00

ANALYSIS

DATE: 08/21/90 | ANALYSIS TIME: 165 | STREAM SEQUENCE: 1
TIME: 11:12 | CYCLE TIME: 180 | STREAM#: 1
ANALYZER: 802903 | MODE: RUN | CYCLE START TIME: 11:09

COMP NAME	COMP CODE	MOLE %	B.T.U.*	SP. GR. *
C O 2	117	43.347	0.00	0.6587
OXYGEN	116	0.485	0.00	0.0054
NITROGEN	114	2.548	0.00	0.0246
METHANE	100	53.620	542.63	0.2970
TOTALS		100.000	542.63	0.9857

* @ 14.730 PSIA DRY & UNCORRECTED FOR COMPRESSIBILITY

COMPRESSIBILITY FACTOR (1/Z) = 1.0033
DRY B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 544.4
SAT B.T.U. @ 14.730 PSIA & 60 DE. F CORRECTED FOR (1/Z) = 534.9
REAL SPECIFIC GRAVITY = 0.9884
UNNORMALIZED TOTAL = 99.04

RADIAN
CORPORATION

Run Number Site 5 - Perimeter   DATE 8-23-90

Samplers Initials WG

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	951	102	78		25.5		29.95		
2	1000	179	78		25.75		"		
3	1011	109	78		17.0		"		

NOTES:

Method 3C Field Sampling Data Sheet

RADIAN
CORPORATION

Run Number Site 5 - Main **DATE** 8-23-90

Samplers Initials ALD

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
4	1125	115	80		28.1		29.92		
5	1134	135	81		28.0		29.92		
6	1143	900	81		28.5		29.92		

NOTES:

Method 25C Field Sampling Data Sheet

RADIAN CORPORATION

FIELD DATA

PLANT Site 5
DATE 8-23-90
SAMPLING LOCATION Chiller Inlet
SAMPLE TYPE
RUN NUMBER 1
OPERATOR ALD
AMBIENT TEMPERATURE 76
BAROMETRIC PRESSURE 29.95
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER Y

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

100

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	937	165.460					78				56
	942	165.83					78				61
	947	166.11					78				60
	952	166.40					78				58
	957	166.69					79				58
	1002	166.975					79				57
										100 ml	

COMMENTS:

EPA (Dur) 235
5 ??

RADIAN CORPORATION

FIELD DATA

PLANT: Site 5
DATE: 8-23-90
SAMPLING LOCATION:
SAMPLE TYPE:
RUN NUMBER: 2
OPERATOR: ALD
AMBIENT TEMPERATURE: 78
BAROMETRIC PRESSURE: 29.95
STATIC PRESSURE, (P_s):
FILTER NUMBER (s):

PROBE LENGTH AND TYPE:
NOZZLE I.D.:
ASSUMED MOISTURE, %:
SAMPLE BOX NUMBER:
METER BOX NUMBER:
METER $\Delta H_@$:
C FACTOR:
PROBE HEATER SETTING:
HEATER BOX SETTING:
REFERENCE Δp:
METER γ:

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

100

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1010	167.027					81				61
	1015	167.31					81				59
	1020	167.60					82				54
	1025	167.84					82				52
	1030	168.11					82				52
	1035	168.399					82				52
									100	

COMMENTS:

EPA (Dur) 235

RADIAN CORPORATION

FIELD DATA

PLANT Site 5
DATE 8-23-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 3
OPERATOR ALD
AMBIENT TEMPERATURE 78
BAROMETRIC PRESSURE 29.75
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER γ
99.75

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1042	168.430					82				64
	1047	168.70					83				63
	1052	168.96					83				63
	1057	169.23					84				60
	1102	169.47					84				59
	1107	169.720					84				58
										100	

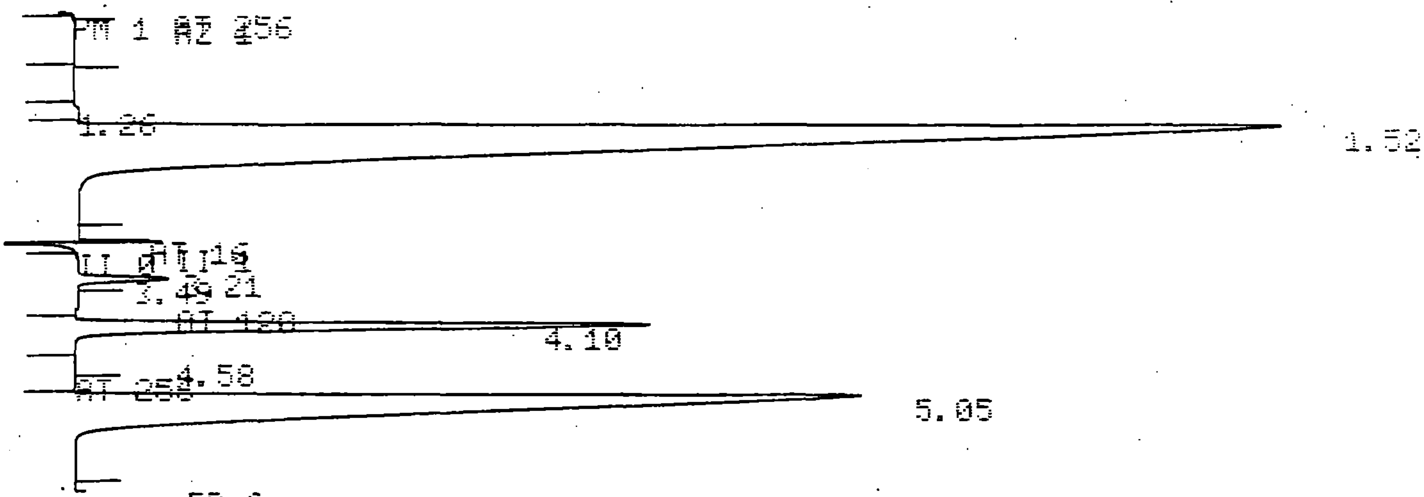
COMMENTS

EPA (Dur) 235

TOTAL 100.

CA= 0

CHANNEL A INJECT 08/23/90 09:52:04



LFGAS 08/23/90 09:52:04 CH= "A" PS= 1.

FILE 1. METHOD 1. RUN 384 INDEX 1

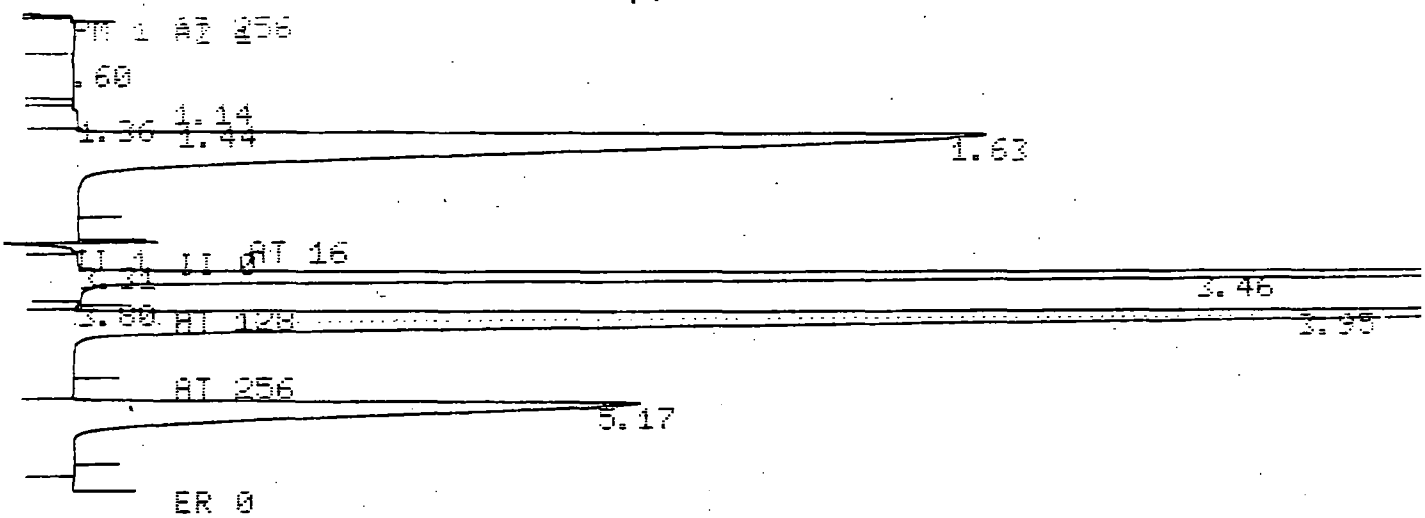
NAME	%	RT	AREA	BC	RF	RRT
1	0.	1.26	18245	02		0.829
CO2	44.288	1.52	8344744	03	1.	1.
3	0.	3.21	519	02		2.112
O2	0.094	3.49	8666	03	2.031	2.296
N2	6.511	4.1	625737	08	1.961	2.697
6	0.	4.58	152	05		3.013
CH4	49.107	5.05	4050605	01	2.284	3.322
TOTALS	100.		13048668			

SUMMARY REPORT INDEX 1 FILE 1. CH= "A" PS= 1.

NAME	%
CO2	44.288
O2	0.094
N2	6.511
CH4	49.107
TOTAL	100.

Sales

CHANNEL A INJECT 08/23/90 10:04:04



LFGAS 08/23/90 10:04:04 CH= "A" PS= 1.

FILE 1. METHOD 1. RUN 385 INDEX 2

NAME	%	RT	AREA	BC	RF	RRT
1	0.	0.6	789	02		0.368
2	0.	1.14	65	02		0.699
3	0.	1.36	8860	02		0.834
4	0.	1.44	11363	02		0.883
CO2	29.66	1.63	5421137	03	1.	1.
6	0.	3.31	456	02		2.031
7	0.	3.46	392934	09		2.123
O2	40.578	3.95	3651264	01	2.031	2.423
CH4	29.762	5.17	2381332	01	2.284	3.172
TOTALS	100.		11868200			

SUMMARY REPORT INDEX 2 FILE 1. CH= "A" PS= 1.

NAME	%
CO2	29.66
O2	40.578
N2	0.
CH4	29.762
TOTAL	100.

12" 2.0 #9
1

LFGAS 08/23/90 10:04:04 CH= "A" PS= 1.

