TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

DIFFERENTIAL ABSORPTION LIDAR STUDY

FINAL REPORT

Prepared by

Chief Engineer's Office

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EXECUTIVE SUMMARY

The TCEQ contracted National Physical Laboratory (NPL), based in the United Kingdom, to perform differential absorption lidar (DIAL) measurements on industrial emissions sources located in a refinery and a storage terminal in the Houston-Galveston-Brazoria ozone nonattainment area between July 9, 2007, and August 18, 2007. Measurements focused on those industrial sources that are difficult to measure using conventional sampling techniques. NPL's complete report concerning DIAL measurements can be found in Appendix A.

The objective of the DIAL study was to compare DIAL emissions measurements to emissions predicted using conventional methods and models. Independent reviewers were contracted to analyze the DIAL emissions measurements and compare these emissions to emissions determined using conventional methods or models. The results of these analyses are summarized in this report, presented in entirety in the appendices, and are accompanied by additional TCEQ analyses in the "Evaluation" section.

FLARE MEASUREMENTS

NPL measured total volatile organic compound (VOC) emissions from two elevated flares at the refinery for three days. The independent analysis of flare measurements and process data indicate that one of the refinery flares achieved a destruction and reduction efficiency (DRE) that was higher than the expected DRE of 98 percent, and the other refinery flare achieved a DRE that was lower than 98 percent. Cross-wind effects did not likely contribute to the low DRE observations, per the independent analysis. The independent analysis recommended additional measurement and evaluation to accurately assess potential reasons for the low DRE observations. The TCEQ analysis concurs, but suggests that waste gas stream composition and flow rates, in addition to flare assist rates may be potential causes for the low DRE observations.

STORAGE TANK MEASUREMENTS

NPL measured total VOC emissions from 37 storage tanks at the bulk terminal and the refinery. The independent analysis of storage tank measurements indicates emissions determined using conventional models generally fall within the range of DIAL emissions measurements. Emissions measurements of gasoline storage tanks correspond more closely to conventional model emissions estimates than similar comparisons performed for crude oil storage tanks, where measured emissions were mostly greater in magnitude than conventional emissions estimates. The independent analysis suggests that tank filling or wind direction could be potential reasons for these higher emissions rates, but recommends further targeted studies to ascertain probable causes. The TCEQ analysis suggests potential reasons for this discrepancy may include reliance on EPA default data for a complex liquid mixture such as crude oil that can have large variations in vapor pressure and composition.

OTHER MEASURED SOURCES

NPL measured both the effluent treatment (wastewater) and delayed coking facilities at the refinery. Available wastewater process data was obtained from the refinery for emissions determination and associated analysis. Unfortunately, the available process data was not sufficient to calculate emissions using conventional models. All data collected are presented in the Appendices; please reference the Table of Contents.

NPL measured total VOC as well as benzene emissions from the delayed coker; measurements were made to capture as much of the entire coking cycle as possible. Coker benzene emissions measurements approached the DIAL system's detection limit (10 ppb). There are no published methods for estimating VOC emissions from delayed cokers. Since no comprehensive data or conventional approach exists, an analysis of conventionally determined delayed coking emissions was not performed.

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INTRODUCTION

Background and Purpose

VOC atmospheric concentration measurements in the Houston-Galveston-Brazoria ozone nonattainment area (HGB area) performed during the second Texas Air Quality Study (TexAQS II, 2006) indicate VOC emissions are potentially under-represented in the TCEQ's emissions inventory.

Although the TCEQ has performed qualitative research to identify under-represented VOC emissions sources, quantitative measurements of industrial sources are necessary to improve reported estimates. To obtain quantitative data, the TCEQ used DIAL technology to measure VOC emissions from industrial sources. These measurements were compared to emissions determined using conventional, established methods to evaluate the accuracy of these emissions methods and therefore identify potentially under-reported emissions sources.

DIAL Measurement Technique

DIAL measures range-resolved concentrations of targeted compounds in a two-dimensional field. To translate these concentrations to emission rates from a targeted source, other relevant parameters must be taken into account, including wind speed and direction, any contribution from other upwind sources, and any differences between the response of the DIAL technology to the actual compounds present versus the response to compounds used to calibrate the DIAL technology. NPL included non-detect concentrations as zeros for yhe purposes of reporting average concentrations.

DIAL emission rates are therefore calculated from a combination of direct DIAL concentration measurements and other parameter measurements. It is important to note that the total VOC measurements presented in this report represent the total of hydrocarbons with three or more carbon atoms (C3 plus hydrocarbons), and not the total of regulatory VOC as defined by the Environmental Protection Agency (EPA). More detail about DIAL measurements can be found in the NPL report in Appendix A. An analysis of the limitations of DIAL measurements is presented in the independent analysis of storage tanks in Appendix B.

DIAL STUDY OVERVIEW

DIAL measurements were conducted for seven to eight hours per day, six days per week, for 28 working days at two industrial sites in the HGB ozone nonattainment area. Passive infrared HAWK camera crews conducted ground-level observations for the project's duration to detect any possible interference from other VOC sources. An aerial survey using the HAWK camera occurred during the project to detect any potential VOC sources outside the site boundaries that could influence site measurements. The results of the ground surveys are summarized in Appendix C.

The first operational week of the project measured total VOC emissions from naphtha storage tanks at a storage tank leasing site. The second through fifth weeks of the project measured industrial emissions sources located at a refinery. Specifically, the DIAL measured total VOC emissions from storage tanks, coker units, flares, and wastewater treatment areas; benzene measurements were performed on coker units and process areas. Crude oil, fuel oil, diesel, and gasoline storage tank emissions were measured. TCEQ personnel accompanied the DIAL and HAWK crews throughout the duration of the project.

To validate or assess the accuracy of the DIAL measurements, the DIAL measured sulfur dioxide emissions from a sulfur recovery unit equipped with a continuous emissions monitoring system (CEMS) within the refinery. These measurements were compared to the CEMS data to provide field verification of the DIAL system, as detailed in NPL's final report in Appendix A. Additionally, NPL performed blind measurements of various calibration gases provided by the refinery for validation purposes; these results are also presented in NPL's report. NPL's measurements deviated from the actual certified gas values by approximately one to 12 percent.

ANALYSIS

The TCEQ retained independent contractors to evaluate the conventional methods and models for determining VOC emissions from the industrial sources measured during the DIAL study. The independent contractors assessed the accuracy of these conventional emissions determination methods by comparing the predicted emissions to the direct emissions measurements, drew conclusions about how accurately each of the methods or models correspond to the actual emissions measurement, and presented possible reasons for any discrepancies. These detailed analyses are presented in Appendices B and D. A detailed evaluation of these analyses as well as DIAL measurements follows. All process data collected are presented in the Appendices; please reference the Table of Contents in the Appendices.

EVALUATION

FLARE MEASUREMENTS

NPL measured total VOC emissions from two elevated flares, one temporary flare and one permanent process/emergency flare, at the refinery for three days.

The refinery supplied process and operational data from its monitoring and compositional analysis instrumentation located at the flare header. During the three days of DIAL measurements, the temporary flare was combusting a waste gas stream composed of primarily hydrogen (approximately 80 molar percent) and approximately 5 to 10 molar percent VOC; the flow rate to the flare ranged from 400,000 to approximately 900,000 standard cubic feet (scf) per hour.

During the three days of DIAL measurements, the permanent process/emergency flare was combusting a waste gas stream that was composed primarily of nitrogen and methane (approximately 80 molar percent total) and approximately 2 to 5 molar percent VOC. Waste gas flow typically ranged from 0 to 300,000 scf per hour; maximum reported flow rate was 510,000 scf per hour. The permanent process/emergency flare was a newly constructed refinery flare that had recently commenced service a few months before the DIAL testing.

DIAL measurement scans isolated the emissions flux, or rate of flow across a given surface, from the temporary flare on the third day of flare measurements; however, due to the permanent process flare's location, its emissions fluxes were impossible to separate from the temporary flare's emissions fluxes. When isolated, the temporary flare's emissions fluxes were relatively low, averaging 6 pounds/hour. According to the independent analysis, the low emissions flux from the temporary flare is due to its high DRE of 99.9 percent. Therefore, when reporting the total emissions flux from both flares, NPL attributes the majority of the flux to the process/emergency flare. However, this attribution cannot be entirely representative of the entire measurement period, since, at certain points, the total measured VOC emissions rate exceeds the mass of uncontrolled VOC in the waste stream routed to the permanent process/emergency flare.

The DIAL system detected background (upwind) concentrations during the measurement period; in the NPL report, these concentrations, which could originate from nearby process units, have not been subtracted from the average fluxes reported in the tables throughout this document. DIAL measurement results from the NPL report are summarized in Table 1 below.

Table 1: Summary of Flare DIAL Measurements

Sources	Measurement period(s)	Average total VOC emissions fluxes	Average upwind total VOC emissions fluxes
Temporary and permanent process/emergency flares	Three days	147 to 263 lbs/hr	<1 to 14 lb/hr
Temporary flare (isolated)	One hour	<1 to 15 lb/hr	<1 lb/hr

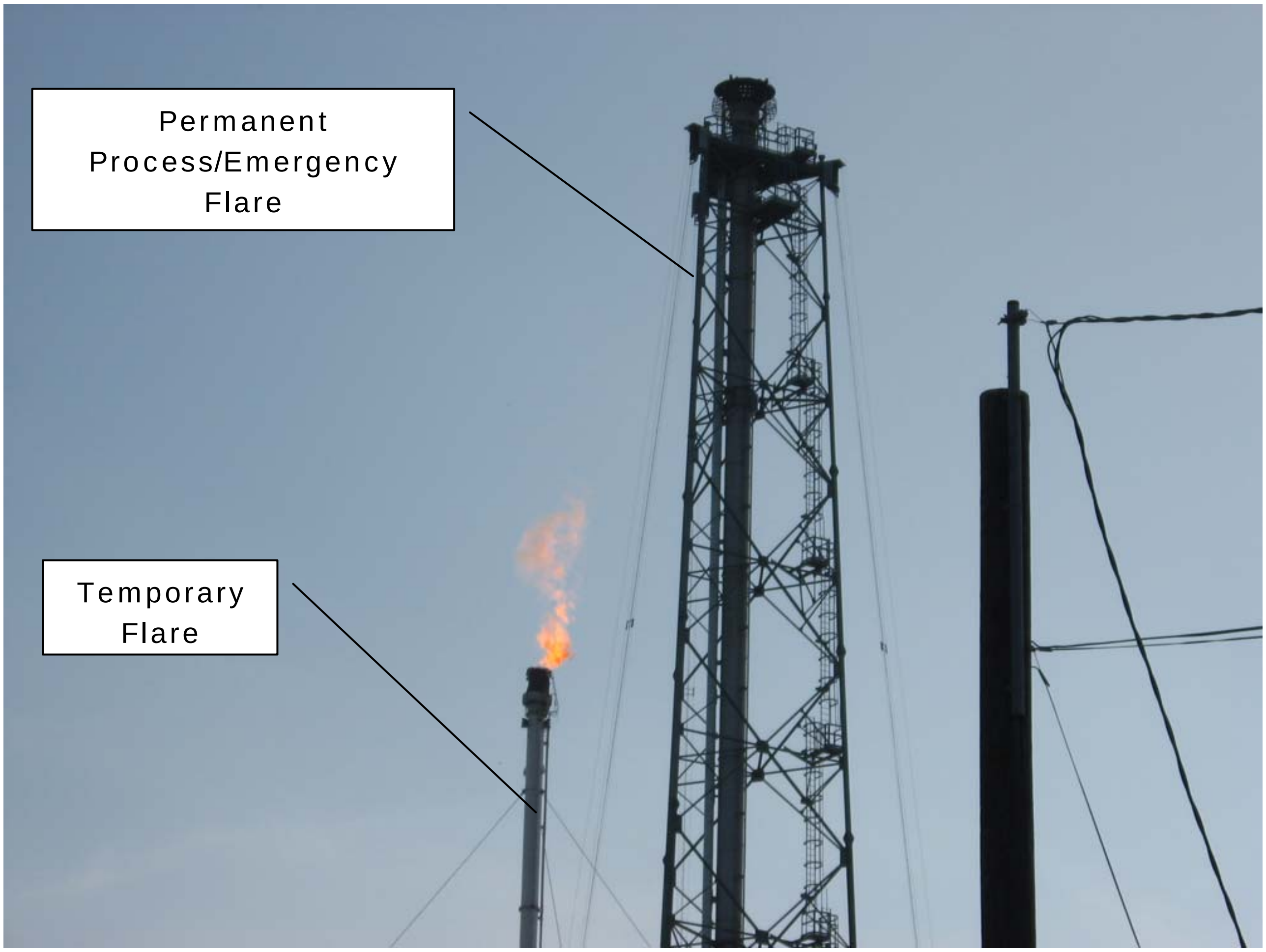
Detailed Review: Independent Analysis of Flare Measurements

Eastern Research Group, Inc., performed the flare measurement and process data analysis. Conventional flare emissions estimates were determined using engineering calculations based upon assumed DRE and monitored composition and operational data provided by the refinery.

This independent analysis of flare measurements and process data indicates the waste stream combusted by the temporary flare comprises 93 to 98 percent of the combined waste streams combusted by both the temporary and the permanent process/emergency flares. Therefore, the temporary flare's DRE "overwhelmingly" influences and contributes to the overall destruction efficiency of the combined flares. The independent analysis concluded that the temporary flare's DRE was 99.9 percent, based on the measurements that isolated the temporary flare emissions (August 11 measurements).

Visually, the temporary flare had a significant and obvious combustion plume at least 50 feet in height during the measurement period, and appeared to have a cooler flame temperature based upon its yellow color. In contract, the permanent flare had a blue, virtually inconspicuous flame, as illustrated in Photo 1 below.

Photo 1: Refinery Flares.



Using the observed temporary flare DRE of 99.9 percent, the independent analysis inferred that the permanent process flare's DRE ranged from 38 to 66 percent throughout the measurement period. If the temporary flare's DRE were lowered slightly to 99.5 percent, the DRE of the permanent process/emergency flare would range from 44 to 79 percent. In either case, the permanent process/emergency flare failed to achieve the expected DRE of 98 percent.

Several factors could influence the observed low flare DRE, including flare waste gas composition, assist-to-waste gas ratios, and high crosswinds. However, based on wind speed measurements, cross-wind effects did not likely contribute to the low DRE observations. The refinery did not measure steam assist mass flow rates. Additional measurement and evaluation were recommended to accurately assess potential reasons for the low DRE observations.

TCEQ Analysis

It is important to note that both the temporary and permanent process/emergency flare both met the minimum heating value requirements specified in 40 Code of Federal Regulations (CFR) §60.18, and are both assumed to have met the exit velocity requirements based on the presence of a stable flame. Given both flares' compliance with operational requirements, the differences in flare DRE are notable. Potentially, compliance with 40 CFR 60.18 does not automatically ensure that the expected flare DRE of 98 percent will be achieved.

Analyzing the data presented in Table 2, two potential reasons for the permanent flare achieving a DRE below 98 percent can be inferred:

- Waste gas composition: The temporary flare's waste gas composition consisted primarily of hydrogen, methane, and hydrocarbons, compounds which are expected to combust readily. The permanent process/emergency flare's waste gas stream composition, however, contained significant inert compounds, primarily nitrogen (approximately 40 percent). Of note, the permanent flare had very little C3 plus hydrocarbon compounds present in its waste gas stream.
- Flow rates: On average, the permanent flare had much lower waste gas flow rates, averaging less than 20 percent of the temporary flare's waste gas flow rates.

Flare assist rates, which were not directly measured and quantified by the refinery and therefore not available, may be another potential cause for the low DRE observations.

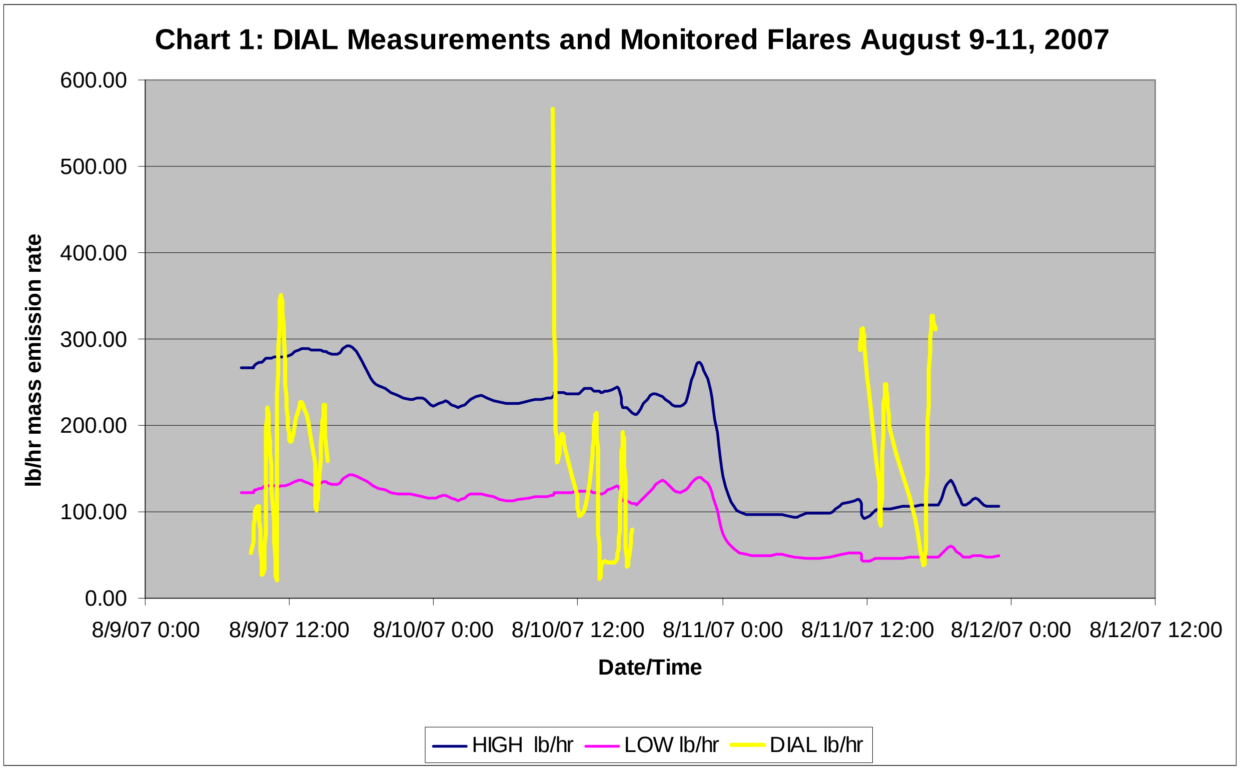
Table 2: Average Flare Waste Stream Composition and Heating Value Analysis

Parameter	Temporary Flare Average	Permanent Process/emergency flare Average
Hydrogen content, weight percent	19.2	1.2
Methane content, weight percent	15.2	47.6
Nitrogen content, weight percent	2.9	39.4
C3 plus hydrocarbons content, weight percent	55.7	5.4
Average waste gas flow rate range, scf/hour	400,000 to 822,000	78,000 to 115,000

Parameter	Temporary Flare Average	Permanent Process/emergency flare Average
Minimum to maximum waste gas flow rate range, scf/hour	400,000 to 933,000	0 to 510,000
Waste gas average heating value, British thermal units (BTU)/scf	563	629.6
Waste gas heating value range, BTU/scf	437 to 668	423.2 to 837.5

TCEQ analysis of the permanent flare's implied DRE generally agrees with the independent contractor's analysis. Assigning an expected 98 percent DRE to the temporary flare would imply that the permanent flare's DRE was also 98 percent for two out of the three measurement days (August 9 and 10); however, on August 11, the permanent flare's implied DRE would drop to approximately 40 to 80 percent. Based on available data, the permanent flare's operational conditions did not vary significantly within the three day measurement period, and there would be no obvious explanation for such a reduction in DRE.

Since the temporary flare's DRE was observed to be 99.9 percent on August 11, and the temporary flare maintained a high waste gas flow rate composed of readily combusted compounds, a DRE of less than 99 percent is not probable. However, since the permanent flare emissions were not isolated, this assertion cannot be confirmed. Chart 1 presents the combined DRE of both flares plotted against the DIAL measurements for the entire measurement period.



Storage Tank Measurements

NPL measured total VOC emissions from a wide variety of petroleum product storage tanks (37 storage tanks) at the bulk terminal and the refinery. These storage tanks had different constructions (fixed roof, external floating roof, and internal floating roof tanks) and stored different petroleum products (naphtha, crude oil, fuel oil, diesel, and gasoline).

Leak Surveys, Inc., performed ground-level HAWK camera surveys of tanks where measurements occurred over several days (crude oil, gasoline, and naphtha storage tanks). These surveys, which are documented in Appendix C, identified several tank condition issues that could contribute to elevated emissions rates, as well as emissions from a naphtha storage tank that the bulk terminal was mixing. EPA (AP-42) equations do not account for identified condition issues or emissions from mixing, blending, or similar agitation processes.

DIAL measurements were conducted during both day and night in an effort to capture a full diurnal cycle of tank emissions. Storage tank emissions measurement results are summarized in Table 3 below. Notably, night-time measurements of storage tanks, although lower than day-time measurements, were "not [statistically] significantly different", according to NPL.

Background (upwind) concentrations measured less than one lb/hr, except for gasoline tank measurements, where upwind concentrations from a ground flare were significant.

Table 3: Summary of DIAL Storage Tank Measurements

Product stored	Tank type	Location	Measurement period(s)	Average total VOC emissions fluxes per tank
Naphtha	External floating	Bulk terminal	three days, one night	Day: non-detect to 5 lb/hr, ± 2.4 lb/hr Night: one lb/hr (detection limit)
Naphtha	Internal floating	Bulk terminal	three days, one night	Day: 18-28 lbs/hr, ± 5 lb/hr Night: 14 lb/hr, ± 7 lb/hr
Diesel	Fixed roof	Refinery	one day, one night	Day: detection limit to 7 lb/hr Night: 24 lb/hr, ± 8 lb/hr
Crude oil (sour)	External floating	Refinery	four days, one night	Day: <2 to 39 lb/hr Night: 24 lb/hr
Gasoline	Internal floating	Refinery	one day, one night	Day: 5 lb/hr Night: close to detection limit; wind direction not good for measurements
Fuel oil no. 6	Heated fixed	Refinery	one night	Night: 6 to 9 lb/hr

Detailed Review: Independent Analysis of Storage Tank Measurements

Rob Ferry of The TGB Partnership performed the storage tank measurement and process data analysis. The majority of the DIAL measurement data collected is storage tank data, and the independent analysis of tank measurements and process data categorizes tank analysis by measurement location and wind direction as well as date. This report, presented in Appendix B, also presents a detailed analysis of the limitations of DIAL measurements.

The analysis determines conventional emissions estimates by modifying the AP-42 equations, which were developed to estimate long-term emissions, as appropriate to estimate short-term emissions. The report also provides a detailed commentary on parameters not typically accounted for in conventional emissions estimates, such as loss of light ends during fillings and the use of EPA TANKS default data. For the emissions determinations presented in this report, the analysis uses the best available, site-specific composition data for the petroleum products, instead of the default data typically used for petroleum products.

The conventional emissions estimates generally compared well with DIAL measurements, except for the crude oil tank measurements. The analysis suggests that either tank filling or an upwind source could be responsible for the higher than predicted emissions. The report recommends targeted future studies to evaluate how light ends with flashing potential in crude oil, if present, or the filling process contribute to the observed emissions rates.

TCEQ Analysis

Analyzing the data presented in the independent report, three additional potential reasons for discrepancies between storage tank measurements and conventional emissions estimates can be inferred:

- Default composition data: Conventional emissions estimates for petroleum storage tanks storing mixtures whose composition can vary considerably typically (crude oil, fuel oil, naphtha) deviated more from DIAL measurements than the gasoline storage tank estimates. Gasoline is a more refined petroleum product with more stringent pipeline and regulatory specifications than the other petroleum mixtures, so variations in vapor pressure and composition would not be as large as such variations in less refined mixtures.
- Tank condition issues: HAWK passive infrared camera footage visualizes emissions from tank components not accounted for in conventional emissions estimates, such as damaged rim seals. These components could have significant emissions, depending on the length of time that elapses before repair occurs.
- Tank processes: Mixing, blending, and other processes are not accounted for in traditional emissions estimates, and could account for observed emissions rates higher than predicted emissions rates.

OTHER MEASURED SOURCES

Wastewater Area

DIAL measurements were conducted at the refinery's wastewater treatment area, which included surge basins, effluent treatment facilities, and equalization external floating roof tanks; according to NPL, the majority of emissions from this area originated from the effluent treatment facilities. Measurements were also made downwind of the American Petroleum Institute (API) separator and at wastewater junction vent pipes located near the crude storage area. Background (upwind) concentrations measured less than one lb/hr. Results are summarized in Table 4 below.

Table 4: Summary of DIAL Wastewater Measurements

Source	Measurement period(s)	Average total VOC emissions fluxes
Wastewater treatment area	one day	30 lb/hr
API separator	one day	7 lbs/hr
Vent pipes	one hour	9 lbs/hr

Delayed Coking Unit

DIAL measurements were conducted at the refinery's delayed coking process area, which included: one active coker performing four product cuts operating on a 20-hour cycle, equipped with a vapor recovery unit; a coke yard; and conveyors. Background (upwind) concentrations were notable and have not been subtracted from the average fluxes; these concentrations could originate from nearby process units and/or the coker vapor recovery unit. Results are summarized in Table 5 below.

Table 5: Summary of DIAL Delayed Coking VOC Measurements

Source	Measurement period(s)	Average total VOC emissions fluxes	Average upwind total VOC emissions fluxes
Delayed Coking Process Area	four days, one night	Day: 10 to 32 lb/hr Night: 4 lb/hr	Day: 2 to 8 lb/hr Night: non-detect

Delayed Coking Benzene Measurements

Coke cutting occurred during the benzene measurement period. During the coke cutting, a small benzene emissions flux was observed. DIAL benzene measurements ranged from 0.1 to 0.3 parts per million (ppm); the system's detection limit was 10 ppb. Background (upwind) concentrations were negligible. Results are summarized in Table 6 below.

Table 6: Summary of DIAL Delayed Coking Benzene Measurements

Source	Measurement period(s)	Average benzene emissions fluxes	Average background benzene emissions fluxes
Coker	one day	0.5 to 1 lb/hr (minimum: 0 lb/hr; maximum: 2.1 lb/hr)	Negligible

Aromatics Process Unit Benzene Measurements

DIAL measurements of fugitive benzene emissions were conducted in an aromatics process unit at the refinery. For one measurement day, the EPA measured a parallel path using open-path ultraviolet differential optical absorption spectrometry (UV-DOAS). For safety concerns, the path EPA measured was not the same path measured by the DIAL, but was as close as logistically possible. DIAL benzene measurements ranged from 0.3 to 26.3 parts per billion (ppb); the system's benzene lower detection limit is 10 ppb. Therefore, emissions fluxes are not summarized below. EPA benzene emissions measurements were similar to those obtained by the DIAL system, and ranged from 4.9 to 12.7 ppb.

DIAL Validation Emissions

In addition to the benzene emissions flux verification using UV-DOAS technology above, DIAL measurement validation was performed by comparing sulfur dioxide measurements to continuous emissions monitoring data, and by comparing DIAL measurements of standards whose concentrations were unknown to NPL to certified values.

Sulfur Recovery Unit

DIAL measurements of sulfur dioxide emissions from the sulfur recovery unit wet scrubber at the refinery were compared to the unit's CEMS data. CEM concentrations of all sulfur oxides ranged from 0.59 to 12 ppm; DIAL measurements were close to the detection limit, and ranged from 0.001 to 0.005 ppm.

Gas Cell Measurements

During periods of inclement weather, the DIAL system measured standards of concentrations unknown to NPL; measured compounds included benzene, pentane, and propane. The certified standard concentration generally fell within the standard deviations of the DIAL measurements, as presented in Table 7 below.

Table 7: Summary of DIAL Gas Cell Validation Measurements

Cell length	Standard	Measured concentration	Actual concentration
10 centimeters (cm)	Propane	8180 ± 530	8413
10 cm	Pentane	7100 ± 700	7500
10 cm	Pentane	8200 ± 1200	7500
10 cm	Pentane	7600 ± 100	7500
20 cm	Benzene	900 ± 70	1000

RECOMMENDATIONS AND CONCLUSIONS

FLARES

It is important to note that both the temporary and permanent process/emergency flare both met the minimum heating value requirements specified in 40 CFR §60.18, and are both assumed to have met the exit velocity requirements based on the presence of a stable flame. Given both flares' compliance with operational requirements, the differences in flare DRE are notable. Potentially, compliance with 40 CFR 60.18 does not automatically ensure that the expected flare DRE of 98 percent will be achieved.

Potential reasons for observed flare VOC DRE below 98 percent include operational parameters such as low waste gas flow rates, waste gas streams with significant inert gas composition, and potentially large assist-to-waste gas ratios. Current federal regulations in 40 CFR §60.18 and §63.11 do not address the above operating parameters.

Additional measurement and evaluation is warranted to accurately assess potential reasons for the low DRE observations. The TCEQ is planning to conduct a flare research study in 2010 that will assess the impact of various operational conditions on flare combustion efficiency and DRE in a controlled testing environment. Direct measurement techniques and remote sensing measurement techniques will be used to quantify flare emissions under varying waste gas flow rates and composition as well as varying assist-to-hydrocarbon ratios.

STORAGE TANKS

Reliance on EPA default data to determine emissions for complex liquid mixtures such as crude oil and mid-refined petroleum products could potentially lead to under-estimation of emissions. These complex liquid mixtures can have large variations in vapor pressure and composition, and if entrained light ends exist in the mixtures, have the potential to weather. Default data therefore may not accurately represent the true composition and physical properties of these products.

Tank condition issues and unique tank processes such as mixing may also contribute to under-estimating emissions. Future targeted studies are recommended to further investigate each of these potential areas of uncertainty as budget and time allow.

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APPENDIX A: NPL FINAL REPORT AND ADDENDUM

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Test Report

Measurements of VOC emissions from petrochemical industry sites in the Houston area using Differential Absorption Lidar (DIAL) during Summer 2007.

FOR:	Texas Commission on Environmental Quality
FOR THE ATTENTION OF:	Russell Nettles
DATE OF TEST PERIOD:	16/07/07 to 18/08/07
AUTHORS:	Rod Robinson, Tom Gardiner, Bob Lipscombe

Reference: QBN1701-TCEQ-2007

Date of Issue: 6 February 2008

Signed:

Checked by:

Name: Melanie Williams
for Managing Director

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Checked by: RA Robinson

Introduction

This report presents the results of a measurement campaign carried out using the NPL differential absorption LIDAR (DIAL) system at two petrochemical facilities in the The Houston non-attainment area region of South East Texas, between 16th July to 18th August 2007. The project was carried out for the Texas Commission on Environmental Quality (TCEQ). This report covers the measurements undertaken by NPL, and does not cover additional measurements undertaken by other contractors.

The primary objective of the study was to assess emission fluxes of VOCs and benzene from a number of identified potential sources, including storage tanks, a delayed coker unit, waste water treatment areas and flares.

The report provides a summary of the VOC fluxes measured using the DIAL technique at a Bulk Terminal in the Houston non-attainment area (hereafter the Bulk Terminal) (Section 1) and a Refinery in the Houston non-attainment area (hereafter the Refinery) (Sections 2 and 3). Annex 1 provides an overview of the DIAL technique, and discusses the calibration and validation procedures. Annex 2 presents the results of speciation measurements of air samples, and Annex 3 presents a summary of the meteorological measurements undertaken during the campaign.

Section 1. Measurements of VOC emissions from a Bulk Terminal, in the Houston non-attainment area.

Measurement description.

DIAL measurements of the emissions of VOCs from storage tanks at the Bulk Terminal facility were carried out on 16th, 17th , 18th, 19th July and on the night of the 20th-21st July. The tanks selected by TCEQ/Bulk Terminal for measurement were naphtha storage tanks, numbers 22,23, 27, 28, and 29. Tank 3792 was also included in some of the measurements, though no specific identifiable emissions were observed that could be attributed to this tank.

Two measurement locations were used for the DIAL measurements; these were both on Avenue H, the southern road within the plant. The GPS coordinates for these measurement locations were:

DIAL Location 1.
North side of Ave H, due south of Tank 3770
29°21'23.64"N
94°55'2.82"W

DIAL Location 2
South side of Ave H, south of Tank 3792.
29°21'23.47"N
94°54'52.79"W

Measurements of VOC fluxes were carried out using the NPL DIAL as described in Annex 1. Fluxes were obtained by scanning the DIAL measurement line-of-sight in vertical planes, downwind of the target emissions sources. Measurements were also made upwind of the target sources to check for any upwind VOC fluxes. The measurement lines are shown in Figure 1.1.

Definition of VOCs

The DIAL technique, as operated during these measurements, provides a measurement of mass emission in gasoline vapour equivalent. The DIAL measures VOCs by measuring the differential absorption of two wavelengths of light sensitive to hydrocarbons of C3 and above.

This has been calculated for each air sample taken, and Annex 2 presents a set of correction factors for each measurement location. For the measurements at the Bulk Terminal the factors range from between 0.8 to 1.6.

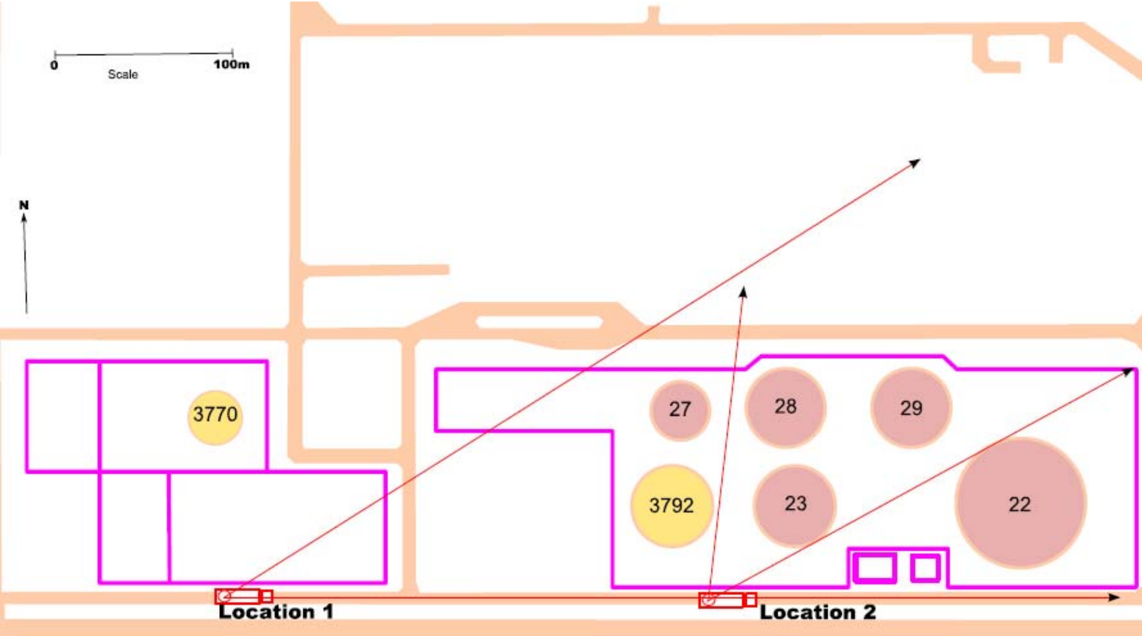


Figure 1.1.DIAL locations and scan lines used for VOC measurements at the Bulk Terminal.

Measurements on the 16th July.

From Location 1, scans were made which measured the emissions from tanks 23,27,28,29 and 3792. Tank 22 emissions would also have been observed if these had been significant. Table 1.1 presents these results. The wind direction was generally from the SE, with speeds of 3 to 6 m/s.

A small flux was measured, at a range consistent with emissions from tanks 27, 28 and 23. This is shown in Figure 1.2. No observable emissions were seen from tank 22 or tank 3792. The average emission observed was 28 lbs/hr with a standard deviation of ± 5 lbs/hr. It should be noted the standard deviation of the results includes both the inherent uncertainty in the DIAL measurements and any real variability in the emissions (whether due to source variability or variable dispersion).

Upwind scans (Scan IDs 16 and 21) gave results at or below the detection limit, which for the conditions prevailing at the Bulk Terminal was 1 lbs/hr.

Scan ID	Time	Wind Speed m/s	Wind Direction Degrees	Emission rate lbs/hr	Concentration ppm	Notes
10	16:24	6.3	169.6	31	0.10	Downwind Tanks 23, 27, 28, 29
11	16:32	3.7	139.8	24	0.17	Downwind Tanks 23, 27, 28, 29
12	16:39	5.0	163.0	24	0.30	Downwind Tanks 23, 27, 28, 29
13	16:50	5.2	154.1	33	0.24	Downwind Tanks 23, 27, 28, 29
16	17:22	3.7	101.4	<1	0.14	upwind
21	17:42	3.4	114.4	<1	0.07	upwind
22	17:55	3.4	86.3	<1	0.15	Right next to tank 27

Table 1.1. VOC fluxes measured on 16th July at Bulk Terminal.

The DIAL provides a range resolved measurement of VOC concentrations. A DIAL scan can provide not only a measurement of the mass emissions flux, but also a visual indication of the location of the emission plume. Figure 1.2 shows an example of such a visualisation, for Scan ID 12 on the 16th July. The plot illustrates the vertical plane through which the DIAL scanned, and indicates the distribution of VOCs within this plume. The wind direction is indicated by the red arrow. The intensity of the colour plot is related to the concentration of the VOCs. The maximum VOC concentration in this plot is 300 ppb.

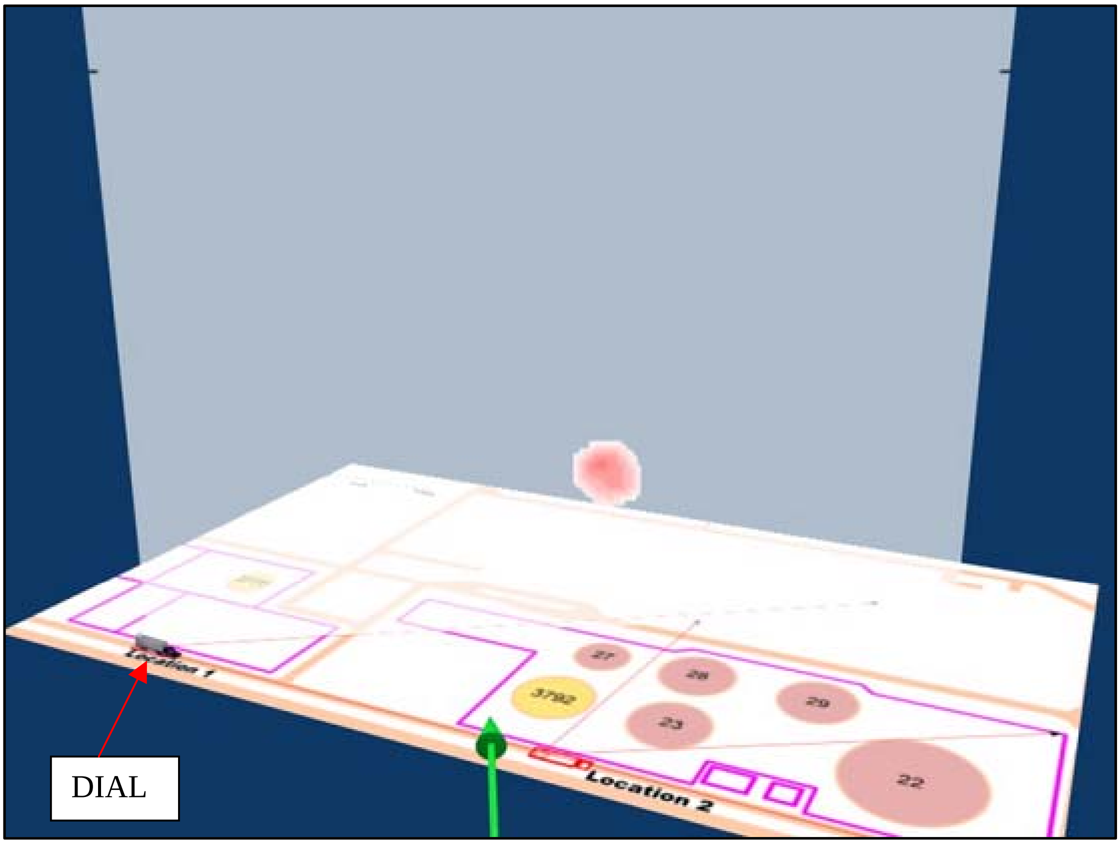


Figure 1.2. Example of the VOC distribution seen in a vertical scan at the Bulk Terminal (Scan 12, 16th July). The green arrow represents the average wind direction. The peak VOC concentration observed in this scan was 300 ppb.

Measurements on the 17th July

A further series of measurements were made of tanks 27,28,29 and 23 from Location 1. The wind was from the south, shifting slightly to south-westerly during the day with wind speeds ranging between 2.8 and 8.7 m/s. The results are presented in Table 1.2. The average flux observed for these tanks on the 17th July was 21 lbs/hr with a standard deviation of ± 5 lbs/hr. Upwind scans were below the detection limit, indicating no contribution from other sources.

In order to separate out and directly measure fluxes from tank 22, the DIAL was moved to Location 2, to the south of tank 3792. Scans could then be made isolating the emissions from tank 22. It should be noted that this measurement configuration is not ideal for flux measurements, as the measurement line of sight is very close to tank 22. Other locations were not possible due to construction work on the road to the north of tank 22. Scans made from location 1 had indicated that the emissions observed from tank 22 were not significant. This was apparent because no significant concentrations were observed at ranges which would have been consistent with a plume from tank 22. Moving to a measurement line of sight further away from tank 22, to the north of Ave G, would have reduced the chance of measuring any small emissions from tank 22 due to dispersion. The fluxes observed, even close to tank 22, were very small, with an average flux of 3 lbs/hr and a standard deviation of 1.3 lbs/hr. The peak concentrations observed were less than 100 ppb, and these emissions would generally be considered insignificant in the context of a DIAL survey.

		Wind Speed	Wind Direction	Emission rate	Concentration	Notes
Scan ID	Time	m/s	Degrees	lbs/hr	ppm	
3	11:41	5.3	186.7	20	0.22	Downwind tanks 27/28/23
4	11:51	5.2	189.6	21	0.17	Downwind tanks 27/28/23
5	12:04	5.1	191.6	24	0.34	Downwind tanks 27/28/23
6	12:25	5.1	188.0	19	0.16	Downwind tanks 27/28/23
7	12:38	4.6	194.6	31	0.24	Downwind tanks 27/28/23
8	12:50	4.9	204.6	25	0.15	Downwind tanks 27/28/23
9	13:09	5.0	189.5	<1	0.01	Upwind
10	13:21	5.7	198.3	<1	0.03	Upwind
13	13:36	6.2	180.6	<1	0.01	Upwind
14	13:51	5.8	186.7	25	0.21	Downwind tanks 27/28/23
21	15:03	8.7	207.5	20	0.21	Downwind tanks 27/28/23
23	15:25	6.8	216.3	15	0.19	Downwind tanks 27/28/23
24	15:47	5.8	218.2	22	0.12	Downwind tanks 27/28/23
25	16:06	5.5	219.1	11	0.11	Downwind tanks 27/28/23
						Moved to Location 2
26	16:46	2.8	226.6	1	0.05	Downwind tank 22
27	17:04	3.7	220.3	4	0.09	Downwind tank 22
28	17:22	3.5	213.8	4	0.07	Downwind tank 22
29	17:41	3.4	209.6	3	0.07	Downwind tank 22

Table 1.2. VOC fluxes measured on 17th July at the Bulk Terminal.