FILE 1. METHOD 1. RUN 385 INDEX 2

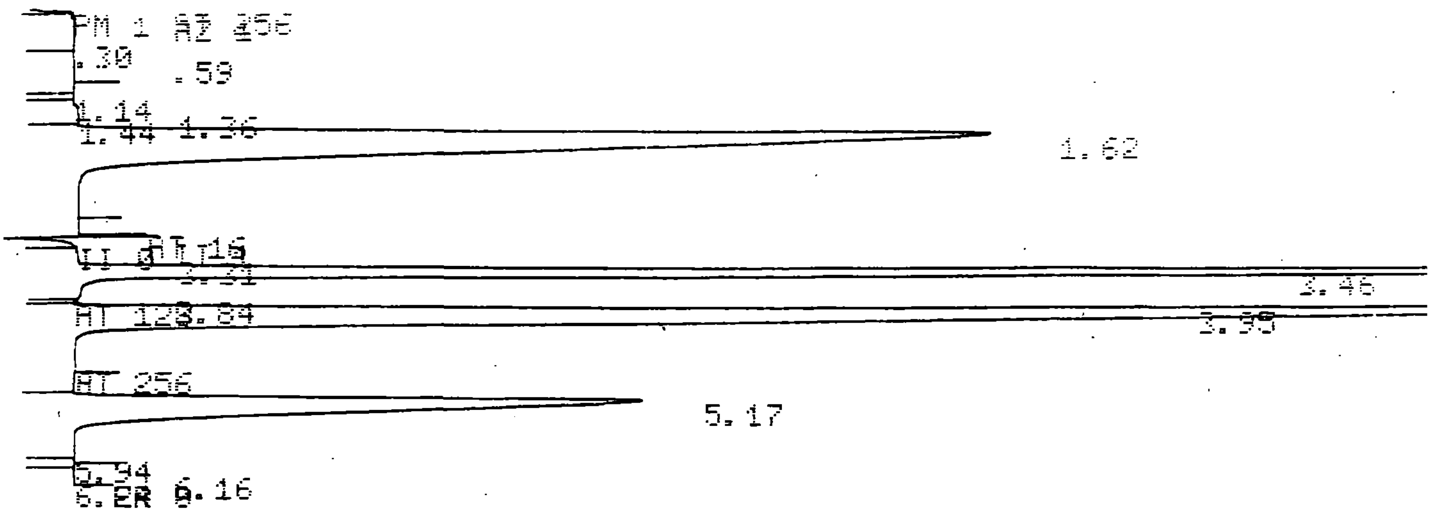
NAME	%	RT	AREA	BC	RF	RRT
1	0.	0.6	789	02		0.368
2	0.	1.14	65	02		0.699
3	0.	1.36	8860	02		0.834
4	0.	1.44	11363	02		0.883
CO2	28.808	1.63	5421137	03	1.	1.
6	0.	3.31	456	02		2.031
O2	4.242	3.46	392934	09	2.031	2.123
N2	38.043	3.95	3651264	01	1.961	2.423
CH4	28.907	5.17	2381332	01	2.284	3.172
TOTALS	100.		11868200			

SUMMARY REPORT INDEX 2 FILE 1. CH= "A" PS= 1.

NAME	%
CO2	28.808
O2	4.242
N2	38.043
CH4	28.907
TOTAL	100.

12" 2.0 Hg MCS.

CHANNEL A



LFGAS 08/23/90 10:16:53 CH= "A" PS= 1.

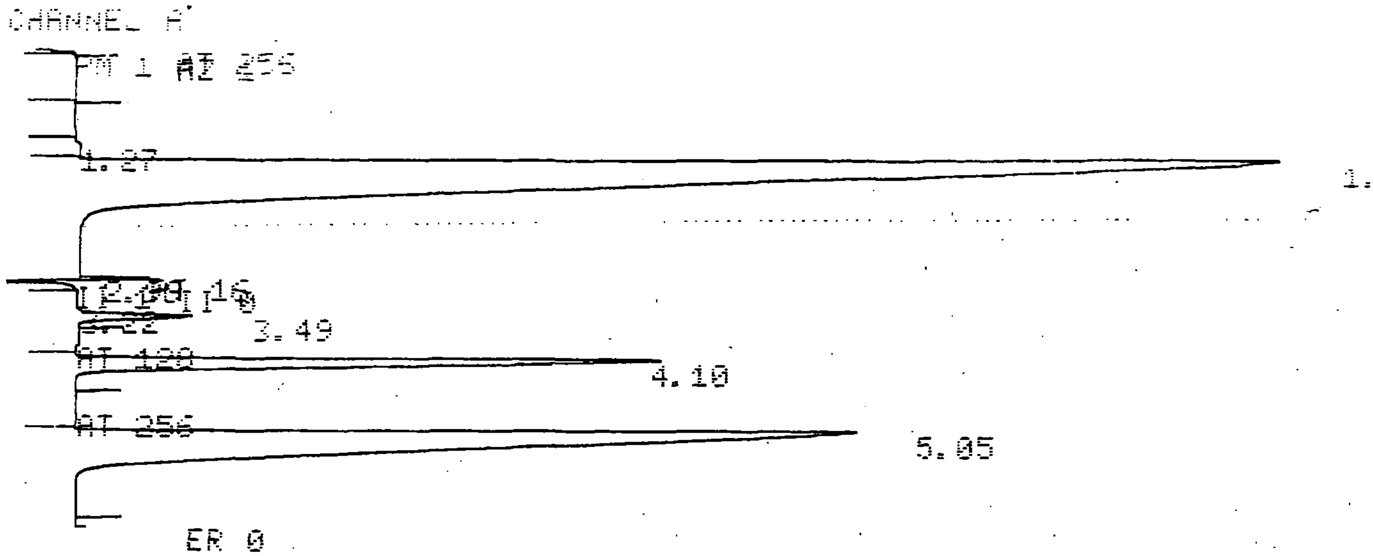
FILE 1. METHOD 1. RUN [illegible] INDEX 3

NAME	%	RT	AREA	BC	RF	RRT
1	0.	0.3	1414	02		0.185
2	0.	0.59	835	03		0.364
3	0.	1.14	40	02		0.704
4	0.	1.36	8839	02		0.84
5	0.	1.44	11374	02		0.889
CO2	29.062	1.62	5467858	03	1.	1.
7	0.	3.31	463	02		2.043
O2	4.156	3.46	384959	08	2.031	2.136
N2	37.641	3.95	3612043	03	1.961	2.438
CH4	29.141	5.17	2400203	02	2.284	3.191
11	0.	5.94	47	03		3.667
12	0.	6.24	41	03		3.852
TOTALS	100.		11888116			

SUMMARY REPORT INDEX 3 FILE 1. CH= "A" PS= 1.

NAME	%
CO2	29.062
O2	4.156
N2	37.641
CH4	29.141
TOTAL	100.

Flare #3 mcs



LFGAS 08/23/90 10:24:23 CH= "A" PS= 1.

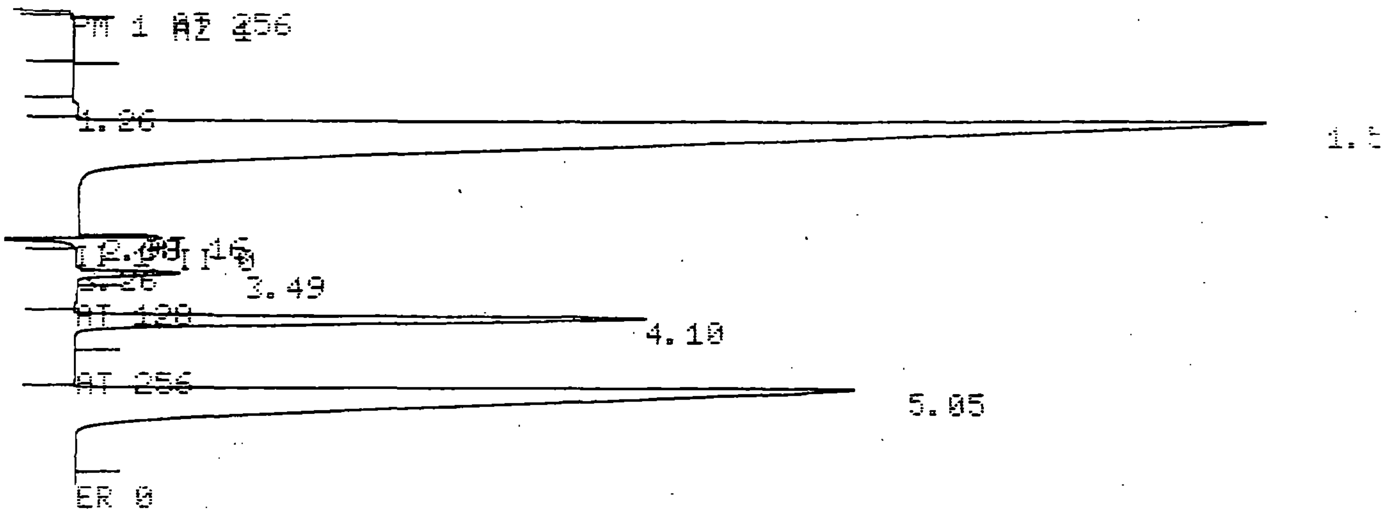
FILE 1. METHOD 1. RUN 387 INDEX 4

NAME	%	RT	AREA	BC	RF	RRT
1	0.	1.27	21775	02		0.836
CO2	44.86	1.52	8492990	02	1.	1.
3	0.	2.99	12608	03		1.967
O2	0.006	3.22	498	02	2.031	2.118
5	0.	3.49	10895	03		2.296
N2	6.634	4.1	640577	01	1.961	2.697
CH4	48.5	5.05	4019699	01	2.284	3.322
TOTALS	100.		13199042			

SUMMARY REPORT INDEX 4 FILE 1. CH= "A" PS= 1.

NAME	%
CO2	44.86
O2	0.006
N2	6.634
CH4	48.5
TOTAL	100.

CHANNEL A INJECT 08/23/90 10:35:31



LFGAS 08/23/90 10:35:31 CH= "A" PS= 1.

FILE 1. METHOD 1. RUN 388 INDEX 5

NAME	%	RT	AREA	BC	RF	RRT
1	0.	1.26	22416	02		0.829
CO2	44.836	1.52	8443952	02	1.	1.
3	0.	2.98	7905	03		1.961
O2	0.005	3.26	498	02	2.031	2.145
5	0.	3.49	9934	03		2.296
N2	6.522	4.1	626396	01	1.961	2.697
CH4	48.637	5.05	4009955	01	2.284	3.322
TOTALS	100.		13121056			

SUMMARY REPORT INDEX 5 FILE 1. CH= "A" PS= 1.