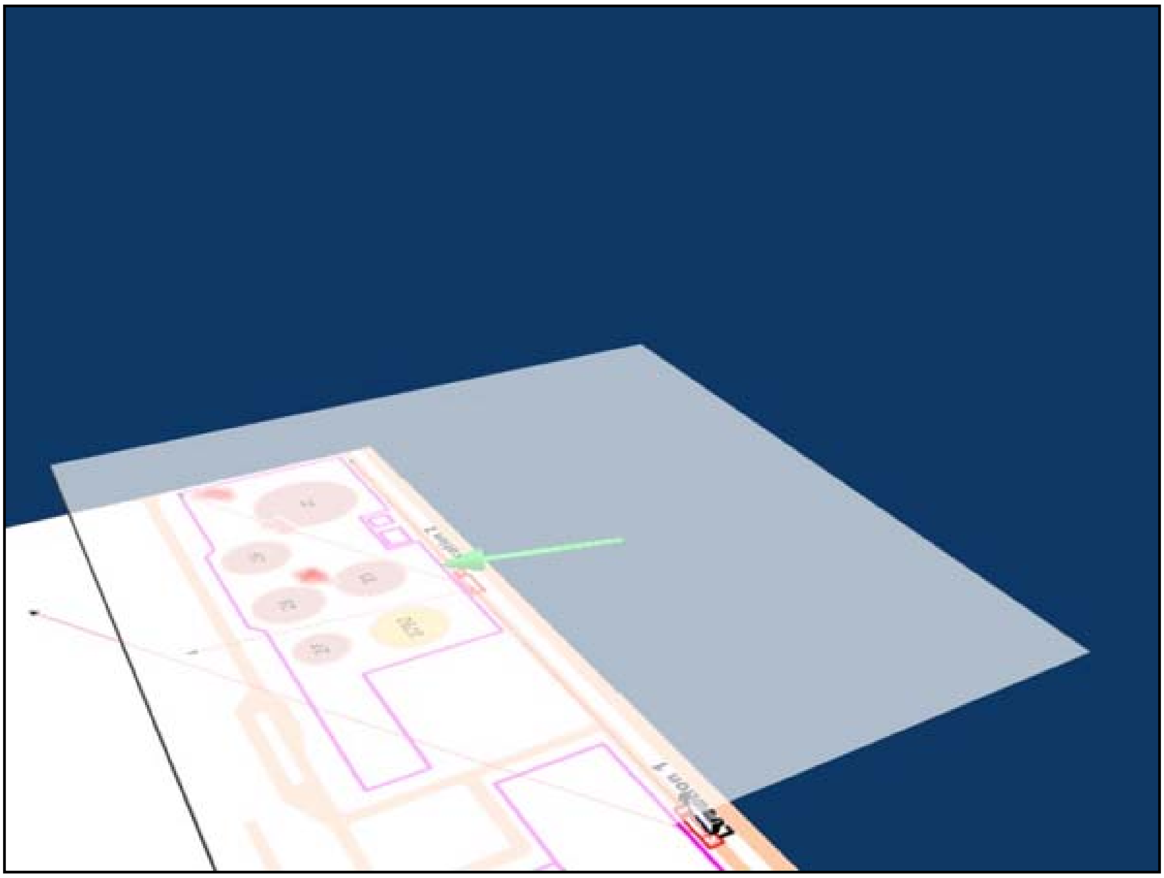


Figure 1.3. Example of a horizontal scan showing the VOC distribution above naphtha tanks at the Bulk Terminal (Scan 17, 17th July). The green arrow represents the average wind direction. The peak VOC concentration observed in this scan was 288 ppb.

Measurements on the 18th July and 19th July

Further scans were made of tank 22 on both the 18th and 19th July, tables 1.3 and 1.4 present these data. The average emissions fluxes measured were 5 lbs/hr with a standard deviation of 2.4 lbs/hr on the 18th and 3 lbs/hr with a standard deviation of 2.4 lbs/hr on the 19th.

Two scans were made on the 18th July to measure the emissions from tanks 23 and 28 from location 2. These scans may also have included the contribution from tanks 29 and 22. However, the emissions from these tanks would be quite dispersed and are probably not included in the measured fluxes. The scans are not ideal for flux determination, as the wind field would be very disturbed by the proximity of the tanks. The scans gave flux results that are much lower than those measured on the previous days for these tanks, with an average value of 3.5 lbs/hr. This indicates either, that the larger emissions originated from tank 27 (included in earlier measurements), and are not included in these scans. A more likely explanation, given subsequent measurements on the 19th, is that the wind field was not ideal and the scans did not capture the emissions from the tanks. On the 19th July similar scans measured an average emission flux of 18 lbs/hr, which is consistent with the measurements made on the 16th and 17th July for these tanks.

Scan ID	Time	Wind Speed m/s	Wind Direction Degrees	Emission rate lbs/hr	Concentration ppm	Notes
3	09:54	5.6	131.3	5	0.03	Downwind tank 22
5	10:35	5.0	133.3	3	0.08	Downwind tank 22
6	10:56	5.1	136.3	7	0.09	Downwind tank 22
7	11:14	4.6	140.0	10	0.09	Downwind tank 22
8	11:36	3.8	141.8	<1	0.01	Upwind
9	11:46	4.3	140.9	<1	0.00	Upwind
10	12:00	3.8	139.4	4	0.07	Downwind tanks 28 and 23
11	12:12	3.7	136.2	3	0.04	Downwind tanks 28 and 23
13	13:49	4.7	212.9	4	0.03	Downwind tank 22
14	14:08	3.3	202.1	<1	0.01	Upwind
15	14:18	3.0	196.8	<1	0.02	Upwind
16	14:32	1.8	201.0	3	0.10	Downwind tank 22
17	14:50	1.6	162.2	3	0.06	Downwind tank 22
18	15:02	2.7	198.9	6	0.09	Downwind tank 22
19	15:14	2.3	185.8	<1	0.01	Upwind

Table 1.3. VOC fluxes measured on 18th July at the Bulk Terminal

Scan ID	Time	Wind Speed m/s	Wind Direction Degrees	Emission rate lbs/hr	Concentration ppm	Notes
31	14:42	3.4	123.8	1	0.06	Downwind tank 22
32	15:01	2.8	120.1	<1	0.05	Downwind tank 22 - wind shifted so upwind
33	15:22	3.1	149.6	<1	0.01	Upwind
34	15:32	3.3	172.0	<1	0.01	Upwind
35	15:42	2.4	170.7	5	0.08	Downwind tank 22
39	17:07	4.5	148.0	4	0.13	Downwind tank 22
40	17:28	3.6	132.4	20	0.23	Downwind tanks 28 and 23
41	17:47	3.8	125.2	16	0.20	Downwind tanks 28 and 23

Table 1.4. VOC fluxes measured on 19th July at the Bulk Terminal

Night-time measurements on the 20th-21st July.

A series of measurements was made on the night of the 20th-21st July from Location 2, the results of these scans are given in Table 1.5. These repeated the scans made from this location during the daytime. The wind was initially from further to the east, which was not ideal for this location, however it subsequently shifted further south, providing useable measurements of tank 22 and tanks 23/28. The average emission flux measured from tank 22 was 1 lbs/hr, which is at the detection limit.

The measurements of the emissions from tanks 23 and 28 gave an average emission flux of 14 lbs/hr, with a standard deviation of 7 lbs/hr. Although this emission is lower than that measured during the day. That, coupled with the variable wind pattern close to the tanks and the fact that the wind speed itself was lower during these measurements, suggests that conclusions about the relationship between day and night-time emissions cannot be drawn from these data, except to recognise that emissions are observed during the night-time, and therefore night time cannot be discounted from annualisation calculations based on day time measurements.

A series of air samples, using canisters and pumped sorbent tubes was also taken, and the results of these are reported in Annex 2. Figure A1.1 indicates the locations of these samples at the Bulk Terminal.

		Wind Speed	Wind Direction	Emission rate	Concentration	Notes
Scan ID	Time	m/s	Degrees	lbs/hr	ppm	
49	0:05	3.0	99.5	1	0.03	Downwind tank 22
50	0:24	3.5	110.4	1	0.04	Downwind tank 22
51	0:43	3.1	104.7	1	0.06	Downwind tank 22
52	1:01	3.1	102.5	<1	0.00	Upwind
53	1:11	3.2	91.1	<1	0.01	Upwind
54	1:21	2.8	107.0	1	0.05	Downwind tank 22
55	1:40	2.7	102.6	2	0.05	Downwind tank 22
56	1:59	3.4	87.2	<1	0.04	Downwind tank 22
61	3:36	3.5	94.0	<1	0.01	Upwind
62	3:45	3.1	111.8	<1	0.01	Upwind
64	4:03	2.5	121.2	15	0.12	Downwind tanks 28 and 23
65	4:21	2.2	120.3	14	0.22	Downwind tanks 28 and 23
66	4:40	2.3	125.7	25	0.23	Downwind tanks 28 and 23
67	4:59	2.2	105.2	15	0.48	Downwind tanks 28 and 23
68	5:17	2.6	100.9	3	0.08	Downwind tanks 28 and 23
69	5:37	2.4	118.2	9	0.17	Downwind tanks 28 and 23
72	6:03	2.6	108.9	1	0.09	Downwind tank 22

Table 1.5. VOC fluxes measured on the night of 20th July at the Bulk Terminal

Section 2 Measurements of VOC emissions from a Refinery in the Houston non-attainment area.

Measurement description.

This section of the report describes the results of measurements of VOC emissions from various sources within the Refinery. Measurements of VOC emissions were carried out from the 25th July to the 11th August. Table 2.1 lists the measurements days and the sources monitored on each day. The DIAL measurement locations are identified on individual maps in the following Sections.

Date	DIAL Location	Sources monitored
25th July	Refinery Location 1	Product tanks
26th July	Refinery Location 1	Product tanks
28th July	Refinery Location 2	Crude oil tanks, coker
29th July	Refinery Location 2	Crude oil tanks
30th July	Refinery Location 3	Gasoline tanks and flare 6
31st July	Refinery Location 2, 2C	Crude oil tanks and coker
1st August	Refinery Location 2	Coker
2nd August	Refinery Location 4	Waste water treatment and crude oil tanks
3rd August	Refinery Location 2	Coker
5th –6th August (Night)	Refinery Location 2	Crude oil tanks
6th – 7th August (Night)	Refinery Location 3	Gasoline tanks, coker and flare 6
7th – 8th August (Night)	Refinery Location 5,6,7	Product tanks Hot oil tanks
9th August	Refinery Location 8	Flares
10th August	Refinery Location 8	Flares
11th August	Refinery Location 8	Flares

Table 2.1 Summary of DIAL VOC flux measurements at the Refinery

The GPS positions for the DIAL locations were:

Refinery Location 1
By Muster Point 8
29°22'1.48"N
94°56'23.11"W

Refinery Location 2
E 4th street, next to tank 1020
29°22'4.56"N
94°55'13.56"W

Refinery Location 2C
Further north on E 4th street
29°22'5.58"N
94°55'14.09"W

Refinery Location 3
Avenue J, North of tank 1045
29°22'10.26"N
94°55'29.40"W

Refinery Location 4
Avenue N, south of Surge Basin 2
29°21'52.38"N
94°55'17.22"W

Refinery Location 5
Outside Gate 16
29°22'3.78"N
94°56'27.42"W

Refinery Location 6
On W 4th St, by tank 17
29°22'21.36"N
94°56'10.98"W

Refinery Location 7
Avenue G, south of ARU
29°22'23.52"N
94°56'15.36"W

Refinery Location 8
Grant Avenue, South of tank 20.
29°22'35.45"N
94°56'29.47"W

The measurement results are presented in the following sections, grouped by the sources measured. It is important to note that the potential emission sources measured were identified by TCEQ and the refinery, and measurements were focussed on these sources. This study did not include a full survey of all sources within the refinery, and was not aimed at determining total refinery emissions.

Measurements of product storage tanks.

A small number of distillate product storage tanks were identified as being of interest. These included tanks 55 and 53. Scans were made of these tanks on the 25^{th} 26^{th} July and during the night of 7^{th} August. These measurements were made from Location 1 on the 25^{th} and 26^{th} and from Location 5 on the 7^{th} August. The results are presented in Table 2.2. The emissions from tank 55 were not significant, with average emission fluxes measured of 5 lbs/hr (not counting the negligible fluxes measured during very low and variable wind conditions). Upwind scans were in general below the detection limit, however one scan down Avenue K and upwind of the hydrogen plants No.1 and No.2 measured a small flux of 7 lbs/hr. Measurements of tank 55 during the evening of the 7^{th} August showed similar emission fluxes, with an average of 6 lbs/hr. Tank 57 was too close to the DIAL to enable it to be measured on the 7^{th} August. Measurements of tank 53 were made during the evening of the 7^{th} August and an average flux of 24 lbs/hr with a standard deviation of 8 lbs/hr was measured. Upwind measurements were below detection limits.

Scan ID	Date	Time	Wind Speed m/s	Wind Direction Degrees	Emission rate lbs/hr	Concentration ppm	Notes
79	25-Jul	17:15	4.5	128.4	2	0.07	Downwind Tank 55
80	25-Jul	17:26	4.1	140.0	3	0.06	Downwind Tank 55
82	25-Jul	18:07	4.7	166.4	2	0.05	Downwind Tank 55
84	25-Jul	18:16	4.9	169.3	<1	0.01	Downwind Tank 55
89	26-Jul	09:55	0.9	241.9	<1	0.01	Tank 55, Wind direction variable, low speed.
90	26-Jul	10:05	2.0	311.4	1	0.07	Tank 55, Wind direction variable.
91	26-Jul	10:15	1.6	286.8	<1	0.01	Tank 55, Wind direction variable.
92	26-Jul	10:27	1.8	304.3	<1	0.01	Tank 55, Wind direction variable.
93	26-Jul	10:43	1.3	256.8	<1	0.01	Tank 55, Wind direction variable, low speed.
94	26-Jul	10:58	0.7	282.6	<1	0.09	Scan down Avenue K, upwind tanks
95	26-Jul	11:09	4.9	117.0	7	0.23	Scan down Avenue K, upwind tanks
96	26-Jul	11:23	6.0	114.3	4	0.08	Scan between tanks 53,55. Downwind tank 55.
97	26-Jul	11:52	5.3	108.8	2	0.04	Scan between tanks 53,55. Downwind tank 55.
98	26-Jul	12:05	5.9	112.8	2	0.04	Scan between tanks 53,55. Downwind tank 55.
99	26-Jul	12:17	4.5	112.6	<1	0.01	Downwind tank 55
100	26-Jul	12:28	4.6	118.1	2	0.05	Downwind tank 55
101	26-Jul	12:38	5.2	112.2	1	0.02	Downwind tank 55
102	26-Jul	12:57	5.3	115.1	7	0.10	Downwind tank 55
106	26-Jul	14:26	7.4	136.4	5	0.05	Downwind tank 55
107	26-Jul	14:45	7.6	156.6	14	0.14	Downwind tank 55
108	26-Jul	15:03	6.3	155.0	6	0.05	Downwind tank 55
369	7-Aug	21:05	3.5	173.4	8	0.12	Downwind tanks 55, 66
373	7-Aug	21:42	3.5	175.9	4	0.08	Downwind tanks 55, 66
374	7-Aug	22:00	3.2	171.0	6	0.10	Downwind tanks 55, 66
375	7-Aug	22:23	3.3	167.8	<1	0.05	Upwind tanks
376	7-Aug	22:41	3.5	178.2	<1	0.06	Upwind tanks
377	7-Aug	23:03	3.1	188.3	13	0.11	Downwind tank 53
378	7-Aug	23:21	3.4	195.6	32	0.26	Downwind tank 53
379	7-Aug	23:40	3.3	195.4	29	0.38	Downwind tank 53
380	7-Aug	23:59	3.0	197.3	21	0.29	Downwind tank 53

Table 2.2 Measurements of VOC fluxes from product storage tanks

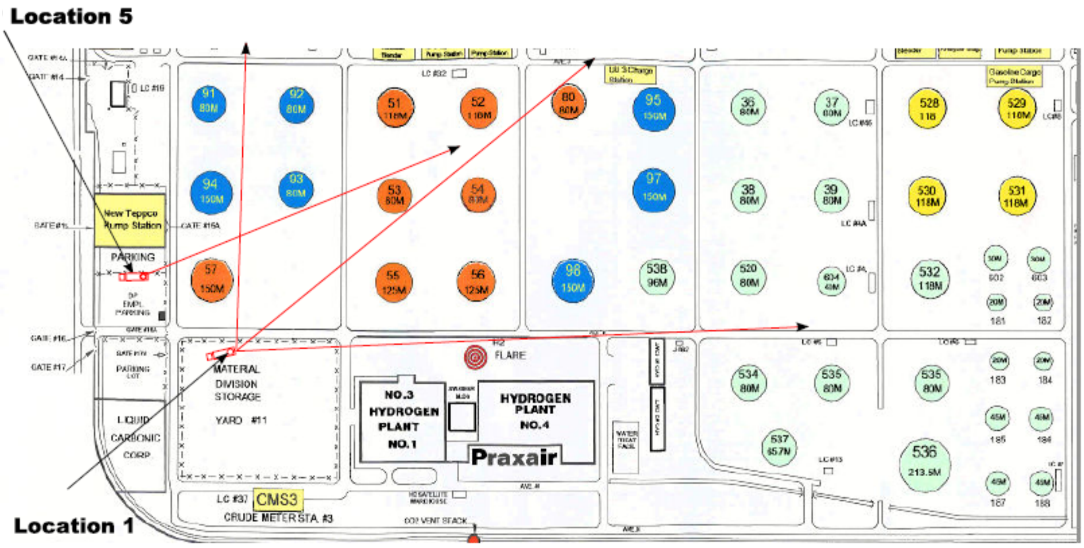


Figure 2.1. DIAL locations and scan lines used for DIAL measurements of VOC emission fluxes from the product storage tanks at the Refinery.

Measurements of crude oil tanks

A series of measurements of the emissions from the crude oil storage tanks was made over several days. Measurements were made on the 28th 29th 31st July, 2nd August and on the night of the 6th August. The results of measurements of different tanks are summarised in Table 2.3, all flux results are presented in Table 2.4.

Measurements were made from Location 2, apart from the measurements of tanks 1020 and 1021 on the 31st July, for which the DIAL was moved north to Location 2C.

Tanks	Average emission flux Lbs/hr
1020	<2
1021	16
1024	5
1025	11
1052	22 28th July 39 2nd August 24 5th August, Night
1053	7
1055	<5

Table 2.3 Summary of VOC fluxes from crude storage tanks

In order to assign emission fluxes to individual tanks, some interpretation of the flux results in Table 2.4 has had to be made. In some cases, flux measurements were made which were downwind of a number of tanks. Where these tanks were also measured separately on other occasions then the split of the flux between the possible sources has been made based on these individual measurements. For the measurements made on the 2nd August from Refinery Location 4, the measurements of tanks 1055 and 1053 probably include a component of the emissions observed from tank 1052. The flux is not significantly higher than that measured from tank 1052 alone, and so it is clear there is no significant emission flux from either tank 1055 or tank 1053. This is consistent with the previous measurements of these tanks, which did not include emissions upwind from tank 1052. Similarly measurements of tanks 1020 and 1021 on the 29th July may have included some emissions from tanks 1025 and 1024, however, the wind direction was such that this is unlikely. The wind direction, and location of the observed flux, also indicate that most of the observed emission flux is attributable to tank 1021, and so the average emissions have been assigned to tank 1021. This is supported by measurement of tank 1020 only, on the 31st July, which gave very low fluxes, many below 1 lbs/hr.

No significant emissions were observed from tank 1055, which was in the near field during a number of scans.

In summary, most of the tanks observed during these measurements did not have significant emission fluxes, and in general, the emission fluxes from individual tanks were < 10 lbs/hr.

A VOC emission was observed from tank 1052, with an average emission of 39 lbs/hr observed on the 2nd August.

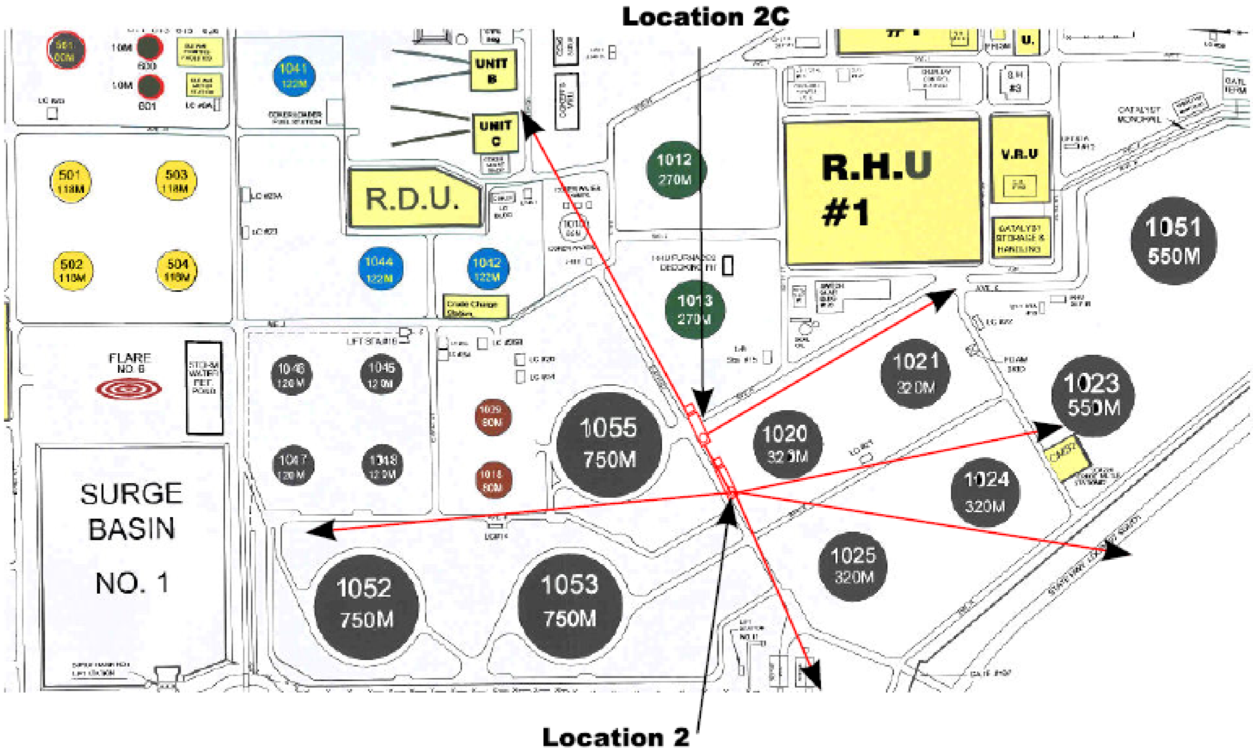


Figure 2.2.DIAL locations and scan lines used for DIAL measurements of VOC emission fluxes from the crude oil tanks at the Refinery.

Scan ID	Date	Time	Wind Speed m/s	Wind Direction Degrees	Emission rate lbs/hr	Concentration ppm	Notes
138	28-Jul	12:37	2.3	268.9	3	0.29	Downwind tank 1025
139	28-Jul	12:48	2.5	257.9	6	0.32	Downwind tank 1025
140	28-Jul	12:58	1.9	225.7	8	0.31	Downwind tank 1025
141	28-Jul	13:16	2.2	209.4	5	0.14	Downwind tank 1025
148	28-Jul	13:59	3.0	180.5	5	0.05	Downwind tank 1025
149	28-Jul	14:36	3.8	164.7	<1	0.01	Upwind tank 1025
152	28-Jul	15:51	3.3	216.0	17	0.14	Downwind coker
153	28-Jul	16:12	2.6	213.4	7	0.10	Downwind coker
154	28-Jul	16:30	3.0	204.1	8	0.12	Downwind coker
155	28-Jul	16:52	4.3	182.7	2	0.12	Downwind tank 1013/ upwind coker
156	28-Jul	17:19	4.6	169.0	7	0.32	Downwind tank 1053
157	28-Jul	17:39	4.3	163.8	13	0.24	Downwind tanks 1052 and 1053
158	28-Jul	18:03	4.1	168.4	23	0.08	Downwind tanks 1052 and 1053
159	28-Jul	18:23	3.8	170.5	31	0.17	Downwind tanks 1052 and 1053
160	28-Jul	18:42	3.8	175.4	<1	0.04	Upwind
163	29-Jul	12:44	1.8	138.4	3	0.12	Downwind tank 1053
164	29-Jul	12:56	3.0	124.3	6	0.16	Downwind tanks 1052, 1053
165	29-Jul	13:07	4.3	117.2	5	0.12	Downwind tank 1053
166	29-Jul	13:16	4.8	123.1	6	0.16	Downwind tank 1053
167	29-Jul	13:26	4.5	124.7	7	0.17	Downwind tank 1053
168	29-Jul	13:36	3.8	151.1	5	0.10	Downwind tank 1053
169	29-Jul	13:50	4.8	170.1	<1	0.05	Upwind 1053
170	29-Jul	13:59	5.2	150.9	<1	0.03	Upwind 1053
171	29-Jul	14:09	4.9	161.8	<1	0.03	Upwind 1053
172	29-Jul	14:19	5.4	156.7	3	0.04	Upwind 1053
173	29-Jul	14:34	4.1	156.4	12	0.23	Downwind tank 1025
174	29-Jul	14:43	4.0	167.1	13	0.50	Downwind tank 1025
175	29-Jul	15:12	4.1	173.8	8	0.19	Downwind tank 1025
176	29-Jul	15:23	3.2	161.6	9	0.28	Downwind tank 1025
178	29-Jul	15:44	3.4	135.6	15	0.23	Downwind tanks 1024, 1025
179	29-Jul	15:50	3.3	158.9	5	0.05	Downwind tank 1024
180	29-Jul	16:08	3.6	159.4	15	0.11	Downwind tanks 1024, 1025
181	29-Jul	16:27	4.0	159.7	14	0.08	Downwind tanks 1024, 1025
182	29-Jul	16:45	3.7	148.2	10	0.22	Downwind tanks 1020, 1021
183	29-Jul	17:13	4.3	153.0	19	0.11	Downwind tanks 1020, 1021
184	29-Jul	17:24	3.7	160.5	13	0.20	Downwind tanks 1020, 1021

Table 2.4 Measurements of VOC fluxes from crude oil storage tanks

Scan ID	Date	Time	Wind Speed m/s	Wind Direction Degrees	Emission rate lbs/hr	Concentration ppm	Notes
186	29-Jul	17:49	3.9	145.7	12	0.18	Downwind tanks 1020, 1021
187	29-Jul	17:59	3.8	150.9	19	0.18	Downwind tanks 1020, 1021
188	29-Jul	18:09	4.0	150.8	20	0.10	Downwind tanks 1020, 1021
231	31-Jul	12:25	3.2	87.8	<1	0.09	Downwind of tank 1053
232	31-Jul	12:35	3.0	114.9	3	0.09	Downwind of tank 1053
233	31-Jul	12:45	3.3	113.1	1	0.08	Downwind of tank 1053
235	31-Jul	13:14	3.5	106.2	<1	0.04	Downwind of tank 1020
236	31-Jul	13:27	3.7	107.4	2	0.10	Downwind of tank 1020
241	31-Jul	14:05	3.5	201.8	<1	0.28	Downwind of tank 1020
242	31-Jul	14:14	3.6	200.9	<1	0.17	Downwind of tank 1020
243	31-Jul	14:24	3.2	179.8	3	0.10	Downwind of tank 1020
258	31-Jul	17:30	4.2	169.5	4	0.08	Downwind of tank 1013
259	31-Jul	17:41	4.1	177.8	2	0.09	Downwind of tank 1013
260	31-Jul	17:50	3.8	172.2	2	0.08	Downwind of tank 1013
279	2-Aug	13:38	3.2	233.4	39	0.26	Downwind of tanks 1053, 1055, 1052
280	2-Aug	13:48	2.5	233.5	19	0.28	Downwind of tanks 1053, 1055, 1052
281	2-Aug	13:58	3.4	207.4	20	0.35	Downwind of tanks 1053, 1055, 1052
282	2-Aug	14:16	3.9	218.5	24	0.15	Downwind of tanks 1053, 1055, 1052
283	2-Aug	14:34	3.0	239.4	18	0.17	Downwind of tanks 1053, 1055, 1052
284	2-Aug	14:57	3.1	257.3	37	0.35	Downwind tank 1052
285	2-Aug	15:07	3.9	225.6	54	0.50	Downwind tank 1052
286	2-Aug	15:17	4.6	221.3	39	0.26	Downwind tank 1052
287	2-Aug	15:27	4.2	218.4	39	0.46	Downwind tank 1052
288	2-Aug	15:46	2.8	240.9	29	0.27	Downwind tank 1052
319	5-Aug	23:48	2.8	161.6	5	0.11	Downwind tank 1025
320	6-Aug	00:07	2.9	156.4	4	0.08	Downwind tank 1025
321	6-Aug	00:26	2.9	145.4	<1	0.05	Downwind tank 1025
322	6-Aug	00:45	3.3	163.3	2	0.29	Downwind tank 1025
323	6-Aug	01:06	3.8	156.7	4	0.12	Downwind tanks 1024 and 1025
324	6-Aug	01:25	4.2	165.1	11	0.11	Downwind tanks 1024 and 1025
325	6-Aug	01:44	3.7	158.8	4	0.08	Downwind tanks 1024 and 1025
326	6-Aug	02:05	4.1	169.8	<1	0.11	Upwind tanks
327	6-Aug	02:23	3.4	160.6	<1	0.08	Upwind tanks
328	6-Aug	02:45	3.9	167.6	44	0.19	Downwind tanks 1052 and 1053
329	6-Aug	03:03	3.6	164.2	22	0.30	Downwind tanks 1052 and 1053
330	6-Aug	03:41	3.1	167.8	12	0.17	Downwind tanks 1052 and 1053
331	6-Aug	03:59	3.4	165.7	19	0.30	Downwind tanks 1052 and 1053
332	6-Aug	04:19	3.6	166.4	1	0.11	Upwind tanks
333	6-Aug	04:37	3.9	183.4	<1	0.08	Upwind tanks
335	6-Aug	05:12	3.3	185.0	13	0.29	Downwind waster water vent (South of tank 1010)
336	6-Aug	05:30	3.4	181.2	5	0.08	Downwind waster water vent (South of tank 1010)
337	6-Aug	05:49	3.0	185.0	10	0.28	Downwind waster water vent (South of tank 1010)
338	6-Aug	06:09	2.9	185.0	1	0.08	Downwind tanks 1024 and 1025
340	6-Aug	06:32	2.2	202.0	1	0.10	Downwind tanks 1024 and 1025

Table 2.4 (continued) Measurements of VOC fluxes from crude oil storage tanks

Measurements of gasoline tanks and flare 6.

Measurements of gasoline storage tanks 501, 502, 503, and 504 were carried out from location 3 on the 30th July and on the night of the 6th August. The results are presented in Table 2.5.

The wind directions for these measurements were not ideal for flux determination; however, any significant emissions would have been observed. Upwind measurements from location 3 included measurements of emissions from flare 6, which was operational during the measurement periods. As can be seen from the results presented in Table 2.5, there was no significant VOC flux observed from these tanks; the measurements are consistent with an emission of approximately 5 lbs/hr from individual tanks. Night time measurements found slightly lower emissions; however as these measurements were close to the detection limit, drawing any conclusion from these results about night versus day emissions is not recommended. Owing to the wind direction during the night time measurements, it is also likely these scans would not have fully captured emissions from tank 502.

Measurements of emissions from flare 6 on the 30th July gave an average flux of 4 lbs/hr. During the night time measurements on the 6th August, an average flux of 22 lbs/hr was measured from flare 6.

It should be noted that these emissions could act as an upwind source for the gasoline tank measurements. However, they were spatially separated from the emissions from the gasoline tanks and were not included in these measured fluxes. Therefore this upwind source did not have to be subtracted from the tank measurements, which can lead to a significant source of uncertainty and is something that is avoided if possible.

Scan ID	Date	Time	Wind Speed m/s	Wind Direction Degrees	Emission rate lbs/hr	Concentration ppm	Notes
193	30-Jul	11:41	2.2	188.0	<1	0.00	Upwind of tanks
196	30-Jul	12:05	2.5	249.8	2	0.07	Downwind tanks 501, 502, 503, 504
198	30-Jul	12:27	2.2	223.6	5	0.11	Downwind of tanks 501, 502, 503, 504
199	30-Jul	12:38	2.7	223.4	3	0.09	Downwind of flare 6
200	30-Jul	12:50	3.0	189.3	3	0.11	Downwind of flare 6
201	30-Jul	13:01	3.6	168.1	3	0.07	Downwind of flare 6
205	30-Jul	13:17	5.5	159.9	2	0.04	Downwind of tanks 501, 504
207	30-Jul	13:28	4.9	178.6	13	0.10	Downwind of tanks 501, 504
208	30-Jul	13:42	3.5	190.9	11	0.15	Downwind of tanks 501, 504
209	30-Jul	14:02	1.3	173.8	<1	0.03	Upwind of tanks
210	30-Jul	14:43	0.4	178.4	<1	0.11	Downwind of flare 6 (wind speed low)
211	30-Jul	14:52	2.3	219.0	3	0.18	Downwind of flare 6
212	30-Jul	15:03	3.2	206.7	11	0.08	Downwind of flare 6
213	30-Jul	15:16	3.9	204.2	2	0.05	Downwind of flare 6
215	30-Jul	15:55	3.3	191.5	3	0.05	Downwind of flare 6
216	30-Jul	16:44	4.5	201.7	3	0.04	Downwind of flare 6
217	30-Jul	16:55	4.2	208.5	4	0.10	Downwind of flare 6
218	30-Jul	17:08	4.1	205.4	5	0.08	Downwind tank 504
220	30-Jul	17:32	4.0	215.1	18	0.24	Downwind tanks 501, 502, 504
221	30-Jul	17:49	4.5	179.4	5	0.11	Downwind tank 504
224	30-Jul	18:11	4.5	217.7	16	0.19	Downwind tanks 501, 502, 504
344	7-Aug	00:25	3.6	139.3	37	0.45	Downwind flare 6, upwind of tanks 501-504
345	7-Aug	00:44	3.5	139.0	22	0.27	Downwind flare 6, upwind of tanks 501-504
346	7-Aug	01:02	2.8	131.6	13	0.26	Downwind flare 6, upwind of tanks 501-504
347	7-Aug	01:23	3.1	138.1	8	0.48	dnwnd 501, 502, 504(wind poor for flux)
353	7-Aug	02:56	2.7	135.7	1	0.13	Downwind of tanks 501, 502, 504 (wind direction not good for flux)
354	7-Aug	03:14	2.6	136.6	<1	0.12	Downwind of tanks 501, 502, 504 (wind direction not good for flux)
355	7-Aug	03:33	2.9	132.0	<1	0.05	Downwind of tanks 501, 502, 504 (wind direction not good for flux)
356	7-Aug	03:52	2.7	135.5	1	0.05	Downwind of tank 503 (wind direction not good for flux)
364	7-Aug	05:52	3.1	175.5	18	0.41	Downwind flare 6, upwind of tanks 501-504
365	7-Aug	06:10	2.8	178.2	18	0.23	Downwind flare 6, upwind of tanks 501-504
366	7-Aug	06:30	2.9	177.8	<1	0.09	Upwind flare 6

Table 2.5 Measurements of VOC fluxes from gasoline storage tanks

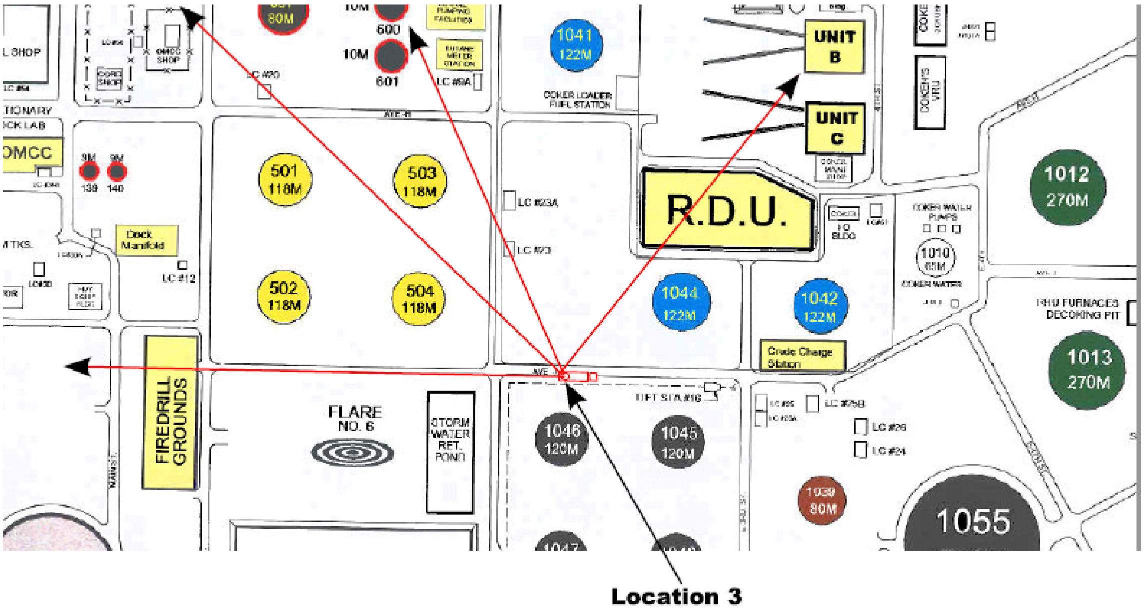


Figure 2.3. DIAL locations and scan lines used for DIAL measurements of VOC emission fluxes from the gasoline tanks at the Refinery.

Measurements of Water Treatment area.

Measurements were made of the water treatment plant on the 2nd August. Measurements were also made of crude tanks on this day and these have been reported in the relevant Section above.

The emissions fluxes observed from the waste treatment areas are given in Table 2.6. The average flux seen from the waste water treatment area, and specifically from the west side of the secondary and tertiary effluent treatment facilities, was 30 lbs/hr. Scans upwind of the water treatment plant measured less than 1 lbs/hr. Two scans were also made of the flux from the API separator located at the NE corner of Surge Basin 2, and these measured a small average emission flux of 7 lbs/hr.

Scan ID	Date and Time	Wind Speed m/s	Wind Direction Degrees	Emission rate lbs/hr	Concentration ppm	Notes
273	02/08/2007 12:18:14	3.2	214.5	<1	0.08	Upwind of waste water plant
275	02/08/2007 12:41:58	4.0	209.0	42	0.43	Downwind of waster water plant
276	02/08/2007 12:51:21	3.0	206.0	35	0.27	Downwind of waster water plant
277	02/08/2007 13:03:14	3.5	218.6	15	0.21	Downwind of waster water plant
299	02/08/2007 18:47:05	3.2	141.2	5	0.23	Downwind API separator
300	02/08/2007 19:05:29	2.5	168.3	8	0.24	Downwind API separator

Table 2.6 Measurements of VOC fluxes water treatment areas

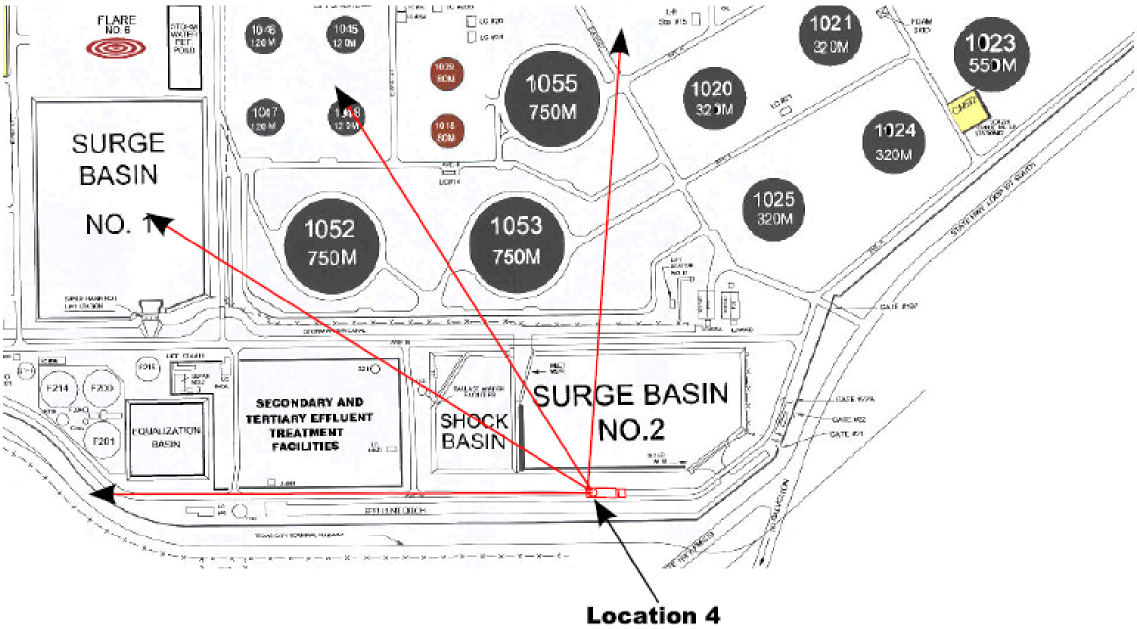


Figure 2.4. DIAL locations and scan lines used for DIAL measurements of VOC emission fluxes from the waste water treatment areas at the Refinery.

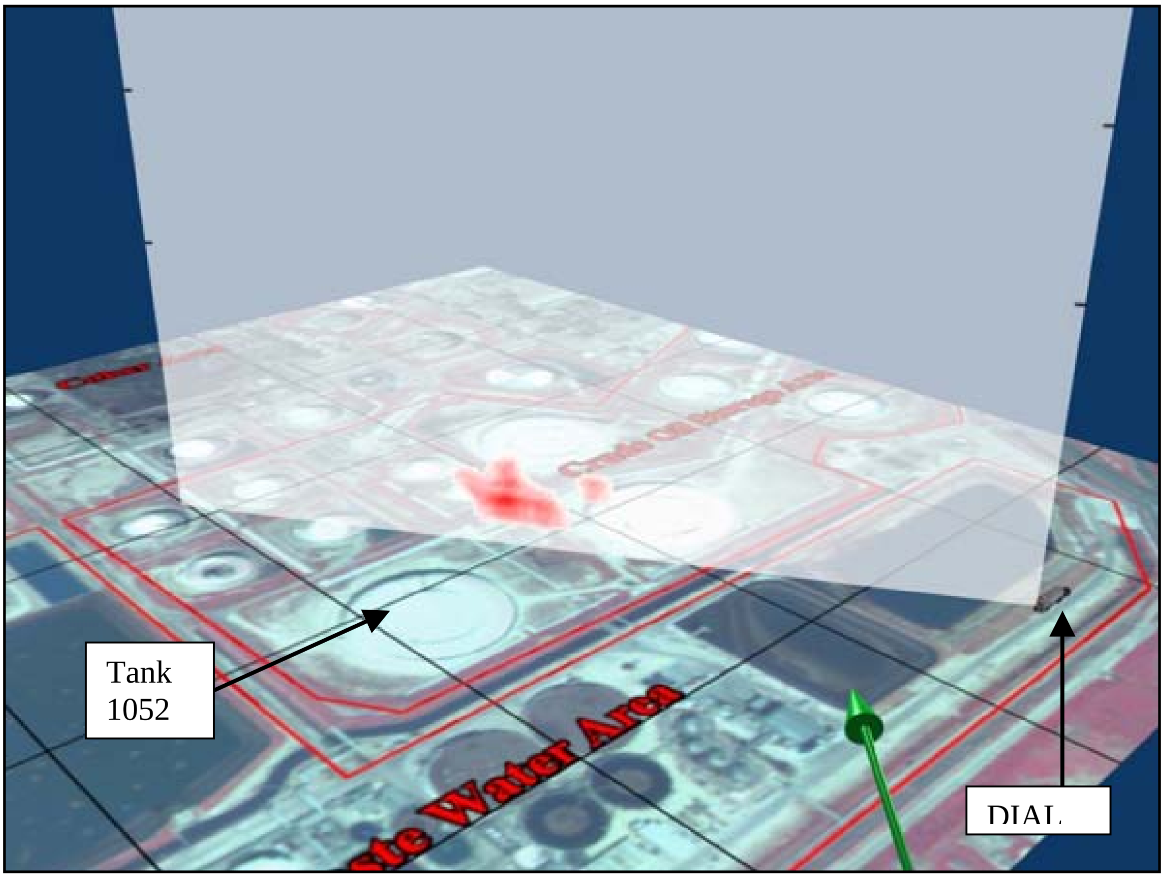


Figure 2.5. Example of the VOC distribution seen in a vertical scan at the Refinery (Scan 285). This scan measured the VOC emissions from tank 1052. The green arrow represents the average wind direction. The peak VOC concentration observed in this scan was 495 ppb.

Measurements of VOC emissions from coker C

Measurements were made of the VOC emissions from the operating coker, unit C, on the 28th July, 31st July, 1st 3rd August.

It had been suggested that refinery coker units could be a significant source of emissions, and figures of several hundred lbs/hr were discussed. One of the primary aims of these measurements was therefore to determine if the emissions from this coker were of a similar level. Over a number of measurement days, with different conditions, and through several cycles of the coker, the highest emission flux observed during a DIAL scan from the coker was 44 lbs/hr

The average emission fluxes observed from the coker are given in Table 2.7, and all individual flux results are presented in Table 2.8.

Date	Average emission flux from coker	Average upwind flux
28th July	10 lbs/hr	2 lbs/hr
31st July	31 lbs/hr	3 lbs/hr
1st August	12 lbs/hr	4 lbs/hr
3rd August	32 lbs/hr	8 lbs/hr
6th August - Night	4 lbs/hr	N/A

Table 2.7, Summary of VOC emissions fluxes measured from Coker 'C'

Measurements upwind of the cokers identified some small fluxes intermittently on the 31st July and 3rd August. These presumably arise from process units close to the cokers, including potentially, the coker vapour recovery unit. These upwind concentrations have not been subtracted from the observed coker results, however, their potential impact on the uncertainty of the results should be considered.

During the coker measurements on the 3rd August a small, localised emission was observed south of tank 1010. This was consistent with emissions from waste water vent pipes, located at the north end of E-4th street. The average emission flux observed from this source was 9 lbs/hr.

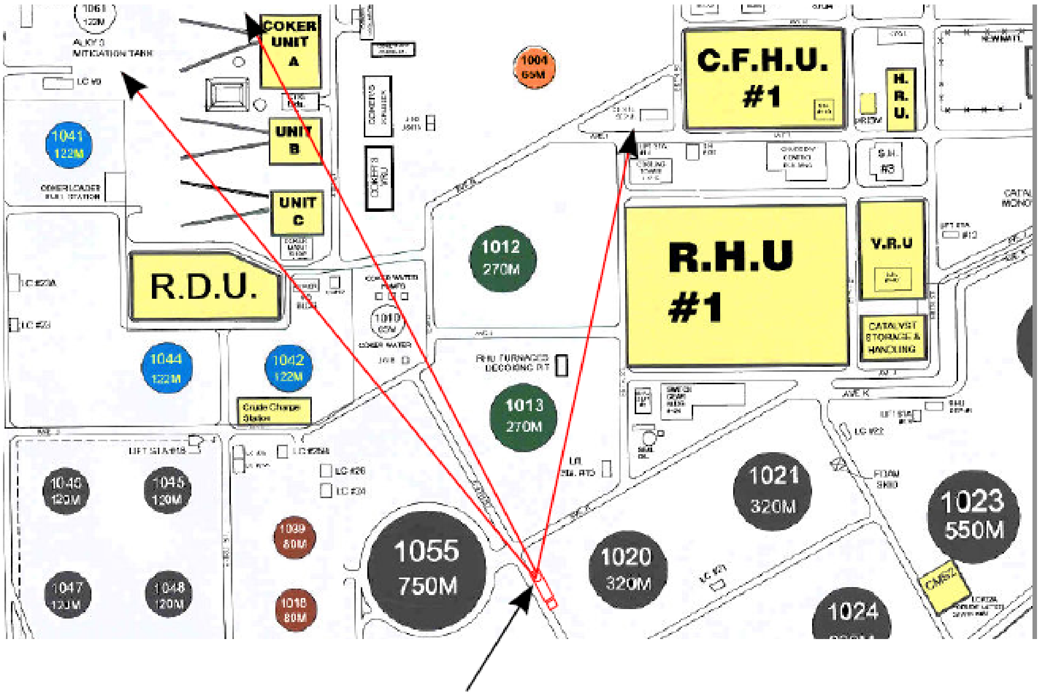


Figure 2.6.DIAL locations and scan lines used for DIAL measurements of VOC emission fluxes from coker C at the Refinery.

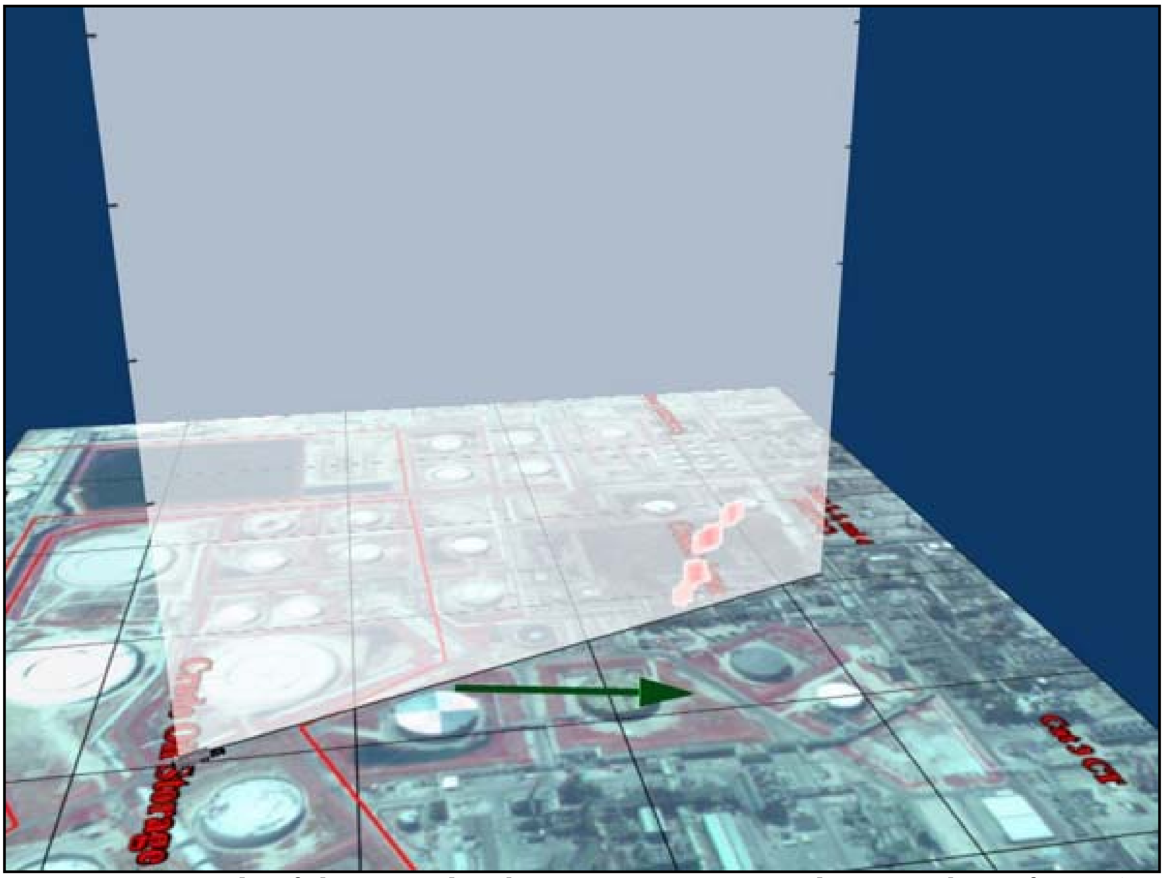


Figure 2.7. Example of the VOC distribution seen in a vertical scan at the Refinery (Scan 263), downwind of coker C. The green arrow represents the average wind direction. The peak VOC concentration observed in this scan was 234 ppb.

Scan ID	Date	Time	Wind Speed m/s	Wind Direction Degrees	Emission rate lbs/hr	Concentration ppm	Notes
152	28-Jul	15:51	3.3	216.0	17	0.14	Downwind coker
153	28-Jul	16:12	2.6	213.4	7	0.10	Downwind coker
154	28-Jul	16:30	3.0	204.1	8	0.12	Downwind coker
225	31-Jul	11:21	2.3	135.1	<1	0.21	Upwind of coker
226	31-Jul	11:31	1.6	119.0	1	0.26	Upwind of coker
227	31-Jul	11:41	1.9	90.8	8	0.34	Upwind of coker
228	31-Jul	11:52	1.6	75.5	<1	0.20	Upwind of coker
229	31-Jul	12:02	2.4	99.3	1	0.09	Upwind of coker
230	31-Jul	12:11	3.1	123.6	<1	0.05	Upwind of coker
244	31-Jul	14:35	2.8	158.9	30	0.33	Downwind of coker
245	31-Jul	14:44	4.4	155.2	42	0.25	Downwind of coker
246	31-Jul	14:54	4.5	142.4	32	0.21	Downwind of coker
247	31-Jul	15:06	4.4	138.7	25	0.27	Downwind of coker
248	31-Jul	15:16	4.2	150.7	44	0.35	Downwind of coker
249	31-Jul	15:26	4.3	171.8	20	0.29	Downwind of coker
250	31-Jul	15:45	4.3	169.9	26	0.18	Downwind of coker
251	31-Jul	15:59	3.8	172.3	29	0.16	Downwind of coker
252	31-Jul	16:27	4.2	179.9	N/A	0.75	Concentrations across vent pipes
253	31-Jul	16:38	3.8	175.5	N/A	0.37	Concentrations across vent pipes
254	31-Jul	16:48	3.6	169.5	N/A	0.19	Concentrations across vent pipes
255	31-Jul	16:59	3.5	176.4	13	0.34	Upwind of coker
256	31-Jul	17:08	3.6	169.3	<1	0.10	Upwind of coker
257	31-Jul	17:18	4.5	179.5	2	0.11	Upwind of coker
262	1-Aug	11:14	2.4	270.0	11	0.28	Downwind of coker
263	1-Aug	11:28	3.0	287.1	20	0.23	Downwind of coker
264	1-Aug	12:01	2.0	261.7	8	0.24	Downwind of coker
265	1-Aug	12:17	2.9	271.4	17	0.26	Downwind of coker
266	1-Aug	12:32	2.7	252.4	7	0.22	Downwind of coker
267	1-Aug	12:51	2.4	258.4	9	0.15	Downwind of coker
268	1-Aug	13:26	1.7	16.2	4	0.18	Upwind of coker
269	1-Aug	14:15	1.6	135.2	5	0.22	Upwind of coker (wind variable)
271	1-Aug	15:26	2.6	165.3	3	0.16	Upwind of coker (wind variable / rain)
302	3-Aug	11:05	4.3	75.0	20	0.68	Downwind of coker
303	3-Aug	11:24	4.2	75.8	22	0.22	Downwind of coker
304	3-Aug	11:57	4.5	93.4	37	0.43	Downwind of coker
306	3-Aug	12:35	3.7	92.4	11	0.46	Upwind of cokers
307	3-Aug	12:56	5.1	98.8	6	0.38	Upwind of coker
308	3-Aug	13:16	4.9	92.6	34	0.63	Downwind of coker
312	3-Aug	14:07	4.1	77.4	9	0.41	Flux from waster water vents (near tank 1010)
313	3-Aug	14:48	3.2	104.0	9	0.79	Flux from waster water vents (near tank 1010)
314	3-Aug	15:07	4.3	109.2	39	0.73	Downwind of coker
316	3-Aug	15:53	4.6	101.9	38	0.58	Downwind of coker
317	3-Aug	16:11	5.3	115.1	36	0.47	Downwind of coker
350	7-Aug	01:59	3.2	136.9	3	0.18	Downwind of coker
351	7-Aug	02:18	3.2	139.1	2	0.14	Downwind of coker
352	7-Aug	02:37	2.6	137.0	8	0.19	Downwind of coker
360	7-Aug	04:48	3.1	131.6	6	0.12	Downwind of coker
361	7-Aug	05:06	2.3	140.5	5	0.13	Downwind of coker
363	7-Aug	05:25	2.3	149.8	1	0.11	Downwind of coker

Table 2.8. Measurements of VOC emission fluxes from coker ‘c’.

Measurements of VOC emissions from heated oil tanks

A small number of heated tanks containing fuel oil were measured. These tanks were monitored on the night of the 7th August. The emissions from two tanks 43, and 60 were measured, and the results are given in Table 2.9.

The average emission flux from Tank 43 was 6 lbs/hr and from Tank 60 the average emission flux was 9 lbs/hr. Upwind fluxes were less than 1 lbs/hr. These results show the emissions from these tanks are very low and they are not significant sources of VOC emissions.

			Wind Speed	Wind Direction	Emission rate	Concentration	Notes
Scan ID	Date	Time	m/s	Degrees	lbs/hr	ppm	
							Moved to location 6, W 4th St.
382	8-Aug	02:00	3.6	213.1	3	0.11	Downwind tank 43
383	8-Aug	02:19	3.6	211.7	2	0.10	Downwind tank 43
384	8-Aug	02:30	3.7	211.4	1	0.06	Downwind tank 43
385	8-Aug	02:40	3.8	208.8	<1	0.01	Upwind tanks
386	8-Aug	02:49	3.5	209.0	<1	0.01	Upwind tanks
387	8-Aug	02:59	3.7	211.7	<1	0.02	Upwind tanks
388	8-Aug	03:16	3.0	215.3	8	0.16	Downwind tank 43
389	8-Aug	03:26	3.1	213.7	13	0.15	Downwind tank 43
390	8-Aug	03:36	2.7	213.5	7	0.13	Downwind tank 43
							Moved to location 7 Av G
399	8-Aug	05:14	2.2	204.3	9	0.11	Downwind tanks 60 and 63 - mainly tank 60
400	8-Aug	05:33	1.9	200.0	12	0.15	Downwind tanks 60 and 63 - mainly tank 60
401	8-Aug	05:42	2.1	203.9	15	0.17	Downwind tanks 60 and 63 - mainly tank 60
402	8-Aug	05:52	2.2	201.4	4	0.22	Downwind tanks 60 and 63 - mainly tank 60
403	8-Aug	06:01	2.0	186.0	9	0.23	Downwind tanks 60 and 63 - mainly tank 60
404	8-Aug	06:11	1.6	190.1	5	0.28	Downwind tanks 60 and 63 - mainly tank 60

Table 2.9. Measurements of VOC emission fluxes from hot oil tanks.

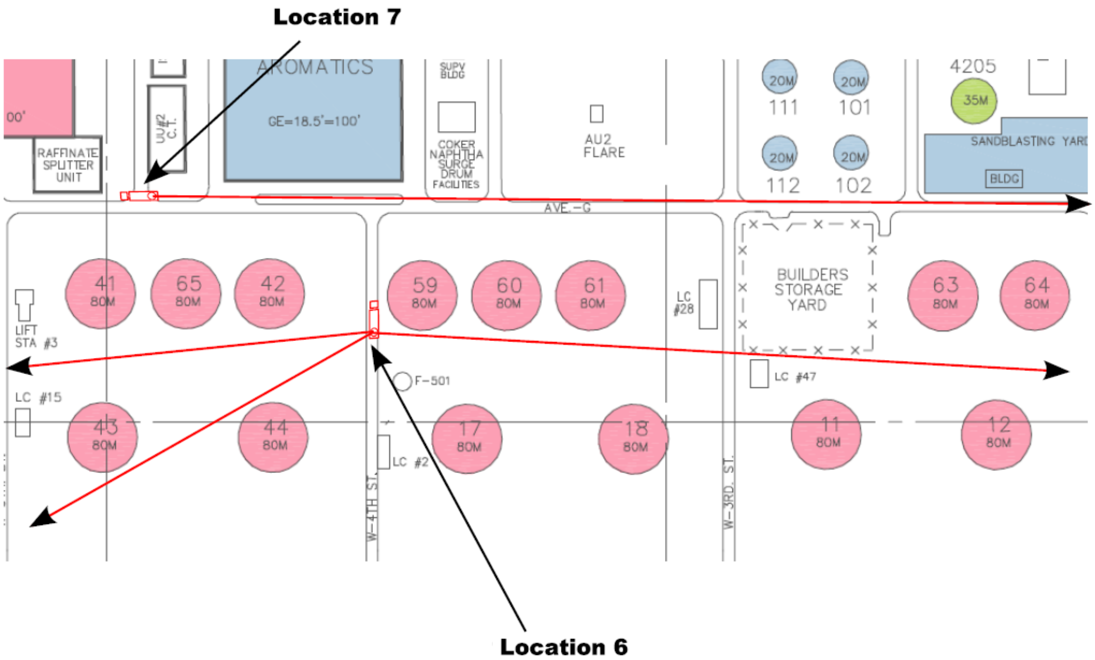


Figure 2.8. DIAL locations and scan lines used for DIAL measurements of VOC emission fluxes from the hot oil tanks at the Refinery.

Measurement of VOC emissions from elevated flares.

Measurements of a temporary flare stack located in the NW corner of the refinery were undertaken. This flare had a very visible flame, and the aim was to determine any emission due to incomplete combustion in the flare. The DIAL was located in Grant Avenue and measured downwind and upwind of the flare to identify any plume of un-burnt hydrocarbons. These measurements identified very low levels of hydrocarbon downwind of the flare, and the VOC emission flux measured from this flare was ~ 6 lbs/hr. This is not surprising given that the flare was reported to be mainly burning hydrogen.

However, during the measurement of the temporary flare, a high concentration VOC plume was observed at a closer range than the temporary flare stack. This plume was consistent with emissions from another elevated flare, the ULC flare. This flare had an almost invisible flame during daylight, but was observed to be lit at night. Table 2.11 lists all the measured fluxes from these flares, and Table 2.10 provides a summary of the emissions from the ULC flare.

Date	Average VOC emission flux
9th August	147 lbs/hr
10th August	167 lbs/hr
11th August	263 lbs/hr

Table 2.10 Summary of measurements of VOC emissions from ULC flare.

The measurements of the ULC plume showed a fairly high degree of variability, and this will be due to a combination of variability in the flare emissions and the possibly to movement of the narrow plume during the period of each DIAL scan.

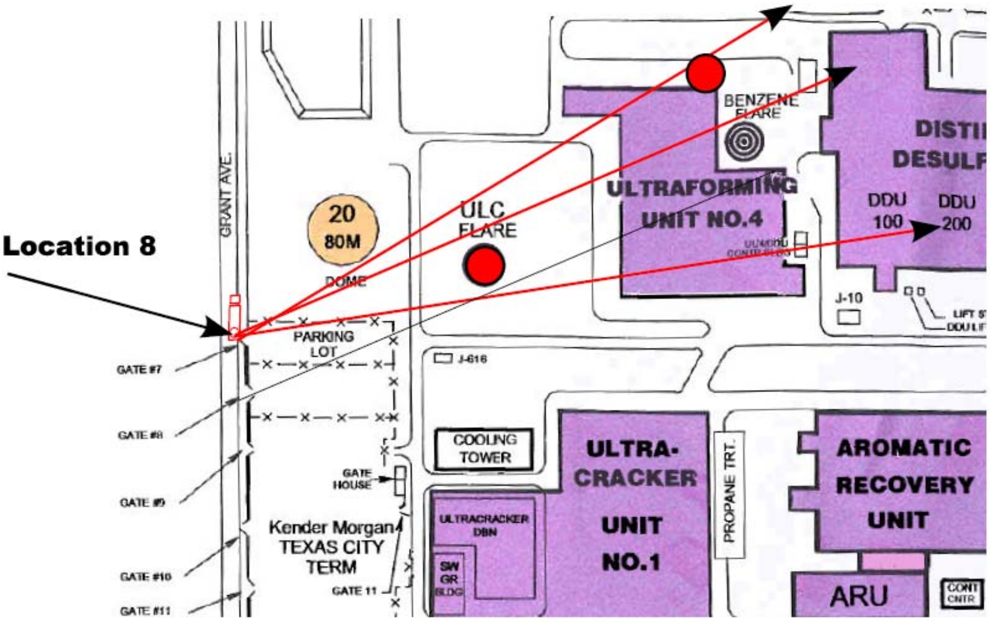


Figure 2.9. DIAL locations and scan lines used for DIAL measurements of VOC emission fluxes from flare stacks at the Refinery

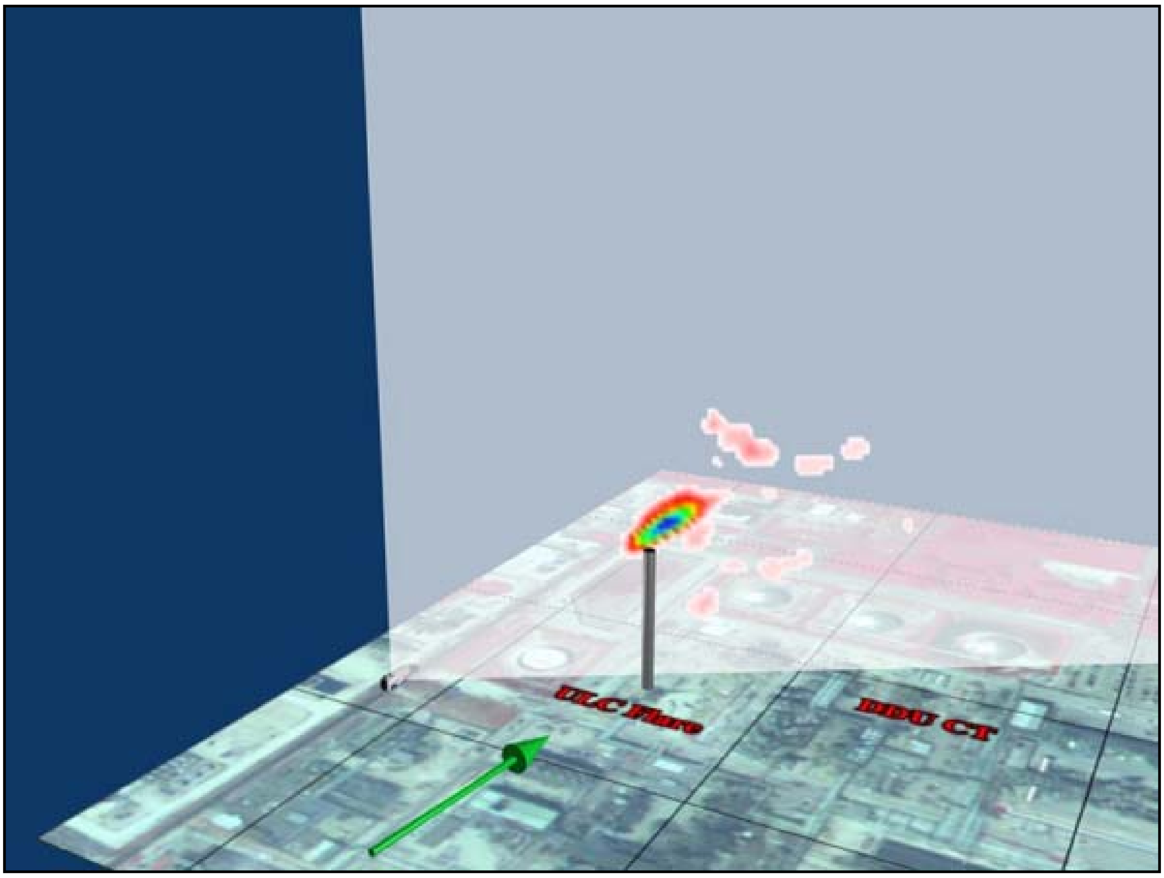


Figure 2.10 Example of the VOC distribution seen in a vertical scan at the Refinery (Scan 432) downwind of the ULC flare. The green arrow represents the average wind direction. The peak VOC concentration observed in this scan was 3.86 ppm.

Scan ID	Date	Time	Wind Speed m/s	Wind Direction Degrees	Emission rate lbs/hr	Concentration ppm	Notes
407	9-Aug	08:50	1.4	286.9	76	4.49	Downwind both flares
408	9-Aug	09:01	1.8	280.3	100	3.92	Downwind both flares
409	9-Aug	09:15	1.8	312.5	127	3.13	Downwind both flares
410	9-Aug	09:29	1.5	297.3	129	4.89	Downwind both flares
411	9-Aug	09:43	1.2	282.7	50	3.81	Downwind both flares
412	9-Aug	09:57	0.6	233.5	56	4.89	Downwind both flares
413	9-Aug	10:11	1.7	168.2	243	5.24	Downwind both flares
414	9-Aug	10:27	1.3	204.6	164	1.86	Downwind both flares
417	9-Aug	10:57	1.3	95.3	43	2.14	Downwind both flares
418	9-Aug	11:15	3.0	119.1	374	4.24	Downwind both flares
419	9-Aug	11:50	3.5	108.9	7	0.34	Upwind both flares
420	9-Aug	12:08	3.5	91.0	<1	0.40	Upwind both flares
421	9-Aug	12:29	3.1	98.7	13	0.36	Background (no plume)
431	9-Aug	14:17	4.1	113.5	126	1.61	Downwind both flares
432	9-Aug	14:53	4.4	121.8	243	3.86	Downwind both flares
433	9-Aug	15:11	4.4	124.7	181	1.69	Downwind both flares
436	9-Aug	15:59	4.4	122.7	1	0.28	Upwind both flares
437	9-Aug	16:18	3.9	126.5	23	0.29	Background (no plume)
439	10-Aug	09:51	3.8	325.4	567	8.16	Downwind both flares
440	10-Aug	10:12	2.7	353.7	159	3.84	Downwind both flares
441	10-Aug	10:31	3.1	350.7	172	3.84	Downwind both flares
442	10-Aug	10:40	3.1	9.0	190	3.40	Downwind both flares
443	10-Aug	11:00	2.8	10.9	<1	0.24	Upwind both flares
448	10-Aug	11:32	3.0	6.0	142	4.42	Downwind both flares
449	10-Aug	11:51	3.1	5.8	<1	0.36	Upwind both flares
450	10-Aug	12:01	2.6	2.8	95	2.80	Downwind both flares
451	10-Aug	12:20	3.2	25.7	<1	0.32	Background
452	10-Aug	12:29	3.0	22.3	102	1.17	Downwind both flares - further downwind
453	10-Aug	13:11	3.3	106.9	169	5.00	Downwind both flares
454	10-Aug	13:30	3.2	102.7	209	5.45	Downwind both flares
457	10-Aug	13:45	3.1	94.2	24	0.79	Downwind both flares (issues with sensitivity)
458	10-Aug	14:03	3.0	94.6	<1	0.57	Background
468	10-Aug	15:23	2.4	118.4	57	1.87	Downwind both flares
469	10-Aug	15:42	3.2	123.1	191	1.65	Downwind both flares
470	10-Aug	16:01	3.0	124.2	36	1.13	Downwind both flares
471	10-Aug	16:28	2.5	126.2	80	1.03	Downwind both flares
474	11-Aug	11:30	3.6	0.6	301	5.03	Downwind both flares
475	11-Aug	11:40	4.3	6.2	311	4.20	Downwind both flares
476	11-Aug	12:00	3.6	6.4	15	0.75	Downwind temporary flare only
477	11-Aug	12:21	3.8	10.2	4	0.27	Downwind temporary flare only
478	11-Aug	12:53	3.8	359.7	<1	0.20	Downwind temporary flare only
479	11-Aug	13:12	2.6	13.2	88	1.25	Downwind both flares
480	11-Aug	13:32	3.1	11.8	244	2.51	Downwind both flares
481	11-Aug	13:50	3.6	22.2	<1	0.19	Background scan
488	11-Aug	14:32	2.4	25.1	<1	0.31	Scan down Grant Avenue
493	11-Aug	15:53	2.1	30.3	<1	0.46	Scan downwind process stacks - A
494	11-Aug	16:07	1.4	37.5	<1	0.39	Scan downwind process stacks - B
495	11-Aug	16:23	2.5	112.3	1	0.58	Scan downwind process stacks - C
496	11-Aug	16:38	2.7	113.9	<1	0.45	Scan downwind process stacks - D
497	11-Aug	16:52	3.0	111.1	42	0.96	Downwind both flares, partial coverage of plume
498	11-Aug	17:10	3.3	121.0	14	0.37	Background
499	11-Aug	17:21	3.8	125.7	326	4.01	Downwind both flares
500	11-Aug	17:46	3.0	109.1	311	5.00	Downwind both flares
501	11-Aug	18:04	2.8	66.1	4	3.04	Background

Table 2.11. Measurements of VOC flux from ULC and temporary flares.

Section 3 Measurements of Benzene emissions from Refinery

Measurement description

Measurements of benzene were carried out on the 17th and 18th August 2007 at the Refinery. Measurements were made of the Aromatic Recovery Unit (ARU) on the 17th and the operational Coker (Coker Unit C) on the 18th. Measurements on the 17th were carried out in parallel with a UV Open Path DOAS spectrometer, operated by the EPA and were made for comparison purposes. Measurements on the 18th were carried out to obtain emissions flux measurements from the coker operations, and were timed to include the period during which the unit was cutting coke.

Benzene concentration measurements on 17th August.

The measurements on the 17th August were carried out to compare the concentrations measured by DIAL with those obtained by the open-path UV-DOAS system operated by Cary Secrest from EPA. Both systems were set up to measure a 200m path close to the ground, downwind of the ARU. Figure 1 shows the DIAL and DOAS locations and also the locations of 2 air samples, which were taken during the tests. The DIAL was located in Avenue C, South of Tank 5, GPS location 29°22'35.28"N, 94°56'2.10"W. The wind was from directions between 130° to 170° from N, at speeds of between 6 mph to 16 mph.

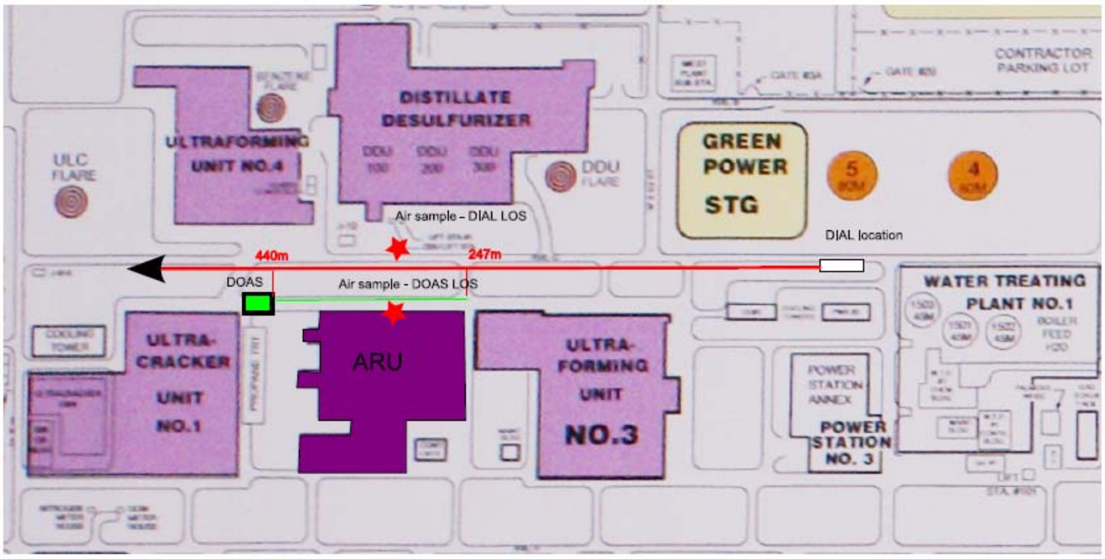


Figure 3.1, Location for measurements of benzene concentrations from the ARU

During these measurements the DIAL beam was kept at a fixed line of sight, in a similar configuration to the UV-DOAS, and not scanned to obtain concentration profiles. Therefore, benzene fluxes were not determined. The two measurement-paths for the DIAL and the UV-

DOAS were as close as was logistically possible. The DIAL data were processed to assess the total integrated concentration over the assigned path. The path length of the DOAS was stated by the EPA operators to be from 247m to 440m from the DIAL. The ARU unit was measured from the site map to be 100m long from 280 to 380 m from the DIAL. The DIAL and UV-DOAS results are plotted for comparison in Figures 2 and 3. The DIAL results are tabulated in Tables 1 and 2. The results plotted for the UV-DOAS are as supplied by Cary Secrest (US EPA). There is no difference between the UV-DOAS results in figures 2 and 3, only the DIAL pathlength has been varied, the UV-DOAS pathlength is a fixed parameter dependant on the instrument configuration. The DIAL results shown in the tables are the averages of a number of measurements taken during the periods indicated, and the standard deviations of the concentrations is also given. Where no standard deviation is given this is because the result is for a single measurement.

Scan ID	Start Time	End Time	Benzene Concentration	Standard deviation
			ppb	ppb
538	11:52	12:00	6.3	4.3
539	12:01	12:09	9.7	5.9
540	12:10	12:19	16.1	1.8
542	12:29	12:37	16.1	2.3
543	13:18	13:26	3.9	3.0
544	13:27	13:37	3.8	2.1
545	13:38	13:48	2.3	3.6
546	14:09	14:19	2.6	0.2
547	14:19	14:29	0.3	2.0
550	14:39	14:45	5.9	n/a
552	15:11	15:24	6.1	1.8
553	15:25	15:38	3.4	0.0
554	15:38	15:52	4.1	0.3
555	15:54	16:07	3.5	2.0
556	17:37	17:50	3.6	1.7
558	17:58	18:05	7.8	n/a
560	18:14	18:42	7.5	0.9

Table 3.1, DIAL results – ppb benzene determined over a 193m path comparable to the UV-DOAS.

Scan ID	Start Time	End Time	Benzene Concentration	Standard deviation
			ppb	ppb
538	11:52	12:00	4.6	4.1
539	12:01	12:09	16.7	9.4
540	12:10	12:19	15.3	7.1
542	12:29	12:37	26.3	7.2
543	13:18	13:26	11.3	5.6
544	13:27	13:37	5.4	7.0
545	13:38	13:48	1.9	10.2
546	14:09	14:19	5.3	5.7
547	14:19	14:29	1.6	2.8
550	14:39	14:45	11.5	n/a
552	15:11	15:24	8.9	1.6
553	15:25	15:38	3.8	0.4
554	15:38	15:52	7.0	2.5
555	15:54	16:07	5.9	2.4
556	17:37	17:50	4.5	3.2
558	17:58	18:05	12.7	n/a
560	18:14	18:42	13.5	1.8

Table 3.2, DIAL results – ppb benzene determined over a 100m path comparable to the extent of the ARU.

Air samples were taken in canisters and with pumped sorbent tubes, at the locations shown in Figure 1. Table 3 shows the results of the analyses of these canisters for benzene. The samples were taken between 17:29 and 18:29 for the EPA line of sight and 17:53 and 18:53 for the DIAL line of sight.

	Benzene		Toluene		Ethylbenzene		m/p-Xylene		o-Xylene	
	Tubes	Canisters	Tubes	Canisters	Tubes	Canisters	Tubes	Canisters	Tubes	Canisters
ARU	ppb	ppb	Ppb	ppb	ppb	Ppb	ppb	ppb	ppb	ppb
DIAL LOS	12.87	<2.00	18.79	12.26	2.33	2.04	9.36	5.51	3.05	<2.00
DOAS LOS	6.71	<1.88	9.79	20.52	1.90	2.46	5.29	8.49	1.44	2.59

Table 3.3, Air sample analyses for ARU measurements.

The concentrations of benzene measured using the pumped sorbent tubes are similar to the levels measured with both the UV-DOAS and the DIAL. The concentrations measured by the DIAL are close to the limit of detection for the DIAL system and the standard deviations of the results reflects this.

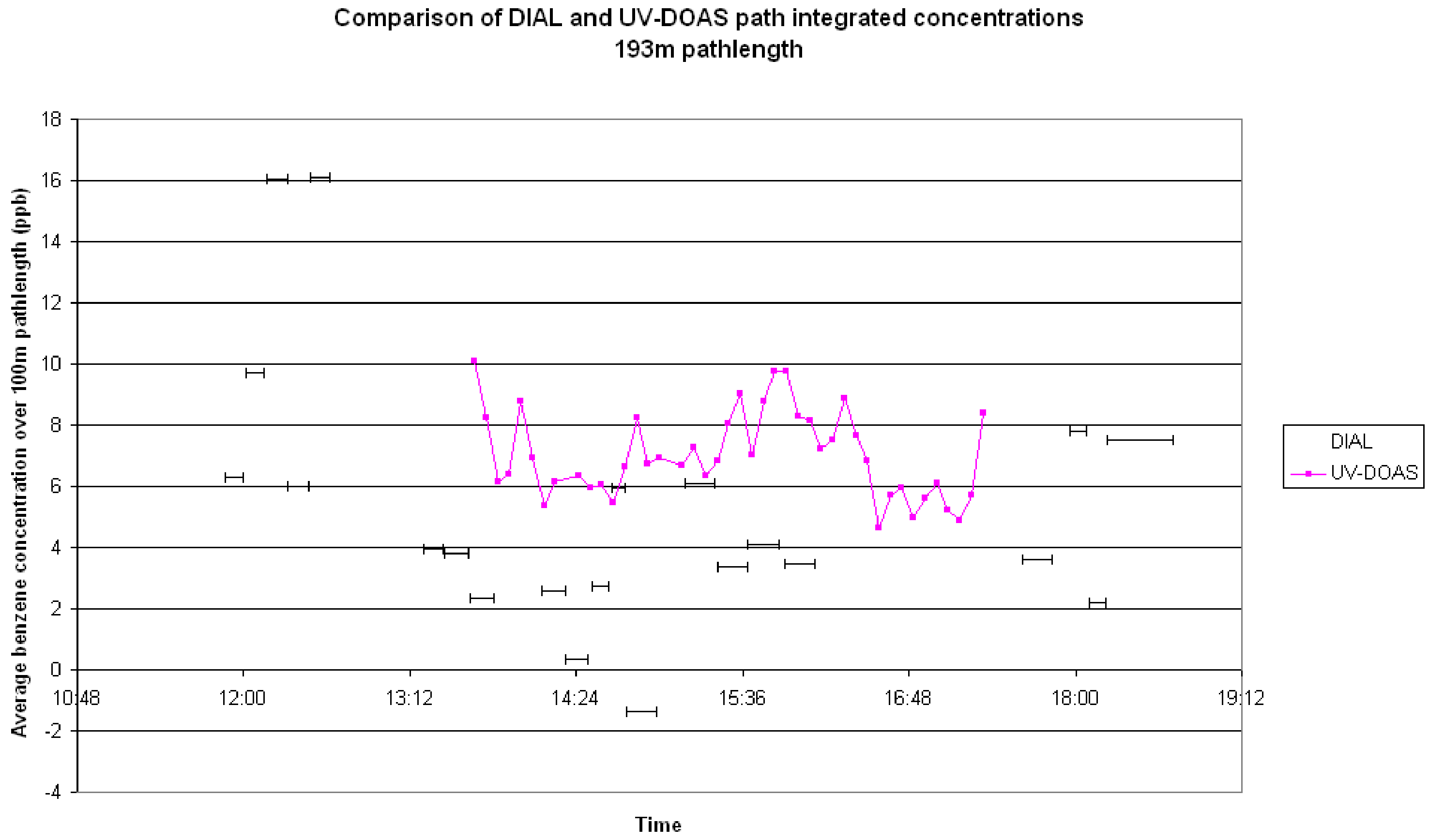


Figure 3.2, Comparison of DIAL and UV-DOAS benzene concentrations. DIAL integrated path corresponding to reported UV-DOAS 193m pathlength.

Checked by:

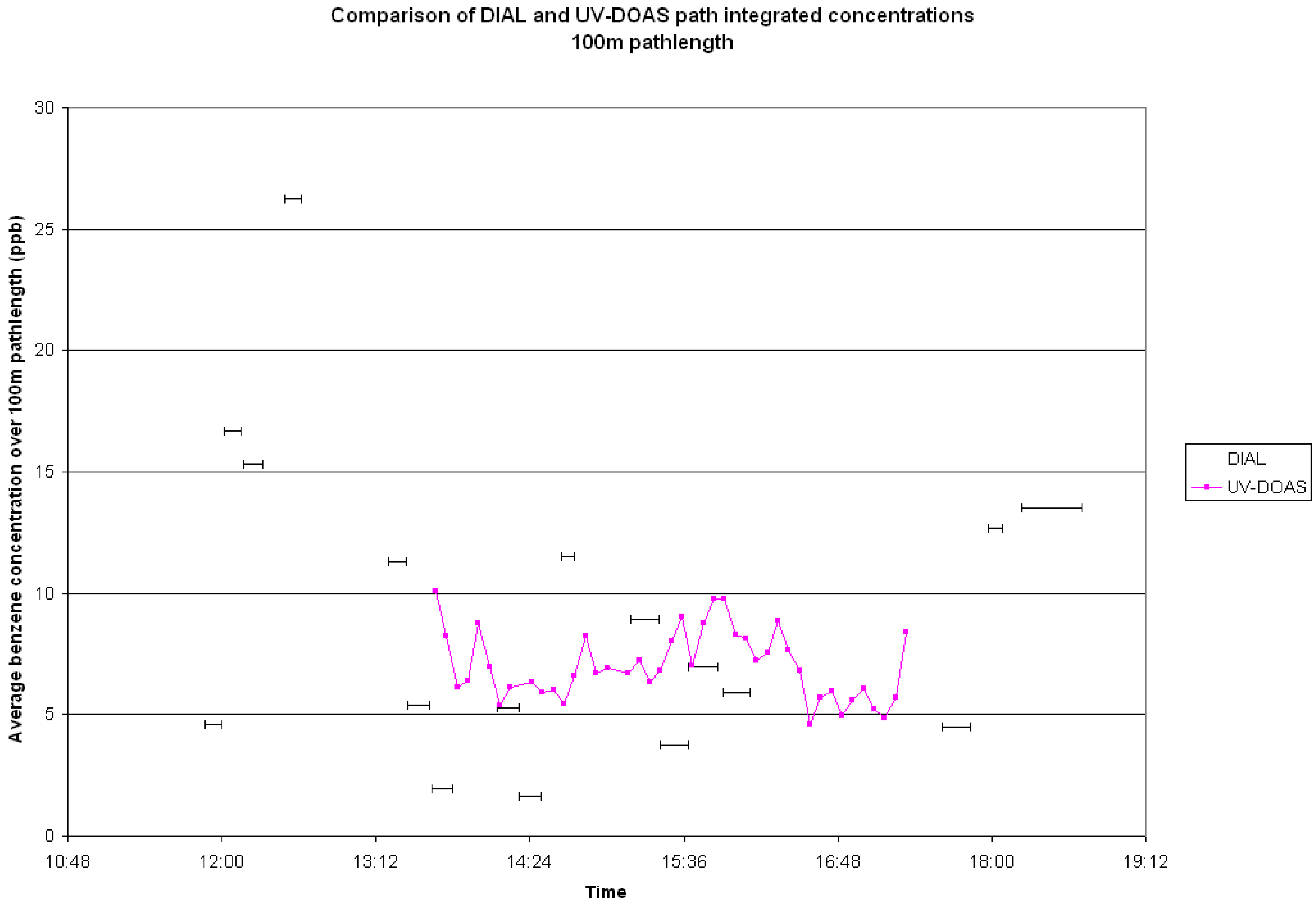


Figure 3.3, Comparison of DIAL and UV-DOAS benzene concentrations. DIAL results for 100m path corresponding to the location of the ARU unit.

Measurements of benzene fluxes from the coker

Measurements were made of the benzene concentrations downwind of coker, unit C, during the operation of this coker on the 18th August. The measurements were carried out from 17:20 to 20:45. The coker was cutting coke between 19:50 and 20:38.