NAME	%
CO2	44.836
O2	0.005
N2	6.522
CH4	48.637
TOTAL	100.

7/2/92 #3 Prod

RADIAN
CORPORATION

Site 6
Run Number Area 1 Units 1&2 DATE 8/24/90

Samplers Initials WCG

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	1210	105	74		28.5				
2	1224	031	75		28.5				
3	1250	140	75		29.0				

NOTES:

Method 25C Field Sampling Data Sheet

RADIAN
CORPORATION

Site 6
Run Number AREA-2 **DATE** 8-24-90

Samplers Initials WCG

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	10:30	014	68.5		28.5				
2	10:45	189	68.5		28.8				

NOTES:

Method 25C Field Sampling Data Sheet

RADIAN
CORPORATION

Run Number Site 6 Area 3 units 4&5

DATE 8-24-90

Samplers Initials ALD

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	1103	001	70		22.0				
2	1210	185	74		24.0				

NOTES:

Method 25C Field Sampling Data Sheet

RADIAN
CORPORATION

site 6
ducts 1&2

Run Number Area 1 DATE 8/24/90

Samplers Initials WCG

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	1115	156	68.5		29.0		?		
2	1125	183	68.5		28.75				
3									

51% 510 CFM

52% 520 CFM

E6-4

NOTES:

Method 3C Field Sampling Data Sheet

RADIAN
CORPORATION

Run Number: Site 6 Area 2

DATE: Area 2 8/24/90

Samplers Initials: WCG

SAMPLE NO.	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL	
1	1053	087	68.5		25.0				
2		170 -	68.5		25.0				

48.5% CH_4 230CFM

49% 230 CFM

NOTES:

Method 3C Field Sampling Data Sheet

RADIAN
CORPORATION

Site 6
Run Number Total

DATE 8/24/90

Samplers Initials WCG

SAMPLE NO. 1	SAMPLE TIME	FLASK #/VOLUME	TEMPERATURE °F		FLASK PRESSURE "Hg		BAROMETRIC PRESSURE "Hg		RECOVERY DATE/TIME	
			INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL		
1	1140	057	70.		24"					51% / 843
2	1149	181	71.		25"					51%
3	1200	142	71		28.6					51%

NOTES:

Method 3C Field Sampling Data Sheet

RADIAN
CORPORATION

FIELD DATA

PLANT Site 6
DATE 8-24-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 1
OPERATOR ALO
AMBIENT TEMPERATURE 73
BAROMETRIC PRESSURE 29.88
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp
METER γ 100

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-h CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1245	169.771					82				68
	1250	170.00					84				60
	1255	170.24					84				55
	1300	170.44					84				50
	1305	170.67					85				46
	1310	170.884					85				42
										100 ml	

COMMENTS:

EPA (Dur) 235
6-72

RADIAN CORPORATION

FIELD DATA

PLANT: Site 6
DATE: 8-24-96
SAMPLING LOCATION:
SAMPLE TYPE:
RUN NUMBER: 2
OPERATOR: ALD
AMBIENT TEMPERATURE: 75
BAROMETRIC PRESSURE: 29.88
STATIC PRESSURE, (P_s):
FILTER NUMBER (s):

PROBE LENGTH AND TYPE:
NOZZLE I.D.:
ASSUMED MOISTURE, %:
SAMPLE BOX NUMBER:
METER BOX NUMBER:
METER $\Delta H_@$:
C FACTOR:
PROBE HEATER SETTING:
HEATER BOX SETTING:
REFERENCE Δp:
METER γ:

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ______ MINUTES

100

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET $(T_{m\,in})$, °F	OUTLET $(T_{m\,out})$, °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1317	170.972					86				64
	1322	171.13					86				62
	1327	171.28					87				55
	1332	171.40					87				52
	1337	171.51					87				46
	1342	171.68					87				44
	1347	171.81					87				42
	1352	170.941					88				42
										100	

COMMENTS:

EPA (Dur) 235

RADIAN CORPORATION

FIELD DATA

PLANT Site 6
DATE 8-24-90
SAMPLING LOCATION
SAMPLE TYPE
RUN NUMBER 3
OPERATOR ALD
AMBIENT TEMPERATURE 77
BAROMETRIC PRESSURE 29.88
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

SCHEMATIC OF TRAVERSE POINT LAYOUT

METER γ 97

READ AND RECORD ALL DATA EVERY ____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1358	171.958				88					69
	1403	172.03				88					67
	1408	172.11				88					57
	1413	172.19				88					49
	1418	172.27				89					46
	1423	172.34				89					45
	1428	172.43				89					43
	1430	172.443				89					43

COMMENTS:

EPA (Dur) 235

APPENDIX F

RESULTS OF REFERENCE METHOD 25C -
DETERMINATION OF NONMETHANE ORGANIC COMPOUNDS (NMOC)
IN LANDFILL GASES

Reference Method 25C (RM 25C) is applicable to the sampling and measurement of nonmethane organic compounds (NMOC) as carbon in landfill gases. A sample of the landfill gas was first extracted with an evacuated cylinder. The NMOC content of the gas was determined by injecting a portion of the gas into a gas chromatographic column to separate the NMOC from carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4); the NMOC are oxidized to CO_2, reduced to CH_4, and measured by a flame ionization detector (FID). In this manner, the variable response of the FID associated with different types of organics is eliminated. This Appendix presents the RM 25C laboratory analysis.

sd1_m25/jym3/hpD

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 SAMPLING DATA

Company Name: Radian Corp.

Run # 1	Tank # 155	Trap #		
Description				20 space limit
	Tank Vacuum [ ] mmHg [x] in.Hg	Barometric Pressure [ ] mmHg [x] in.Hg	Absolute Pressure [ ] mmHg [ ] in.Hg	Temperature degrees [ ] C [x] F
Pre-Test	27.5	30.15		89
Post-Test	0	30.15		89
Run # 2	Tank # 122	Trap #		
Description				20 space limit
	Tank Vacuum [ ] mmHg [x] in.Hg	Barometric Pressure [ ] mmHg [x] in.Hg	Absolute Pressure [ ] mmHg [x] in.Hg	Temperature degrees [ ] C [x] F
Pre-Test	27.5	30.15	3	89
Post-Test	0	30.15		89
Run # 3	Tank # 068	Trap #		
Description				20 space limit
	Tank Vacuum [ ] mmHg [x] in.Hg	Barometric Pressure [ ] mmHg [ ] in.Hg	Absolute Pressure [ ] mmHg [ ] in.Hg	Temperature degrees [ ] C [x] F
Pre-Test	26.5	30.15		87
Post-Test	0	30.15		87
Run # 4	Tank # 019	Trap #		
Description				20 space limit
	Tank Vacuum [ ] mmHg [x] in.Hg	Barometric Pressure [ ] mmHg [ ] in.Hg	Absolute Pressure [ ] mmHg [ ] in.Hg	Temperature degrees [ ] C [x] F
Pre-Test	25.9	30.15		89
Post-Test	0	30.15		89
Run # 5	Tank # 038	Trap #		
Description				20 space limit
	Tank Vacuum [ ] mmHg [x] in.Hg	Barometric Pressure [ ] mmHg [x] in.Hg	Absolute Pressure [ ] mmHg [ ] in.Hg	Temperature degrees [ ] C [x] F
Pre-Test	25.8	30.15		90
Post-Test	0	30.15		90
Run # 6	Tank # 147	Trap #		
Description				20 space limit
	Tank Vacuum [ ] mmHg [x] in.Hg	Barometric Pressure [ ] mmHg [x] in.Hg	Absolute Pressure [ ] mmHg [ ] in.Hg	Temperature degrees [ ] C [x] F
Pre-Test	26.8	30.15		90
Post-Test	0	30.15		90

sdl_m25/jym3/hpD

R E S E A R C H   T R I A N G L E   L A B O R A T O R I E S ,   I N C .

METHOD 25 SAMPLING DATA

Company Name: Radian Corp.

Run # 7	Tank # 105	Trap #		
Description				20 space limit
	Tank Vacuum ☐ mmHg ☒ in.Hg	Barometric Pressure ☐ mmHg ☒ in.Hg	Absolute Pressure ☐ mmHg ☒ in.Hg	Temperature degrees ☐ C ☒ F
Pre-Test	28.5	29.88	—	74
Post-Test	0	29.88		74

Run # 8	Tank # 031	Trap #		
Description				20 space limit
	Tank Vacuum ☐ mmHg ☒ in.Hg	Barometric Pressure ☐ mmHg ☒ in.Hg	Absolute Pressure ☐ mmHg ☐ in.Hg	Temperature degrees ☐ C ☒ F
Pre-Test	28.5	29.88		75
Post-Test	0	29.88		75

Run # 9	Tank # 140	Trap #		
Description				20 space limit
	Tank Vacuum ☐ mmHg ☒ in.Hg	Barometric Pressure ☐ mmHg ☒ in.Hg	Absolute Pressure ☐ mmHg ☐ in.Hg	Temperature degrees ☐ C ☒ F
Pre-Test	29.0	29.88		75
Post-Test	0	29.88		75

Run # 10	Tank # 014	Trap #		
Description				20 space limit
	Tank Vacuum ☐ mmHg ☒ in.Hg	Barometric Pressure ☐ mmHg ☐ in.Hg	Absolute Pressure ☐ mmHg ☐ in.Hg	Temperature degrees ☐ C ☒ F
Pre-Test	28.5	29.88		69
Post-Test	0	29.88		69

Run # 11	Tank # 001	Trap #		
Description				20 space limit
	Tank Vacuum ☐ mmHg ☒ in.Hg	Barometric Pressure ☐ mmHg ☒ in.Hg	Absolute Pressure ☐ mmHg ☐ in.Hg	Temperature degrees ☐ C ☒ F
Pre-Test	22.0	29.88		70
Post-Test	0	29.88		70

Run # 12	Tank # 189	Trap #		
Description				20 space limit
	Tank Vacuum ☐ mmHg ☒ in.Hg	Barometric Pressure ☐ mmHg ☐ in.Hg	Absolute Pressure ☐ mmHg ☐ in.Hg	Temperature degrees ☐ C ☒ F
Pre-Test	28.8	29.88		69
Post-Test	0	29.88		69

sdl_m25/jym3/hpD

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 SAMPLING DATA

Company Name: Radian Corp.

Run #13	Tank # 185	Trap #		
Description				20 space limit
	Tank Vacuum ☐ mmHg ☒ in.Hg	Barometric Pressure ☐ mmHg ☒ in.Hg	Absolute Pressure ☐ mmHg ☒ in.Hg	Temperature degrees ☐ C ☒ F
Pre-Test	24.0	29.88		74
Post-Test	0	29.88		74

Run #14	Tank # 115	Trap #		
Description				20 space limit
	Tank Vacuum ☐ mmHg ☒ in.Hg	Barometric Pressure ☐ mmHg ☒ in.Hg	Absolute Pressure ☐ mmHg ☐ in.Hg	Temperature degrees ☐ C ☒ F
Pre-Test	28.1	29.92		80
Post-Test	0	29.92		80

Run # 15	Tank # 135	Trap #		
Description				20 space limit
	Tank Vacuum ☐ mmHg ☒ in.Hg	Barometric Pressure ☐ mmHg ☒ in.Hg	Absolute Pressure ☐ mmHg ☐ in.Hg	Temperature degrees ☐ C ☒ F
Pre-Test	28.0	29.92		81
Post-Test	0	29.92		81

Run #16	Tank # 900	Trap #		
Description				20 space limit
	Tank Vacuum ☐ mmHg ☒ in.Hg	Barometric Pressure ☐ mmHg ☐ in.Hg	Absolute Pressure ☐ mmHg ☐ in.Hg	Temperature degrees ☐ C ☒ F
Pre-Test	28.5	29.92		81
Post-Test	0	29.92		81

Run #	Tank #	Trap #		
Description				20 space limit
	Tank Vacuum ☐ mmHg ☒ in.Hg	Barometric Pressure ☐ mmHg ☒ in.Hg	Absolute Pressure ☐ mmHg ☐ in.Hg	Temperature degrees ☐ C ☒ F
Pre-Test				
Post-Test				

Run #	Tank #	Trap #		
Description				20 space limit
	Tank Vacuum ☐ mmHg ☒ in.Hg	Barometric Pressure ☐ mmHg ☐ in.Hg	Absolute Pressure ☐ mmHg ☐ in.Hg	Temperature degrees ☐ C ☒ F
Pre-Test				
Post-Test				

RESEARCH TRIANGLE LABORATORIES

METHOD 25 REPORT

prepared for

RADIAN CORPORATION

by

RESEARCH TRIANGLE LABORATORIES, INC.

Gene Mull
Chemist

John Y. Morimoto, Ph.D.
Chemist

RTL ID# 90-275

August 28, 1990

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A Member of the Andersen Technology Group

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 TABLE OF RESULTS

Name: Radian Corporation ID #90-141-275 Date: 8/20-22/90

Sample Number	Sample Description	Concentrations (ppmC) CO+CH4	CO2	Noncondensibles	Condensibles	TGNMO	Mass Conc. (mgC/cu.m)
1		434032	296449	1904	0	1904	951
2		116264	196976	2930	0	2930	1463
3		114879	191109	1613	0	1613	805
4		408519	278376	1360	0	1360	679
5		111716	189487	1606	0	1606	802
6		113253	192639	1242	0	1242	620
7		874051	651608	1684	0	1684	841
8		637980	420544	983	0	983	491
9		139108	237992	1545	0	1545	771
10		142354	243972	1095	0	1095	547
11		642138	419894	1112	0	1112	555
12		132075	225284	1128	0	1128	563
13		120613	205833	2635	0	2635	1316
14		118510	202461	2580	0	2580	1288
15		121396	209779	4266	0	4266	2130
16		126594	218626	1532	0	1532	765
17		116812	201279	1331	0	1331	665
18		117211	203412	2455	0	2455	1226

RESEARCH TRIANGLE LABORATORIES, INC.

COMMENTS ON THE ANALYSES

Report #90-141-275

Samples #2,3,5,6,9,10,12-18:

For these samples, electrometer overload prevented proper integration of the areas for CH_4 and CO_2 and therefore the reported concentrations are lower than the actual tank concentrations. For the six other samples, the electrometer range was increased which resulted in properly integrated areas. For these samples, the areas were multiplied by 10 to bring them in line with the other areas.

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 EXPERIMENTAL PROCEDURE

Calibration

A propane calibration gas mixture of 82 ppm CO, 68 ppm CH_4, 2.07% CO_2, and 75 ppm propane is injected via a 1-mL sampling loop into the analyzer. The injections are repeated until three integrated areas indicate reasonable agreement. A 1.18% CO_2 standard is run daily with the same requirement. The average daily response factors must agree within 5% of the RF(CO_2) and the RF(NMO) from the initial performance check.

Daily Performance Checks are performed at the beginning of each work day. Calibrations are performed daily or between customer sets of samples, whichever comes first. Additionally, a System Background Check is performed between each set of samples. Duplicate injections of 1.0% CO_2 are made after the final sample each day.

Response factors (average integrated area/concentration in ppmC) are calculated daily from the initial triplicate injections.

Analysis

Each trap is stored under dry ice until just prior to analysis and is flushed of CO_2 by passing zero air through it at -78 °C and via the CO_2 NDIR to the sample tank. Flushing is continued until no NDIR response is noted. The trap is baked at 200 °C with zero air flushing through the trap and via the oxidation catalyst and the NDIR into the collection vessel. Collection is continued until no NDIR response is noted. The trap is transferred to an oven set at 350 °C and baking is continued for 30 minutes. This ensures the cleanliness of the trap for a subsequent sampling. The trap is taken out of the oven and allowed to cool; it is then capped and stored for shipment.

The sample tank is analyzed by injecting an aliquot via a 1-mL sample loop into the GC column, which is held at 85 °C to elute the CO+CH_4 and then the CO_2 which is passed to the oxidation catalyst, reduction catalyst, and FID. The column is then backflushed at 195 °C to elute the organic fraction. The collection vessel is analyzed identically. In both cases, triplicate injections are made. The sample tank is pumped for 5 minutes (to less than 5 mmHg) and air is then allowed in via a paper fiber filter; this procedure is repeated. The tank is pumped 10 minutes and allowed to stand overnight. The tank is then connected to a pressure gauge to test for leaks (maximum permissible leak rate = 10 mmHg/day). If the tank passes the leak test, it is filled with zero air to slightly greater than atmospheric pressure and stored for shipment.

Calculations

Calculations are done in accord with EPA Method 25 procedures. A sample calculation is provided using client/RTL data.

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 SAMPLE CALCULATION

Note: All pressure values have been converted when necessary to mm Hg and all temperature values to Kelvin.

Name: Radian Corporation   ID #90-141-275   Date: 8/20-22/90

Sample # 1

D A T A

Tank 6191:   Trap NA   Collection Vessel:

Volume (cu.m) = 0.005785   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	348.0	302.0			
Postsampling	767.1	302.0			
Final	1052.0	299.2	Final	0.0	273.2

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	880.5	902.0
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	150,834,200	150,684,700	150,857,900
CO2	102,969,400	102,999,900	103,009,500
Noncondensibles	763,820	729,530	639,410
Condensibles	0	0	0

C A L C U L A T I O N S

Measured Concentrations, corrected for blank:

Cm(CO+CH4) = Area(CO+CH4)/RF(CO2)
= 1.508342E+08 /880.5 = 171305.2
= 1.506847E+08 /880.5 = 171135.4
= 1:508579E+08 /880.5 = 171332.1

Cm(CO2) = Area(CO2)/RF(CO2)
= 1.029694E+08 /880.5 = 116944.3
= 1.029999E+08 /880.5 = 116978.9
= 1.030095E+08 /880.5 = 116989.8

Cm(Noncondensibles) = [Area(Noncondensibles) - Blank Area(NMO)]/RF(NMO)
= (763820 - 33183)/902.0 = 810.0
= (729530 - 33183)/902.0 = 772.0
= (639410 - 33183)/902.0 = 672.1

Cm(Condensibles) = Area(Condensibles)/RF(CO2) - Blank(CO2)
= 0 /880.5 - 6.6 = -6.6
= 0 /880.5 - 6.6 = -6.6
= 0 /880.5 - 6.6 = -6.6

Pressure-Temperature Ratio, Q(i) = P(i)/T(i):

```
postsampling tank: Q(1) =  767.08 / 302.0389 = 2.539673
presampling tank:  Q(2) =  347.98 / 302.0389 = 1.152103
final tank:        Q(3) =  1052 / 299.15 = 3.516631
final CV:          Q(4) =  0 / 273.15 = 0

Volume Sampled (dscm) = 0.3857 x Tank Volume x [Q(1)-Q(2)]
                      = 0.3857 x .005785  x [2.5397 - 1.1521]
                      = 0.003096
```

Averages and % Relative Standard Deviations (%RSD) of Cm's are calculated. (%RSD of C = %RSD of Cm)

Calculated Concentrations:

```
C(CO+CH4) = Q(3)/[Q(1)-Q(2)] x Cm(CO+CH4)
          = 3.5166/(2.5397 - 1.1521) x 171257.6 = 434032.0

C(CO2) = Q(3)/[Q(1)-Q(2)] x Cm(CO2)
       = 3.5166/(2.5397 - 1.1521) x 116971.0 = 296449.1

C(Noncondensibles) = Q(3)/[Q(1)-Q(2)] x Cm(Noncondensibles)
                   = 3.5166/(2.5397 - 1.1521) x    751.4 =    1904.3

C(Condensibles)
    = Volume(CV)/Volume(Tank) x Q(4)/[Q(1)-Q(2)] x Cm(Condensibles)
    = 0.004551/0.005785 x 0.0000/(2.5397 - 1.1521) x     -6.6 =      0.0

Total Gaseous Non-Methane Organics(TGNMO)=C(Noncondensibles)+C(Condensibles)
                                         =   1904.3 +      0.0
                                         =   1904.3

Mass Concentration = 0.4993 x TGNMO
                   = 0.4993 x  1904.3 =   950.8
```

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 SAMPLE QA/QC DATA & CALIBRATION CHECK/A

5.1.1 Carrier Gas and Auxiliary Oxygen Blank (1/3/90)

$CO + CH_4 + CO_2 + NMO = 0$ ppm   Requirement: < 5 ppm

5.1.2 Catalyst Efficiency Check (1/4/90)

$CO_2 = 9982$ ppmC   Requirement: $CO_2 = 10000 \pm 200$ ppmC

5.1.3 System Performance Check (1/4/9087)

	Average Percent Recovery	%RSD
50 uL hexane/decane	107.6/103.6	0.1/0.5
10 uL hexane/decane	102.1/103.2	0.5/0.9
Requirement	100 ± 10%	< 5

5.2.1 Oxidation Catalyst Efficiency Check (1/5/90)

FID Response with Reduction Catalyst Out = 0.25%

Requirement < 1%

5.2.2 Reduction Catalyst Efficiency Check (1/5/90)

Response of CO_2 with Oxidation Catalyst and Reduction Catalyst operative was 100.3% of response with catalyst out.