The configuration of the measurements and location of the DIAL during these measurements is shown in Figure 4

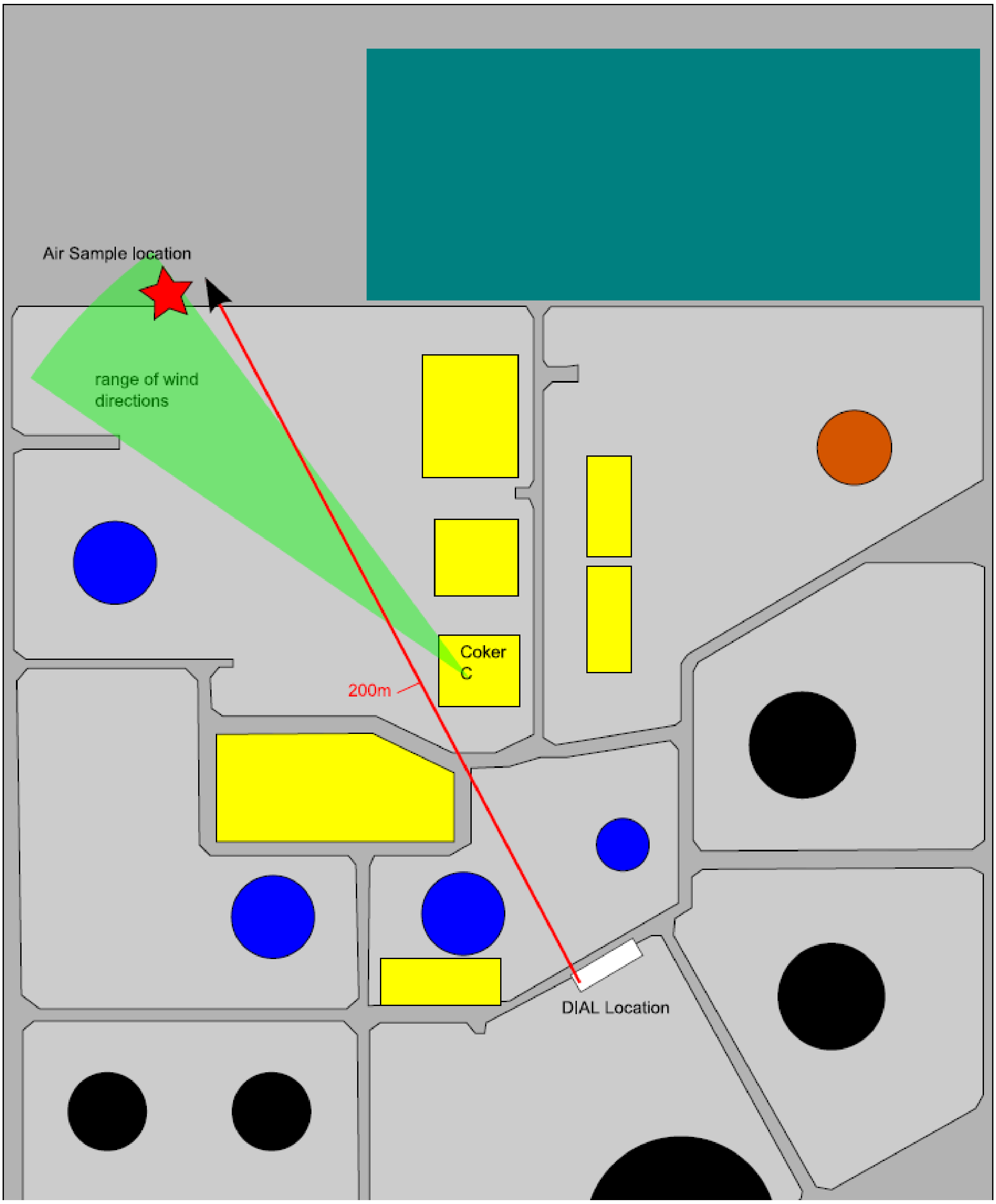


Figure 3.4. Location of DIAL for measurements of benzene fluxes from coker Unit C.
The DIAL was located on Avenue J, to the west of Tank 1010, at GPS coordinates 29°22'10.98"N, 94°55'19.50"W. The wind during the measurements was from directions between 125° to 143° from N, with speeds between 6 mph to 9 mph. Vertical scans were made downwind of the coker; scans were also made upwind of the coker to check for any other sources of benzene. The results are given in Table 4. During most of the period of measurements the DIAL values are at or below the detection limits. For these measurements, the detection limits, in terms of lbs per hr flux, were of the order of 0.5 to 1 lbs per hr. During the period before the coker commenced cutting, the fluxes measured were often below the detection limit and have been reported as 0 lbs per hr. In some cases, a figure of less than a given flux is reported. In these cases, a detectable concentration was recorded, but the uncertainty in the results is such that only an upper limit is reported. Detected concentrations of benzene were in general around 0.1 ppm. During the coker cut, a small but observable flux of benzene was measured, the two results giving fluxes of 1.5 lbs per hr and 2.1 lbs per hr. Upwind scans showed no significant source of benzene.

The results of the analyses of the air sample taken downwind of the coker are shown in Table 5. This sample was taken during the period of the coker cut, and a low concentration of benzene ~ 1 to 2 ppb was measured.

		Met Data							
		DIAL Trailer		Mast					
				Upper		Lower			
		Average Wind Speed	Average Wind Direction	Wind Speed	Wind Direction	Wind Speed	Wind Direction	Emission rate	Concentration
Scan ID	**Time**	m/s	Degrees	m/s	Degrees	m/s	Degrees	lbs/hr	ppm
562	17:45	2.0	179.8092	3.3	129.6	2.6	148.6	0.9	0.2
563	18:04	2.4	197.3375	3.3	135.0	2.9	154.1	0.9	0.1
565	18:24	2.1	208.6307	3.2	127.1	2.7	154.7	1.3	0.1
566	18:41	1.9	186.855	3.6	129.3	2.9	152.3	0.0	0.1
567	18:57	1.9	191.1686	3.8	131.7	3.2	152.0	0.0	0.1
568	19:12	2.2	198.3785	2.7	135.5	2.4	156.5	0.0	0.1
569	19:23	1.7	179.4866	2.9	125.5	2.5	144.4	< 0.9	0.3
570	19:41	1.6	214.1907	3.0	136.9	2.6	156.9	0.0	0.2
571	19:56	1.2	122.1	2.7	137.0	2.4	157.3	< 0.7	0.2
572	20:11	1.8	139.7	2.8	143.1	2.4	162.1	1.5	0.1
573	20:26	1.7	135.1	3.2	136.8	2.7	156.7	2.1	0.2

Table 3.4. Measured fluxes during coker operation.

	Benzene		**Toluene**		**Ethylbenzene**		**m/p-Xylene**		**o-Xylene**	
	Tubes	**Canisters**	**Tubes**	**Canisters**	**Tubes**	**Canisters**	**Tubes**	**Canisters**	**Tubes**	**Canisters**
	ppb	**ppb**	**ppb**	**ppb**	**ppb**	**ppb**	**ppb**	**ppb**	**ppb**	**ppb**
Downwind Coker	1.33	<2.00	0.61	2.11	0.44	<2.00	0.49	<2.00	<0.3	<2.00

Table 3.5, results of air sample analyses downwind of coker.

Section 4. Measurements of SO_2 from the Sulphur Recovery Unit

A series of measurements was carried out on the 14th August to measure the SO_2 flux from the Sulphur Recovery Unit wet gas scrubber plume. Close to the stack this appeared as a visible plume, mainly consisting of water vapour. The measurements were made through the plume, roughly at the point at which it became invisible to the unaided eye. The enhanced backscatter from the plume was used to check that the scans did intercept the plume. The aim of the measurements was to compare the measured flux with an emission rate determined from the stack flow rate and measurements of the stack gas SO_2 concentration determined from an installed continuous emissions monitor. However, prior calculations indicated that the likely concentration within the plume would be at or below the DIAL detection limit, and this was found to be the case. The average flux measured by the DIAL was 0.003 lbs/hr, with a standard deviation of 0.008 lbs/hr. Table 4.1 lists the measured SO_2 fluxes.

Scan ID	Time	Wind Speed m/s	Wind Direction Degrees	Emission rate lbs/hr	Concentration ppm	Notes
502	09:52	3.1	19.6	<0.01	0.001	SRU unit plume
503	10:02	3.3	6.6	<0.01	0.001	SRU unit plume
507	10:47	3.3	8.9	0.02	0.001	SRU unit plume
508	11:14	4.0	0.1	0.01	0.001	SRU unit plume
509	11:43	3.6	6.2	<0.01	0.001	SRU unit plume
510	12:02	4.1	4.5	<0.01	0.001	SRU unit plume
511	12:22	2.5	29.1	0.01	0.005	SRU unit plume
512	12:34	2.7	7.7	<0.01	0.001	SRU unit plume
518	13:51	3.5	71.4	<0.01	0.001	SRU unit plume
519	14:10	4.6	96.4	<0.01	0.003	SRU unit plume
525	15:14	4.2	124.7	0.02	0.001	SRU unit plume
529	16:19	4.0	121.9	<0.01	0.001	SRU unit plume

Table 4.1. Measurements of SO_2 flux from SRU.

The DIAL location was:

Refinery Location 13
Avenue F, north of flare 5.
29°22'28.42"N
94°54'54.56"W

Annex 1. Description of the DIAL technique.

Overview of the Dial technique

The Differential Absorption Lidar (DIAL) technique is a laser-based remote monitoring technique which enables range-resolved concentration measurements to be made of a wide range of atmospheric species. This section explains the theory of the DIAL technique and describes the NPL system in detail.

Description of the theory of Dial measurements

The atmospheric return signal measured by a DIAL system is given by the Light Detection and Ranging (Lidar) equation, a simplified form of which is given in Equation 1.

$$P_x(r) = E_x \frac{D_x}{r^2} B_x(r) \exp\{-2\int_0^r [\, A_x(r') + \alpha_x C(r')] d'r\} \qquad \textbf{(1)}$$

where D_x is a range independent constant, C(r) is the concentration of an absorber with absorption coefficient α_x and $A_x(r)$ is the absorption coefficient due to all other atmospheric absorption, E_x is the transmitted energy and B_x is the backscatter coefficient for the atmosphere at wavelength x.

The equation has three basic components:

- a backscatter term based on the strength of the signal scattering medium
- parameters associated with the DIAL system
- a term which is a measure of the amount of absorption of the signal which has occurred due to the presence of the target species.

In the DIAL technique, the laser is operated alternately at two adjacent wavelengths. One of these, the "on-resonant wavelength", is chosen to be at a wavelength which is absorbed by the target species. The other, the "off-resonant wavelength", is chosen to be at a wavelength which is not absorbed significantly by the target species.

Pairs of on- and off-resonant signals are then acquired and averaged separately until the required signal to noise ratio is achieved.

The two wavelengths used are close together, hence the atmospheric terms $A_x(r)$ and $B_x(r)$ in the lidar equation can be assumed to be the same for both wavelengths. These terms are then cancelled by taking the ratio of the two returned signals.

The path-integrated concentration (CL) may be derived (Equation 2) by multiplying the logarithm of the ratio of the signals by the ratio of the absorption of the two wavelengths by the target species.

$$CL(r) = \frac{1}{2\Delta\alpha}\frac{1}{N}\sum_{i=1}^{N}\log\frac{S_{ON,i}(r)}{S_{OFF,i}(r)} \qquad \textbf{(2)}$$

where N is the number of pulse pairs averaged, $\Delta\alpha = \alpha_{OFF}-\alpha_{ON}$ is the differential absorption coefficient and S represents the received power after normalisation for the on- and off-resonant signals respectively.

This path-integrated concentration represents the total concentration of the target species in the atmosphere along the measured line-of-sight out to the range r.

The range-resolved concentration can then be derived by differentiating the path-integrated concentration (Equation 3).

$$C(r) = \frac{dCL(r)}{dr} \qquad \textbf{(3)}$$

where C(r) is the point concentration at range r along the line-of-sight.

Description of facility operated by NPL

The DIAL system operated by NPL is housed in a mobile laboratory. It can operate in the infrared and ultraviolet spectral regions allowing coverage of a large number of atmospheric species. A scanner system directs the output beam and detection optics, giving almost full coverage in both the horizontal and vertical planes.

The system also contains ancillary equipment for meteorological measurements, including an integral 10 m meteorological mast with wind speed, direction, temperature and humidity measurements.

The system is fully self contained, with power provided by an on board generator, and has full air conditioning to allow operation in a range of ambient conditions.

The following sections describe the DIAL system in more detail.

Source
The source employs a combination of Nd-YAG and dye lasers together with various non-linear optical stages to generate the tuneable infrared and ultraviolet wavelengths. The source has a pulse repletion rate of 10 Hz and an output laser pulse duration of ~10 ns. A small fraction of the output beam in each channel is split off by a beam splitter and measured by a pyroelectric detector (PED) to provide a value for the transmitted energy with which to normalise the measured backscatter return.

Detection
The returned atmospheric backscatter signal is collected by the scanning telescope. This directs the collected light into separate paths for the infrared and ultraviolet lidar channels. The

returned light passes through band pass filters relevant to each detection channel and is then focused onto the detection elements. Solid-state cryogenically-cooled detectors are used in the infrared channel and low-noise photomultipliers in the ultraviolet.

After amplification the signals from these detectors are digitised using high speed digitisers. The digitisers are clocked using a clock generator triggered by an optical detector in the transmission chain. This ensures the range gating is correctly synchronised to the laser pulse transmission. The signals from the PED monitoring the transmitted energy are also digitised and stored.

Data Analysis
The data acquired are analysed, using the DIAL techniques described below, to give the range-resolved concentration along each line-of-sight.

The data analysis process consists of the following steps :

i) Background subtraction
Any DC background value is subtracted from the signals. This measured background takes account of any DC signal offset which may be present due to electronic offsets and from incident background radiation. The background level is derived from the average value of the far field of the returned lidar signal where no backscattered light is present.

ii) Normalisation for variation in transmitted energy
The two signal returns are normalised using the monitored values of the transmitted energy. The mean transmitted energy is used to normalise the averaged return signal. For this application, this has been shown to be equivalent to normalising individual shots against transmitted energy and then averaging the normalised values.

iii) Calculation of path-integrated concentration
The path-integrated concentration of the target species, out to the range r, is calculated by multiplying the log of the ratio of the returned normalised signals by the differential absorption.

The absorption coefficients used in this calculation are derived from high-resolution spectroscopy carried out using reference gas mixtures at NPL.

iv) Derivation of range-resolved concentrations.
In order to better visualise the data the integrated concentration profiles are piecewise differentiated to give the range-resolved concentration along the line-of-sight.

v) Calculation of emission fluxes
Range-resolved concentration measurements along different lines-of-sight are combined to generate a concentration profile. This is carried out using algorithms developed at NPL which reduce artefacts due to the difference in data density at different ranges, due to the polar scanning format of the data. The emission flux is then determined using the concentration profile together with meteorological data.

The emitted flux is calculated using the following mathematical steps:-

(a) The product is formed of the gas concentration measured with the DIAL technique at a given point in space, and the component of the wind velocity perpendicular to the DIAL measurement plane at the same location.

(b) This product is computed at all points within the measured concentration profile, to form a two-dimensional array of data.

(c) This array of results is then integrated over the complete concentration profile to produce a value for the total emitted flux.

Considerable care is needed in applying the meteorological data, particularly when the concentration profile measured by the DIAL technique has large and complex spatial variations since, for example, errors in the wind speed in regions where large concentrations are present will significantly affect the accuracy of the results. In such cases, a more complex procedure is used which employs a further software package to combine the data from the set of anemometers with that of an additional meteorological model, to generate the complete wind field over the concentration profile. This model calculates the variation of wind speed with height, as a function of various parameters (such as the roughness of the terrain). The calculated wind field is then combined with the measured gas concentration profile using the procedure described above.

A summary of the ultraviolet and infrared performance capabilities of the NPL DIAL facility are given in Tables A1.1 and A1.2. The values given in these tables are based on the actual levels of performance of the system obtained during field measurements, rather than calculations based on theoretical noise performances. For simplicity the numbers are presented as a single concentration sensitivity and maximum range values. However, the detailed performance behaviour of a DIAL system is much more complex and there are a number of key points that should be noted :

- The DIAL measurement is of concentration per unit length rather than just concentration. So the sensitivity applies for a specified pathlength – 50 metres in this case. Measurements over a shorter path would have a lower sensitivity, and would be more sensitive over a longer path.
- Since the backscattered lidar signal varies with range, generally following a (range)-2 function, the sensitivity is a function of range. The sensitivity values given in the table apply at a range of 200 metres, and these will get poorer at longer ranges.
- The maximum range of the system is generally determined by the energy of the emitted pulse and the sensitivity of the detection system, except in the case of nitric oxide where range is limited by oxygen absorption at the short ultraviolet wavelengths required for this species.
- In all cases the performance parameters are based on those obtained under typical meteorological conditions. For the ultraviolet measurements the meteorological conditions do not have a great effect on the measurements as the backscattered signal level is predominantly determined by molecular (Rayleigh) scattering, and this does not vary greatly. However, in the infrared the dominant scattering mechanism is from particulates (Mie scattering). So the signal level, and therefore the sensitivity, is dependant on the particular loading of the atmosphere, and this can vary dramatically over relatively short timescales.

The NPL DIAL has a theoretical range resolution of 7 metres along the measurement beam, and a vertical or horizontal scan resolution which can be less than 1 metre at 100 metres. However, the actual range resolution determined by the signal averaging used, will depend on atmospheric conditions and the concentration of the measured pollutant, and may be of the order of 30 m.

The DIAL is able to make measurements of a wide range of compounds, including benzene and other aromatics, individual VOCs and total VOCs, see Tables 2a and 2b. The methodology for obtaining measurements of the total VOC content from C3 to C15 is provided below. It consists of the combination of DIAL measurements with air sampling and GC analysis. The system is able to monitor individual aromatic compounds and VOC species, which have absorption features in the IR and UV spectral regions covered by the DIAL system. NPL has the spectral expertise, access to spectral libraries and in-house spectroscopic capability to assess the DIAL sensitivity for additional individual species.

The general hydrocarbon measurement listed in Table A1.2 uses an infrared absorption that is common to all hydrocarbons with three or more carbon atoms, linked to the stretch frequency of the carbon-hydrogen bond. As such it provides a measure of the mixture of volatile organic compounds (VOCs) that are present at an oil or petrochemical site. The pair of infrared wavelengths used for this DIAL measurement are selected so that the absorption per unit mass is relatively invariant with respect to the mix of different hydrocarbons that are present. However, the sensitivity of this measurement in terms of ppb of hydrocarbon depends on the mixture of species present, and the value given in the table reflects the typical mix of hydrocarbons found at oil refineries.

Although the general hydrocarbon measurement provides a good estimate of the overall amount of hydrocarbons present, the accuracy of this measurement can be improved, and the total VOC concentration calculated, by combining the DIAL measurements with the results of gas chromatography (GC) analysis of the emitted gases. The standard procedure for this involves taking whole air samples around the site in locations where the DIAL measurements show the emitted plumes are present. The VOCs present in these samples are identified and quantified by GC analysis. The results provide the relative levels of all the VOCs present with a concentration of 0.1 ppb or higher. The results of this analysis are combined with NPL's unique spectral library of quantified infrared absorptions of an extensive set of VOCs to calculate the combined absorption coefficient for the actual VOC mixture present at the site. Appling this absorption coefficient to the DIAL results enables the total VOC emission rates to be calculated.

Species	Sensitivity(1)	Maximum range(2)
Nitric oxide	5 ppb	500 m
Sulphur dioxide	10 ppb	3 km
Ozone	5 ppb	2 km
Benzene	10 ppb	800 m
Toluene	10 ppb	800 m

Table A1.1 Ultraviolet capability of NPL DIAL Facility

Species	Sensitivity(1)	Maximum range(2)
Methane	50 ppb	1 km
Ethane	20 ppb	800 m
Ethene	10 ppb	800 m
Ethyne	40 ppb	800 m
General hydrocarbons	40 ppb	800 m
Hydrogen chloride	20 ppb	1 km
Methanol	200 ppb	500 m
Nitrous oxide	100 ppb	800 m

Table A1.2 Infrared capability of NPL DIAL Facility

Note 1. The concentration sensitivities apply for measurements of a 50 metre wide plume at a range of 200 metres, under typical meteorological conditions.

Note 2. The range value represents the typical working maximum range for the NPL DIAL system.

Calibration and validation

The NPL DIAL system has several in-built calibration techniques and procedures. The most important are the in-line gas calibration cells. The gas cells are filled with known concentrations of the target species, from NPL standard gas mixtures, which are directly traceable to national standards. A fraction of the transmitted beam is split off and directed through a gas cell to a PED, in the same way as the beam for the transmitted energy monitors. This provides a direct measurement of the differential absorption at the operating wavelengths by the target gas. The transmission through the gas cells is continuously monitored during the operation of the system to detect any possible drift in the laser wavelengths. The system also employs a wavemeter to monitor the wavelengths transmitted during operation. The calibration cells are also periodically placed in the output beam to show the concentration response of the whole system is as expected.

A number of field comparisons have been undertaken to demonstrate the accuracy of the measurements obtained with DIAL. Examples of these carried out by NPL are detailed below:

i) Intercomparisons have been carried out in the vicinity of chemical and petrochemical plants where a large number of different volatile organic species are present. In these intercomparisons, the DIAL radiation was directed along the same line of sight as a line of point samplers. The point samplers were operated either by drawing air into internally-passivated, evacuated gas cylinders or by pumping air at a known rate, for a specified time, through a series of absorption tubes which efficiently absorb all hydrocarbon species in the range C_2 - C_8. The results obtained for the total concentrations of VOCs measured by the point samplers and those measured by the infrared DIAL technique agreed within ± 15%. The concentrations of atmospheric toluene measured by the ultraviolet DIAL system agreed with those obtained by the point samplers to within ± 20%.

ii) The ultraviolet DIAL system was used to monitor the fluxes and concentrations of sulphur dioxide produced from combustion and emitted by industrial stacks. These stacks were instrumented with calibrated in-stack sampling instruments. The results of the two sets of measurements agreed to within ± 12%.

iii) DIAL Measurements of controlled releases of methane from a stack agreed with the known emission fluxes to within ± 15%.

Measurements of gas cell concentrations during the Texas measurement campaign.

A series of measurements was made of a 10 cm gas cell filled with a pentane standard gas mixture provided by TCEQ/REFINERY. The measurements were made by placing the gas cell in the output transmitted beam. This introduces an absorption into the DIAL signal at zero range, which has the effect of introducing an offset in the signals, equivalent to the total concentration-pathlength of the gas in the cell. The differential absorption for pentane at the wavelengths used for the VOC DIAL measurements was determined from the NPL quantified spectral database, and this was used to calculate the concentration of pentane in the gas cell. In addition a number of other gas cell measurements were made of propane and benzene.

The results of these measurements are given in Table A1.3 below. These present the means of a series of measurements made of the gas cells on different days.

Date	Scans	Cell	Measured column	Concentration (ppm)	
				Predicted	Actual
27/07/2007	110-112	10 cm propane	0.57 ± 0.04	8180 ± 530	8413
27/07/2007	117-123	10 cm pentane	1.16 ± 0.12	7100 ± 700	7500
30/07/2007	222-223	10cm pentane	1.34 ± 0.20	8200 ± 1200	7500
07/08/2007	371-372	10cm pentane	1.24 ± 0.01	7600 ± 100	7500
17/08/2007	557-558	20cm benzene	0.09	900 ± 70	1000

Table A1.3, Measurements of gas cell concentrations.
The uncertainty figures are based on the standard deviation of the individual measurements.

NPL open-path calibration facility

NPL has also developed and operate a full-scale facility for the calibration of open path monitors, including DIAL. This consists of a 10 m long windowless cell able to maintain a uniform, independently-monitored concentration of a gaseous species along its length. This provides a known controlled section of the atmosphere with traceable concentration over a defined range (10m). The absence of windows removes reflections and other artefacts from measurements made using optical techniques, providing a direct way to validate and assess the calibration of DIAL instruments.

The calibration facility is windowless with a 1 m diameter, to minimise any beam reflections from the cell walls and ends. At each end of the cell is an annular calibration-gas feed ring with multiple outlets injecting the calibration gas mixture into the cell. A ring of tangential fans around the centre of the cell extract gas and entrained air pulled in through the open ends of the cell. This ensures the backscatter in the cell approximates to the ambient air conditions. Each fan has a long exhaust tube to avoid recirculation of the gas into the cell.

This facility has been employed to directly validate VOC measurements by the NPL DIAL facility [2].

Figure A1.1 The NPL 10m calibration cell.

The facility provides the ability to generate a defined concentration path and so it also provides range-resolution validation for DIAL and lidar instruments. The system was used to validate the DIAL with a number of measurements of propane and methane, as a part of its acceptance tests for Siemens, Shell and British Gas.

[1] Measurements of the Emissions to Atmosphere of Volatile Organic Compounds from the Hellenic Aspropyrgos Oil Refinery; T D Gardiner, M.J.T. Milton, R.A. Robinson, P.T.Woods, A.S.Andrews, H. D’Souza, D Alfonso, N.R Swann; NPL Report QM S99, Sept 1996

[2] Calibration of DIAL and Open Path Systems Using External Gas Cells; M.J.T. Milton, P.T. Woods, R.H. Partridge, B.A Goody; Proc. Europto, Munich 1995.

Annex 2 Speciated VOC measurements and Flux Correction Factors

The DIAL measures VOCs by measuring the differential absorption of two wavelengths of light. The wavelengths used, at around 3000 cm-1, are chosen to measure, in effect, the C-H stretch in the hydrocarbons for C3 and above. The sensitivity of the DIAL is slightly different to different hydrocarbons, and for example an oxygenated hydrocarbon will give a different absorption per mass than a straight chain alkane. The differential absorption strength used was calibrated to give a mass emission rate for a gasoline vapour. A different 'cocktail' of hydrocarbons would give a slightly different response per unit mass. Air samples were taken at locations which would provide an indication of the actual speciation of the emission fluxes sampled by the DIAL. If the actual (relative) composition is known, from the air sample analyses, then by determining the absorption of each constituent it is possible to determine a correction factor which will provide the true 'mass value' assuming the emissions measured have a similar relative composition to the sampled air.

Flux Correction Factors

The multi-component analysis of the ambient air sample results was used to determine the differential absorption coefficient (in m^2g-1) for the particular cocktail of hydrocarbons in each sample. This was done by taking the differential absorption coefficient for each species from the NPL quantified database of the infrared absorption of industrial organic species, and scaling it by the mass-fraction of that species in the sample. The standard DIAL differential absorption coefficient for VOC measurements is 0.49 m2g-1, based on the infrared absorption of gasoline vapour.

These results are summarised in Table A2.1, which show the differential absorption coefficients, and the factor by which the standard DIAL VOC flux results need to be multiplied by to take into account the particular VOC mix present.

Sample	Tube	
	diff abs	flux factor
DTTS1	0.62	0.8
DTTS2	0.39	1.3
DTTS3	0.55	0.9
DTTS4	0.31	1.6
DTTS5	0.29	1.7
DTTS6	0.41	1.2
DTTS7	0.37	1.3
DTTS8	0.41	1.2
DTTS9	0.44	1.1
DTTS10	0.46	1.1
DTTS11	0.24	2.0
DTTS12	0.43	1.1
DTTS13	0.24	2.1
DTTS14	0.50	1.0
DTTS15	0.44	1.1
DTTS16	0.47	1.0

Table A2.1. Flux correction factors determined from each of the air samples.

Air samples were taken at a number of locations around the plants. Figures A2.1, A2.2, A2.3 and A2.4 show the locations of the samples. The Air samples were taken using SUMO canisters and pumped Perkin Elmer Automatic Thermal Desorption (ATD) tubes.

The ATD tubes were sampled at a flow rate of 40ml/min, to enable a comparison between the SUMO canisters and the ATD tubes; a flow restrictor was fitted to canister, so each sample was taken over the same time period.

The sampler tubes are approximately 6mm OD and length 90mm long. The sampler tubes contained approximately 200milligrams to 300 milligrams of sorbent. Two sorbent tubes were used in series containing two sorbent materials used, a porous polymer (Tenax TA) and a carbon black (Carbopack X). Different sorbents are needed to cover the diverse boiling point ranges and chemical functional groups of VOCs.

The SUMO canister analysis gave results in the Carbon number range of C_2-C_{10}, whilst the linked ATD tubes containing Tenax TA and Carbopack-X gave a Carbon number range of C_4-C_{22}

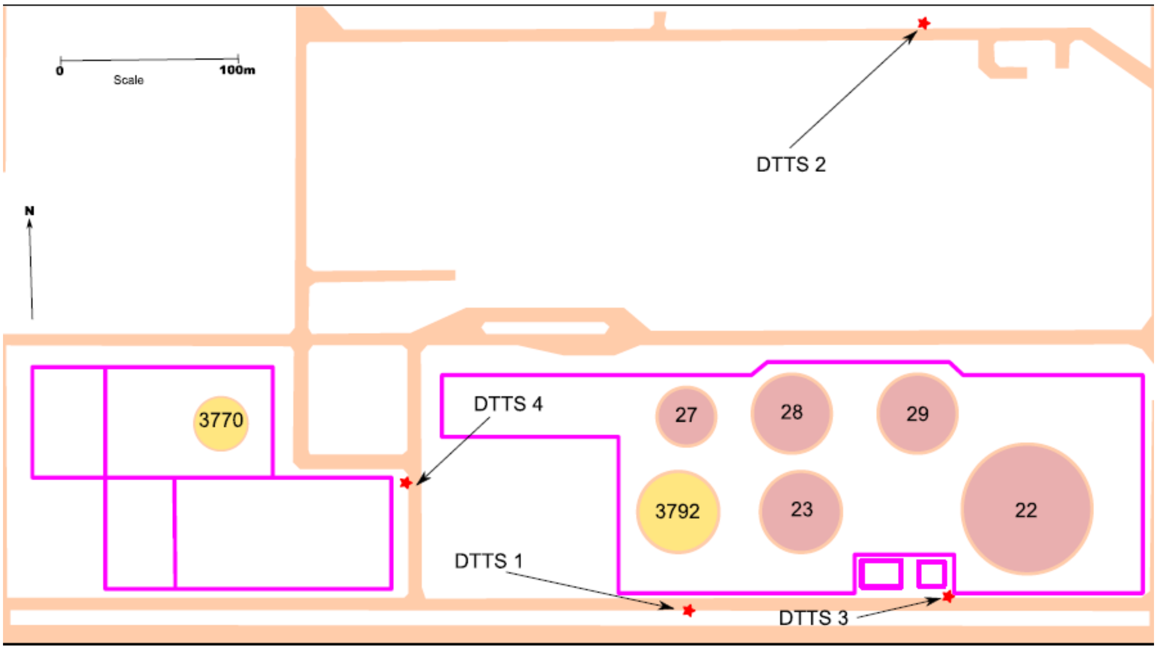


Figure A2.1 Location of air samples around the naphtha tanks at the Bulk Terminal

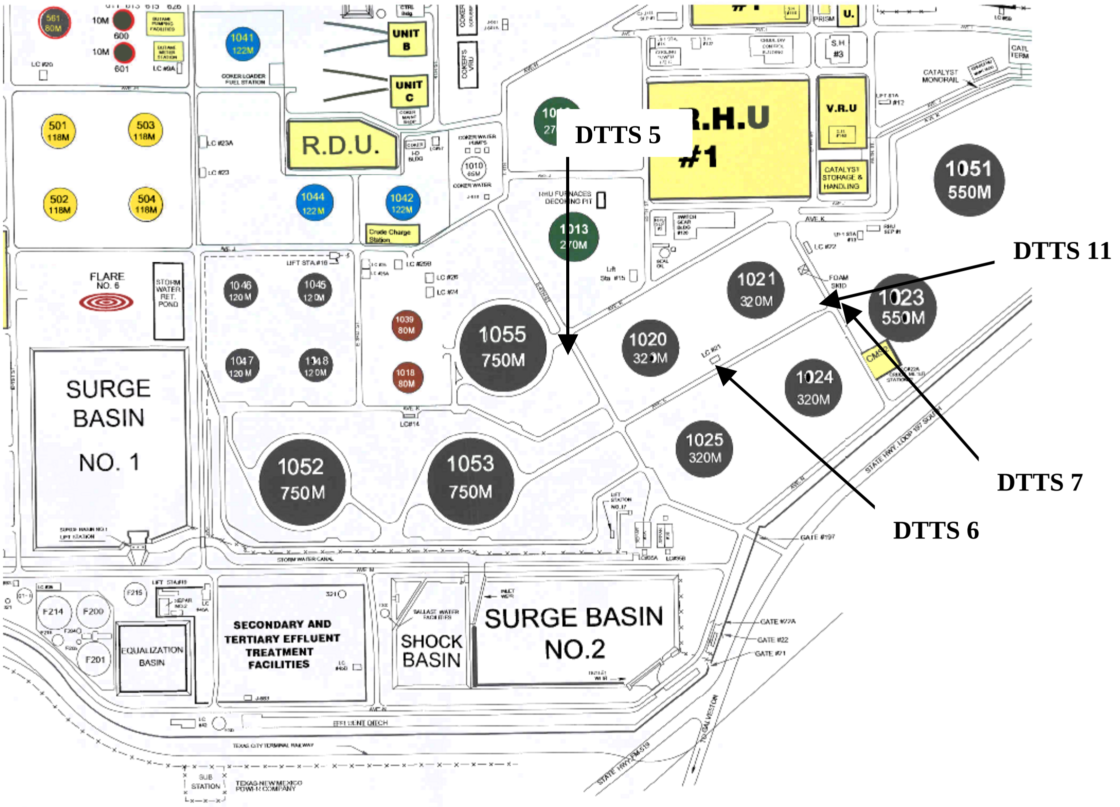


Figure A2.2 Location of air samples in the crude oil storage areas at the Refinery.

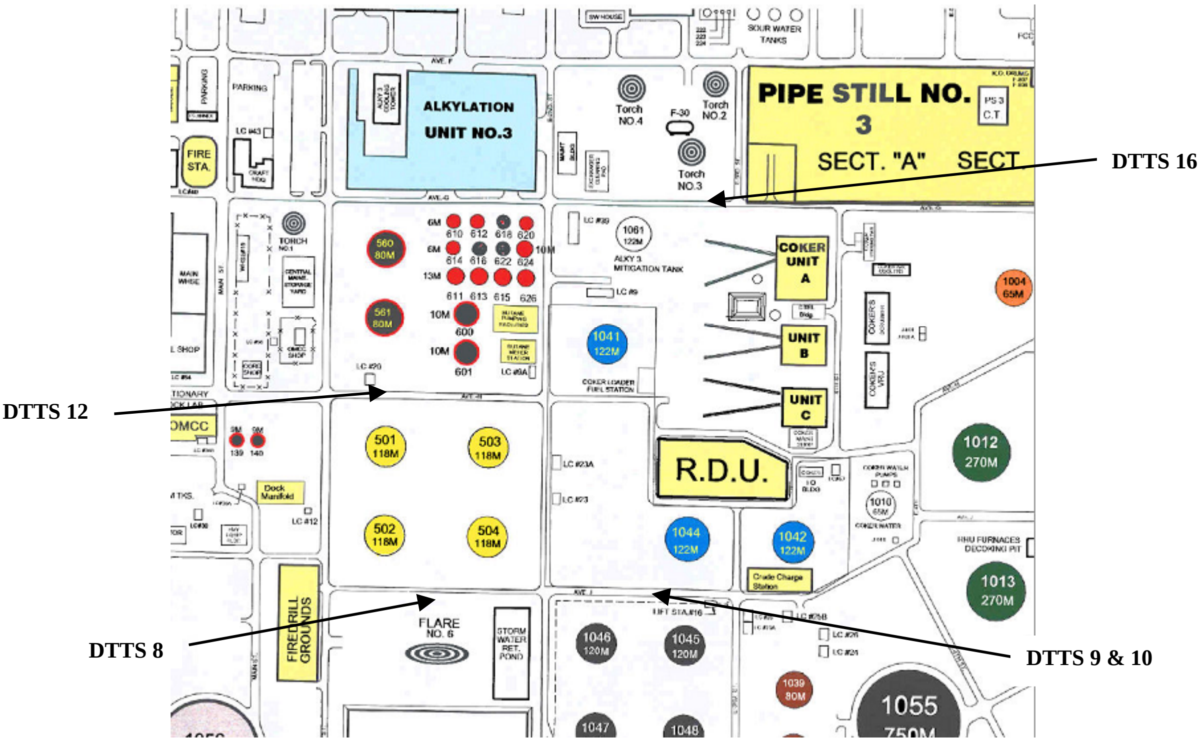


Figure A2.3 Location of air samples in the gasoline tanks and coker areas at the Refinery.

Checked by: RA Robson

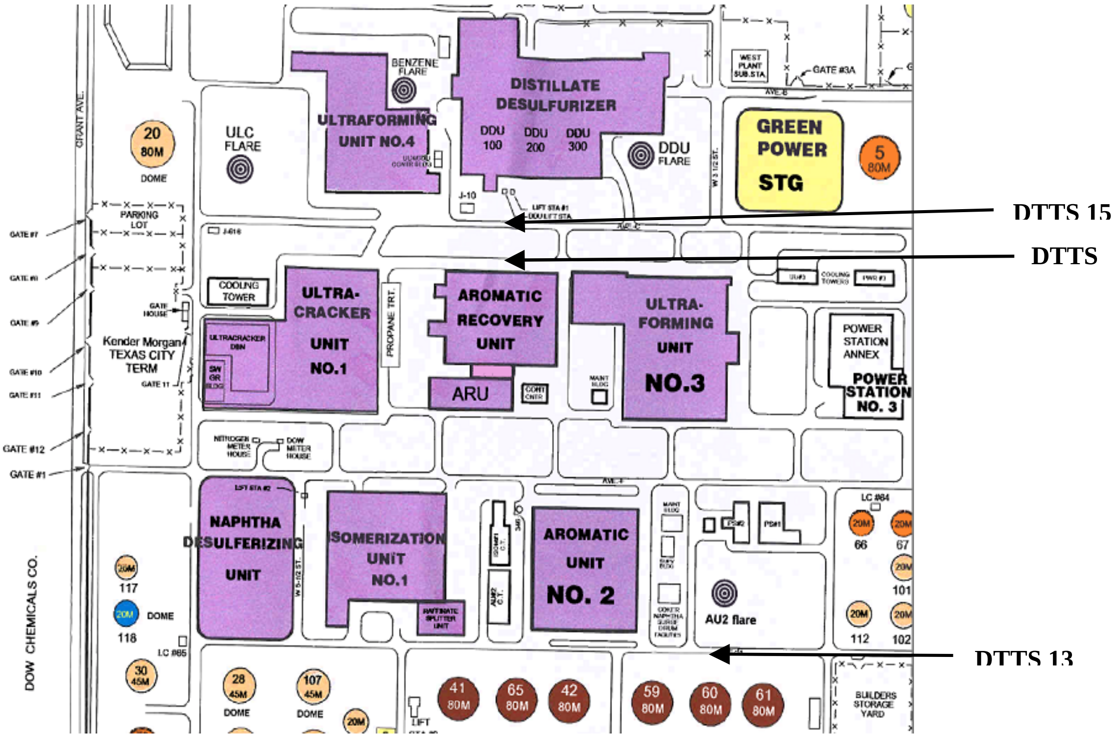
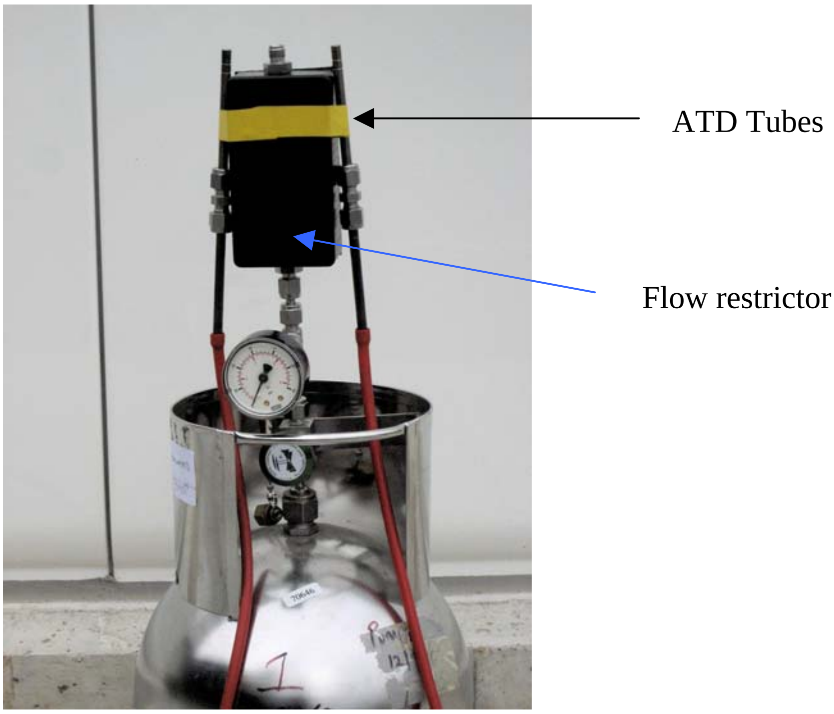


Figure A2.4 Location of air samples in the gasoline tanks and coker areas at the Refinery.

Checked by:

Sampling Procedure

The ATD tubes were attached to the flow restrictor so as the tubes were at the same height as the top of flow restrictors sample entry point.



The samples were taken at a height of approximately 2m by mounting the sampling array on a Tripod. The samples were taken by opening the valve on the SUMO canister and starting the sampling pumps. The flow restrictors had been set so as they sampled over a period of 1.25 hours.

Analysis of the ATD tubes

The method of analysis was based on EN ISO 16017-2 [1] and was carried out using UKAS (United Kingdom Accreditation Service) accredited method QPDQM/B/526. This method combines Automatic Thermal Desorption with Gas Chromatography, with a Flame Ionisation Detector [1]

The analysis instrument used is an Automated Thermal Desorber autosampler coupled to a Gas Chromatograph usually with a flame ionisation detector. The VOCs are released from the sampler tube using a heated oven in an inert gas stream of helium. The VOCs are refocused onto a small cold trap prior to transfer onto the gas chromatography column. Generally a coated fused silica gas chromatography column of diameter 320 micrometers and length 60 meters is used to separate the individual VOCs collected. Using VOC standard materials, the identification of the individual VOC components are compared to the column elution time (retention time) of the standard VOC materials. The mass of VOCs collected is quantified using the flame ionisation detector. A series of calibrations standards are used to calibrate the flame ionisation detector response. The concentration of the VOC in ambient air is then calculated using from the mass collected and the volume of air sampled.

Tables A2.2 and A2.3 present the results from the canister and tube analyses respectively. The tube analyses were carried out by NPL's in house accredited analysis laboratory, the canister samples were analysed by EAS Environmental Analytical Service, Inc, California.

Table A2.2 Full results of the speciation analyses on the Canister Samples.

Sample No.	DTTS1	DTTS2	DTTS3	DTTS4	DTTS5	DTTS6	DTTS7	DTTS8
Date	17-Jul-07	18-Jul-07	19-Jul-07	21-Jul-07	28-Jul-07	28-Jul-07	29-Jul-07	30-Jul-07
Start time	17:17	16:20	12:31	03:57	14:25	14:40	16:56	16:39
End time	18:09	17:27	13:44	05:06	15:47	16:00	18:12	17:51
Average Wind Direction/deg	164	128	322	95	170	174	149	159
Average Wind Speed/mph	4.5	2.4	4.6	2.3	4.3	4.3	3.9	4.2
Cannister Number	169	610	708	881	190	996	762	606
Species	ppb V	ppb V	ppb V	ppb V	ppb V	ppb V	ppb V	ppb V
Ethene	<1.93	<1.91	4.76	<1.91	<1.96	<1.94	<2.00	20.24
Acetylene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Ethane	<1.93	1.98	15.93	3.14	2.83	10.86	7.01	223.95
Propene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Propane	<1.93	6.32	10.65	2.15	<1.96	5.45	12.16	23.61
I-Butane	3.73	5.17	12.74	8.22	6.02	16.72	8.00	72.47
Methanol	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1-Butene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1,3-Butadiene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	4.88
n-Butane	<1.93	<1.91	24.44	2.43	<1.96	3.97	6.69	11.16
t-2-Butene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	4.70
c-2-Butene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Ethanol	<1.93	<1.91	<2.09	7.52	<1.96	<1.94	<2.00	2402.7
3-Methyl-1-butene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Acetone	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
i-Pentane	323.89	5.67	63.51	17.78	4.80	26.94	8.13	36.51
1-Pentene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Isopropanol	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2-Methyl-1-butene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
n-Pentane	<1.93	<1.91	38.65	<1.91	<1.96	2.65	2.35	39.77
Isoprene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
t-2-Pentene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
c-2-Pentene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Tert butyl alcohol	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2-Methyl-2-butene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2,2-Dimethylbutane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Cyclopentene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
n-Propanol	<1.93	<1.91	2.78	<1.91	<1.96	<1.94	<2.00	4.66
Cyclopentane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Methyl tert butyl ether	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2,3-Dimethylbutane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2-Methylpentane	<1.93	<1.91	8.13	<1.91	<1.96	<1.94	<2.00	<2.06
3-Methylpentane	<1.93	<1.91	5.33	<1.91	<1.96	<1.94	<2.00	<2.06
1-Hexene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
n-Hexane	<1.93	<1.91	10.26	<1.91	<1.96	<1.94	<2.00	12.04
Diisopropyl ether	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
3-Methylcyclopentene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Ethyl tert butyl ether	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Methylcyclopentane	<1.93	<1.91	3.77	<1.91	<1.96	<1.94	<2.00	<2.06
2,4-Dimethylpentane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Benzene	<1.93	<1.91	3.17	<1.91	<1.96	<1.94	5.19	<2.06
Cyclohexane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2-Methylhexane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2,3-Dimethylpentane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
3-Methylhexane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2-Methyl-1-hexene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06

Sample No.	DTTS1	DTTS2	DTTS3	DTTS4	DTTS5	DTTS6	DTTS7	DTTS8
Date	17-Jul-07	18-Jul-07	19-Jul-07	21-Jul-07	28-Jul-07	28-Jul-07	29-Jul-07	30-Jul-07
Start time	17:17	16:20	12:31	03:57	14:25	14:40	16:56	16:39
End time	18:09	17:27	13:44	05:06	15:47	16:00	18:12	17:51
Average Wind Direction/deg	164	128	322	95	170	174	149	159
Average Wind Speed/mph	4.5	2.4	4.6	2.3	4.3	4.3	3.9	4.2
Cannister Number	169	610	708	881	190	996	762	606
Tert amyl methyl ether	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2,2,4-Trimethylpentane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
n-Heptane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Methylcyclohexane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2,5-Dimethylhexane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2,4-Dimethylhexane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2,3,4-Trimethylpentane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Toluene	<1.93	<1.91	3.03	<1.91	1.99	<1.94	3.35	28.65
2,3-Dimethylhexane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2-Methylheptane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
4-Methylheptane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2-Ethyl-3-methylpentane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
3-Methylheptane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2-Methyl-1-heptane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
n-Octane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	2.12
Ethylbenzene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
m,p-xylene	<1.93	2.74	<2.09	<1.91	<1.96	<1.94	<2.00	2.84
Styrene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
o-xylene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1-Nonene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
n-Nonane	<1.93	4.09	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
i-Propylbenzerne	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
n-Propylbenzerne	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
a-Pinene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
3-Ethyltoluene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
4-Ethyltoluene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1,3,5-Trimethylbenzene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
2-Ethyltoluene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
b-Pinene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1,2,4-Trimethylbenzene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	2.07	<2.06
n-Decane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1,2,3-Trimethylbenzene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	2.28
Indan	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
d-Limonene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1,3-Diethylbenzene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1,4-Diethylbenzene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
n-Butylbenzene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1,4-Dimethyl-2-ethylbenzene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1,3-Dimethyl-4-ethylbenzene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1,2-Dimethyl-4-ethylbenzene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Undecane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1,2,4,5-Tetramethylbenzene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
1,2,3,5-Tetramethylbenzene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Napthalene	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06
Dodecane	<1.93	<1.91	<2.09	<1.91	<1.96	<1.94	<2.00	<2.06

Sample No.	DTTS9	DTTS10	DTTS11	DTTS12	DTTS13	DTTS14	DTTS15	DTTS16
Date	3-Aug-07	3-Aug-07	5-Aug-07	6-Aug-07	7-Aug-07	17-Aug-07	17-Aug-07	18-Aug-07
Start time	13:30	15:37	04:48	04:30	04:55	17:53	17:29	20:05
End time	14:47	17:28	06:03	05:54	06:19	18:58	18:30	20:57
Average Wind Direction/deg	84	113	183	140	201	131	131	128
Average Wind Speed/mph	4.3	5	3.4	2.6	2	4.4	4.7	2.4
Cannister Number	2968	711	782	2962	2970	758	732	656

Species	ppb V	ppb V	ppb V	ppb V	ppb V	ppb V	ppb V	ppb V
Ethene	9.65	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Acetylene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Ethane	24.58	27.98	5.36	117.36	3.35	9.17	6.96	15.92
Propene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Propane	28.92	14.99	8.47	48.25	80.36	13.33	16.46	10.30
I-Butane	15.23	9.19	7.12	39.59	5.26	20.06	15.94	5.97
Methanol	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
1-Butene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
1,3-Butadiene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	3.09	<2.00
n-Butane	16.33	9.88	4.99	64.73	<1.93	11.47	29.96	5.95
t-2-Butene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
c-2-Butene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Ethanol	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
3-Methyl-1-butene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Acetone	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
i-Pentane	19.88	<1.97	<1.94	<1.96	8.87	53.05	110.80	16.86
1-Pentene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Isopropanol	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2-Methyl-1-butene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
n-Pentane	<1.94	<1.97	<1.94	<1.96	<1.93	4.64	39.57	11.68
Isoprene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
t-2-Pentene	<1.94	<1.97	<1.94	2.85	<1.93	<2.00	<1.88	<2.00
c-2-Pentene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Tert butyl alcohol	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2-Methyl-2-butene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2,2-Dimethylbutane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	5.39	<2.00
Cyclopentene	<1.94	2.91	<1.94	9.48	<1.93	<2.00	<1.88	<2.00
n-Propanol	<1.94	2.11	<1.94	2.86	<1.93	<2.00	<1.88	<2.00
Cyclopentane	<1.94	<1.97	<1.94	<1.96	<1.93	2.25	<1.88	<2.00
Methyl tert butyl ether	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2,3-Dimethylbutane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2-Methylpentane	<1.94	<1.97	<1.94	<1.96	<1.93	5.21	<1.88	10.70
3-Methylpentane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	5.76
1-Hexene	2.88	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
n-Hexane	<1.94	<1.97	<1.94	<1.96	6.72	<2.00	<1.88	<2.00
Diisopropyl ether	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
3-Methylcyclopentene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Ethyl tert butyl ether	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Methylcyclopentane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2,4-Dimethylpentane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Benzene	<1.94	<1.97	<1.94	<1.96	4.58	<2.00	<1.88	<2.00
Cyclohexane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2-Methylhexane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2,3-Dimethylpentane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	7.20
3-Methylhexane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2-Methyl-1-hexene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00

Sample No.	DTTS9	DTTS10	DTTS11	DTTS12	DTTS13	DTTS14	DTTS15	DTTS16
Date	3-Aug-07	3-Aug-07	5-Aug-07	6-Aug-07	7-Aug-07	17-Aug-07	17-Aug-07	18-Aug-07
Start time	13:30	15:37	04:48	04:30	04:55	17:53	17:29	20:05
End time	14:47	17:28	06:03	05:54	06:19	18:58	18:30	20:57
Average Wind Direction/deg	84	113	183	140	201	131	131	128
Average Wind Speed/mph	4.3	5	3.4	2.6	2	4.4	4.7	2.4
Cannister Number	2968	711	782	2962	2970	758	732	656
Tert amyl methyl ether	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2,2,4-Trimethylpentane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
n-Heptane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	5.54	<2.00
Methylcyclohexane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2,5-Dimethylhexane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2,4-Dimethylhexane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2,3,4-Trimethylpentane	3.92	<1.97	2.58	<1.96	<1.93	<2.00	<1.88	<2.00
Toluene	<1.94	<1.97	<1.94	<1.96	1.96	12.26	20.52	2.11
2,3-Dimethylhexane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2-Methylheptane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
4-Methylheptane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2-Ethyl-3-methylpentane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
3-Methylheptane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2-Methyl-1-heptane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
n-Octane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	2.09	<2.00
Ethylbenzene	<1.94	<1.97	<1.94	<1.96	<1.93	2.04	2.46	<2.00
m,p-xylene	<1.94	<1.97	<1.94	<1.96	<1.93	5.51	8.49	<2.00
Styrene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
o-xylene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	2.59	<2.00
1-Nonene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
n-Nonane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
i-Propylbenzerne	<1.94	2.13	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
n-Propylbenzerne	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
a-Pinene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
3-Ethyltoluene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
4-Ethyltoluene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
1,3,5-Trimethylbenzene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
2-Ethyltoluene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
b-Pinene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
1,2,4-Trimethylbenzene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	2.06	<2.00
n-Decane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
1,2,3-Trimethylbenzene	2.54	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Indan	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
d-Limonene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
1,3-Diethylbenzene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
1,4-Diethylbenzene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
n-Butylbenzene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
1,4-Dimethyl-2-ethylbenzene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
1,3-Dimethyl-4-ethylbenzene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
1,2-Dimethyl-4-ethylbenzene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Undecane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
1,2,4,5-Tetramethylbenzene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
1,2,3,5-Tetramethylbenzene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Napthalene	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00
Dodecane	<1.94	<1.97	<1.94	<1.96	<1.93	<2.00	<1.88	<2.00

Checked by: R A Robson

Table A2.3 Full results of the speciation analyses on the Sorbent Tube Samples.

Sample No.	TRV BLK A	TRV BLK B	DTTS1	DTTS2	DTTS3	DTTS4	DTTS5
Date			17-Jul-07	18-Jul-07	19-Jul-07	21-Jul-07	28-Jul-07
Start time			17:17	16:20	12:31	03:57	14:25
End time			18:09	17:27	13:44	05:06	15:47
Sample Volume/ml			2500.5	3230.8	2970.4	3297.5	3948.6
Average Wind Direction/deg			164	128	322	95	170
Average Wind Speed/mph			4.5	2.4	4.6	2.3	4.3
	ppb v/v	ppb v/v	ppb v/v	ppb v/v	ppb v/v	ppb v/v	ppb v/v
i-Butane	0.8	0.7	4.4	1.6	13.1	7.5	2.4
n-Butane	<0.6	<0.6	<0.6	0.6	19.3	1.0	<0.6
trans-2-Butene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1-Butene	<0.6	<0.6	<0.6	<0.6	0.8	<0.6	<0.6
2-methylpropene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
cis-2-butene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1,3 Butadiene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
i-pentane	<0.6	<0.6	60.8	0.9	13.7	1.9	0.6
1-pentene	<0.6	<0.6	2.8	<0.6	0.9	<0.6	<0.6
2 me-1-butene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
isoprene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-pentane	<0.6	<0.6	<0.6	1.4	34.6	1.1	<0.6
cis-2-pentene (Z)-	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
trans-2-pentene (E)-	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1,2 dime cyclopropane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2,2-di me butane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
cyclo pentene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
4-me-1-pentene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2,3-di me butane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
cyclo pentane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2-me pentane	<0.6	<0.6	<0.6	<0.6	7.1	<0.6	<0.6
4-me-cis-2-pentene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
4-me-trans-2-pentene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
3-me pentane	<0.6	<0.6	<0.6	<0.6	3.6	<0.6	<0.6
1-hexene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-hexane	<0.6	<0.6	6.5	<0.6	11.8	<0.6	<0.6
cis-2-hexene (Z)-	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
trans-3-hexene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
trans-2-hexene (E)-	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
methylcyclopentane	<0.6	<0.6	<0.6	<0.6	3.0	<0.6	<0.6
2,4 di me pentane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2,2,3-trimethyl-1-butene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2,2,3-tri-me butane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
benzene	<0.2	<0.2	0.2	0.2	5.0	1.8	0.2
cyclohexane	<0.6	<0.6	<0.6	<0.6	1.5	<0.6	<0.6
2-methyl hexane	<0.6	<0.6	<0.6	<0.6	1.2	<0.6	<0.6
2,3 di me pentane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
3-me hexane	<0.6	<0.6	<0.6	<0.6	1.6	<0.6	<0.6
cyclohexene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1-heptene	<0.6	<0.6	<0.6	<0.6	0.9	<0.6	<0.6
2,2,4 tri me pentane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-heptane	<0.6	<0.6	<0.6	<0.6	2.3	<0.6	<0.6
methylcyclohexane	<0.6	<0.6	<0.6	<0.6	2.0	<0.6	<0.6
2,3,4 tri me pentane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2,3,3-tri me pentane	<0.6	<0.6	<0.6	<0.6	2.7	2.4	<0.6

Sample No.	TRV BLK A	TRV BLK B	DTTS1	DTTS2	DTTS3	DTTS4	DTTS5
Date			17-Jul-07	18-Jul-07	19-Jul-07	21-Jul-07	28-Jul-07
Start time			17:17	16:20	12:31	03:57	14:25
End time			18:09	17:27	13:44	05:06	15:47
Sample Volume/ml			2500.5	3230.8	2970.4	3297.5	3948.6
Average Wind Direction/deg			164	128	322	95	170
Average Wind Speed/mph			4.5	2.4	4.6	2.3	4.3
	ppb v/v	ppb v/v	ppb v/v	ppb v/v	ppb v/v	ppb v/v	ppb v/v
toluene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2-methyl heptane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
4-methyl heptane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
cycloheptene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
cycloheptane	<0.6	<0.6	<0.6	<0.6	1.0	<0.6	<0.6
n-octane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
ethylbenzene	<0.6	<0.6	<0.6	<0.6	1.5	<0.6	<0.6
m/p-xylene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2 me octane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
3 me octane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
styrene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
o-xylene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
nonane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
cis-cyclooctene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
isopropylbenzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
cyclooctane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-propylbenzene	<0.6	<0.6	<0.6	<0.6	<0.6	1.0	<0.6
3-ethyl toluene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
4-ethyl toluene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1,3,5 tri me benzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2-ethyl toluene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2-me nonene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1,2,4 tri me benzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-decane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1,2,3-Trimethylbenzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1,2,3,5-tetra me benzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-butyl benzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-undecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-pentylbenzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-dodecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
naphthalene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-tridecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-tetradecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-pentadecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-hexadecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-heptadecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-octadecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-nonadecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-cosane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-docosane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6

Sample No.	DTTS6	DTTS7	DTTS8	DTTS9	DTTS10	DTTS11	DTTS12
Date	28-Jul-07	29-Jul-07	30-Jul-07	3-Aug-07	3-Aug-07	5-Aug-07	6-Aug-07
Start time	14:40	16:56	16:39	13:30	15:37	04:48	04:30
End time	16:00	18:12	17:51	14:47	17:28	06:03	05:54
Sample Volume/ml	3927.9	3637.8	3409.8		5289	3600.9	3980.4
Average Wind Direction/deg	174	149	159	84	113	183	140
Average Wind Speed/mph	4.3	3.9	4.2	4.3	5	3.4	2.6
	ppb v/v	ppb v/v	ppb v/v	ppb v/v	ppb v/v	ppb v/v	ppb v/v
i-Butane	7.5	9.6	24.8	6.5	9.4	3.2	11.8
n-Butane	8.7	4.2	9.8	<0.6	13.8	3.4	21.6
trans-2-Butene	<0.6	<0.6	1.3	<0.6	<0.6	<0.6	1.1
1-Butene	<0.6	<0.6	1.4	<0.6	<0.6	<0.6	1.0
2-methylpropene	<0.6	<0.6	1.4	<0.6	<0.6	<0.6	0.9
cis-2-butene	<0.6	<0.6	1.0	<0.6	<0.6	<0.6	<0.6
1,3 Butadiene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
i-pentane	5.4	2.6	16.5	0.7	7.3	2.2	21.4
1-pentene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2 me-1-butene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
isoprene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-pentane	3.6	1.5	1.6	<0.6	6.4	0.8	4.0
cis-2-pentene (Z)-	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
trans-2-pentene (E)-	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1,2 dime cyclopropane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2,2-di me butane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
cyclo pentene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
4-me-1-pentene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2,3-di me butane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
cyclo pentane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2-me pentane	0.7	<0.6	<0.6	<0.6	0.8	<0.6	1.7
4-me-cis-2-pentene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
4-me-trans-2-pentene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
3-me pentane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	1.0
1-hexene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-hexane	0.9	<0.6	<0.6	<0.6	1.7	<0.6	1.9
cis-2-hexene (Z)-	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
trans-3-hexene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
trans-2-hexene (E)-	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
methylcyclopentane	0.6	<0.6	<0.6	<0.6	0.7	<0.6	1.1
2,4 di me pentane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2,2,3-trimethyl-1-butene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2,2,3-tri-me butane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
benzene	0.9	4.4	0.5	0.2	0.7	0.3	1.6
cyclohexane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2-methyl hexane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	0.7
2,3 di me pentane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
3-me hexane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	0.7
cyclohexene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1-heptene	<0.6	<0.6	0.9	<0.6	<0.6	<0.6	1.1
2,2,4 tri me pentane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-heptane	<0.6	<0.6	<0.6	<0.6	0.9	<0.6	<0.6
methylcyclohexane	0.6	4.8	<0.6	<0.6	0.8	<0.6	0.8
2,3,4 tri me pentane	<0.6	1.7	<0.6	<0.6	<0.6	<0.6	<0.6
2,3,3-tri me pentane	1.6	0.9	1.4	<0.6	0.8	1.5	2.1

Checked by:

Sample No.	**DTTS6**	**DTTS7**	**DTTS8**	**DTTS9**	**DTTS10**	**DTTS11**	**DTTS12**
Date	28-Jul-07	29-Jul-07	30-Jul-07	3-Aug-07	3-Aug-07	5-Aug-07	6-Aug-07
Start time	14:40	16:56	16:39	13:30	15:37	04:48	04:30
End time	16:00	18:12	17:51	14:47	17:28	06:03	05:54
Sample Volume/ml	3927.9	3637.8	3409.8		5289	3600.9	3980.4
Average Wind Direction/deg	174	149	159	84	113	183	140
Average Wind Speed/mph	4.3	3.9	4.2	4.3	5	3.4	2.6
	ppb v/v	ppb v/v	ppb v/v	ppb v/v	ppb v/v	ppb v/v	ppb v/v
toluene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2-methyl heptane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
4-methyl heptane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
cycloheptene	<0.6	<0.6	<0.6	<0.6	<0.6	10.0	<0.6
cycloheptane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-octane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
ethylbenzene	<0.6	<0.6	1.5	<0.6	<0.6	<0.6	1.4
m/p-xylene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2 me octane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
3 me octane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
styrene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
o-xylene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
nonane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
cis-cyclooctene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
isopropylbenzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
cyclooctane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-propylbenzene	0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
3-ethyl toluene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
4-ethyl toluene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1,3,5 tri me benzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
2-ethyl toluene	<0.6	<0.6	<0.6	<0.6	<0.6	1.3	<0.6
2-me nonene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1,2,4 tri me benzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-decane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1,2,3-Trimethylbenzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1,2,3,5-tetra me benzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-butyl benzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-undecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-pentylbenzene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-dodecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
naphthalene	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-tridecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-tetradecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-pentadecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-hexadecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-heptadecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-octadecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-nonadecane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-cosane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
n-docosane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6

Sample No.	DTTS13	DTTS14	DTTS15	DTTS16
Date	7-Aug-07	17-Aug-07	17-Aug-07	18-Aug-07
Start time	04:55	17:53	17:29	20:05
End time	06:19	18:58	18:30	20:57
Sample Volume/ml	4000.8	3217.6	2833.9	2532.6
Average Wind Direction/deg	201	131	131	128
Average Wind Speed/mph	2	4.4	4.7	2.4
	ppb v/v	ppb v/v	ppb v/v	ppb v/v
i-Butane	2.1	10.7	4.0	4.0
n-Butane	0.6	22.8	9.0	7.3
trans-2-Butene	<0.6	5.2	2.7	<0.6
1-Butene	<0.6	1.6	1.0	<0.6
2-methylpropene	<0.6	1.5	0.6	<0.6
cis-2-butene	<0.6	3.7	1.9	<0.6
1,3 Butadiene	<0.6	<0.6	<0.6	<0.6
i-pentane	1.0	82.2	37.6	8.1
1-pentene	1.1	0.8	0.6	<0.6
2 me-1-butene	<0.6	<0.6	<0.6	<0.6
isoprene	<0.6	7.7	2.8	4.2
n-pentane	<0.6	23.7	8.2	4.2
cis-2-pentene (Z)-	<0.6	3.1	1.3	<0.6
trans-2-pentene (E)-	<0.6	<0.6	<0.6	<0.6
1,2 dime cyclopropane	<0.6	3.8	1.5	<0.6
2,2-di me butane	<0.6	<0.6	<0.6	<0.6
cyclo pentene	<0.6	<0.6	<0.6	<0.6
4-me-1-pentene	<0.6	<0.6	<0.6	<0.6
2,3-di me butane	<0.6	2.0	0.7	<0.6
cyclo pentane	<0.6	<0.6	<0.6	<0.6
2-me pentane	2.7	11.4	4.2	1.6
4-me-cis-2-pentene	<0.6	<0.6	<0.6	<0.6
4-me-trans-2-pentene	0.8	<0.6	<0.6	<0.6
3-me pentane	<0.6	6.1	2.4	0.8
1-hexene	<0.6	<0.6	<0.6	<0.6
n-hexane	5.3	13.0	4.0	1.6
cis-2-hexene (Z)-	<0.6	<0.6	<0.6	<0.6
trans-3-hexene	<0.6	0.6	<0.6	<0.6
trans-2-hexene (E)-	<0.6	<0.6	<0.6	<0.6
methylcyclopentane	<0.6	7.5	2.0	<0.6
2,4 di me pentane	<0.6	<0.6	<0.6	<0.6
2,2,3-trimethyl-1-butene	<0.6	<0.6	<0.6	<0.6
2,2,3-tri-me butane	<0.6	<0.6	<0.6	<0.6
benzene	5.1	12.9	6.7	1.3
cyclohexane	<0.6	4.0	2.0	1.5
2-methyl hexane	<0.6	3.8	1.3	<0.6
2,3 di me pentane	<0.6	0.7	<0.6	<0.6
3-me hexane	0.7	4.1	1.6	<0.6
cyclohexene	<0.6	<0.6	<0.6	<0.6
1-heptene	<0.6	1.3	<0.6	<0.6
2,2,4 tri me pentane	<0.6	<0.6	<0.6	<0.6
n-heptane	<0.6	5.7	1.6	<0.6
methylcyclohexane	0.6	6.6	1.7	0.6
2,3,4 tri me pentane	<0.6	<0.6	<0.6	<0.6
2,3,3-tri me pentane	0.7	15.2	7.9	<0.6

Sample No.	DTTS13	DTTS14	DTTS15	DTTS16
Date	7-Aug-07	17-Aug-07	17-Aug-07	18-Aug-07
Start time	04:55	17:53	17:29	20:05
End time	06:19	18:58	18:30	20:57
Sample Volume/ml	4000.8	3217.6	2833.9	2532.6
Average Wind Direction/deg	201	131	131	128
Average Wind Speed/mph	2	4.4	4.7	2.4
	ppb v/v	ppb v/v	ppb v/v	ppb v/v
toluene	<0.6	<0.6	<0.6	<0.6
2-methyl heptane	<0.6	<0.6	<0.6	<0.6
4-methyl heptane	<0.6	1.3	<0.6	<0.6
cycloheptene	<0.6	3.3	<0.6	<0.6
cycloheptane	<0.6	<0.6	0.9	<0.6
n-octane	<0.6	2.2	1.8	<0.6
ethylbenzene	0.9	9.4	5.3	<0.6
m/p-xylene	<0.6	<0.6	<0.6	<0.6
2 me octane	<0.6	0.6	<0.6	<0.6
3 me octane	<0.6	<0.6	<0.6	<0.6
styrene	<0.6	3.1	1.5	<0.6
o-xylene	<0.6	1.6	<0.6	<0.6
nonane	<0.6	<0.6	<0.6	<0.6
cis-cyclooctene	<0.6	<0.6	<0.6	<0.6
isopropylbenzene	<0.6	<0.6	<0.6	<0.6
cyclooctane	<0.6	<0.6	<0.6	<0.6
n-propylbenzene	<0.6	0.6	<0.6	0.6
3-ethyl toluene	<0.6	<0.6	<0.6	<0.6
4-ethyl toluene	<0.6	0.7	<0.6	<0.6
1,3,5 tri me benzene	<0.6	<0.6	<0.6	<0.6
2-ethyl toluene	<0.6	0.6	<0.6	<0.6
2-me nonene	<0.6	1.3	<0.6	<0.6
1,2,4 tri me benzene	<0.6	0.9	<0.6	<0.6
n-decane	<0.6	0.7	<0.6	<0.6
1,2,3-Trimethylbenzene	<0.6	<0.6	<0.6	<0.6
1,2,3,5-tetra me benzene	<0.6	<0.6	<0.6	<0.6
n-butyl benzene	<0.6	0.8	<0.6	<0.6
n-undecane	<0.6	<0.6	<0.6	<0.6
n-pentylbenzene	<0.6	<0.6	<0.6	<0.6
n-dodecane	<0.6	<0.6	<0.6	<0.6
naphthalene	<0.6	<0.6	<0.6	<0.6
n-tridecane	<0.6	<0.6	0.6	<0.6
n-tetradecane	<0.6	<0.6	0.6	<0.6
n-pentadecane	<0.6	<0.6	<0.6	<0.6
n-hexadecane	<0.6	<0.6	<0.6	<0.6
n-heptadecane	<0.6	<0.6	<0.6	<0.6
n-octadecane	<0.6	<0.6	<0.6	<0.6
n-nonadecane	<0.6	<0.6	<0.6	<0.6
n-cosane	<0.6	<0.6	<0.6	<0.6
n-docosane	<0.6	<0.6	<0.6	<0.6

Checked by: RA Robson

Annex 3. Meteorological Measurements

Wind direction and speed were recorded during the DIAL measurements at one fixed location, at the north east of the Bulk Terminal site, and using a mast located on the DIAL facility itself. Two further meteorological stations were operated by TCEQ, located to the north and south of the REFINERY site (one of these stations was located at the southern side of Bulk Terminal during the period measurements were being made at Bulk Terminal). The NPL fixed mast provided wind speed and direction at two heights, ~ 3m and 11m. In general the fixed mast data have been used to derive the wind field for the DIAL flux measurements, though in some cases the DIAL wind has been used where it was observed to be more representative of local conditions.

The following series of plots present the wind roses, taken from the 11m wind vane mounted on the fixed meteorological mast.