Requirement 100 ± 5%

5.2.3 Analyzer Linearity Check and NMO Calibration (1/2/90)

$\overline{RF}$ values agree within 2.5% Requirement: within 2.5%
%RSD values for triplicates < 2% " < 2%
except Propane 4th Dilution (22 ppmc) %RSD = 2.4%

(deviation by Gene Mull, Manager and Joseph Adamovic, Laboratory Manager)

$\frac{RF(NMO)}{RF(CO_2)} = 1.015$ Requirement: $\frac{RF(NMO)}{RF(CO_2)} = 1.0 \pm 0.1$

5.2.4 System Performance Check (1/5/90-4/10/90)

	Measured Value	Expected Value	Requirement
Propane Mix	75.0 ppm	75.0 ppm	± 5%
Hexane	55.4 ppm	55.2 ppm	± 5%
Toluene	54.9 ppm	54.5 ppm	± 5%
Methanol	* ppm	ppm	± 5%

* Methanol is currently being analyzed.

5.3 NMO Analyzer Daily Calibration

Triplicate injections of a mixture containing propane and high-level CO_2 are made at the beginning of each set of samples or every 24 hours, whichever comes first.

Requirements *: DRF(NMO) = [RF(NMO) = 915] ± 5%
DRF(CO_2) = [RF(CO_2) = 862] ± 5%

* Original calibration values were 91.5 and 86.2; on 5/30/90, electrometer range was lowered by a factor of 10, increasing each response factor by a factor of 10.

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-275   Date: 8/20-22/90

Sample # 1

TANK 6191:   TRAP NA   COLLECTION VESSEL:

Volume (cu.m) = 0.005785   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	348.0	302.0			
Postsampling	767.1	302.0			
Final	1052.0	299.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.003096

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	880.5	902.0
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	150,834,200	150,684,700	150,857,900
CO2	102,969,400	102,999,900	103,009,500
Noncondensibles	763,820	729,530	639,410
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO + CH4	434032.0000	0.0623
CO2	296449.1000	0.0203
Noncondensibles	1904.2620	9.4814
Condensibles	0.0000	0.0000
TGNMO	1904.2620	

(= 950.7978 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 DATA REPORT

Name: Radian Corporation ID #90-141-275 Date: 8/20-22/90

Sample # 2

TANK new 87: TRAP NA COLLECTION VESSEL:

Volume (cu.m) = 0.004435 Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	340.4	301.5			
Postsampling	767.1	301.5			
Final	1053.0	300.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002421

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	880.5	902.0
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	41,097,790	41,305,950	41,500,100
CO2	69,691,330	70,112,900	70,115,580
Noncondensibles	1,024,969	1,142,894	1,129,982
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO + CH4	116263.8000	0.4871
CO2	196976.0000	0.3490
Noncondensibles	2929.5530	6.0670
Condensibles	0.0000	0.0000
TGNMO	2929.5530	

(= 1462.7260 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-275 Date: 8/20-22/90

Sample # 3

TANK new 16:   TRAP NA   COLLECTION VESSEL:

Volume (cu.m) = 0.004358   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	340.4	299.3			
Postsampling	767.1	299.3			
Final	1066.0	301.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002397

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	880.5	902.0
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	40,164,670	41,210,500	40,863,970
CO2	67,869,890	67,864,580	67,618,240
Noncondensibles	633,807	577,029	646,652
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO + CH4	114879.2000	1.3074
CO2	191109.0000	0.2121
Noncondensibles	1612.7160	6.3227
Condensibles	0.0000	0.0000
TGNMO	1612.7160	

(= 805.2288 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-275   Date: 8/20-22/90

Sample # 4

TANK new 225:   TRAP NA   COLLECTION VESSEL:

Volume (cu.m) = 0.004500   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	370.8	298.7			
Postsampling	767.1	298.7			
Final	1031.0	299.7	Final	0.0	273.2

Volume Sampled (dscm) = 0.002302

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	880.5	902.0
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	138,436,200	138,868,400	138,733,600
CO2	94,549,180	94,449,920	94,500,420
Noncondensibles	480,780	519,310	518,190
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO + CH4	408518.7000	0.1595
CO2	278375.5000	0.0525
Noncondensibles	1359.8830	4.6371
Condensibles	0.0000	0.0000
TGNMO	1359.8830	

(= 678.9897 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-275 Date: 8/20-22/90

Sample # 5

TANK new 46:   TRAP NA   COLLECTION VESSEL:

Volume (cu.m) = 0.004577   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	340.4	298.7			
Postsampling	767.1	298.7			
Final	1058.0	302.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002522

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	893.2	923.1
Blank (ppmC)	6.6	
Blank Area (area units)		8938

Areas:

CO + CH4	40,713,790	40,618,500	40,797,440
CO2	68,973,120	68,698,180	69,479,010
Noncondensibles	546,647	517,922	776,632
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO + CH4	111715.9000	0.2199
CO2	189486.9000	0.5736
Noncondensibles	1605.9180	23.4465
Condensibles	0.0000	0.0000
TGNMO	1605.9180	

(= 801.8349 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation ID #90-141-275 Date: 8/20-22/90

Sample # 6

TANK 6101: TRAP NA COLLECTION VESSEL:

Volume (cu.m) = 0.005756 Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	340.4	299.3			
Postsampling	767.1	299.3			
Final	1065.0	302.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.003166

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	893.2	923.1
Blank (ppmC)	6.6	
Blank Area (area units)		8938

Areas:

CO + CH4	40,998,370	40,910,500	40,858,750
CO2	70,092,930	69,043,010	69,687,490
Noncondensibles	438,800	465,803	513,266
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO + CH4	113252.6000	0.1725
CO2	192638.8000	0.7607
Noncondensibles	1241.6770	8.1302
Condensibles	0.0000	0.0000
TGNMO	1241.6770	

(= 619.9695 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-275   Date: 8/20-22/90

Sample # 7

TANK new 151:   TRAP NA   COLLECTION VESSEL:

Volume (cu.m) = 0.004551   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	398.0	303.2			
Postsampling	766.3	303.2			
Final	1085.0	300.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002133

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	880.5	902.0
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	258,153,000	258,596,800	259,211,700
CO2	192,904,000	192,964,000	192,614,000
Noncondensibles	536,260	518,070	576,350
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO + CH4	874051.0000	0.2055
CO2	651608.1000	0.0971
Noncondensibles	1683.5730	5.8423
Condensibles	0.0000	0.0000
TGNMO	1683.5730	

(= 840.6078 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-275   Date: 8/20-22/90

Sample # 8

TANK new 47:   TRAP NA   COLLECTION VESSEL:

Volume (cu.m) = 0.004563   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	390.4	303.2			
Postsampling	766.3	303.2			
Final	1058.0	300.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002182

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	880.5	902.0
Blank (ppmC)	6.6	
Blank Area (area units)		33185

Areas:

CO + CH4	196,188,200	197,900,000	198,766,200
CO2	129,548,700	130,610,800	130,638,300
Noncondensibles	333,470	339,000	363,200
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO + CH4	637979.8000	0.6639
CO2	420543.6000	0.4769
Noncondensibles	983.3562	5.0673
Condensibles	0.0000	0.0000
TGNMO	983.3562	

(= 490.9898 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-275   Date: 8/20-22/90

Sample # 9

TANK new 115:   TRAP NA   COLLECTION VESSEL:

Volume (cu.m) = 0.004566   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	390.4	303.2			
Postsampling	766.3	303.2			
Final	1070.0	301.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002184

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	893.2	923.1
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	43,409,700	43,317,830	43,367,040
CO2	74,286,280	74,241,350	74,043,330
Noncondensibles	539,259	557,536	495,752
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO + CH4	139108.1000	0.1060
CO2	237991.6000	0.1742
Noncondensibles	1544.7290	6.3776
Condensibles	0.0000	0.0000
TGNMO	1544.7290	

(= 771.2832 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-275   Date: 8/20-22/90

Sample # 10

TANK new 202:   TRAP NA   COLLECTION VESSEL:

Volume (cu.m) = 0.004489   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	390.7	301.5			
Postsampling	766.6	301.5			
Final	1090.0	301.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002159

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	880.5	902.0
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	43,263,550	43,325,190	42,952,530
CO2	74,336,000	74,503,880	73,173,120
Noncondensibles	366,712	377,219	376,010
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO + CH4	142353.8000	0.4626
CO2	243971.6000	0.9793
Noncondensibles	1094.5880	1.6903
Condensibles	0.0000	0.0000
TGNMO	1094.5880	

(= 546.5279 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation　　　　ID #90-141-275　Date: 8/20-22/90

Sample # 11

TANK new 193:　　　　TRAP NA　　COLLECTION VESSEL:

Volume (cu.m) = 0.004484　　　　Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	390.7	301.5			
Postsampling	766.6	301.5			
Final	1058.0	301.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002156

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	880.5	902.0
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	200,253,100	200,259,500	201,503,400
CO2	131,071,500	130,977,400	131,609,900
Noncondensibles	422,970	356,430	387,840
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO + CH4	642137.6000	0.3588
CO2	419894.5000	0.2601
Noncondensibles	1111.7020	9.3531
Condensibles	0.0000	0.0000
TGNMO	1111.7020	

(= 555.0730 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation ID #90-141-275 Date: 8/20-22/90

Sample # 12

TANK new 351: TRAP NA COLLECTION VESSEL:

Volume (cu.m) = 0.004534 Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	390.7	301.5			
Postsampling	766.6	301.5			
Final	1030.0	299.7	Final	0.0	273.2

Volume Sampled (dscm) = 0.002181

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	880.5	902.0
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	42,433,860	42,360,260	41,760,930
CO2	72,648,320	72,416,580	70,803,780
Noncondensibles	396,154	401,885	408,586
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO + CH4	132074.7000	0.8750
CO2	225283.8000	1.3963
Noncondensibles	1127.8220	1.6861
Condensibles	0.0000	0.0000
TGNMO	1127.8220	