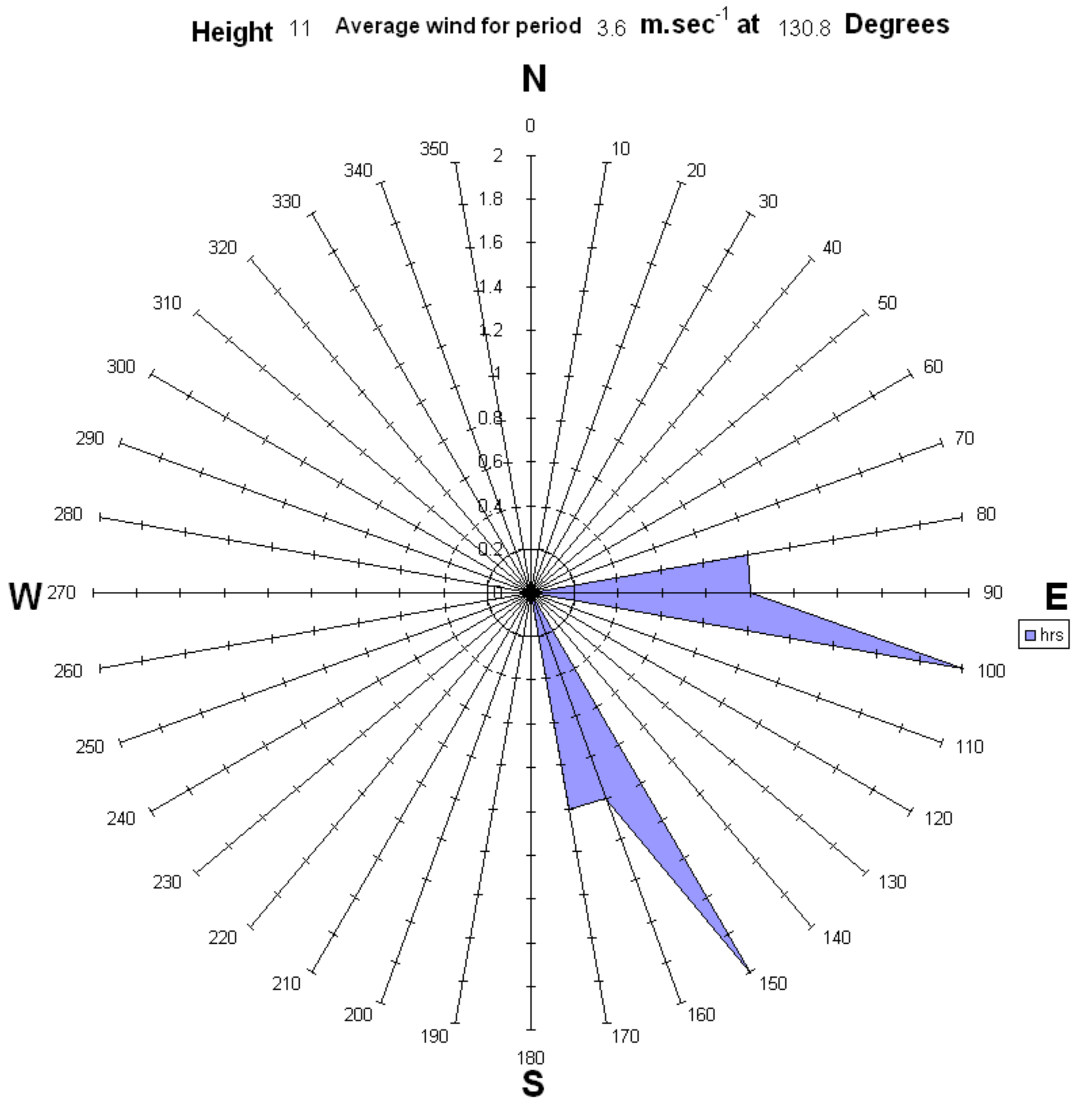


Figure 3.1 Wind rose diagram – top mast – 16 July 2007

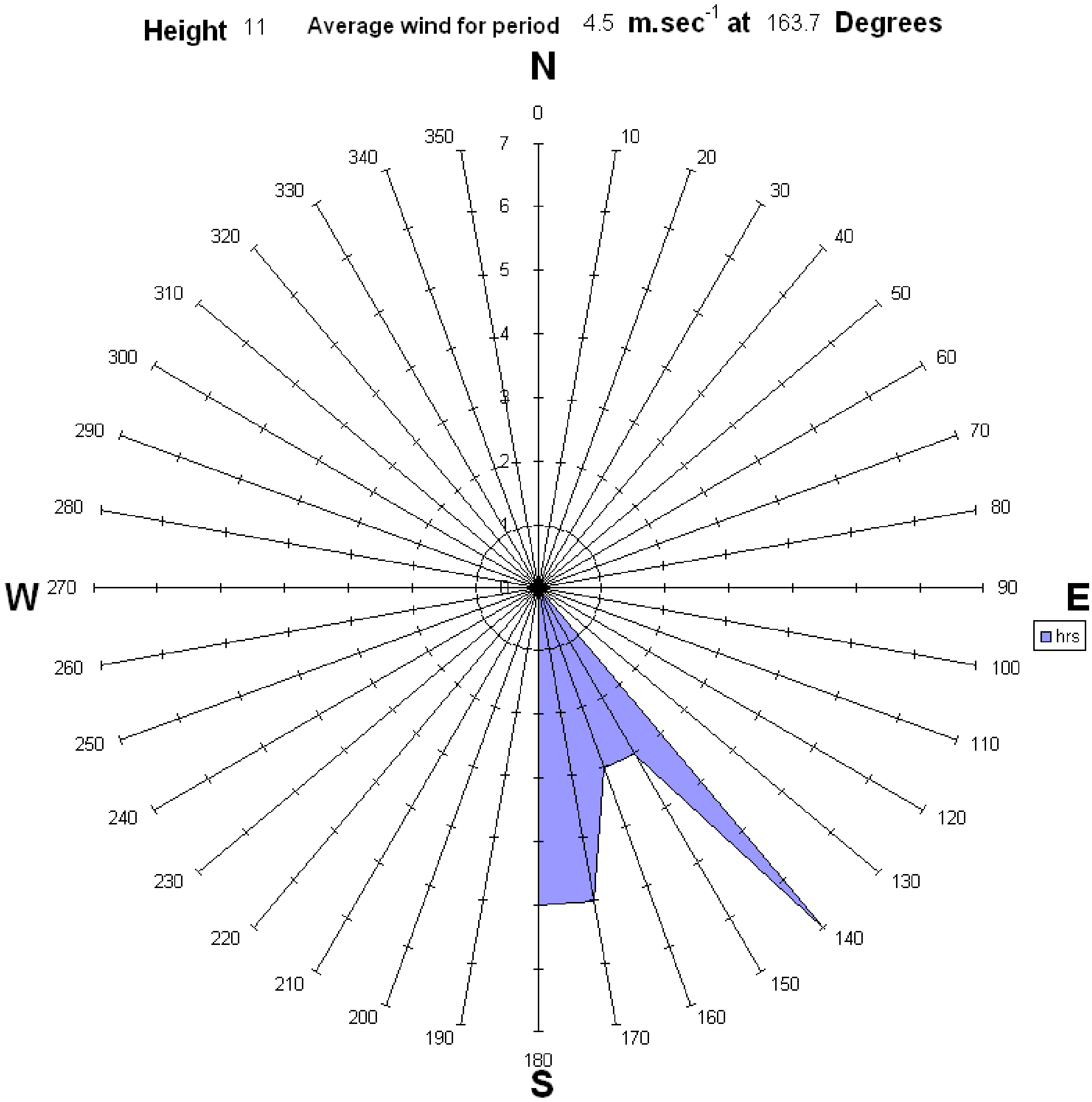


Figure 3.2 Wind rose diagram – top mast – 17 July 2007

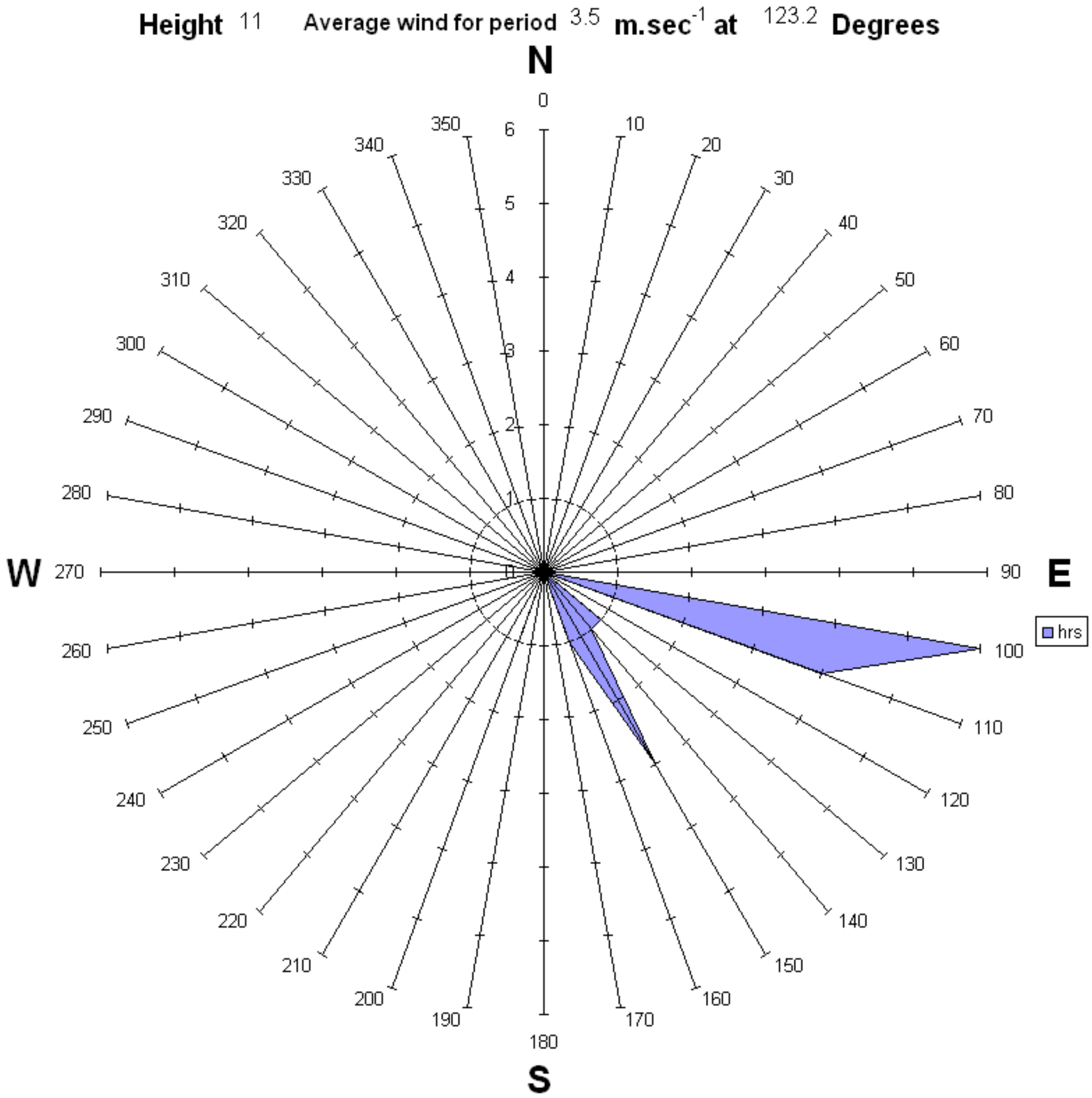


Figure 3.3 Wind rose diagram – top mast – 18 July 2007

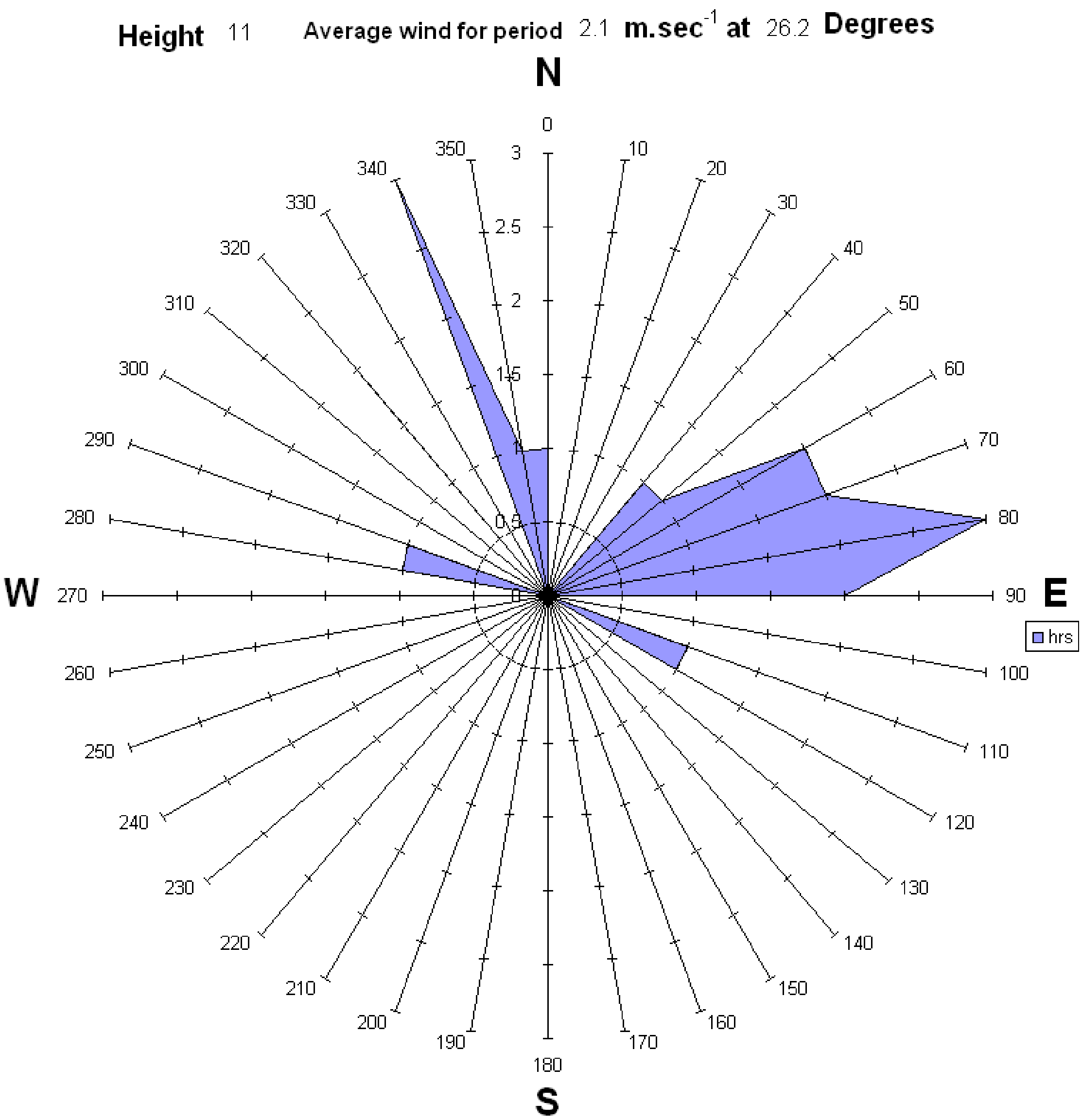


Figure 3.4 Wind rose diagram – top mast – 19 July 2007

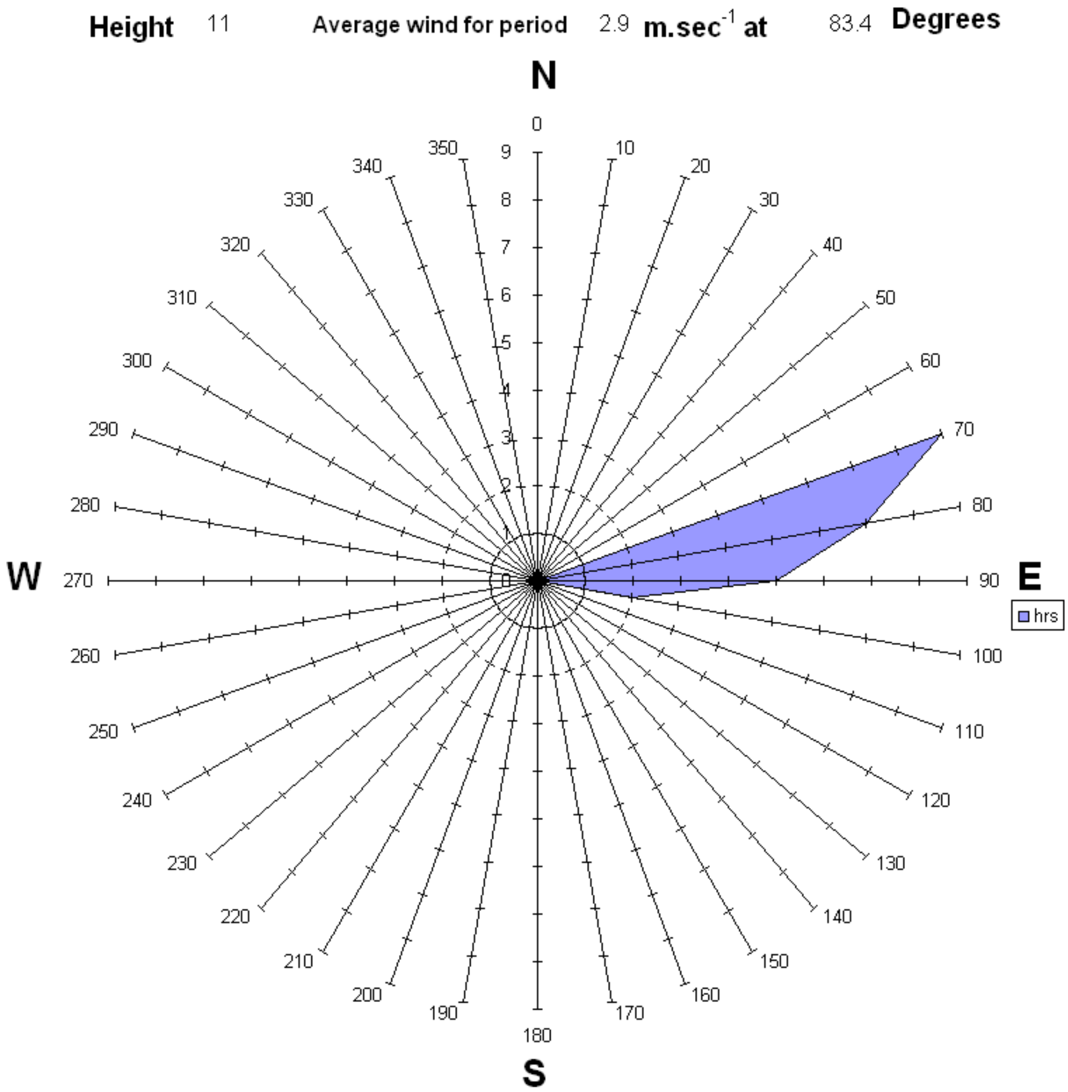


Figure 3.5 Wind rose diagram – top mast – 20 & 21 July 2007

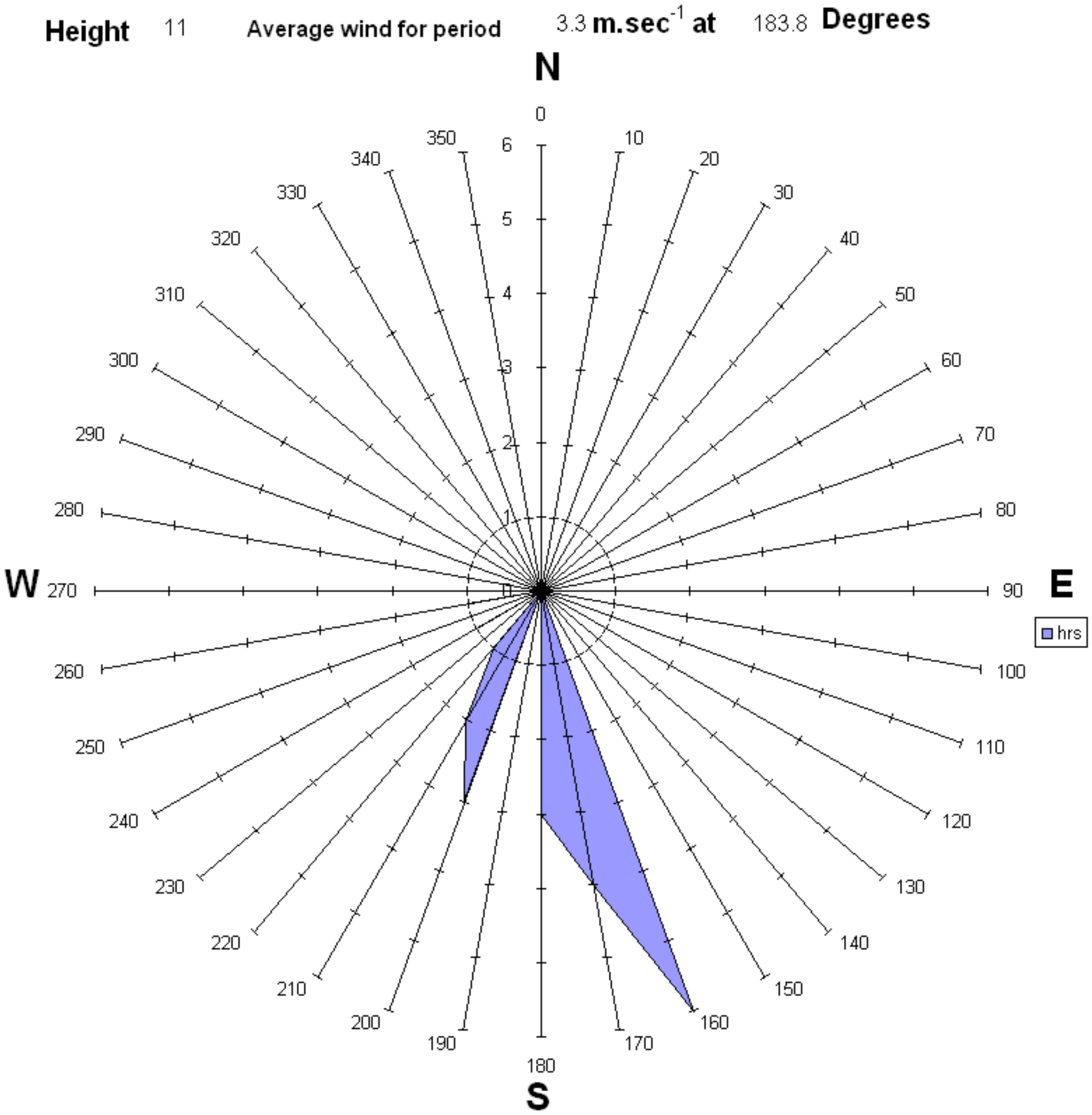


Figure 3.6 Wind rose diagram – top mast – 28 July 2007

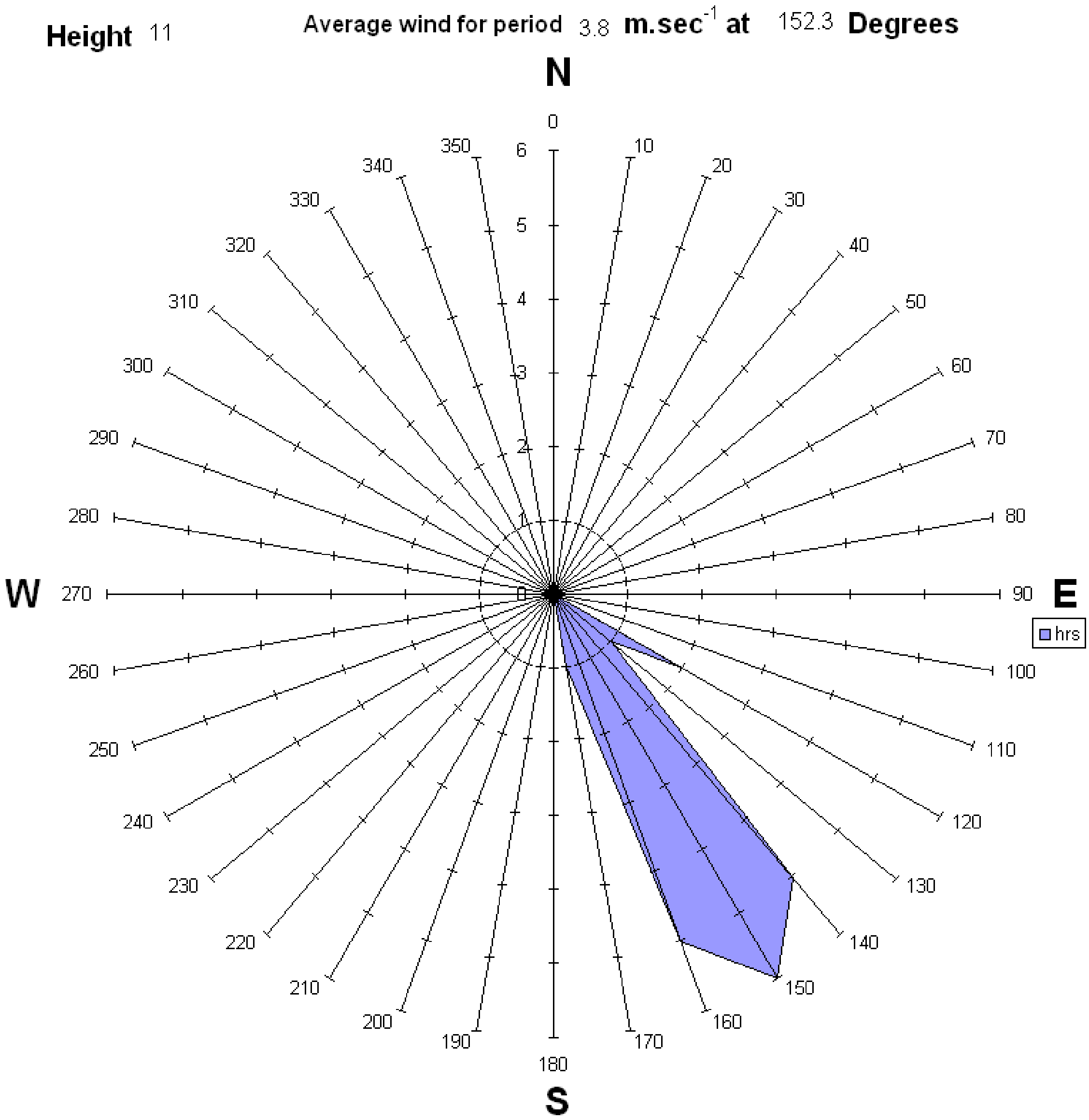


Figure 3.7 Wind rose diagram – top mast – 29 July 2007

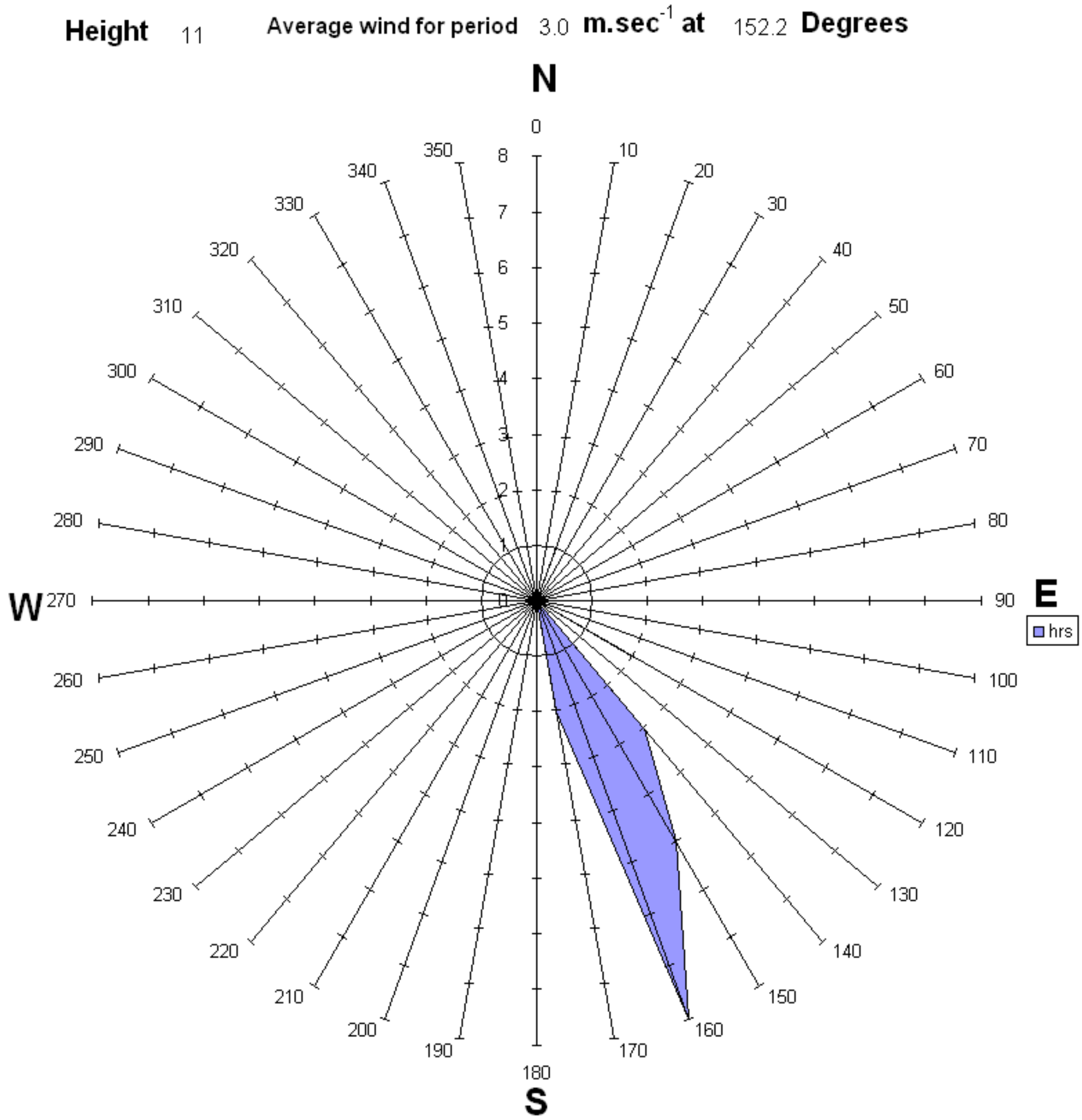


Figure 3.8 Wind rose diagram – top mast – 30 July 2007

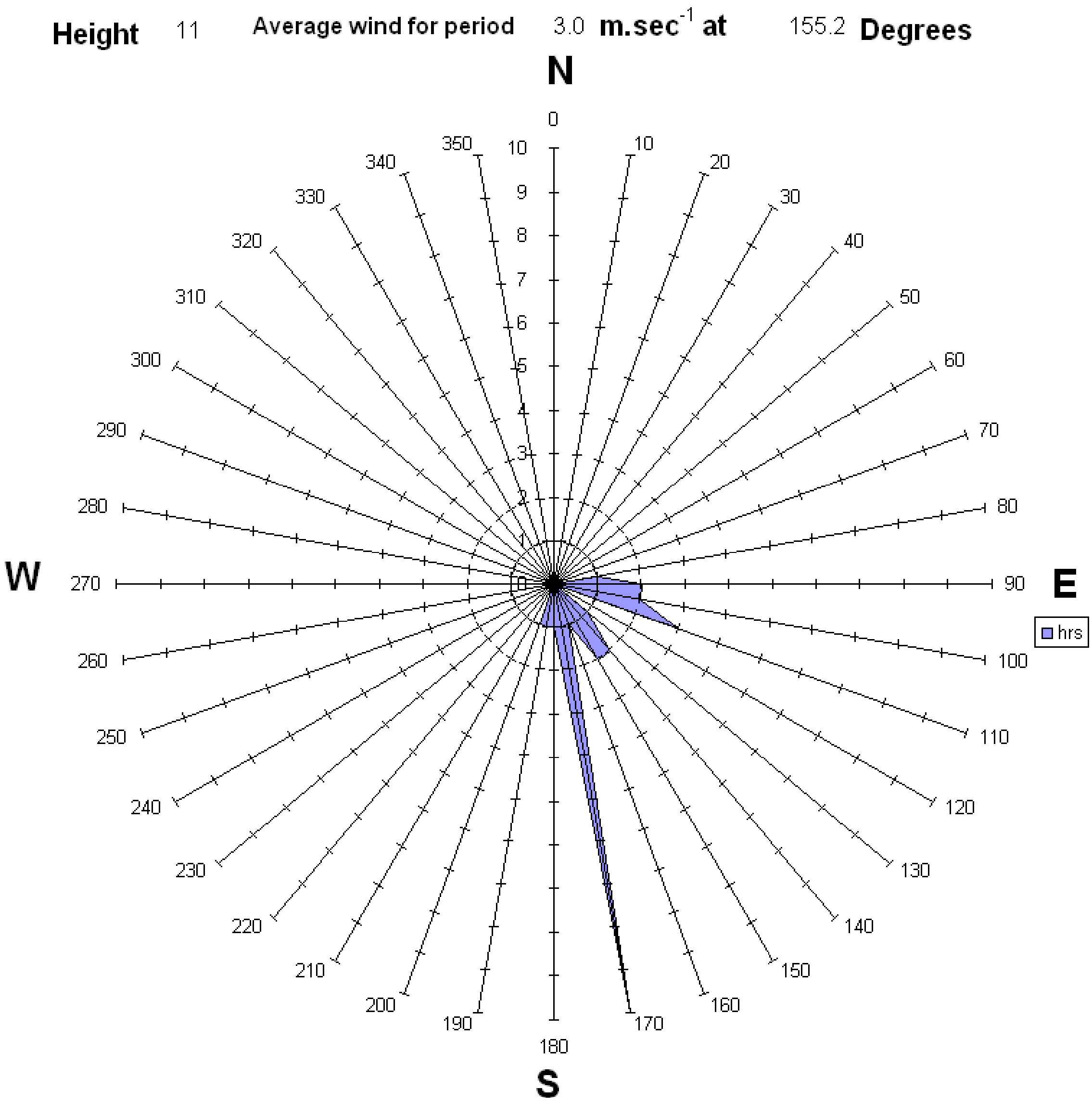


Figure 3.9 Wind rose diagram – top mast – 31 July 2007

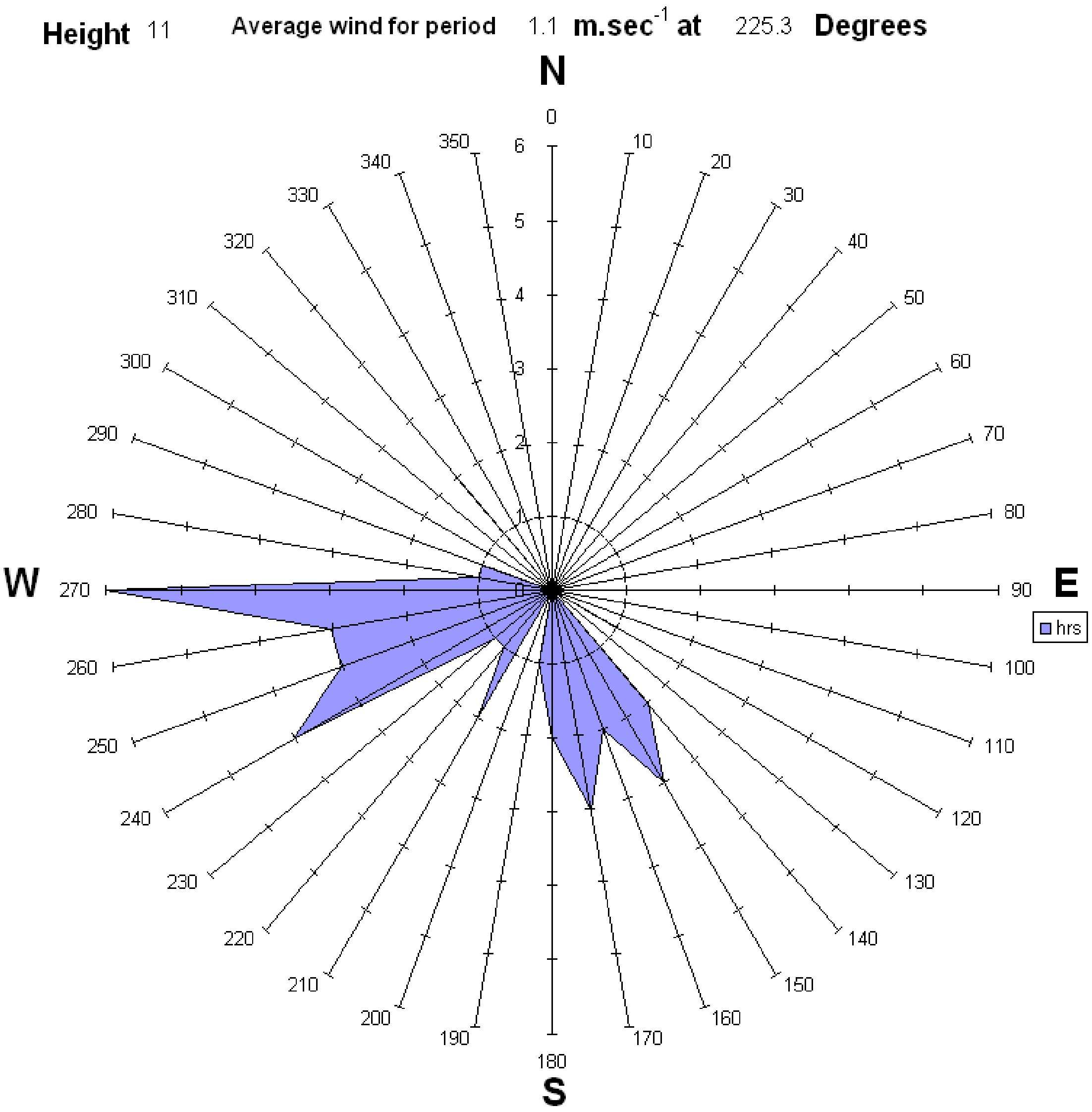


Figure 3.10 Wind rose diagram – top mast – 1 August 2007

Checked by:

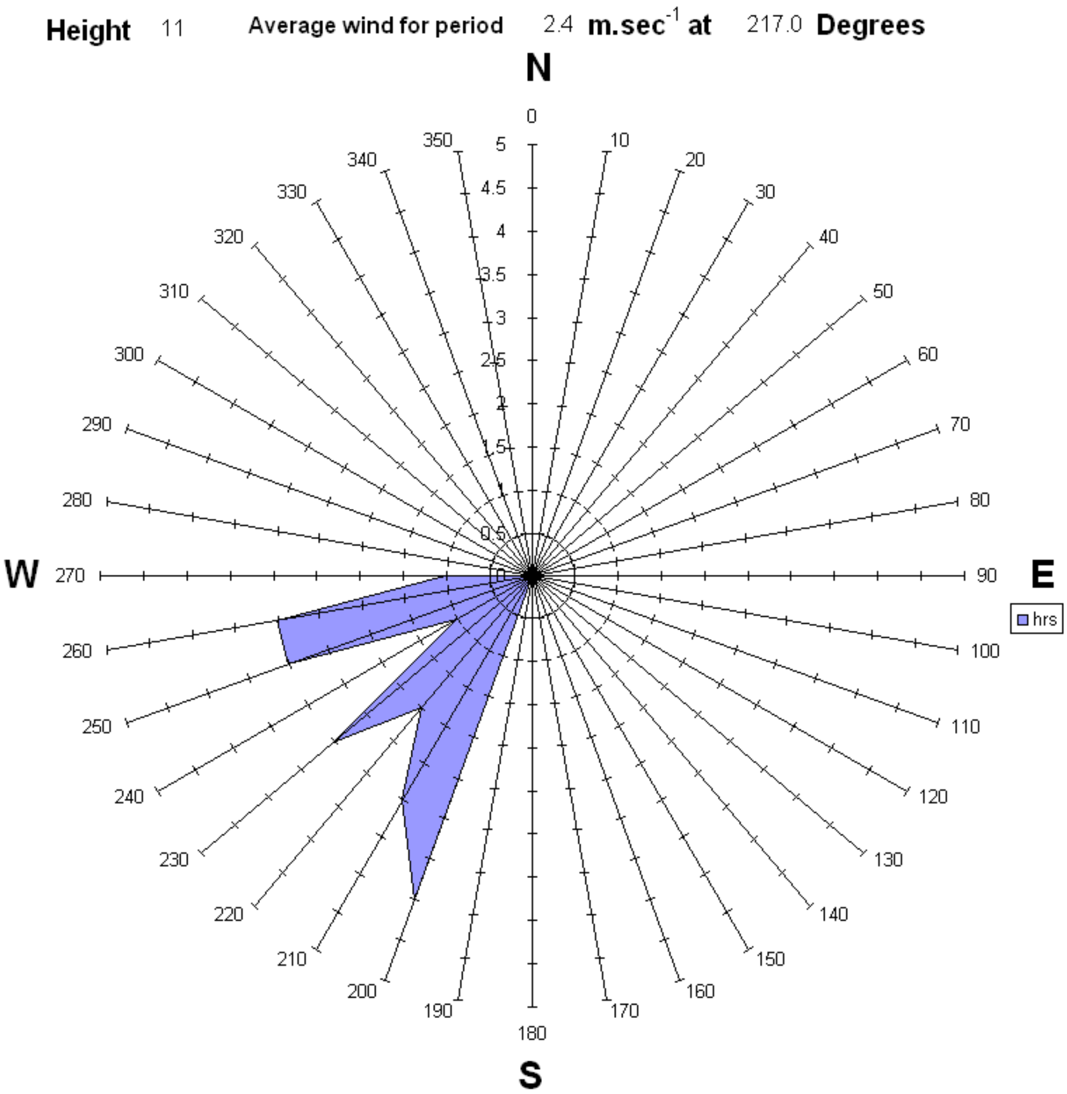


Figure 3.11 Wind rose diagram – top mast – 2 August 2007

Height 11 **Average wind for period** 4.2 **m.sec^{-1} at** 95.3 **Degrees**

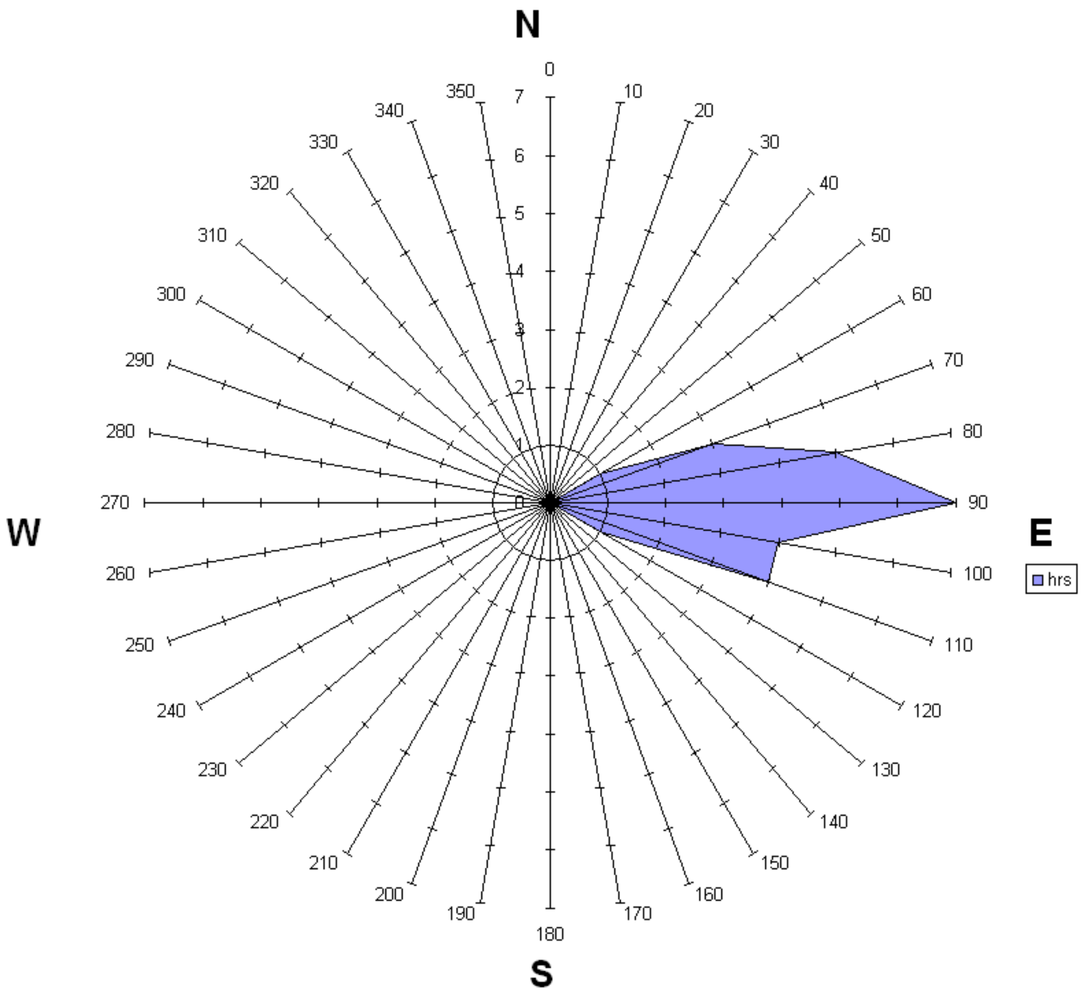


Figure 3.12 Wind rose diagram – top mast – 3 August 2007

Checked by:

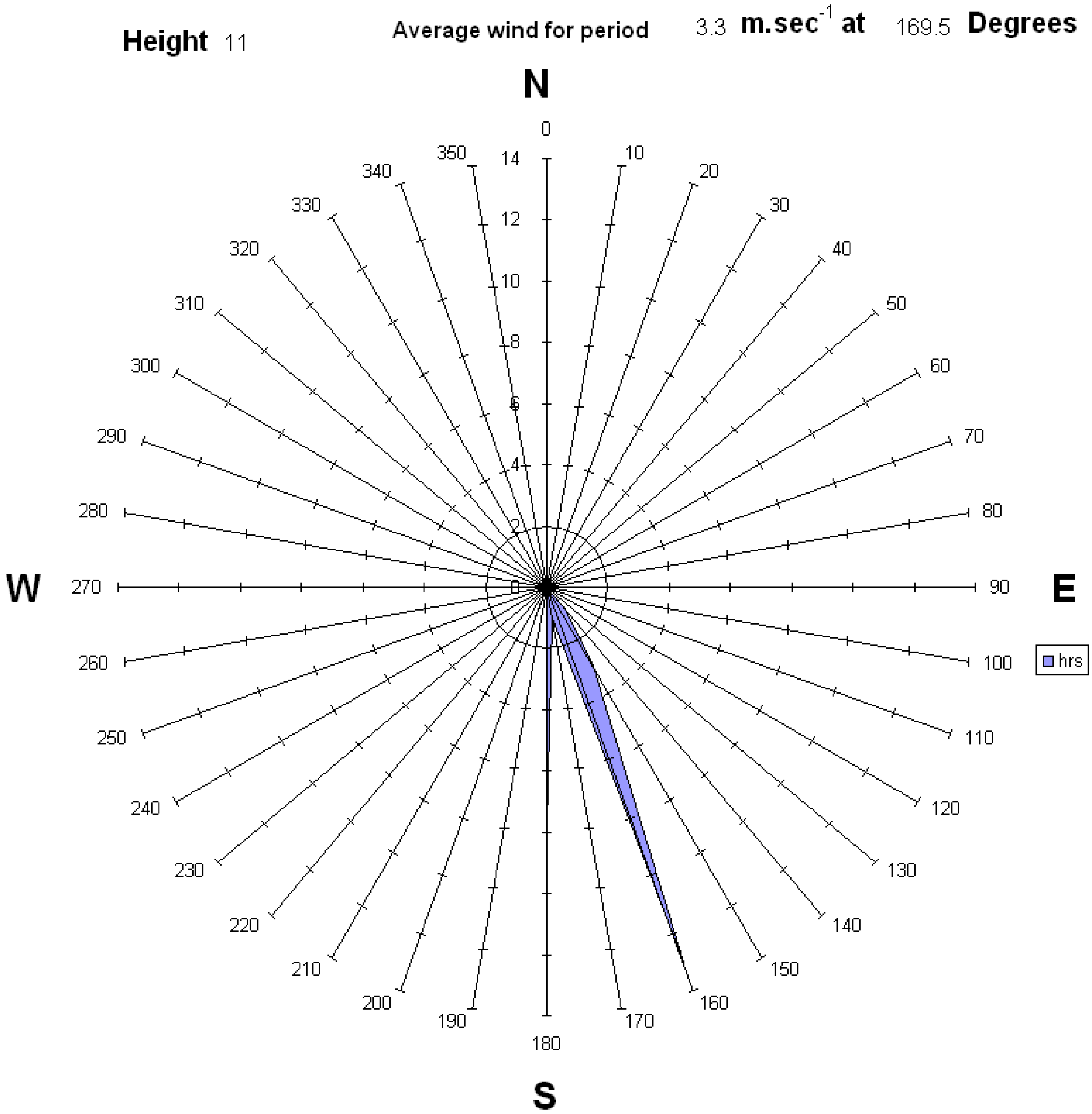


Figure 3.13 Wind rose diagram – top mast – 5 & 6 August 2007

Checked by:

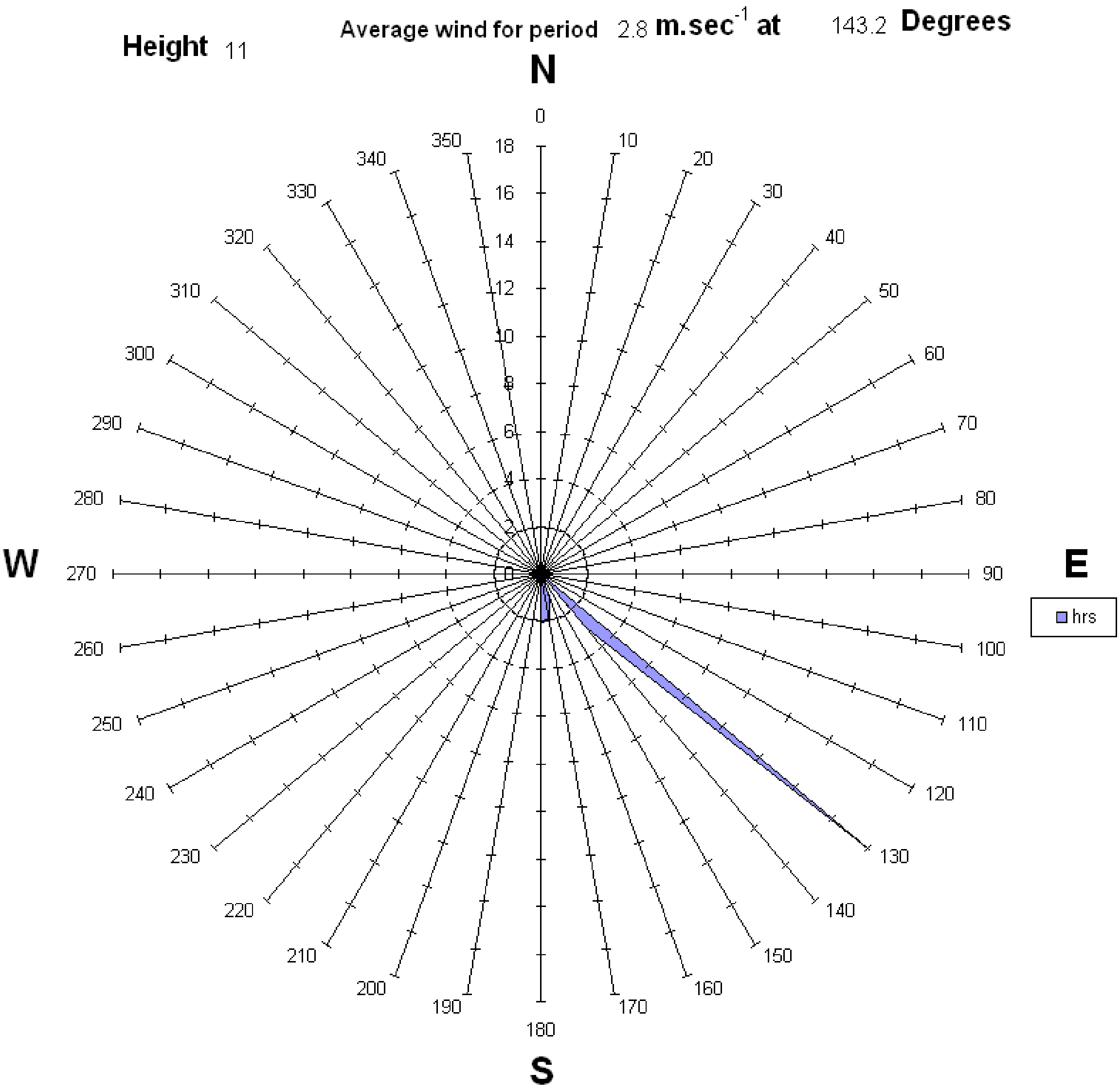


Figure 3.14 Wind rose diagram – top mast – 6 & 7 August 2007

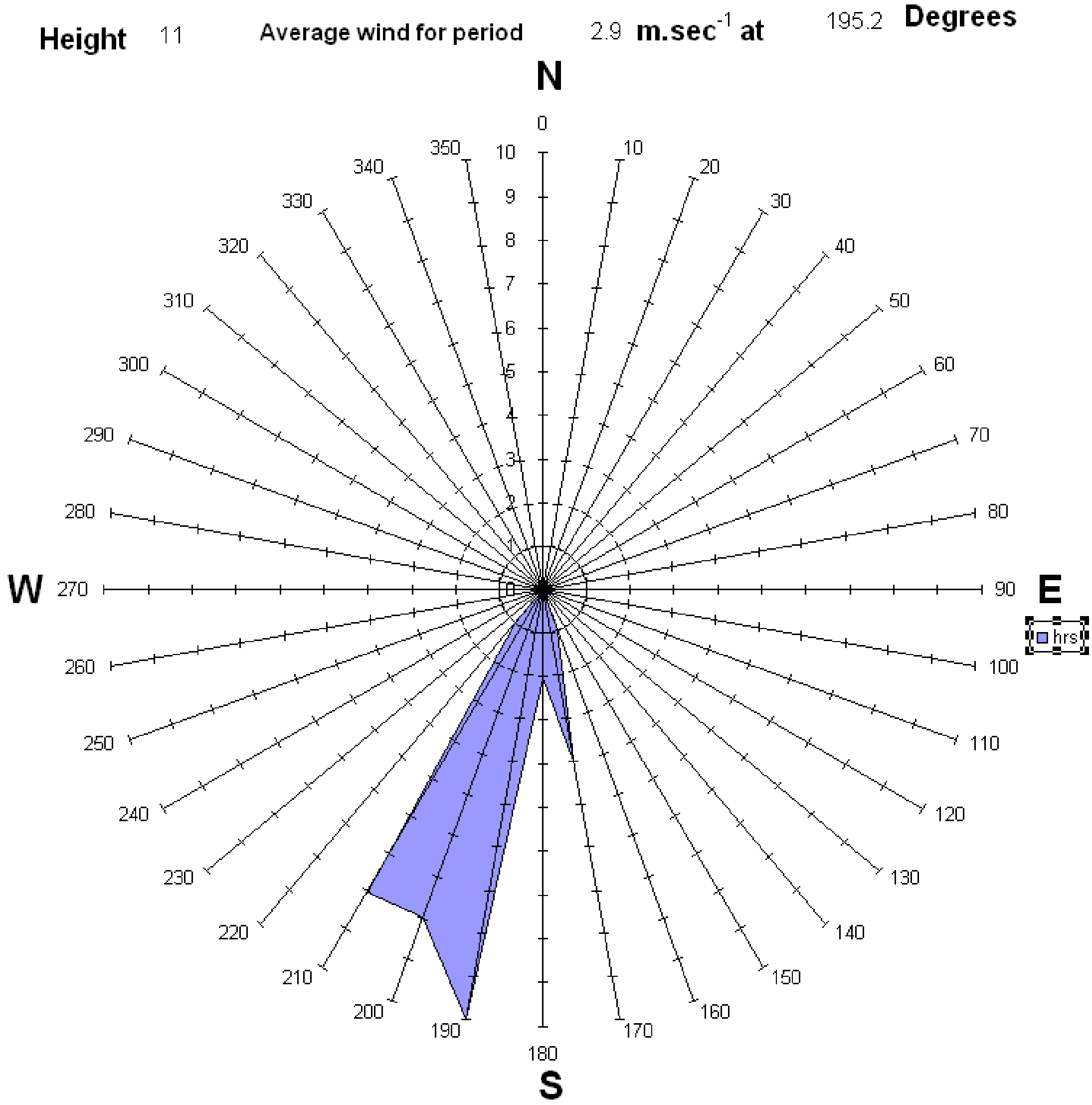


Figure 3.15 Wind rose diagram – top mast – 7 & 8 August 2007

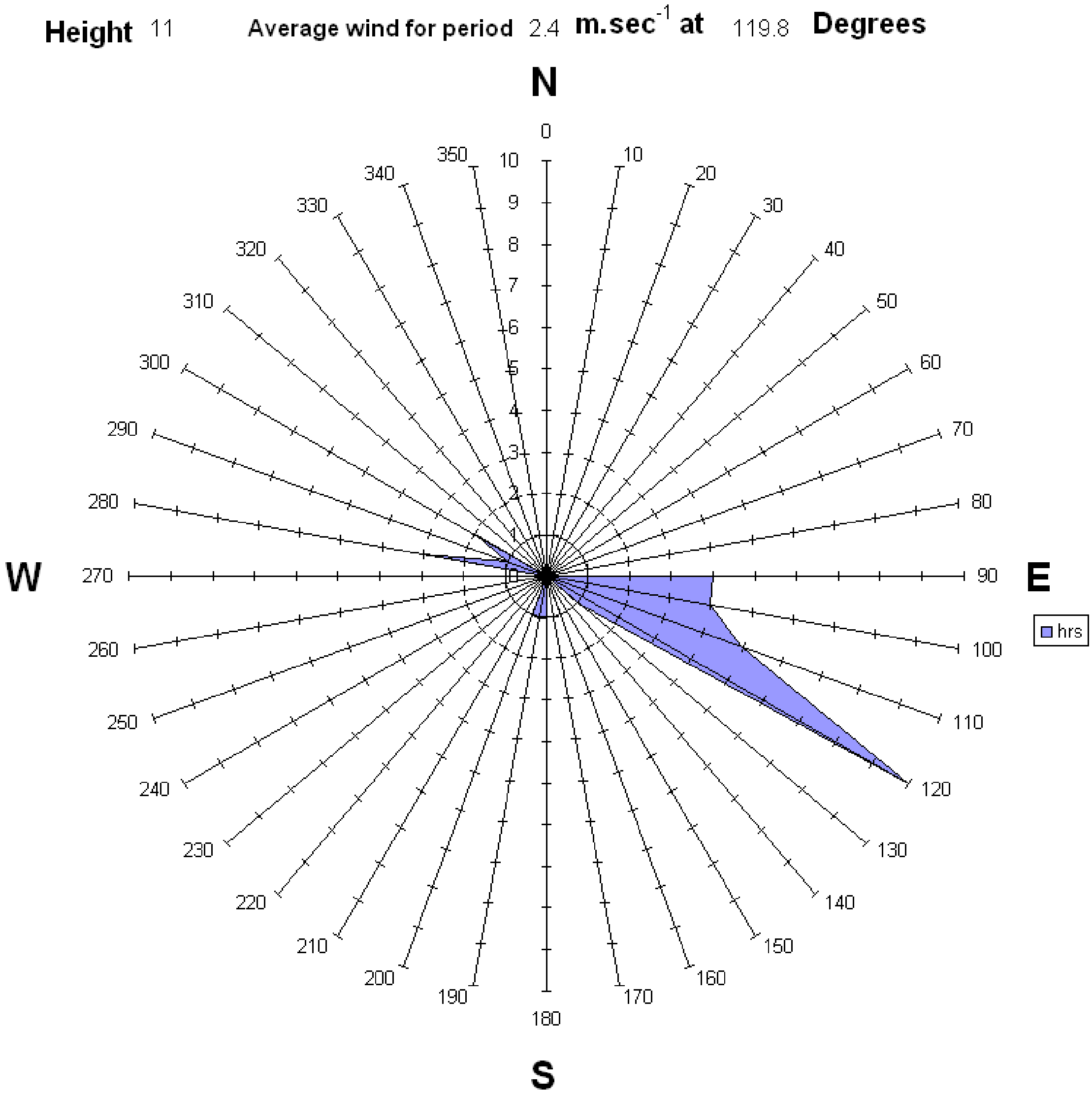


Figure 3.16 Wind rose diagram – top mast – 9 August 2007

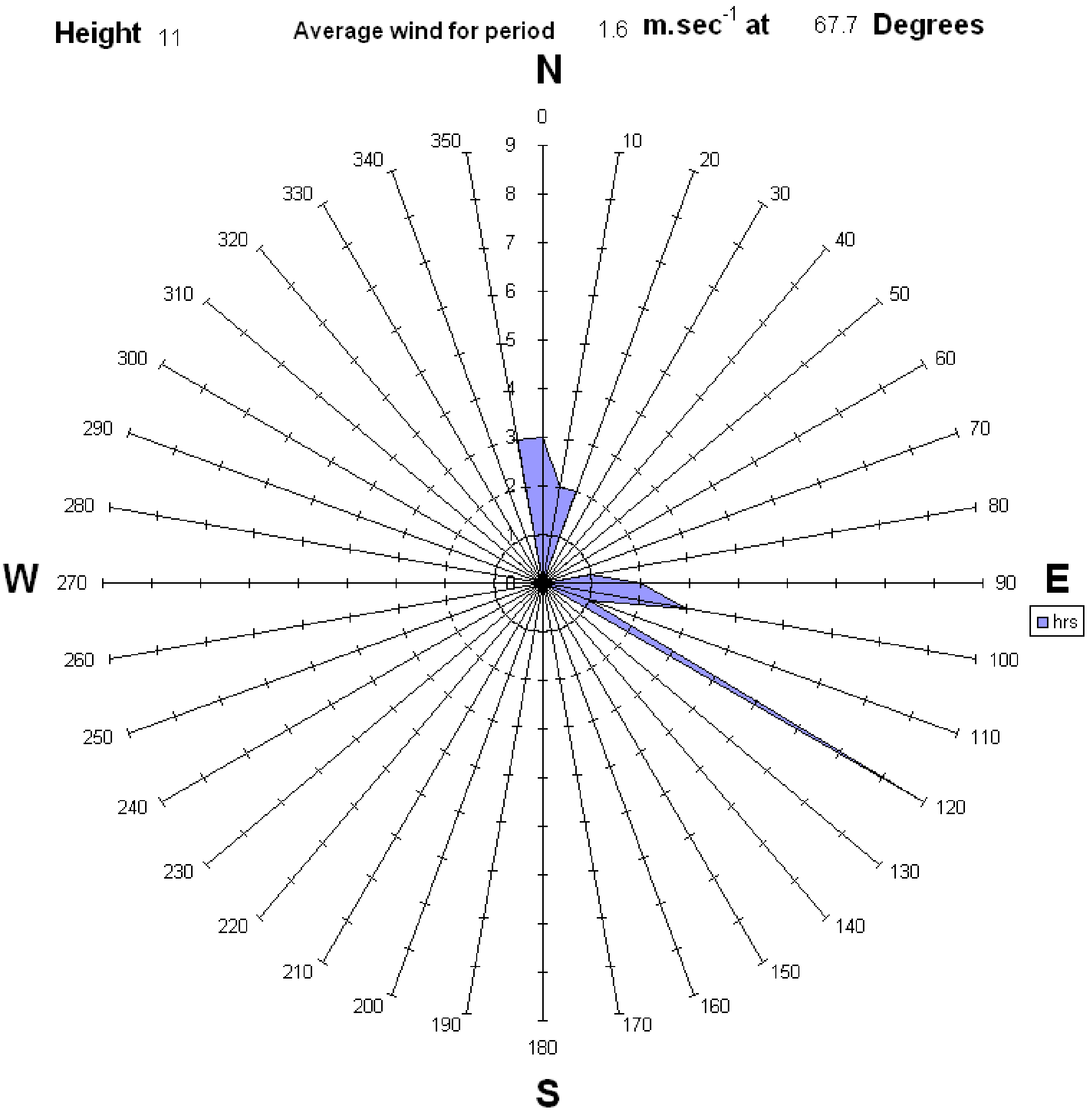


Figure 3.17 Wind rose diagram – top mast – 10 August 2007

Checked by:

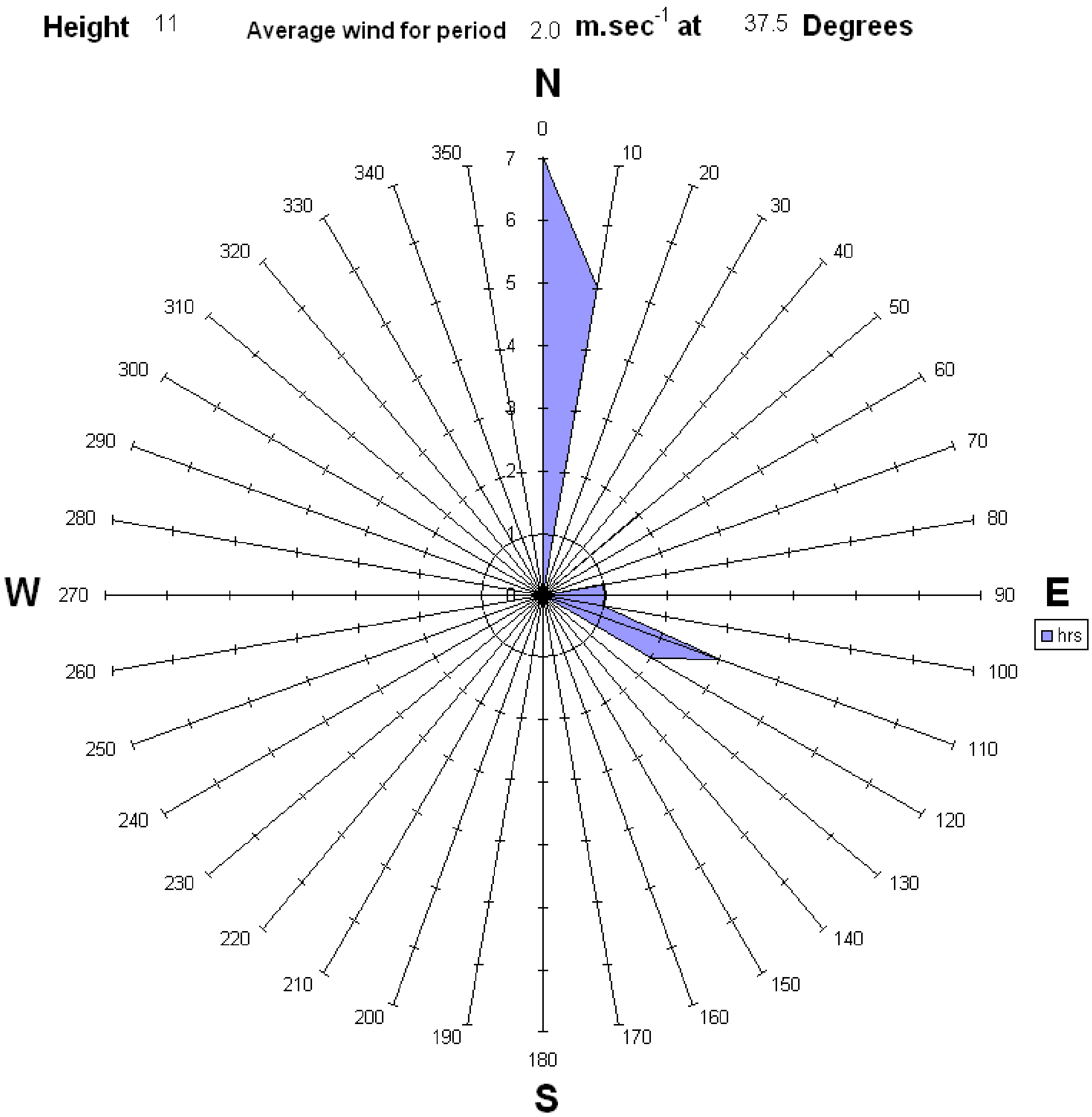


Figure 3.18 Wind rose diagram – top mast – 11 August 2007

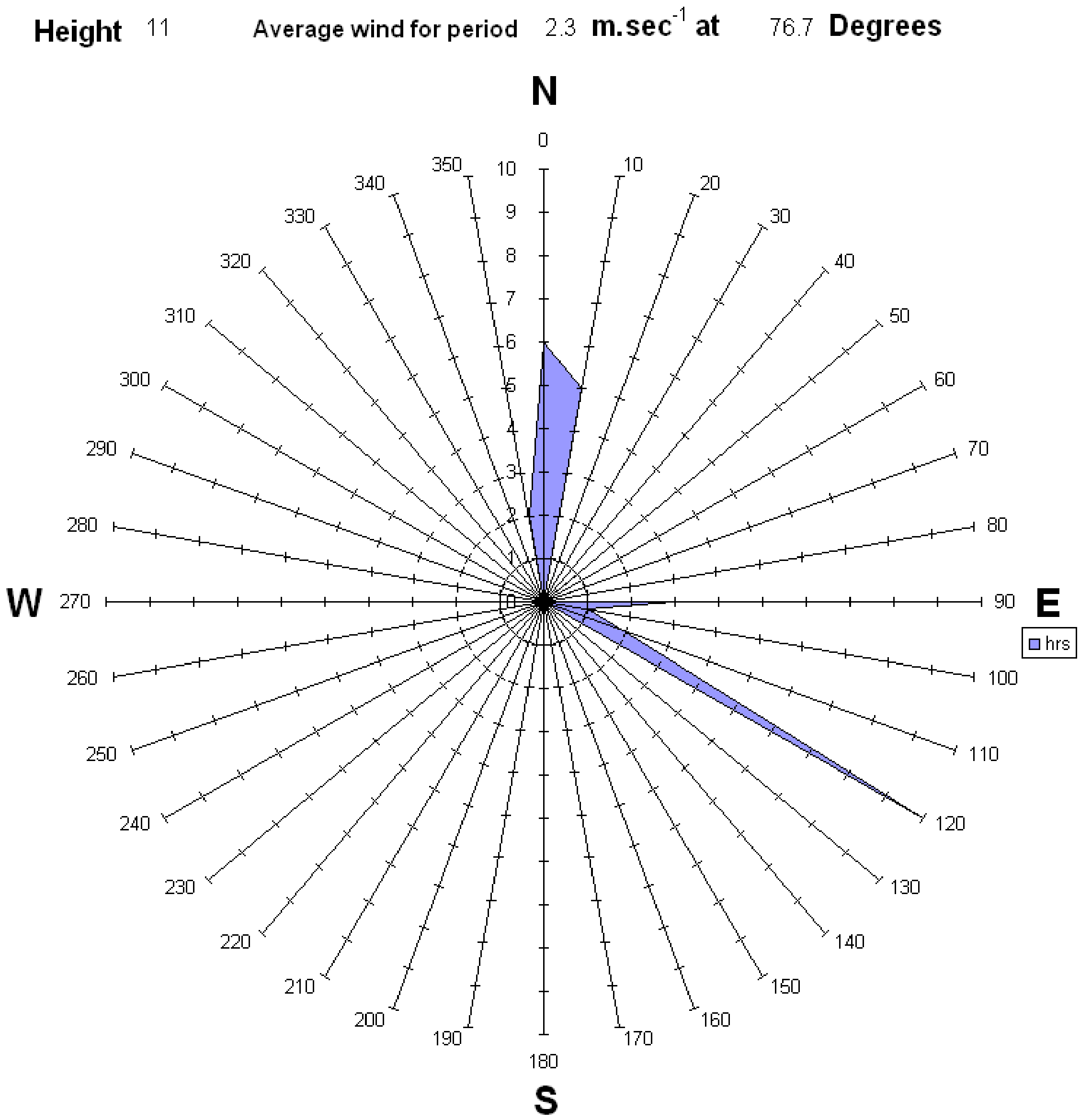


Figure 3.19 Wind rose diagram – top mast – 14 August 2007

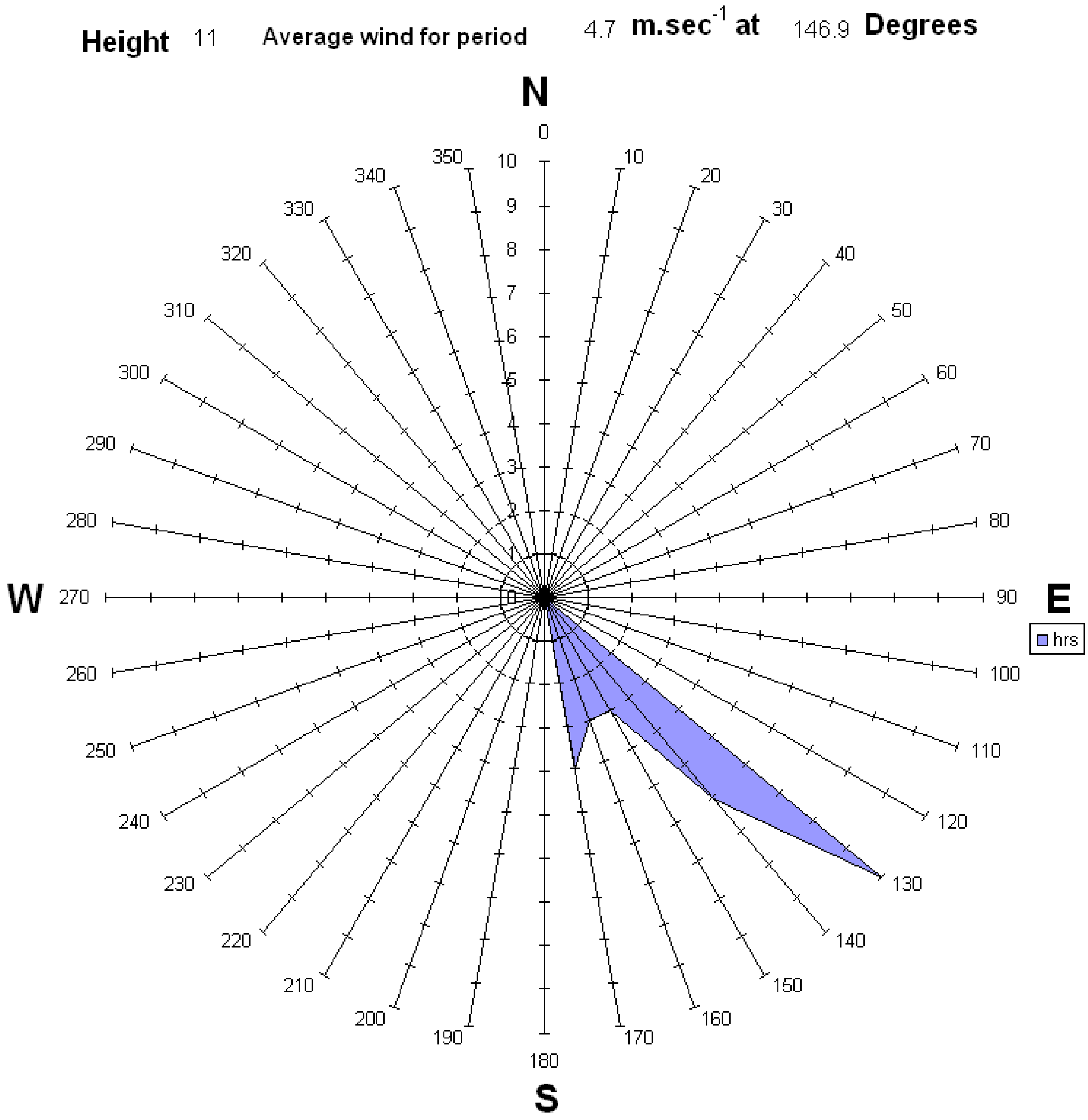


Figure 3.20 Wind rose diagram – top mast – 17 August 2007

Checked by:

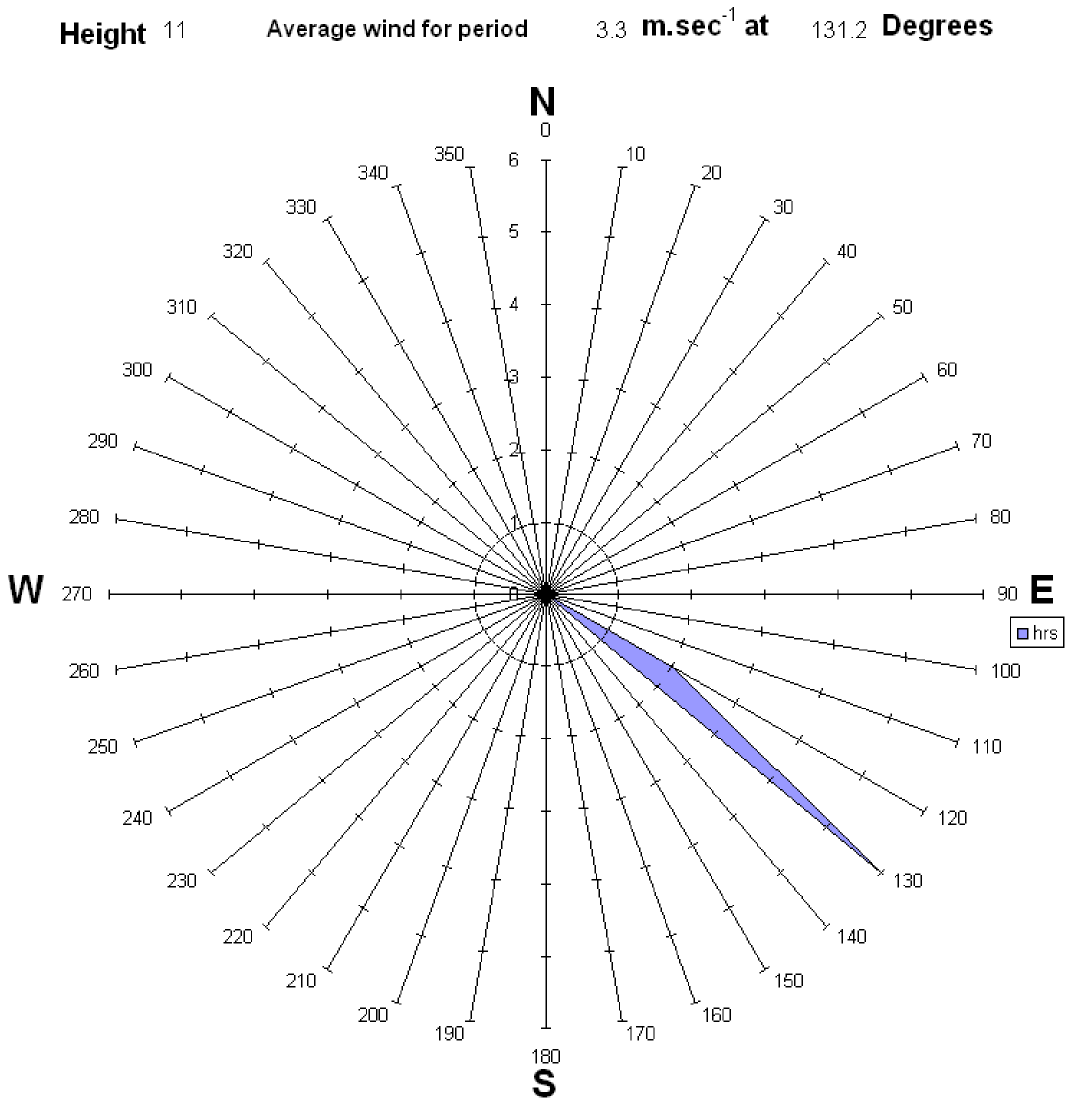


Figure 3.21 Wind rose diagram – top mast – 18 August 2007

Annex 4. Explanatory Note 1. Relationship between flux and concentration values

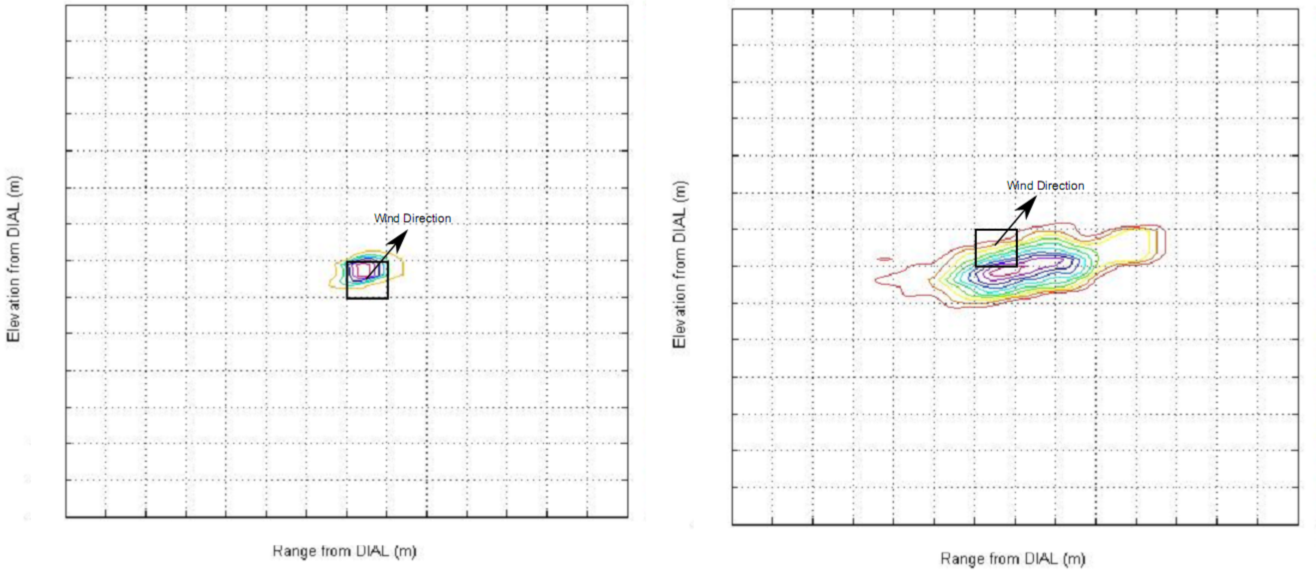


Figure A1.2 Illustration of the flux calculation approach

In this report concentration values are provided alongside each reported emissions flux, to provide an indication of the levels observed in a measurement scan. As described in this report, the flux is determined by making a vertical DIAL measurement scan and determining the concentration profile in this plane. The concentration reported is the maximum concentration determined in the measurement plane. The resolution used in the measurement plane is equal to the DIAL system digitiser resolution and is 3.75 m and so the plane therefore consists of a grid of cells each 3.75 m square. The concentration is determined as an average value in each cell. It should be noted that the concentration values are smoothed across a number of cells and so the actual peak concentration in the atmosphere, over small length scales, may be higher than reported.

Figure A1.2 shows how the flux is calculated – the concentration assigned to each cell is multiplied by the perpendicular wind field determined for that cell, and then the individual fluxes are summed to give the total flux through the plane. This figure shows two example plumes (the cell grids are for indication and are not to scale), one of which has a small plume, and therefore a small integrated flux, and the other of which has a larger plume area, and therefore represents a larger emissions flux. However, the peak concentration in both is similar, and indeed may even be higher in the small plume then the large plume. The concentrations reported therefore do not necessarily correlate directly with the emissions fluxes.

Interpretation of flux with respect to the wind direction

Figure A1.3 shows a schematic representation of two measurement plane configurations observing the same plume. One has a nearly perpendicular orientation to the plume, and the wind direction is therefore also perpendicular to the measurement plane. The other is at an angle through the plume, and therefore the wind is not normal to the plane of the measurements. If only the concentration profile were observed the left hand measurement configuration would show a larger plume (as it cuts obliquely through the plume). However, when the wind direction is taken into account, the normal component of the wind vector is used, and this therefore reduces the flux determined from this scan, resulting (correctly) in the same flux being determined for both measurement orientations.

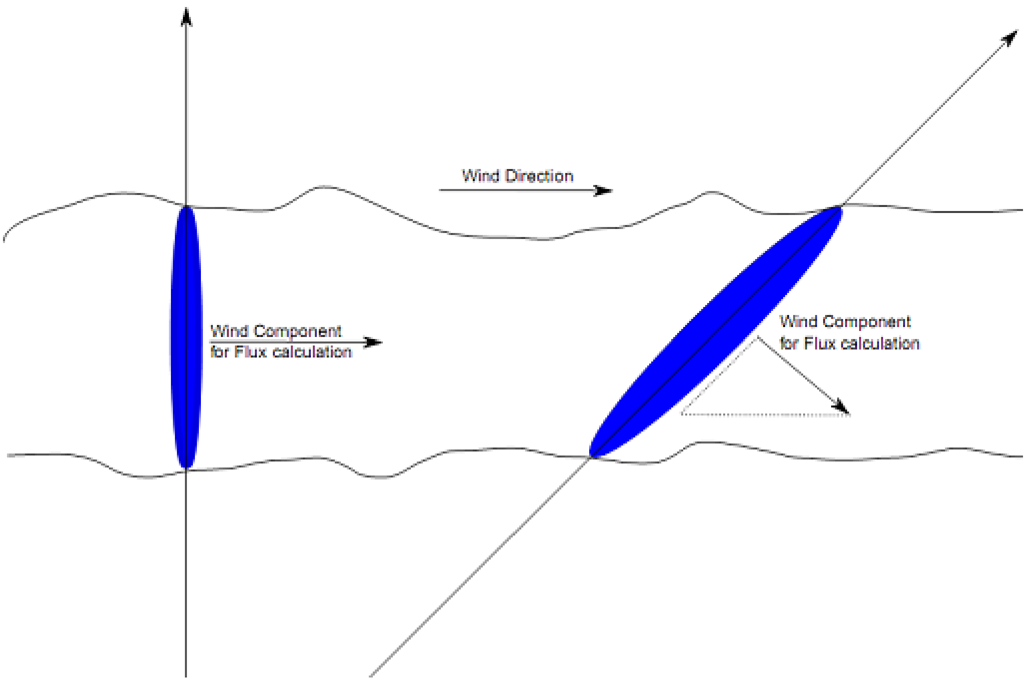


Figure A1.3 Schematic showing relationship between flux and wind direction

APPENDIX B: INDEPENDENT ANALYSIS OF STORAGE TANK DATA

DIAL DATA ANALYSIS

Storage Tank Emissions Estimation

and

Model Evaluation

Submitted to:

Eastern Research Group, Inc.

for the

Texas Commission on Environmental Quality

By:

The TGB Partnership

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F – Sample Calculations for the Refinery .... multiple files in a zipped file

EXECUTIVE SUMMARY

The purpose of this report is to provide an evaluation of the emission rates from storage tanks calculated from DIAL measurements conducted by the National Physical Laboratory (NPL), Middlesex, UK, on behalf of the Texas Commission on Environmental Quality (TCEQ) during the summer of 2007 at a bulk liquid storage terminal (the Bulk Terminal) and a petroleum refinery (the Refinery) in Texas City, TX. This report presents an evaluation of the DIAL data, a comparison of DIAL results to emission rates estimated using conventional methods of estimating storage tank emissions, and an evaluation of the conventional estimation methods in light of the DIAL study.

Short-term emissions were estimated corresponding to each time period and tank group for which NPL reported DIAL results. Emissions were estimated based on the specific tank features, stored liquid properties, operating conditions, and meteorological conditions existing at the time of each set of DIAL scans. The emission estimates were performed using the emission factors and equations published in EPA's AP-42 document, with the equations adjusted as described herein (in accordance with guidance from TCEQ) in an attempt to make them more applicable to short periods of time. As discussed herein, however, the emission factors and equations for storage tanks that are presently available in AP-42 can not entirely accommodate estimates of hourly emissions.

Despite the acknowledged inadequacies in applying the AP-42 methodology to hourly emissions, emission estimates for the storage tanks in this DIAL study generally fall within the range of the DIAL results. For some tanks groups, including the gasoline storage tanks, the DIAL results correspond well with the estimated emissions for each set of DIAL scans. For the crude oil tanks, however, DIAL results for repeat scans of the same tanks under similar conditions vary by as much as an order of magnitude, with the results sometimes similar to estimated emissions and at other times significantly greater than estimated emissions.

The variability of DIAL results for one group of crude oil tanks exhibit a strong correlation with wind direction, which might suggest that a significant upwind source became aligned with these crude oil tanks at a particular wind orientation. However, scans with an IR camera revealed plumes emanating from these crude oil tanks, whereas similar plumes were not observed at tanks storing gasoline.

While there are unresolved questions concerning the variability of the DIAL results, both the DIAL results and observations from the IR camera suggest that emissions from the targeted group of crude oil tanks were greater than expected, whereas no such concern was evident with the targeted gasoline tanks. Limitations and uncertainties associated with these remote sensing technologies, however, preclude resolving what the actual emission rates were from the crude oil tanks or why they appeared to be higher than expected.

Multiple issues have been previously identified by TCEQ concerning potential causes for underreporting of storage tank emissions, including questions concerning emissions from crude oil tanks. These issues merit further investigation, but perhaps by an approach other than a DIAL study.

INTRODUCTION

The purpose of this report is to provide an evaluation of the emission rates from storage tanks calculated from DIAL measurements conducted by the National Physical Laboratory (NPL), Middlesex, UK, on behalf of the Texas Commission on Environmental Quality (TCEQ) during the summer of 2007 at a bulk liquid storage terminal (the Bulk Terminal) and a petroleum refinery (the Refinery) in Texas City, TX. This report presents an evaluation of the DIAL data, a comparison of DIAL results to emission rates estimated using conventional methods of estimating storage tank emissions, and an evaluation of the conventional estimation methods in light of the DIAL study.

DIAL scans that were taken from the same location and in the same direction on a given date were grouped together in sets for this report, and average DIAL results were calculated for each set of scans. These average DIAL results are presented in Tables 3 through 9 of this report, along with estimated emissions corresponding to each set of scans. Detailed data on each DIAL scan set are presented in Attachment A.

DIAL results were further evaluated by grouping all scans taken from the same location and in the same direction, regardless of date. These summaries are presented in Attachment B, along with statistical data for each group.

Detailed data were obtained on the physical features of each tank and floating roof, as well as on the type of stock stored in each tank, the temperature of the stock, and whether stock was being pumped into or out of the tank during the period of the DIAL study. Attachment C contains the detailed tank data used in the emission estimates, except that pump-in and pump-out data for the Refinery are listed in Attachment A. Tank-by-tank summaries of the estimated emissions are presented in Attachment D, and Attachments E and F contain sample calculations of the emission estimates.

DIAL OVERVIEW

DIAL is a technology for measuring range-resolved concentrations of selected gases in a two-dimensional field. This technology permits mapping of vapor concentrations in the plane of measurement, thereby allowing plume shape and height to be estimated.

The results of DIAL studies are sometimes characterized as measured emission rates, but in reality DIAL measures only vapor concentrations. In order to translate these measurements of concentration to an emission rate from a target source, other parameters must be accounted for, including wind speed and direction, any contribution from other upwind sources, and any difference in the response of the DIAL technology to the actual vapors present versus response to the gases to which the DIAL was calibrated.

Wind characterization. Wind speed and direction must be characterized in order to determine a flux, or rate of vapor movement perpendicular to the plane of measurement, associated with each DIAL scan. In order to account for wind speed and direction, one or more meteorological stations are established at the site during the time of the DIAL study. However, a meteorological station is typically not located within the plane of the DIAL measurement.

Upwind contributions. Upwind measurements are taken in order to account for contributions from other sources to the vapor concentrations measured downwind of a target source. A typical DIAL configuration, however, does not accommodate taking these upwind measurements simultaneously with the downwind measurements.

Correction factors. As with all remote sensing technologies, measurements should be corrected to account for differences in the sensitivity of the technology to different gases. These differences are sometimes referred to as response factors. DIAL studies typically involve collection of air samples to determine the gases present in the atmosphere to be measured, in order to develop an appropriate correction (response) factor. The study did not, however, involve controlled release experiments to validate these response factors.

The emission rates calculated in a DIAL study, then, are derived from a combination of direct DIAL measurements of vapor concentration and other data measurements which may be collected or measured either at a different time or a different place from the DIAL measurements themselves.

Furthermore, DIAL studies have historically tended to collect measurements from a given location over a relatively brief period of time. This practice does not accommodate evaluation of the longer term emission rates for sources that may have varying or cyclical emission patterns.

DIAL RESULTS

Identification of the DIAL Results

The DIAL unit was set up at numerous locations, and measurements were taken in multiple directions from most of these locations. The scan direction for a given set of scans depended upon which tanks were being targeted by that scan and the direction of the wind during the scan. The locations are identified on figures in the NPL report which show partial plot plans of the participating facilities. Arrows on these figures indicate the directions along which DIAL scans were made. For this report, these scan directions were assigned labels corresponding to the compass direction obtained by scaling the arrows on the figures of the NPL report. The location and direction of a given scan was not expressly given in the NPL report, but in most cases they could be determined from other information given regarding the scan.

DIAL scans that were taken from the same location and in the same direction on a given date were grouped together in sets for this report, and average DIAL results were calculated for each set of scans. The scans included in each scan set are summarized in Attachment A, along with other information on the scan sets. The average DIAL results calculated for each scan set are presented in Tables 3 through 9 of this report, along with estimated emissions for each set of scans.

General Limitations of the DIAL Results

It is apparent from an evaluation of the DIAL results reported by NPL that there are some limitations in characterizing emission rates from these data. The following considerations were identified from an evaluation of the reported data:

1) Variability. There is significant variability in the reported emission rates. This may be due to some combination of the following causes:

   a. Variability in the actual rate of emissions from the targeted sources. The rate at which vapors are expelled from a tank is expected to vary with changes in meteorological and operational conditions.
   b. Variability in the contribution to emissions from upwind sources. Relatively few upwind scans were reported. Given the variability observed from downwind scans, it is questionable whether the limited upwind scans (generally two to four scans for a given location) were of sufficient duration to characterize potential upwind conditions.
   c. Repeatability of the DIAL. Significant variability was observed among the DIAL scans in the NPL report. As discussed in greater detail later in this report, when mean and standard deviation values were calculated for all scans reported for the same location and scan direction, regardless of date, the standard deviation was greater than 50% of the mean for two-thirds of these groups of scans. Furthermore, the average of one set of scans was observed to vary considerably from the average of another set of scans, even when both sets were taken in the same direction from the same location under nearly identical conditions of temperature and wind speed.

2) Non-detect measurements. Many of the reported measurements were near or below the DIAL detection limit. The text of the NPL report tends to address only those measurements that were above the detection limit, but this imposes an upward bias on the reported results. The non-detect measurements should be accounted for as well.
   a. Periods of non-detect from the target source. When a targeted source has periods of detectable emissions and periods without detectable emissions, the periods without detectable emissions should be included in the averaging of calculated emissions from that source.
   b. Other upwind sources with non-detectable emissions. When there are multiple upwind sources, and the DIAL scans suggest that the detectable emissions are coming from only a portion of those sources, the sources without detectable emissions should be included in the overall evaluation of calculated emissions. For example, if there are four upwind tanks, and the detectable emissions appear to be attributable entirely to one of those tanks, then the evaluation of emissions from those tanks should include acknowledgement that the other three tanks have no detectable emissions (rather than reporting on only the one tank with detectable emissions).

3) Wind characterization. Wind speed and direction were measured at multiple locations, in recognition of the importance of wind characterization in the determination of flux. The NPL report indicates that the wind measurements generally used in the determination of flux, and thus of emission rates, were those taken from the mast fixed to the DIAL truck. The report does not include a comparison of the wind speed and direction measured at the different locations. Such a comparison would have been informative with respect to illustrating the variability of wind conditions at a complex site such as a petroleum refinery.

Statistical Evaluation of Individual Planes of Measurement

DIAL results were further evaluated by grouping all scans taken from the same location and in the same direction, regardless of date. These summaries are presented in Attachment B, along with the mean and sample standard deviation for each group. Each group in Attachment B, then, represents a single vertical plane in the facility. It is apparent from a visual appraisal that some scan groups had similar DIAL results from one day to the next, such as the first group on page B-1. In this case, the emission rate reported by NPL ranged from 24 to 33 pounds per hour (lb/hr) on July 16 and from 11 to 31 lb/hr on July 17.

In many other cases, however, a marked difference is evident from one day to another. The second group on page B-1 shows a range of 3 to 4 lb/hr on July 18 and a range of 16 to 20 lb/hr on July 19. In addition to this significant daily difference, this group shows a near order-of-magnitude range within a short period of time on July 21, dropping from 25 to 3 lb/hr. Referring to Table 1.5 of the NPL report, it appears that the measurements exhibiting this drop were taken only 37 minutes apart.

Other order-of-magnitude swings within the same set of DIAL results include the the first group on page B-3, which shows an increase from 1 to 14 lb/hr on July 26, and the second group on page B-4, which shows a drop from 11 to 1 lb/hr on August 6. It is evident, then, that the DIAL results for a given measurement plane are clearly not steady state.

The variability in the DIAL results for each group is illustrated statistically by the mean and standard deviation. The coefficient of variance, defined as the ratio of the standard deviation to the mean, is a non-dimensional measure of the variability of a set of sample data. The first group on page B-1, which appeared from a visual appraisal to have fairly consistent data, has a coefficient of variation of 0.26. By contrast, 10 of the other 14 groups have coefficients of variation greater then 0.50.

A fairly high degree of variability in the emissions from storage tanks is expected, in that storage tank emissions have been demonstrated to be a function of a number of parameters that would be expected to vary during the period of the study. These parameters include temperature, wind speed, pumping rates, vapor pressure of the stock, and time of day. Given this expected variability, and the confirmation of variation in the data as demonstrated by the calculated coefficients of variance, it was deemed that these groupings of DIAL scans in Attachment B were too broad to be meaningful.

Thus, rather than comparing DIAL results to estimated emissions for a given plane of measurement (as defined by a scan location and direction), the results for each plane of measurement were evaluated separately for each day that scans were taken in that plane. That is, if a set of scans was taken in a given plane on three separate days, then a separate emission estimate was prepared for each of the three days, even though all three sets were taken from the same location in the same direction.

Statistical Evaluation of the Crude Oil Tanks

Section 2.4 of the NPL report addressed DIAL scans taken in the vicinity of two groups of crude oil tanks. A particularly wide variation in the DIAL results was observed for one of these groups of tanks, for which there were a total of six sets of scans as summarized in Table 1.

Table 1 – DIAL Results for Crude Oil Tanks 1052, 1053, and 1055.

Scan Set	Location	Scan Direction	Date	Avg Time of Day	Avg Wind Speed (mph)	Avg Wind Direction	Avg Ambient Temp (F)	**Avg DIAL results (lb/hr)**
7_28 2_266	2	266	7/28/07	17:51	9.4	167.9	82.45	18.50
7_29 2_266	2	266	7/29/07	13:10	8.3	129.8	85.75	5.33
7_31 2_266	2	266	7/31/07	12:35	7.1	105.3	87.3	1.33
8_06 2_266	2	266	8/6/07	3:22	7.8	166.3	80.4	24.25
8_02 4_328	4	328	8/2/07	15:18	8.3	232.7	85.24	39.6
8_02 4_5	4	5	8/2/07	14:02	7.2	226.4	83.34	24.0

The average DIAL results for these scan sets range by a factor of more than 18 (from 1.33 to 24.25), yet the average wind speeds for these scan sets is fairly constant (8.3 mph +/- 1.2 mph) as is the average ambient temperature (83.9^{o}F +/- 3.5 ^{o}F). Thus variations in ambient temperature and wind speed do not explain the variability in the DIAL results.

One observation from an evaluation of the data was that the DIAL results seemed to vary with wind direction. A linear regression of the data indicated that the variation in the four sets of results for Location 2 was about 90% accounted for solely by change in wind direction (R^2 correlation of 0.913). The R^2 correlation was still fairly high (0.837) when the two sets of scans from Location 4 were included in the linear regression, even though these scans were taken along different planes within the group of tanks.

These correlations strongly suggest that the periods of higher DIAL results are accounted for by some phenomenon related to wind direction, such as an upwind source that was aligned with this tank group at a particular wind direction. Statistics can be misleading, however, particularly with a small number of data points and a large number of uncontrolled variables, as is the case in a DIAL study. The seeming dependence on one variable may be coincidental, and the actual cause of the variation may be due to other variables.

The DIAL results for this group of tanks are discussed in more detail in the discussion later in this report on comparisons to estimated emissions. Potential explanations for the DIAL results for this group of tanks, other than the apparent statistical correlation to wind direction, are discussed in the section on conventional methods of estimating emissions.

DEVELOPMENT OF EMISSION ESTIMATES

The methodology published by API and EPA for estimating emissions from storage tanks is intended for estimating annual emissions. The API/EPA methodology is also applied to the estimation of monthly emissions in EPA's TANKS software program, but the methodology is not appropriate for use in estimating emissions for short periods of time. This is because the methodology estimates the total emissions that occur from tank events, but does not address the rate at which emissions occur during these events. The following examples illustrate this issue:

1) Filling loss. Filling loss refers to the expulsion of vapors by the rising liquid during the filling of a fixed-roof tank. The API/EPA methodology estimates the total emissions that occur from a

filling event, and then factors this total by the number of filling events that occur in a year (or a month) in order to estimate the total filling losses for that period. This methodology does not require knowing the rate at which the vapors are expelled, but rather requires an estimation only of the total vapors expelled per filling event. Hourly emissions, however, would depend upon the rate at which vapors are expelled during the filling operation.

2) Withdrawal loss. Withdrawal loss refers to evaporation from wetted surfaces that are left exposed by the falling liquid during the emptying of a floating-roof tank. As with filling losses for fixed-roof tanks, the API/EPA methodology estimates the total emissions that occur from a withdrawal event, and not the rate at which the emissions may occur during the event.

3) Breathing loss. Breathing loss refers to the expulsion of vapors from a tank as a result of the daily temperature cycle. Nighttime cooling causes vapors in the tank to contract, drawing fresh outside air into the tank where it becomes mixed with stock vapors. Daytime warming then expands the vapors in the tank, causing a portion of them to be pushed out through the tank vents. The API/EPA methodology estimates the total emissions that are expelled by a typical daily cycle, but does not address the rate at which vapors may be expelled at a given hour of the day.

The rate of filling loss and withdrawal loss would be expected to be a function of the pumping rate by which the tank is being filled or emptied. Data collected during filling of marine vessels suggest that the filling loss is not constant, however, even when the pump rate is constant. This is because the air at the top of the vapor space that is pushed out initially tends to have a much lower concentration of vapors than the air immediately above the liquid surface, which is pushed out at the end of the filling operation.

TCEQ has suggested a procedure for estimating short-term emissions due to filling loss that applies the pump rate to a fully saturated vapor space, in order to predict a maximum hourly rate of filling loss. This is the approach that was taken in this evaluation, using the TankESP spreadsheet program developed by The TGB Partnership.

TCEQ suggests a similar approach to the estimation of short-term emissions associated with withdrawal loss for floating-roof tanks. In this case, however, the connection between the emission rate and the pump rate is less direct. While the pump rate does determine the rate at which wetted surfaces are exposed, evaporation of those wetted surfaces would not be instantaneous. Directly associating the rate of withdrawal loss to the pump rate, then would be expected to produce a maximum hourly rate of withdrawal loss. Again, this approach was applied using the TankESP program.

The API/EPA methodology for estimating standing storage loss from floating-roof tanks is based on the rate at which vapors escape past the floating roof. Estimates of annual or monthly emissions assume that any vapors which escape past the floating roof into the tank vapor space will eventually be vented to the atmosphere. In that all of the vapors are assumed to be emitted during the year or month in question, the rate or pattern of venting these vapors from the tank is not addressed by the methodology. When evaluating short-term emissions, however, the rate at which the vapors leave the tank is the critical consideration. For example, the methodology assumes that vapors escape past a floating roof continuously. The actual pattern by which these vapors leave the tank, however, may be that the majority of vapors collect in the vapor space of the tank until the tank is filled, and then these vapors are all pushed out together. The actual short-term rate of emissions would then be significantly higher than the average rate of emissions. This would be expected to particularly be an issue with internal floating roof tanks.

A DIAL study has the potential to investigate the pattern of vapor loss from internal floating-roof tanks. This particular study was not adequate for that purpose, however, in that none of the tanks scanned at the Refinery were internal floating-roof tanks, and the data collected from internal floating-roof tanks at the Bulk Terminal are of such variability and so limited in duration that they are not adequate to inform conclusions regarding the pattern of emissions from an internal floating-roof tank.

A DIAL study also has the potential to investigate the pattern of breathing loss from a fixed-roof tank. It would be expected that breathing loss would be negligible during the nighttime hours while the tank vapor space is cooling, and would be at peak levels during the daytime hours when the tank vapor space is warming. The limited DIAL results for fixed-roof tanks in this study were dominated by filling loss, and thus a pattern to breathing loss is not discernible.

The estimation of short-term emissions was based on the following assumptions (see the discussion above for limitations pertaining to these assumptions):

1) Floating-roof tank standing storage losses occur continuously (thereby accounting only for the rate at which vapors escape past the floating roof, and not for the pattern and rate at which vapors leave the tank).
2) Floating-roof tank withdrawal losses occur at the same rate as the wetted shell is exposed, corresponding to the pump rate.
3) Fixed-roof tank filling losses correspond directly to the pump rate, and the vapor space is saturated.
4) Fixed-roof tank breathing losses occur at a constant rate around-the-clock (which does not account for the actual pattern of the breathing loss mechanism).
5) Floating-roof tank emissions are not affected by liquid being pumped in to the tank.
6) Fixed-roof tank emissions are not affected by liquid being pumped out of the tank.