(= 563.1214 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 DATA REPORT

Name: Radian Corporation ID #90-141-275 Date: 8/20-22/90

Sample # 13

TANK new 31: TRAP NA COLLECTION VESSEL:

Volume (cu.m) = 0.004566 Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	350.5	297.6			
Postsampling	764.5	297.6			
Final	1070.0	299.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002450

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	893.2	923.1
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	41,905,540	41,975,970	41,827,460
CO2	71,868,860	71,328,710	71,332,160
Noncondensibles	1,055,117	948,219	934,921
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO + CH4	120613.1000	0.1773
CO2	205833.4000	0.4347
Noncondensibles	2635.4150	6.9637
Condensibles	0.0000	0.0000
TGNMO	2635.4150	

(= 1315.8630 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-275 Date: 8/20-22/90

Sample # 14

TANK new 134:   TRAP NA   COLLECTION VESSEL:

Volume (cu.m) = 0.004554   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	348.0	297.6			
Postsampling	764.5	297.6			
Final	1049.0	301.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002459

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	893.2	923.1
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	42,971,750	42,678,400	41,959,680
CO2	71,899,260	73,905,600	72,202,370
Noncondensibles	1,005,653	954,375	1,010,856
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO + CH4	118509.8000	1.2242
CO2	202460.8000	1.4883
Noncondensibles	2580.2030	3.2615
Condensibles	0.0000	0.0000
TGNMO	2580.2030	

(= 1288.2950 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-275   Date: 8/20-22/90

Sample # 15

TANK new 133:   TRAP NA   COLLECTION VESSEL:

Volume (cu.m) = 0.004555   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	348.0	297.6			
Postsampling	764.5	297.6			
Final	1042.0	300.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002459

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	880.5	902.0
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	43,000,230	43,294,740	42,998,910
CO2	73,924,230	74,849,220	74,653,700
Noncondensibles	1,618,009	1,528,139	1,607,910
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO + CH4	121395.9000	0.3954
CO2	209779.0000	0.6546
Noncondensibles	4266.0190	3.1731
Condensibles	0.0000	0.0000
TGNMO	4266.0190	

(= 2130.0240 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation　　　　ID #90-141-275　Date: 8/20-22/90

Sample # 16

TANK new 84:　　　　TRAP NA　　　COLLECTION VESSEL:

Volume (cu.m) = 0.004583　　　　Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	340.4	297.6			
Postsampling	764.5	297.6			
Final	1126.0	301.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002520

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	880.5	902.0
Blank (ppmC)	6.6	
Blank Area (area units)		33183

Areas:

CO + CH4	41,935,490	43,041,990	42,499,520
CO2	72,634,660	74,528,260	72,989,180
Noncondensibles	569,587	570,168	540,546
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO + CH4	126593.5000	1.3021
CO2	218626.3000	1.3718
Noncondensibles	1532.3790	3.2144
Condensibles	0.0000	0.0000
TGNMO	1532.3790	

(= 765.1167 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-275   Date: 8/20-22/90

Sample # 17

TANK new 222:   TRAP NA   COLLECTION VESSEL:

Volume (cu.m) = 0.004496   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	342.9	297.6			
Postsampling	764.5	297.6			
Final	1067.0	302.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002457

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	893.2	923.1
Blank (ppmC)	6.6	
Blank Area (area units)		8938

Areas:

CO + CH4	41,805,730	41,607,870	42,170,050
CO2	72,230,530	71,571,460	72,591,620
Noncondensibles	482,187	503,635	520,218
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO + CH4	116812.2000	0.6812
CO2	201279.4000	0.7171
Noncondensibles	1331.3410	3.8670
Condensibles	0.0000	0.0000
TGNMO	1331.3410	

(= 664.7388 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-275′ Date: 8/20-22/90

Sample # 18

TANK new 79:   TRAP NA   COLLECTION VESSEL:

Volume (cu.m) = 0.004559   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	345.4	297.6			
Postsampling	764.5	297.6			
Final	1058.0	300.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.002476

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	893.2	923.1
Blank (ppmC)	6.6	
Blank Area (area units)		8938

Areas:

CO + CH4	41,919,590	41,710,910	41,852,550
CO2	72,664,260	72,416,580	72,686,280
Noncondensibles	884,386	978,659	880,483
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO + CH4	117211.3000	0.2547
CO2	203412.1000	0.2063
Noncondensibles	2455.4350	6.1386
Condensibles	0.0000	0.0000
TGNMO	2455.4350	

(= 1225.9990 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES

METHOD 25 REPORT

prepared for

RADIAN CORPORATION

by

RESEARCH TRIANGLE LABORATORIES, INC.

Gene Mull
Chemist

John Y. Morimoto, Ph.D.
Chemist

RTL ID# 90-304

September 25, 1990

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RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 TABLE OF RESULTS

Name: Radian Corporation ID #90-141-304 Date: 9/18-9/19/90

#	Sample Description	Concentrations (ppmC)						Mass Conc. (mgC/cu.m)
		CO	CH4	CO2	Noncon-densibles	Conden-sibles	TGNMO	
1	Run 1	0	588777	440273	1807	0	1807	902
2	Run 2	0	576308	429887	1869	0	1869	933
3	Run 3	0	579089	427375	2040	0	2040	1019
4	Run 4	0	576860	426636	1778	0	1778	888
5	Run 5	0	620554	461827	1454	0	1454	726
6	Run 6	0	605251	449943	2336	0	2336	1166
7	Run 7	0	547630	397193	1007	0	1007	503
8	Run 8	0	559645	408619	770	0	770	384
9	Run 9	0	559157	405974	817	0	817	408
10	Run 10	0	516040	378688	812	0	812	405
11	Run 11	0	586596	445773	1286	0	1286	642
12	Run 12	0	523619	388038	923	0	923	461
13	Run 13	0	548983	410480	1203	0	1203	601
14	Run 14	0	552874	465279	5431	0	5431	2712
15	Run 15	0	565403	482293	5480	0	5480	2736
16	Run 16	0	556735	473719	5489	0	5489	2741

Tank Pressure* History

#	Tank #	Pressure (Temperature) After Connection	Pressure (Temperature) After Pressurization	Pressure (Temperature) After Analysis
1	155	619 (26)	1057 (26)	885 (26)
2	122	609 (26)	1033 (26)	960 (26.5)
3	068	588 (26.5)	1104 (26.5)	1050 (27)
4	019	577 (28)	1115 (28)	1080 (28)
5	038	612 (28)	1126 (28)	1074 (29)
6	147	647 (29)	1094 (29)	1027 (28)
7	105	666 (29)	1080 (29)	1045 (29)
8	031	670 (29)	1055 (29)	1020 (30)
9	140	699 (30)	1087 (30)	950 (30)
10	014	696 (27.5)	1124 (27.5)	1027 (27)
11	001	691 (26)	1084 (26)	1014 (28)
12	189	701 (27)	1068 (27)	988 (28)
13	185	682 (28)	1070 (28)	986 (29)
14	115	687 (29)	1303 (29)	1114 (30)
15	135	691 (29)	1116 (29)	1077 (30)
16	900	683 (30)	1085 (30)	1048 (30)

* Pressure, mmHg: Temperature, °C

RESEARCH TRIANGLE LABORATORIES, INC.

COMMENTS ON THE ANALYSES

Report #90-141-304

All samples: CH_4 and CO_2 were analyzed with the electrometer set at a range 100 times less sensitive than normal in order to prevent signal overload. The areas were multiplied by 100 before calculations. The NMO were analyzed at the normal electrometer range.

All NMO peaks tailed badly: this may have resulted in some degree of integration error.

Since tank volumes were not supplied, a volume of 2 L was used for all samples. The only results affected by this are the volume sampled and the [zero value] condensibles concentrations.

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 EXPERIMENTAL PROCEDURE

Calibration

A propane calibration gas mixture of 82 ppm CO, 68 ppm CH_4, 2.07% CO_2, and 75 ppm propane is injected via a 1-mL sampling loop into the analyzer. The injections are repeated until three integrated areas indicate reasonable agreement. A 1.18% CO_2 standard is run daily with the same requirement. The average daily response factors must agree within 5% of the RF(CO_2) and the RF(NMO) from the initial performance check.

Daily Performance Checks are performed at the beginning of each work day. Calibrations are performed daily or between customer sets of samples, whichever comes first. Additionally, a System Background Check is performed between each set of samples. Duplicate injections of 1.0% CO_2 are made after the final sample each day.

Response factors (average integrated area/concentration in ppmC) are calculated daily from the initial triplicate injections.

Analysis

Each trap is stored under dry ice until just prior to analysis and is flushed of CO_2 by passing zero air through it at -78 °C and via the CO_2 NDIR to the sample tank. Flushing is continued until no NDIR response is noted. The trap is baked at 200 °C with zero air flushing through the trap and via the oxidation catalyst and the NDIR into the collection vessel. Collection is continued until no NDIR response is noted. The trap is transferred to an oven set at 350 °C and baking is continued for 30 minutes. This ensures the cleanliness of the trap for a subsequent sampling. The trap is taken out of the oven and allowed to cool; it is then capped and stored for shipment.

The sample tank is analyzed by injecting an aliquot via a 1-mL sample loop into the GC column, which is held at 85 °C to elute the CO+CH_4 and then the CO_2 which is passed to the oxidation catalyst, reduction catalyst, and FID. The column is then backflushed at 195 °C to elute the organic fraction. The collection vessel is analyzed identically. In both cases, triplicate injections are made. The sample tank is pumped for 5 minutes (to less than 5 mmHg) and air is then allowed in via a paper fiber filter; this procedure is repeated. The tank is pumped 10 minutes and allowed to stand overnight. The tank is then connected to a pressure gauge to test for leaks (maximum permissible leak rate = 10 mmHg/day). If the tank passes the leak test, it is filled with zero air to slightly greater than atmospheric pressure and stored for shipment.

Calculations

Calculations are done in accord with EPA Method 25 procedures. A sample calculation is provided using client/RTL data.

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 SAMPLE CALCULATION

Note: All pressure values have been converted when necessary to mm Hg and all temperature values to Kelvin.

Name: Radian Corporation ID #90-141-304 Date: 9/18-9/19/90

Sample # 1 Run 1

D A T A

Tank 155: Volume (cu.m) = 0.002000	Pressure (mm Hg)	Temp.(K)	Trap	Collection Vessel: Volume (cu.m) = 0.004551	Pressure (mm Hg)	Temp.(K)
Presampling	67.3	304.8				
Postsampling	765.8	304.8				
Final	1057.0	299.2		Final	0.0	273.2

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	890.4	911.2
Blank (ppmC)	21.4	
Blank Area (area units)		7710

Areas:

CO	0	0	0
CH4	340,139,800	339,868,800	339,988,000
CO2	253,890,600	254,771,800	254,066,900
Noncondensibles	1,047,863	1,115,551	1,064,129
Condensibles	0	0	0

C A L C U L A T I O N S

Measured Concentrations, corrected for blank:

Cm(CO) = Area(CO)/RF(CO2)
= 0 /890.4 = 0.0
= 0 /890.4 = 0.0
= 0 /890.4 = 0.0

Cm(CH4) = Area(CH4)/RF(CO2)
= 3.401398E+08 /890.4 = 382007.9
= 3.398688E+08 /890.4 = 381703.5
= 3.39988E+08 /890.4 = 381837.4

Cm(CO2) = Area(CO2)/RF(CO2)
= 2.538906E+08 /890.4 = 285142.2
= 2.547718E+08 /890.4 = 286131.9
= 2.540669E+08 /890.4 = 285340.2

Cm(Noncondensibles) = [Area(Noncondensibles) - Blank Area(NMO)]/RF(NMO)
= (1047863 - 7710)/911.2 = 1141.5
= (1115551 - 7710)/911.2 = 1215.8
= (1064129 - 7710)/911.2 = 1159.4

Cm(Condensibles) = Area(Condensibles)/RF(CO2) - Blank(CO2)
= 0 /890.4 - 21.4 = -21.4
= 0 /890.4 - 21.4 = -21.4
= 0 /890.4 - 21.4 = -21.4

Pressure-Temperature Ratio, Q(i) = P(i)/T(i):

postsampling tank: Q(1) = 765.81 / 304.8167 = 2.512363
presampling tank: Q(2) = 67.30999 / 304.8167 = .2208212
final tank: Q(3) = 1057 / 299.15 = 3.533345
final CV: Q(4) = 0 / 273.15 = 0

Volume Sampled (dscm) = 0.3857 x Tank Volume x [Q(1)-Q(2)]
= 0.3857 x .002 x [2.5124 - 0.2208]
= 0.001768

Averages and % Relative Standard Deviations (%RSD) of Cm's are calculated.
(%RSD of C = %RSD of Cm)

Calculated Concentrations:

C(CO) = Q(3)/[Q(1)-Q(2)] x Cm(CO)
= 3.5333/(2.5124 - 0.2208) x 0.0 = 0.0

C(CH4) = Q(3)/[Q(1)-Q(2)] x Cm(CH4)
= 3.5333/(2.5124 - 0.2208) x 381849.6 = 588776.6

C(CO2) = Q(3)/[Q(1)-Q(2)] x Cm(CO2)
= 3.5333/(2.5124 - 0.2208) x 285538.0 = 440273.2

C(Noncondensibles) = Q(3)/[Q(1)-Q(2)] x Cm(Noncondensibles)
= 3.5333/(2.5124 - 0.2208) x 1172.2 = 1807.5

C(Condensibles)
= Volume(CV)/Volume(Tank) x Q(4)/[Q(1)-Q(2)] x Cm(Condensibles)
= 0.004551/0.002000 x 0.0000/(2.5124 - 0.2208) x -21.4 = 0.0

Total Gaseous Non-Methane Organics(TGNMO)=C(Noncondensibles)+C(Condensibles)
= 1807.5 + 0.0
= 1807.5

Mass Concentration = 0.4993 x TGNMO
= 0.4993 x 1807.5 = 902.5

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 SAMPLE QA/QC DATA & CALIBRATION CHECK/A

5.1.1 Carrier Gas and Auxiliary Oxygen Blank (1/3/90)

$CO + CH_4 + CO_2 + NMO = 0$ ppm Requirement: < 5 ppm

5.1.2 Catalyst Efficiency Check (1/4/90)

$CO_2 = 9982$ ppmC Requirement: $CO_2 = 10000 \pm 200$ ppmC

5.1.3 System Performance Check (1/4/90)

	Average Percent Recovery	%RSD
50 uL hexane/decane	107.6/103.6	0.1/0.5
10 uL hexane/decane	102.1/103.2	0.5/0.9
Requirement	100 ± 10%	< 5

5.2.1 Oxidation Catalyst Efficiency Check (1/5/90)

FID Response with Reduction Catalyst Out = 0.25%
Requirement < 1%

5.2.2 Reduction Catalyst Efficiency Check (1/5/90)

Response of CO_2 with Oxidation Catalyst and Reduction Catalyst operative was 100.3% of response with catalyst out.

Requirement 100 ± 5%

5.2.3 Analyzer Linearity Check and NMO Calibration (1/2/90)

$\overline{RF}$ values agree within 2.5% Requirement: within 2.5%
%RSD values for triplicates < 2% " < 2%
except Propane 4th Dilution (22 ppmc) %RSD = 2.4%

(deviation by Gene Mull, Manager and Joseph Adamovic, Laboratory Manager)

$\frac{RF(NMO)}{RF(CO_2)} = 1.015$ Requirement: $\frac{RF(NMO)}{RF(CO_2)} = 1.0 \pm 0.1$

5.2.4 System Performance Check (1/5/90-4/10/90)

	Measured Value	Expected Value	Requirement
Propane Mix	75.0 ppm	75.0 ppm	± 5%
Hexane	55.4 ppm	55.2 ppm	± 5%
Toluene	54.9 ppm	54.5 ppm	± 5%
Methanol	* ppm	ppm	± 5%

* Methanol is currently being analyzed.

5.3 NMO Analyzer Daily Calibration

Triplicate injections of a mixture containing propane and high-level CO_2 are made at the beginning of each set of samples or every 24 hours, whichever comes first.

Requirements *: DRF(NMO) = [RF(NMO) = 915] ± 5%
DRF(CO_2) = [RF(CO_2) = 862] ± 5%

* Original calibration values were 91.5 and 86.2; on 5/30/90, electrometer range was lowered by a factor of 10, increasing each response factor by a factor of 10.

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation | ID #90-141-304 | Date: 9/18-9/19/90

Sample # 1 Run 1

TANK 155: | TRAP | COLLECTION VESSEL:

Volume (cu.m) = 0.002000 | Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	67.3	304.8			
Postsampling	765.8	304.8			
Final	1057.0	299.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.001768

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	890.4	911.2
Blank (ppmC)	21.4	
Blank Area (area units)		7710

Areas:

CO	0	0	0
CH4	340,139,800	339,868,800	339,988,000
CO2	253,890,600	254,771,800	254,066,900
Noncondensibles	1,047,863	1,115,551	1,064,129
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO	0.0000	0.0000
CH4	588776.6000	0.0400
CO2	440273.2000	0.1834
Noncondensibles	1807.4730	3.3079
Condensibles	0.0000	0.0000
TGNMO	1807.4730	

(= 902.4711 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 DATA REPORT

Name: Radian Corporation ID #90-141-304 Date: 9/18-9/19/90

Sample # 2 Run 2

TANK 122:
Volume (cu.m) = 0.002000

	Pressure (mm Hg)	Temp.(K)
Presampling	67.3	304.8
Postsampling	765.8	304.8
Final	1033.0	299.2

TRAP

COLLECTION VESSEL:
Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)
Final	0.0	273.2.

Volume Sampled (dscm) = 0.001768

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	890.4	911.2
Blank (ppmC)	21.4	
Blank Area (area units)		7710

Areas:

CO	0	0	0
CH4	340,554,400	340,540,500	340,497,800
CO2	254,036,500	254,076,000	253,927,000
Noncondensibles	1,029,935	1,152,579	1,231,263
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO	0.0000	0.0000
CH4	576308.4000	0.0087
CO2	429887.4000	0.0304
Noncondensibles	1869.0940	8.9771
Condensibles	0.0000	0.0000
TGNMO	1869.0940	

(= 933.2387 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation ID #90-141-304 Date: 9/18-9/19/90

Sample # 3 Run 3

TANK 068: TRAP COLLECTION VESSEL:
Volume (cu.m) = 0.002000 Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	92.7	303.7			
Postsampling	765.8	303.7			
Final	1104.0	299.7	Final	0.0	273.2

Volume Sampled (dscm) = 0.001710

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	890.4	911.2
Blank (ppmC)	21.4	
Blank Area (area units)		7710

Areas:

CO	0	0	0
CH4	309,882,600	310,270,400	310,363,400
CO2	228,621,800	228,515,400	229,595,700
Noncondensibles	1,045,804	1,178,481	1,153,974
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO	0.0000	0.0000
CH4	579089.4000	0.0822
CO2	427375.3000	0.2601
Noncondensibles	2040.3390	6.3126
Condensibles	0.0000	0.0000
TGNMO	2040.3390	

(= 1018.7410 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-304 Date: 9/18-9/19/90

Sample # 4 Run 4

TANK 019:
Volume (cu.m) = 0.002000

	Pressure (mm Hg)	Temp.(K)
Presampling	108.0	304.8
Postsampling	765.8	304.8
Final	1115.0	301.2

TRAP

COLLECTION VESSEL:
Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)
Final	0.0	273.2

Volume Sampled (dscm) = 0.001665

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	890.4	911.2
Blank (ppmC)	21.4	
Blank Area (area units)		7710

Areas:

CO	0	0	0
CH4	299,183,700	299,508,200	299,521,000
CO2	221,236,500	221,205,400	221,862,100
Noncondensibles	928,609	927,797	1,000,344
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO	0.0000	0.0000
CH4	576859.5000	0.0638
CO2	426636.2000	0.1673
Noncondensibles	1778.2950	4.4098
Condensibles	0.0000	0.0000
TGNMO	1778.2950	

(= 887.9027 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-304   Date: 9/18-9/19/90

Sample # 5   Run 5

TANK 038:   TRAP   COLLECTION VESSEL:

Volume (cu.m) = 0.002000   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	110.5	305.4			
Postsampling	765.8	305.4			
Final	1126.0	301.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.001655

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	890.4	911.2
Blank (ppmC)	21.4	
Blank Area (area units)		7710

Areas:

CO	0	0	0
CH4	317,011,400	317,370,900	316,999,000
CO2	236,101,800	236,354,100	235,577,300
Noncondensibles	759,143	792,136	752,935
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO	0.0000	0.0000
CH4	620554.3000	0.0666
CO2	461826.5000	0.1679
Noncondensibles	1453.9110	2.7711
Condensibles	0.0000	0.0000
TGNMO	1453.9110	

(= 725.9380 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation ID #90-141-304 Date: 9/18-9/19/90

Sample # 6 Run 6

TANK 147: Volume (cu.m) = 0.002000

TRAP

COLLECTION VESSEL: Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	85.1	305.4			
Postsampling	765.8	305.4			
Final	1094.0	302.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.001720

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	890.4	911.2
Blank (ppmC)	21.4	
Blank Area (area units)		7710

Areas:

CO	0	0	0
CH4	331,748,500	331,744,500	331,881,300
CO2	246,575,200	246,731,000	246,653,300
Noncondensibles	1,312,223	1,337,616	1,304,746
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO	0.0000	0.0000
CH4	605251.4000	0.0235
CO2	449942.8000	0.0316
Noncondensibles	2336.0070	1.3147
Condensibles	0.0000	0.0000
TGNMO	2336.0070	

(= 1166.3680 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-304 Date: 9/18-9/19/90

Sample # 7 Run 7

TANK 105:
Volume (cu.m) = 0.002000

	Pressure (mm Hg)	Temp.(K)
Presampling	35.1	296.5
Postsampling	759.0	296.5
Final	1080.0	302.2

TRAP

COLLECTION VESSEL:
Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)
Final	0.0	273.2

Volume Sampled (dscm) = 0.001883

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	890.4	911.2
Blank (ppmC)	21.4	
Blank Area (area units)		7710

Areas:

CO	0	0	0
CH4	333,049,600	333,093,500	333,098,900
CO2	241,706,200	241,573,400	241,465,800
Noncondensibles	628,062	647,449	627,329
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO	0.0000	0.0000
CH4	547629.9000	0.0081
CO2	397193.3000	0.0498
Noncondensibles	1006.6510	1.8211
Condensibles	0.0000	0.0000
TGNMO	1006.6510	

(= 502.6207 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-304   Date: 9/18-9/19/90

Sample # 8   Run 8

TANK 031:   TRAP   COLLECTION VESSEL:

Volume (cu.m) = 0.002000   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	35.1	297.0			
Postsampling	759.0	297.0			
Final	1055.0	302.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.001880

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	890.4	911.2
Blank (ppmC)	21.4	
Blank Area (area units)		7710

Areas:

CO	0	0	0
CH4	347,793,000	347,856,800	347,759,400
CO2	253,837,400	253,846,400	254,149,400
Noncondensibles	495,672	519,682	475,993
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO	0.0000	0.0000
CH4	559645.3000	0.0142
CO2	408618.5000	0.0699
Noncondensibles	769.5199	4.4708
Condensibles	0.0000	0.0000
TGNMO	769.5199	

(= 384.2213 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation ID #90-141-304 Date: 9/18-9/19/90

Sample # 9 Run 9

TANK 140:
Volume (cu.m) = 0.002000

	Pressure (mm Hg)	Temp.(K)
Presampling	22.4	297.0
Postsampling	759.0	297.0
Final	1087.0	303.2

TRAP

COLLECTION VESSEL:
Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)
Final	0.0	273.2

Volume Sampled (dscm) = 0.001913

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	890.4	911.2
Blank (ppmC)	21.4	
Blank Area (area units)		7710

Areas:

CO	0	0	0
CH4	344,141,800	344,357,000	344,468,600
CO2	250,368,200	249,554,200	250,059,400
Noncondensibles	512,900	539,399	515,176
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO	0.0000	0.0000
CH4	559157.0000	0.0482
CO2	405973.7000	0.1644
Noncondensibles	816.8888	2.8529
Condensibles	0.0000	0.0000
TGNMO	816.8888	

(= 407.8726 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-304 Date: 9/18-9/19/90

Sample # 10   Run 10

TANK 014:   TRAP   COLLECTION VESSEL:

Volume (cu.m) = 0.002000   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	35.1	293.7			
Postsampling	759.0	293.7			
Final	1124.0	300.7	Final	0.0	273.2

Volume Sampled (dscm) = 0.001901

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	888.0	897.0
Blank (ppmC)	21.4	
Blank Area (area units)		3918

Areas:

CO	0	0	0
CH4	302,808,200	302,995,400	302,960,000
CO2	221,618,100	221,622,100	221,844,200
Noncondensibles	485,521	471,923	494,452
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO	0.0000	0.0000
CH4	516039.8000	0.0328
CO2	378687.7000	0.0584
Noncondensibles	811.7649	2.3633
Condensibles	0.0000	0.0000
TGNMO	811.7649	

(= 405.3142 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 DATA REPORT

Name: Radian Corporation ID #90-141-304 Date: 9/18-9/19/90

Sample # 11 Run 11

TANK 001: TRAP COLLECTION VESSEL:

Volume (cu.m) = 0.002000 Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	200.2	294.3			
Postsampling	759.0	294.3			
Final	1084.0	299.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.001465

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	888.0	897.0
Blank (ppmC)	21.4	
Blank Area (area units)		3918

Areas:

CO	0	0	0
CH4	273,855,800	273,897,600	273,407,800
CO2	207,763,900	207,334,200	207,247,200
Noncondensibles	580,017	628,954	616,222
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO	0.0000	0.0000
CH4	586595.6000	0.0992
CO2	445773.2000	0.1334
Noncondensibles	1285.8970	4.2002
Condensibles	0.0000	0.0000
TGNMO	1285.8970	

(= 642.0481 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-304   Date: 9/18-9/19/90

Sample # 12   Run 12

TANK 189:   TRAP   COLLECTION VESSEL:

Volume (cu.m) = 0.002000   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	27.4	293.7			
Postsampling	759.0	293.7			
Final	1068.0	300.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.001921

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	888.0	897.0
Blank (ppmC)	21.4	
Blank Area (area units)		3918

Areas:

CO	0	0	0
CH4	326,599,800	326,399,700	326,045,300
CO2	241,062,600	241,073,300	241,448,500
Noncondensibles	613,481	562,669	573,629
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO	0.0000	0.0000
CH4	523618.6000	0.0860
CO2	388037.7000	0.0911
Noncondensibles	922.7015	4.6156
Condensibles	0.0000	0.0000
TGNMO	922.7015	

(= 460.7049 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-304   Date: 9/18-9/19/90

Sample # 13   Run 13

TANK 185:   TRAP   COLLECTION VESSEL:

Volume (cu.m) = 0.002000   Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	149.4	296.5			
Postsampling	759.0	296.5			
Final	1070.0	301.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.001586

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	888.0	897.0
Blank (ppmC)	21.4	
Blank Area (area units)		3918

Areas:

CO	0	0	0
CH4	282,945,800	282,846,900	282,819,700
CO2	210,669,600	210,938,700	211,196,500
Noncondensibles	611,123	646,701	627,839
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO	0.0000	0.0000
CH4	548983.4000	0.0235
CO2	410479.8000	0.1249
Noncondensibles	1203.3470	2.8496
Condensibles	0.0000	0.0000
TGNMO	1203.3470	

(= 600.8314 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation — ID #90-141-304 — Date: 9/18-9/19/90

Sample # 14 Run 14

TANK 115:
Volume (cu.m) = 0.002000

	Pressure (mm Hg)	Temp.(K)
Presampling	46.2	299.8
Postsampling	760.0	299.8
Final	1303.0	302.2

Volume Sampled (dscm) = 0.001836

TRAP

COLLECTION VESSEL:
Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)
Final	0.0	273.2

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	888.0	897.0
Blank (ppmC)	21.4	
Blank Area (area units)		3918

Areas:

CO	0	0	0
CH4	271,662,100	271,904,500	271,691,200
CO2	228,319,700	228,023,700	227,899,700
Noncondensibles	2,697,226	2,681,410	2,701,270
Condensibles	0	0	0

Concentrations (ppmC):		%RSD
CO	0.0000	0.0000
CH4	552873.9000	0.0487
CO2	465279.2000	0.0946
Noncondensibles	5431.2260	0.3903
Condensibles	0.0000	0.0000
TGNMO	5431.2260	

(= 2711.8110 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.
METHOD 25 DATA REPORT

Name: Radian Corporation ID #90-141-304 Date: 9/18-9/19/90

Sample # 15 Run 15

TANK 135: Volume (cu.m) = 0.002000

TRAP

COLLECTION VESSEL: Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	48.8	300.4			
Postsampling	760.0	300.4			
Final	1116.0	302.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.001826

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	888.0	897.0
Blank (ppmC)	21.4	
Blank Area (area units)		3918

Areas:

CO	0	0	0
CH4	322,280,200	323,576,500	322,320,500
CO2	274,264,500	275,876,200	273,495,800
Noncondensibles	3,108,126	3,110,944	3,246,762
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO	0.0000	0.0000
CH4	565403.0000	0.2284
CO2	482293.1000	0.4425
Noncondensibles	5480.4360	2.5145
Condensibles	0.0000	0.0000
TGNMO	5480.4360	

(= 2736.3820 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES, INC.

METHOD 25 DATA REPORT

Name: Radian Corporation   ID #90-141-304 Date: 9/18-9/19/90

Sample # 16   Run 16

TANK 900: Volume (cu.m) = 0.002000

TRAP

COLLECTION VESSEL: Volume (cu.m) = 0.004551

	Pressure (mm Hg)	Temp.(K)		Pressure (mm Hg)	Temp.(K)
Presampling	36.1	300.4			
Postsampling	760.0	300.4			
Final	1085.0	303.2	Final	0.0	273.2

Volume Sampled (dscm) = 0.001859

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	888.0	897.0
Blank (ppmC)	21.4	
Blank Area (area units)		3918

Areas:

CO	0	0	0
CH4	333,794,900	334,197,400	333,394,100
CO2	281,729,600	283,869,600	284,171,000
Noncondensibles	3,263,488	3,342,518	3,351,486
Condensibles	0	0	0

Concentrations (ppmC):

		%RSD
CO	0.0000	0.0000
CH4	556735.1000	0.1203
CO2	473718.8000	0.4699
Noncondensibles	5488.7910	1.4607
Condensibles	0.0000	0.0000
TGNMO	5488.7910	

(= 2740.5530 mgC/cu.m)