Data sources used in the estimation of short-term emissions are summarized in Table 2. The detailed physical data compiled for each tank are summarized in Attachment C, except that pump-in and pump-out rates for the Refinery tanks, calculated from changes in the liquid level, are presented in Attachment A.

Table 2 – Data sources.

Parameter	**Refinery Source**	**Bulk Terminal Source**
Tank dimensions	Site data	Drawings
Tank color & condition	Field survey	Field survey
Floating roof features	Field survey	Drawings
Stored liquid	Site data on normal service	Communications with site
Liquid properties	Facility EI database	Communications with site
Liquid bulk temperature	Facility PI database	Communications with site
Changes in liquid level	Facility PI database	Communications with site
Wind speed & direction	NPL report	NPL report
Ambient temperature	Texas City data	Texas City data
Solar insolation	Galveston monthly average	Galveston monthly average

EPA's TANKS software was not used to prepare estimates of short-term emissions for this study, in that it has limitations that do not accommodate the procedure described above. It does not accommodate input of a pumping rate. The pump rate could be modeled by entering a monthly throughput based on the pump rate occurring around-the-clock for the entire month. The resulting high throughput rate, however, would result in TANKS calculating a reduced saturation level for the vapor space. In order to model the assumption of a saturated vapor space, the throughput would have to be kept low in the TANKS model, but then the resulting emissions estimate generated by TANKS would have to be factored by the pump rate in a separate calculation. While this manipulation could address the pump rate, TANKS has other limitations in estimating short-term emissions.

Another limitation to TANKS is that, even when the monthly emissions estimate is selected, TANKS applies the annual average bulk liquid temperature rather than a monthly value. This is not a concern for a tank that is heated and the bulk liquid temperature is maintained at a given value year round, but it is an issue for tanks that are subject to temperature change in response to changes in ambient temperature. Most tanks are not heated, and the bulk liquid is warmer in the summer and colder in the winter than the annual average temperature. Furthermore, TANKS does not make the heated tank option available for floating-roof tanks. These and other limitations precluded the use of EPA's TANKS software in the estimation of short-term emissions for this study.

COMPARISON OF DIAL RESULTS TO ESTIMATED EMISSIONS

Emission estimates for the storage tanks in the DIAL study are generally within the range of the DIAL results. There is, however, considerable variability in the DIAL results. The results for each group of tanks in the study are discussed briefly below. Attachment A contains additional data for each DIAL scan set. Attachment C contains the detailed tank data used in the emission estimates. Attachment D contains tank-by-tank summaries of the estimated emissions, and Attachments E and F contain sample calculations of the emission estimates.

The Refinery

Average DIAL results for three of the four groups of tanks scanned at the Refinery are less than the estimated level of short-term emissions. DIAL results for the gasoline tanks correspond particularly well to the emission estimates. DIAL results for other tank groups, however, exhibit considerably more variability than would be expected from the observed conditions, with the results sometimes similar to estimated emissions and other times significantly greater than estimated emissions. This is particularly evident for the crude oil tanks.

Gasoline Tanks

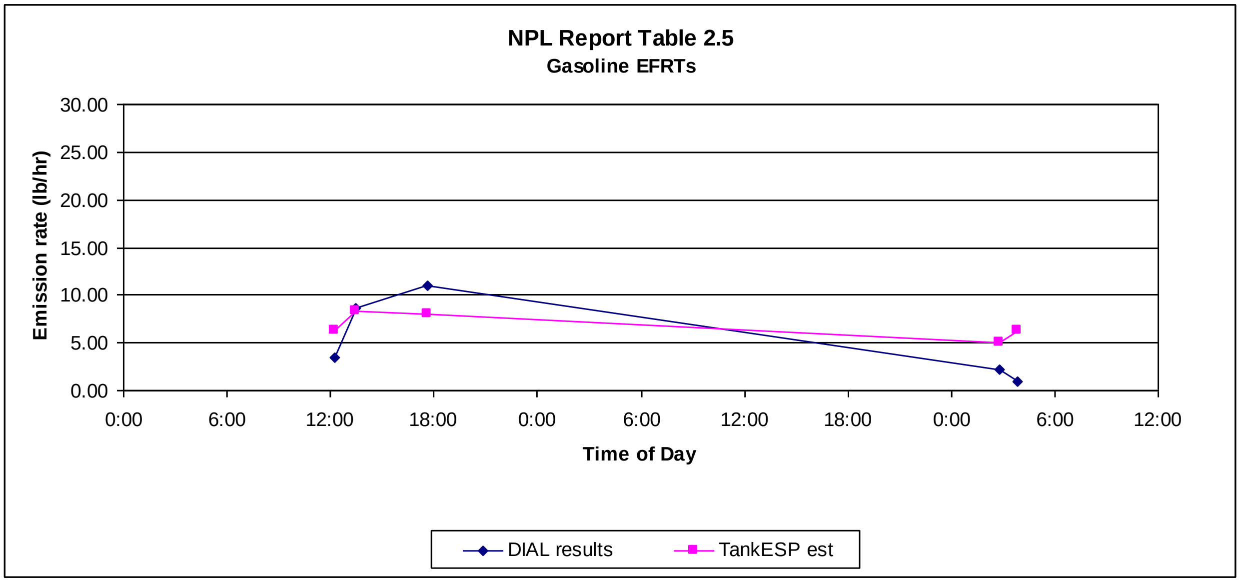
This group represents 4 external floating-roof tanks (EFRTs) storing gasoline. A comparison of the DIAL results to estimated emissions for this group are presented in Table 3.

Table 3 – Gasoline tanks at the Refinery.

Scan Set	Date	Avg Time of Day	Avg Wind Speed (mph)	Avg Wind Direction	Avg Ambient Temp (F)	**Avg DIAL results (lb/hr)**	**Avg Estimated emission rate (lb/hr)**
7_30 3_335	7/30/07	12:16	5.3	236.7	84.6	3.50	6.3
7_30 3_313a	7/30/07	13:29	10.4	176.5	83.4	8.67	8.4
7_30 3_313b	7/30/07	17:40	9.6	204.4	84.0	11.00	8
8_07 3_313	8/7/07	2:46	6.3	135.6	81.6	2.25	5.1
8_07 3_335	8/7/07	3:52	6.0	135.5	81.5	1.00	6.3
				Average of all scan sets:		**5.28**	**6.82**

The DIAL results are compared graphically to estimated emissions for these tanks in Figure 1.

Figure 1 – Gasoline tanks at the Refinery.



Flare 6 poses a significant potential for upwind contribution to emissions for this group of tanks, but it did not seem to impact these measurements.

The first 3 scan sets were obtained during daytime hours, and the last 2 scan sets were obtained at night. Estimated emissions for external floating-roof tanks (EFRTs) are driven by temperature and wind effects, and thus would only be expected to exhibit a diurnal pattern to the extent that temperature and wind may tend to exhibit a diurnal pattern.

While there is more variability in the DIAL results than would be expected from the range of temperature and wind speed values, the DIAL results overlap the estimated emissions reasonably well.

Distillate Tanks

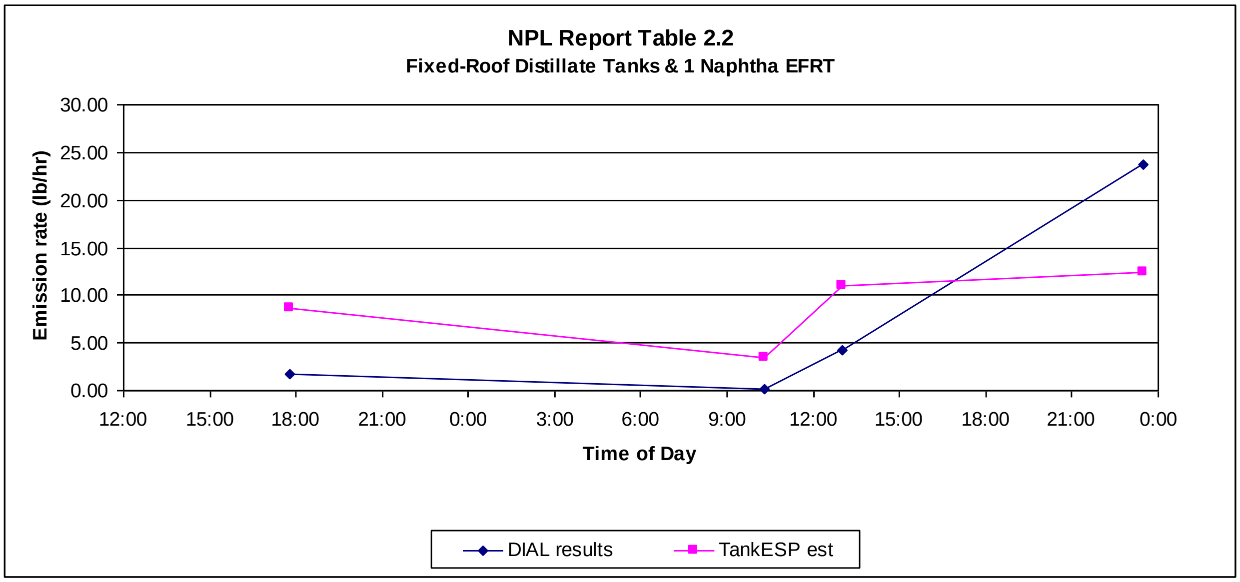
This group represents 4 fixed-roof tanks (FRTs) storing distillate stocks, and 1 EFRT storing naphtha. A comparison of the DIAL results to estimated emissions for this group are presented in Table 4.

Table 4 – Distillate tanks at the Refinery.

Scan Set	Date	Avg Time of Day	Avg Wind Speed (mph)	Avg Wind Direction	Avg Ambient Temp (F)	**Avg DIAL results (lb/hr)**	**Avg Estimated emission rate (lb/hr)**
7_25 1	7/25/07	17:46	10.2	151.0	81.525	1.75	8.6
7_26 1a	7/26/07	10:17	3.4	280.2	80.34	0.20	3.4
7_26 1b	7/26/07	12:59	13.0	124.2	80.21	4.30	11
8_07 5	8/7/07	23:30	7.2	194.2	78.65	23.75	12.4
				Average of all scan sets:		**7.50**	**8.85**

The DIAL results are compared graphically to estimated emissions for these tanks in Figure 2.

Figure 2 – Distillate tanks at the Refinery.



This group of tanks is positioned between refinery process units and a large tank farm. The potential contribution of upwind sources is a matter of appreciable uncertainty. For example, if filling of an upwind tank began after the upwind measurements were taken, then the increased contribution to emissions from that upwind tank would not have been captured by the prior upwind measurements.. Furthermore, while the NPL report states that upwind measurements were "in general below the detection limit," there were only two upwind measurements recorded on July 25 and 26 for this group of tanks, and one of those upwind scans was equal to or greater than all but one of the downwind scans on these dates.

The first 3 scan sets were obtained during daytime hours, and the last scan set was obtained at night. While breathing losses from FRTs would be expected to be minimal at night and peak during the day, the nighttime emissions for this group of tanks was dominated by one of the tanks being filled. This nighttime filling episode, as well as the presence of an EFRT in this group of tanks, precluded making any observations concerning the diurnal breathing cycle for these tanks.

While there is again more variability in the DIAL results than would be expected from the estimated emissions, the DIAL results overlap the estimated emissions reasonably well.

Heated Fuel Oil Tanks

The tanks characterized in the NPL report as heated oil tanks were, at best, only nominally heated. These were not insulated tanks, and they are generally not heated above about 150 F. The tank identified in the NPL report as having the highest level of emissions was only at 88.6 F during the time of the study. While these tanks did not exhibit higher than expected emissions, they were not sufficiently heated to qualify as candidates to evaluate questions concerning potential underreporting of emissions from heated tanks.

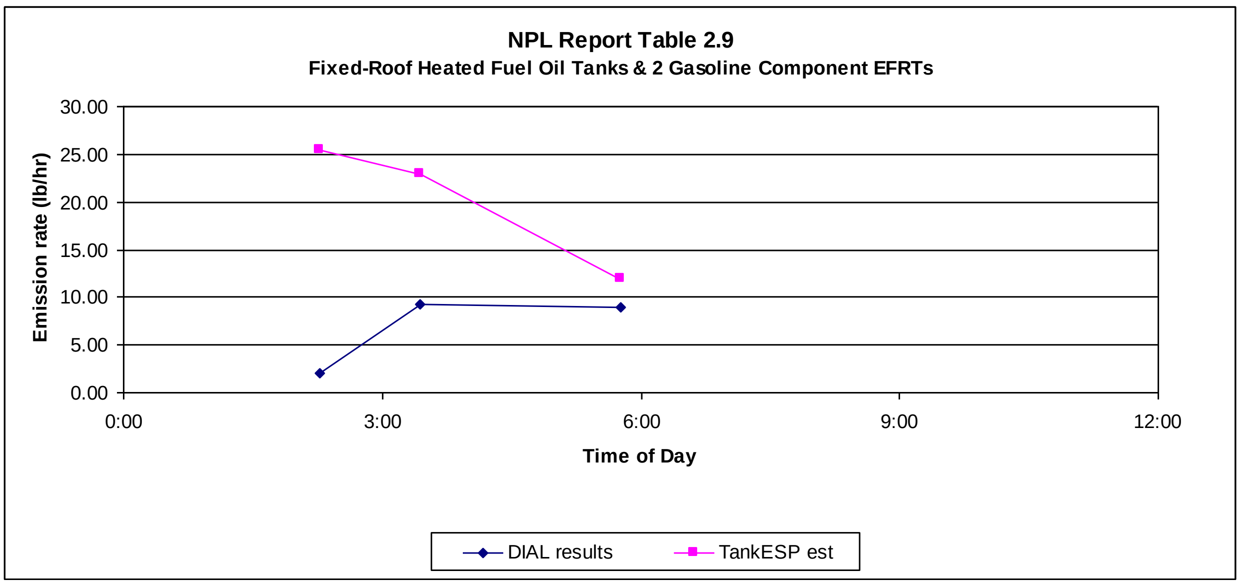
The first two scan sets in this group were for a single FRT storing heated fuel oil. The third scan set represents 6 fixed-roof tanks (FRTs) storing heated fuel oil, and 2 EFRTs storing light naphtha. A comparison of the DIAL results to estimated emissions for this group are presented in Table 5.

Table 5 – Heated Fuel Oil tanks at the Refinery.

Scan Set	Date	Avg Time of Day	Avg Wind Speed (mph)	Avg Wind Direction	Avg Ambient Temp (F)	**Avg DIAL results (lb/hr)**	**Avg Estimated emission rate (lb/hr)**
8_08 6_265a	8/8/07	2:16	8.1	212.1	76.9	2.00	25.4
8_08 6_265b	8/8/07	3:26	6.6	214.2	76.3	9.33	23
8_08 7_90	8/8/07	5:45	4.5	197.6	77.2	9	11.9
				Average of all scan sets:		6.78	20.10

The DIAL results are compared graphically to estimated emissions for these tanks in Figure 3.

Figure 3 – Heated Fuel Oil tanks at the Refinery.



This group is also positioned between refinery process units and a large tank farm. Again, the potential contribution of upwind sources, such as an upwind FRT being filled during a scan of these tanks, is not known.

The first 2 scan sets, of a single FRT, were obtained while this tank was being filled. The DIAL results fall considerably short of estimated emissions for this filling event. The DIAL results show reasonable agreement with the estimated emissions for the third scan set, which represents a group of tanks.

Crude Oil Tanks

This group represents 7 external floating-roof tanks (EFRTs) storing crude oil. A comparison of the DIAL results to estimated emissions for this group are presented in Table 6.

Table 6 – Crude Oil tanks at the Refinery.

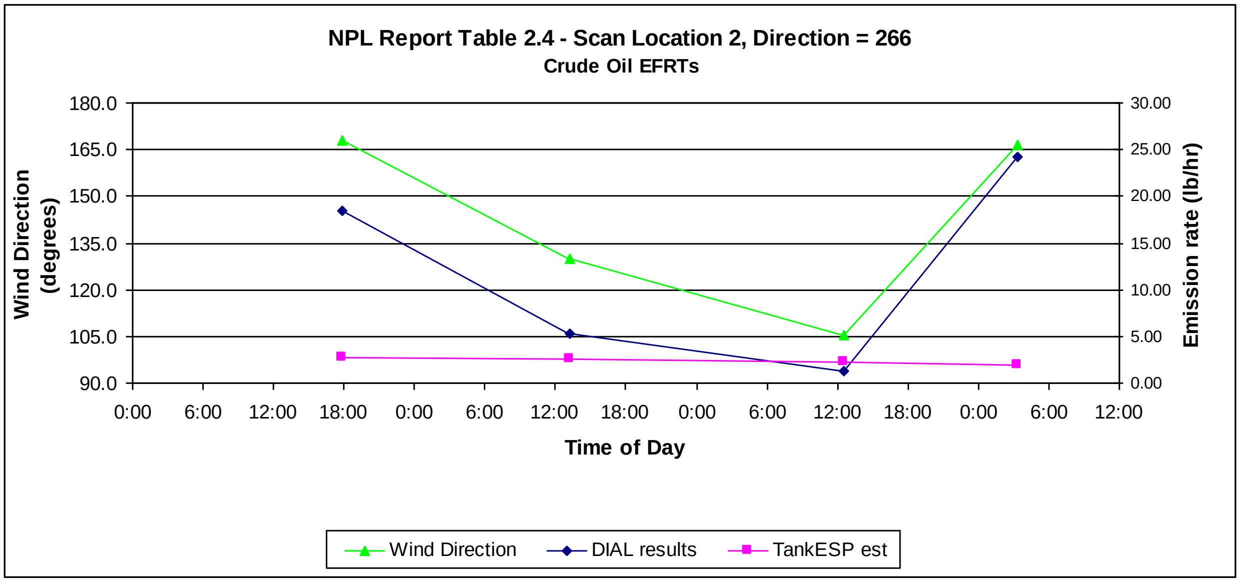
Scan Set	Date	Avg Time of Day	Avg Wind Speed (mph)	Avg Wind Direction	Avg Ambient Temp (F)	**Avg DIAL results (lb/hr)**	**Avg Estimated emission rate (lb/hr)**
7_28 2_99	7/28/07	13:07	5.3	228.5	87.48	5.40	0.6
7_29 2_99	7/29/07	14:58	8.6	164.7	86.5	10.50	0.8
8_05 2_99	8/5/07	0:26	6.7	156.7	81.7	2.75	0.7
					Average:	**6.2**	**0.7**
7_29 2_78	7/29/07	16:02	8.0	153.4	84.2	12.25	1.8
8_06 2_78a	8/6/07	1:25	8.7	160.2	81.3	6.33	1.8
8_06 2_78b	8/6/07	6:20	5.7	193.5	80.6	1.00	1.3
					Average:	**6.5**	**1.6**
7_31 2C_60	7/31/07	13:52	7.8	159.2	89.02	**1.00**	**6**
7_28 2_266	7/28/07	17:51	9.4	167.9	82.45	18.50	2.7
7_29 2_266	7/29/07	13:10	8.3	129.8	85.75	5.33	2.5
7_31 2_266	7/31/07	12:35	7.1	105.3	87.3	1.33	2.3
8_06 2_266	8/6/07	3:22	7.8	166.3	80.4	24.25	2
					Average:	**12.4**	**2.4**
8_02 4_328	8/2/07	15:18	8.3	232.7	85.24	**39.6**	**1.4**
8_02 4_5	8/2/07	14:02	7.2	226.4	83.34	**24.0**	**3.4**

DIAL results for this group of crude oil tanks range from below the estimated emissions to an order of magnitude greater than estimated emissions. This variability in the DIAL results does not appear to be attributable to variations in the actual tank emissions, in that there is considerable variability in the DIAL results for scans made during periods of similar temperature and wind speed.

For example, scan sets 7_29 2_78 and 8_06 2_78a were obtained under nearly identical conditions, yet the DIAL results differ by a factor of 2. Furthermore, review of the individual DIAL scans within these two sets shows that they range by a factor of 4.

The unexplained variability in the DIAL results is illustrated graphically in Figure 4, which shows the results of the scan sets from Location 2 and scan direction 266.

Figure 4 – Crude Oil tanks at the Refinery.



As suggested by the graph, the one variable that appears to correspond to the variability in DIAL results is wind direction. Changes in wind direction would not be expected to appreciably impact the actual emissions from these tanks. The cause of the variability, then, may be limitations on the accuracy and repeatability of the DIAL technology or, more likely, unaccounted for contributions from upwind sources.

The Refinery has wastewater treatment facilities (WWTP) located upwind of this group of tanks. The NPL report indicates an average emission rate from the WWTP of 30 lb/hr, with individual scans as high as 42 lb/hr. This WWTP is located directly south of the crude oil tanks being scanned, and thus as the wind direction approaches 180 degrees, the potential for the WWTP to contribute as an upwind source increases. While the emission rate reported for the WWTP is higher than the emission rate reported for the crude oil tanks, the DIAL results for the crude oil tanks are not adjusted in the NPL report for any contribution from the upwind WWTP.

As noted earlier in the discussion on statistical evaluations, however, the seemingly strong correlation between the DIAL results and wind direction for this group of crude oil tanks may be misleading. Other potential explanations are offered in the discussion later in this report on conventional methods of estimating emissions.

The Bulk Terminal

A single group of tanks was investigated at the Bulk Terminal. These included 4 internal floating-roof tanks (IFRTs) storing naphtha, 1 EFRT storing naphtha, and 1 FRT storing butanol. Scans were obtained from two locations. One location scanned downwind of the entire group of tanks. The other scan location utilized two scan directions, one downwind of only the EFRT and the other downwind of the EFRT and 3 of the IFRTs..

There was considerable variability in the DIAL results which, as with the crude oil tanks at the Refinery, does not appear to be attributable to variations in the actual tank emissions. The data from one set of scans is summarized in Table 7. This set of scans was downwind of 3 IFRTs and the EFRT.

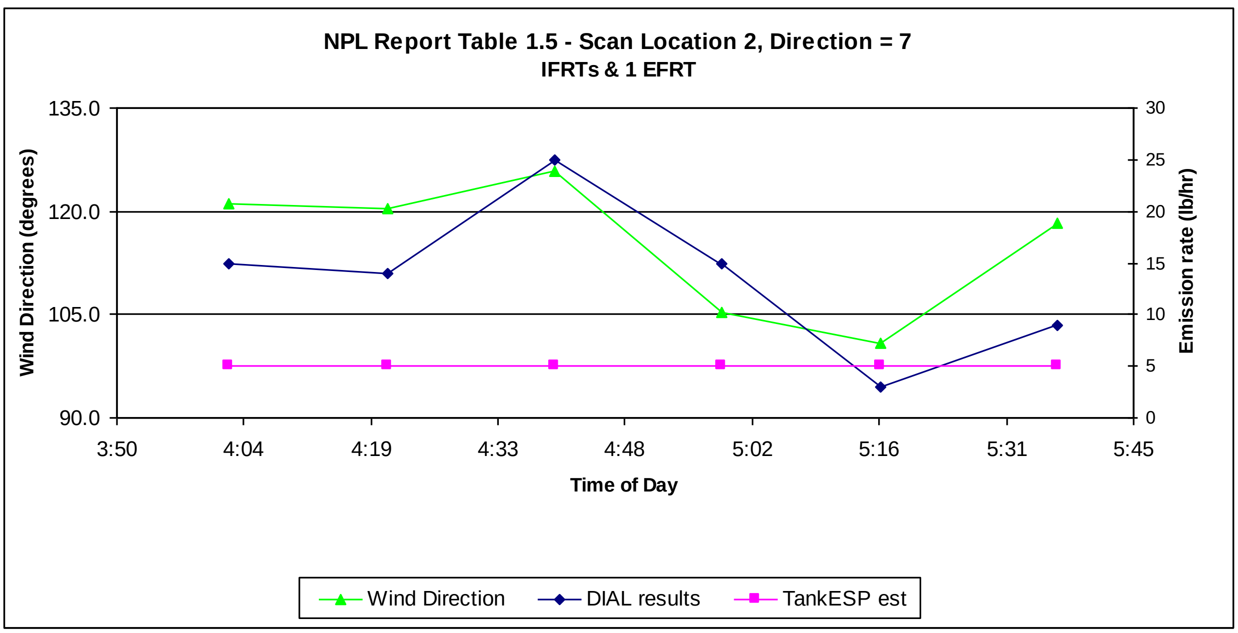
Table 7 – Three IFRTs and one EFRT at the Bulk Terminal.

Scan ID	Date	Start Time	Wind Speed (mph)	Wind Direction	Ambient Temp (F)	**Avg DIAL results (lb/hr)**	**Avg Estimated emission rate (lb/hr)**
64	7/21/07	4:03	5.6	121.2	78.2	15	*
65	7/21/07	4:21	4.9	120.3	78.2	14	*
66	7/21/07	4:40	5.1	125.7	78.4	25	*
67	7/21/07	4:59	4.9	105.2	78.4	15	*
68	7/21/07	5:17	5.8	100.9	78.4	3	*
69	7/21/07	5:37	5.4	118.2	78.8	9	*
					Average of all scans:	13.5	5.0

*Estimated emissions were based on the average conditions for the set of scans.

The conditions during these scans changed very little. The wind speed was in the range of 5.4 mph +/- 0.5 mph, the ambient temperature was in the range of 78.5°F +/- 0.3°F, there was no solar insolation during any of the scans due to the early morning time frame, and the facility reported that there had been no change in the liquid level of any of these tanks for several days. As suggested by the graph in Figure 5, the one variable that appears to correspond to the variability in DIAL results is wind direction (which is the same association observed for the crude oil tanks at the Refinery). Whereas there is an evident potential source of upwind contributions to emissions from the crude oil tanks at the Refinery, there is no such readily evident upwind source at the Bulk Terminal. The variability of the DIAL results with changes in wind direction remains unexplained.

Figure 5 – Three IFRTs and one EFRT at the Bulk Terminal.



Results from the scans of multiple tanks at the Bulk Terminal are compared to estimated emissions in Table 8. The DIAL results range from below the estimated emissions to 3.5 times greater than the estimated emissions.

Table 8 – Scans of multiple tanks at the Bulk Terminal.

Scan Set	Date	Avg Time of Day	Avg Wind Speed (mph)	Avg Wind Direction	Avg Ambient Temp (F)	**Avg DIAL results (lb/hr)**	**Avg Estimated emission rate (lb/hr)**
7_16 1	7/16/07	16:36	11.3	156.6	81.65	**28.0**	**7.6**
7_17 1	7/17/07	13:36	12.8	200.3	86.4	**21.2**	**8.0**
7_18 2	7/18/07	12:06	8.4	137.8	80.7	**3.5**	**5.4**
7_19 2	7/19/07	17:37	8.3	128.8	79.7	**18**	**5.4**
7_21 2	7/21/07	4:49	5.3	115.3	78.4	**13.5**	**5.0**

There is considerable variability in the DIAL results, even when comparing scan sets representing similar conditions. For example, the average DIAL results for scan sets 7_18 2 and 7_19 2 differ by a factor of more than 5 (from 3.5 to 18), yet the average wind speeds for these scan sets is fairly constant (8.3 to 8.4 mph) as is the average ambient temperature (79.7^{o}F to 80.7 ^{o}F) and the average wind direction (128.8 to 137.8 degrees), and both sets of scans were obtained during the daytime. In this case, it is less likely that the difference in DIAL results is associated with a change in wind direction.

Results from scans of only the EFRT at the Bulk Terminal are compared in Table 9. The DIAL results range from slightly above the estimated emissions to more than 4 times greater than the estimated emissions.

Table 9 – Scans of only the EFRT at the Bulk Terminal.

Scan Set	Date	Avg Time of Day	Avg Wind Speed (mph)	Avg Wind Direction	Avg Ambient Temp (F)	**Avg DIAL results (lb/hr)**	**Avg Estimated emission rate (lb/hr)**
7_17 2_61	7/17/07	17:13	7.5	217.6	81.9	**3.0**	**1.03**
7_18 2_61	7/18/07	12:36	8.7	164.5	80.3	**5.1**	**1.14**
7_19 2_61	7/19/07	15:38	7.3	140.7	80.5	**2.5**	**0.95**
7_21 2_61	7/21/07	1:45	6.7	102.9	78.1	**1.0**	**0.82**

The average DIAL results for sets of scans at the Bulk Terminal range from 1.0 lb/hr to 28 lb/hr, and the average of all scan sets is 10.6 lb/hr. Estimated emissions for these scan sets range from 0.8 to 8.0 lb/hr, and the average of all scan sets is 3.9 lb/hr.

COMMENTS ON CONVENTIONAL ESTIMATION METHODS

As discussed earlier, there was an apparently strong correlation between the DIAL results for a group of crude oil tanks and the direction of the wind. This suggests that the periods of higher DIAL results could be explained by contributions from an upwind source. It could be, however, that this correlation is largely coincidental, and that other factors are at play.

For example, another observation from the data was that on three of the four periods of particularly high DIAL results, at least one tank in the group was being filled. On the two days with DIAL results that were close to the estimated emissions, none of the tanks were being filled.

The emissions estimating method for external floating-roof tanks does not account for tank filling as a cause for increased emissions, except in the event that the floating roof had been landed on its support legs. A review of the tank data, however, indicated that the floating roofs had not been landed in any of these tanks during the period of the DIAL study. Furthermore, if tank filling were the causal factor, that would not explain the fourth period of high DIAL results.

While explanations of the cause of the higher DIAL results cannot be discerned from the DIAL study itself, potential causes of higher than expected emissions from crude oil tanks may be postulated.

Loss of Light Ends During Filling

One consideration with respect to receiving crude oil is the potential for the crude oil to contain light ends that flash out of solution when the crude oil enters an atmospheric tank. It is generally assumed that crude oil is stable by the time that it arrives at the refinery, but if there were, in fact, unstable light ends present, these could result in temporarily higher emissions during tank filling.

Another consideration with respect to receiving crude oil into a floating-roof tank is that the estimation method includes a product factor, K_C, of 0.4 for crude oil. This product factor may be due in part to the potential for crude oil to weather at the surface, which refers to the loss of light ends even if those light ends do not have the flash potential discussed above. That is, the vapor pressure of the liquid at the surface is lowered as light ends evaporate, unless those light ends are replaced by diffusion from the lower portions of the liquid at a rate equal to the rate of evaporation from the surface. This replacement by diffusion readily occurs with most refined stocks, and thus refined stocks have a product factor of 1.0 (*i.e.*, no reduction). Crude oil, on the other hand, has a product factor of 0.4, which means that the estimated emissions are reduced by 60%.

If the product factor reduction is largely attributable to weathering, but the filling process were to result in mixing such that the weathered layer at the liquid surface were replaced with fresh crude oil, then the reduction would not take effect until after the initial evaporation of light ends from the region near the liquid surface. This would suggest that crude oil emissions would be higher than estimated immediately after filling, even if the light ends are stable (*i.e.*, do not flash), but would then decrease as the layer of crude oil near the surface is weathered. Another consideration, if weathering is the phenomenon supporting the product factor, is that stock would not be expected to experience weathering if a mixer is used, in that the mixer would cause constant replacement of the liquid at the surface. Similarly, weathering would be less likely to occur in a tank that has frequent turnovers or frequent flow through the tank.

It may be that the variation in DIAL results for the crude oil tanks had a combination of explanations. For example, in some cases it may have been due to tank filling, and in other cases it may have been due to the wind shifting to align with an upwind source just at the time that there was a release from that upwind source. Then, again, the real explanation may be something else entirely. It is simply not possible to know from the results of the DIAL study.

TANKS Defaults

An additional issue with respect to estimating emissions from storage tanks is the use of default values from EPA's TANKS program. For the case of crude oil storage tanks, a particular concern is the use of the default value given in TANKS for Reid vapor pressure (RVP). TANKS contains default physical properties for crude oil which include an RVP value of 5 pounds per square inch (psi). However, actual values for the RVP of crude oil vary substantially from this default value. For example, a review of RVP data from one refinery (not the refinery in this DIAL study) over a period of one year showed values that varied from 0.93 psi to 12.80 psi. The effect of RVP on estimated emissions is in the P* vapor pressure function, which is calculated from the true vapor pressure (TVP) of the stock. The TVP, in turn, may be calculated from the RVP. It is apparent from the table below that the observed range in crude oil RVP at one refinery would result in estimated emissions that range by a factor of about 60 (it is only coincidental that the calculations were based on an assumed temperature of 60 degrees Fahrenheit).

RVP (psi)	**TVP** (@ 60 F)	**P*** (dimensionless)
0.93	0.29	0.005
5	2.90	0.055
12.80	10.5	0.304

While it is apparent that significant error can be introduced by using the TANKS default values when estimating emissions from storage tanks, the refinery in this DIAL study did not use the TANKS default value of 5 psi for the RVP of crude oil. Rather, this refinery used an RVP value of 9 psi for estimating emissions from crude oil tanks.

SUMMARY

Short-term emissions were estimated for storage tanks at a Refinery and at a Bulk Terminal in Texas City, TX, corresponding to the time periods and tank groups for which NPL reported DIAL results. Emissions were estimated based on the specific tank features, stored liquid properties, operating conditions, and meteorological conditions existing at the time of each set of DIAL scans. The emission estimates were performed using the emission factors and equations published in EPA's AP-42 document, with the equations adjusted as described herein (in accordance with guidance from TCEQ) in an attempt to make them more applicable to short periods of time. As discussed herein, however, the emission factors and equations that are presently available in AP-42 can not entirely accommodate estimates of hourly emissions.

Despite the acknowledged inadequacies in applying the AP-42 methodology to hourly emissions, the emission estimates corresponding to this DIAL study generally fall within the range of the DIAL results. The DIAL results exhibit considerable variability, however, and range to higher levels than the corresponding emission estimates. The DIAL results were not sufficiently repeatable to support conclusions as to whether any tank was exhibiting significantly greater emission rates than expected. Furthermore, the variability of DIAL results precludes making any empirical observations concerning typical emission rates for a given tank configuration, in that the DIAL results for repeat scans of the same tanks under similar conditions vary by as much as an order of magnitude.

Nevertheless, DIAL results from a number of the data sets for crude oil tanks were higher than expected. The strong correlation of some of the DIAL results with wind direction could suggest that a significant upwind source became aligned with the crude oil tanks at a particular wind direction. It might also be observed, however, that tank filling was taking place when some of the higher results were recorded.

Specific issues might be more effectively investigated by targeted studies, such as the study of floating roof landing losses that resulted in the methodology now published in AP-42. A targeted study of the issue of whether there are light ends (with the potential to flash) present in the crude oil received at the refinery might be effectively evaluated by a program of sampling and analysis of crude oils as they are received, in conjunction with surveys by IR camera during the filling process of those tanks receiving the crude oil. This would provide information on whether observed plumes tend to be present during filling episodes and, if so, whether the crude oil received contained light ends with the potential to flash. In a similar manner, a targeted study could be designed to investigate each issue of concern.

Summary of scan data for the bulk terminal.

Scan Set: This is a label assigned by TGB for a group of scans taken from the same location and in the same direction on a given date.
NPL Table: This is the table number in the NPL report.
NPL Location: This is the DIAL location in the NPL report.
Scan Direction: This is the approximate compass direction of the scans, as scaled from the figures in the NPL report.
Scans Included: These are the Scan ID's from the NPL report.
Avg Wind Speed: This is the average of the wind speeds reported by NPL for the given Scan IDs.
Avg Ambient Temp: This is the average of the Texas City hourly temperatures during the measurement period for the given Scan IDs.
A daily temperature range of +/- 4 degrees F was assumed for estimating fixed-roof tank breathing loss rates, based on the historically typical summer range for Galveston.
Insolation: This is the insolation for Texas City on the day of the measurements, accumulated through the average time of the given Scan IDs.
These insolation values are significantly lower than is historically typical for Galveston, and the measurements were taken on sunny days, so the insolation values might be grossly understated.

Scan Set	NPL Table	NPL Location	Scan Direction	Scans Included	Avg Wind Speed (mph)	Avg Ambient Temp (F)	Insolation (Btu / ft^2 day)	Tanks Upwind of This Scan Location
7_16 1	1.1	1	58	10, 11, 12, 13	11.3	81.65	1226	22, 23, 27, 28, 29, 3792
7_17 1	1.2	1	58	3, 4, 5, 6, 7, 8, 14, 21, 23, 24, 25	12.8	86.4	852	22, 23, 27, 28, 29, 3792
7_18 2	1.3	2	7	10, 11	8.4	80.7	354	22, 23, 28, 29
7_19 2	1.4	2	7	40, 41	8.3	79.7	346.5	22, 23, 28, 29
7_21 2	1.5	2	7	64, 65, 66, 67, 68, 69	5.3	78.4	0	22, 23, 28, 29
7_17 2_61	1.2	2	61	26, 27, 28, 29	7.5	81.9	1083	22
7_18 2_61	1.3	2	61	3, 5, 6, 7, 13, 16, 17, 18	8.7	80.3	364.75	22
7_19 2_61	1.4	2	61	31, 32, 35, 39	7.3	80.5	297.75	22
7_21 2_61	1.5	2	61	49, 50, 51, 54, 55, 56, 72	6.7	78.1	1	22

Summary of scan data for the refinery.

Scan Set: This is a label assigned by TGB for a group of scans taken from the same location and in the same direction on a given date.
NPL Table: This is the table number in the NPL report.
NPL Location: This is the DIAL location in the NPL report.
Scan Direction: This is the approximate compass direction of the scans, as scaled from the figures in the NPL report.
Scans Included: These are the Scan ID's from the NPL report.
Avg Wind Speed: This is the average of the wind speeds reported by NPL for the given Scan IDs.
Avg Ambient Temp: This is the average of the Texas City hourly temperatures during the measurement period for the given Scan IDs.
A daily temperature range of +/- 4 degrees F was assumed for estimating fixed-roof tank breathing loss rates, based on the historically typical summer range for Galveston.
Insolation: This is the insolation for Texas City on the day of the measurements, accumulated through the average time of the given Scan IDs.
These insolation values are significantly lower than is historically typical for Galveston, and the measurements were taken on sunny days, so the historically typical value for July in Galveston was used (1846 Btu / ft^2 day).
Tanks Upwind: These were determined by visual appraisal of the figures in the NPL report.
Pumping Action: This was not from the NPL report, but rather was calculated from changes in liquid level as determined from the refinery's PI data.
For purposes of estimating emissions, only pump in was considered for fixed-roof tanks, and pump out for floating roof tanks.

Scan Set	NPL Table	NPL Location	Scan Direction	Scans Included	Avg Wind Speed (mph)	Avg Ambient Temp (F)	Insolation (Btu / ft^2 day)	Tanks Upwind of This Scan Location	Pumping Activity (gallon/hour)
7_25 1	2.2	1	50	79, 80, 82, 84	10.2	81.525	1846	54, 55, 56, 98	
7_26 1a	2.2	1	?	89, 90, 91, 92, 93	3.4	80.34	1846	54, 55, 56, 98	
7_26 1b	2.2	1	50	96, 97, 98, 99, 100, 101, 102, 106, 107, 108	13.0	80.21	1846	54, 55, 56, 98	
8_07 5	2.2	5	68	377, 378, 379, 380	7.2	78.65	1846	53, 54, 55, 56	TK53: 57,792
7_28 2_99	2.4	2	99	138, 139, 140, 141, 148	5.3	87.48	1846	1025	
7_29 2_99	2.4	2	99	173, 174, 175, 176	8.6	86.5	1846	1025	
8_05 2_99	2.4	2	99	319, 320, 321, 322	6.7	81.7	1846	1025	
7_29 2_78	2.4	2	78	178, 179, 180, 181	8.0	84.2	1846	1024, 1025	
8_06 2_78a	2.4	2	78	323, 324, 325	8.7	81.3	1846	1024, 1025	
8_06 2_78b	2.4	2	78	338, 340	5.7	80.6	1846	1024, 1025	
7_31 2C_60	2.4	2C	60	235, 236, 241, 242, 243	7.8	89.0	1846	1020, 1021, 1024, 1025	TK1020: 105,368 TK1024: 272,143
7_28 2_266	2.4	2	266	156, 157, 158, 159	9.4	82.45	1846	1052, 1053	TK1053: 112,243
7_29 2_266	2.4	2	266	163, 164, 165, 166, 167, 168	8.3	85.75	1846	1052, 1053	TK1052: 35,006
7_31 2_266	2.4	2	266	231, 232, 233	7.1	87.3	1846	1052, 1053	TK1052: 44,849

Scan Set	NPL Table	NPL Location	Scan Direction	Scans Included	Avg Wind Speed (mph)	Avg Ambient Temp (F)	Insolation (Btu / ft^2 day)	Tanks Upwind of This Scan Location	Pumping Activity (gallon/hour)
8_06 2_266	2.4	2	266	328, 329, 330, 331	7.8	80.4	1846	1052, 1053	
8_02 4_5	2.4	4	5	279, 280, 281, 282, 283	7.2	83.34	1846	1052, 1053, 1055	TK1052: 58,780
8_02 4_328	2.4	4	328	284, 285, 286, 287, 288	8.3	85.24	1846	1052	TK1052: 73,903
7_30 3_335	2.5	3	335	196, 198	5.3	84.6	1846	501, 502, 503, 504	
8_07 3_335	2.5	3	335	356	6.0	81.5	1846	501, 502, 503, 504	
7_30 3_313a	2.5	3	313	205, 207, 208	10.4	83.4	1846	501, 502, 504	
7_30 3_313b	2.5	3	313	218, 220, 221, 224	9.6	84.0	1846	501, 502, 504	TK502: 64,205
8_07 3_313	2.5	3	313	347, 353, 354, 355	6.3	81.63	1846	501, 502, 504	
8_08 6_265a	2.9	6	265	382, 383, 384	8.1	76.9	1846	43	TK43: 43,180
8_08 6_265b	2.9	6	265	388, 389, 390	6.6	76.27	1846	43	TK43: 38,782
8_08 7_90	2.9	7	90	399, 400, 401, 402, 403, 404	4.5	77.15	1846	11, 12, 18, 42, 60, 61, 63, 65	TK18: 27,293

Grouping of scan data for the bulk terminal.

DIAL results are summarized in the tables below by grouping scans taken from the same location and in the same direction, regardless of date. The column headings should be understood as follows:

Scan Set: This is a label assigned by TGB for a group of scans taken from the same location and in the same direction on a given date.

NPL Table: This is the table number in the NPL report.

NPL Location: This is the DIAL location in the NPL report.

Scan Direction: This is the approximate compass direction of the scans, as scaled from the figures in the NPL report.

NPL Emission Rate: This is the emission rate reported by NPL. Values listed as '<1' are taken as 0.5.

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
7_16 1	1.1	10	7/16/07	1	58	31
7_16 1	1.1	11	7/16/07	1	58	24
7_16 1	1.1	12	7/16/07	1	58	24
7_16 1	1.1	13	7/16/07	1	58	33
7_17 1	1.2	3	7/17/07	1	58	20
7_17 1	1.2	4	7/17/07	1	58	21
7_17 1	1.2	5	7/17/07	1	58	24
7_17 1	1.2	6	7/17/07	1	58	19
7_17 1	1.2	7	7/17/07	1	58	31
7_17 1	1.2	8	7/17/07	1	58	25
7_17 1	1.2	14	7/17/07	1	58	25
7_17 1	1.2	21	7/17/07	1	58	20
7_17 1	1.2	23	7/17/07	1	58	15
7_17 1	1.2	24	7/17/07	1	58	22
7_17 1	1.2	25	7/17/07	1	58	11
	no. of scans:	15			mean:	23
			Sample standard deviation:			5.9

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
7_18 2	1.3	10	7/18/07	2	7	4
7_18 2	1.3	11	7/18/07	2	7	3
7_19 2	1.4	40	7/19/07	2	7	20
7_19 2	1.4	41	7/19/07	2	7	16
7_21 2	1.5	64	7/21/07	2	7	15
7_21 2	1.5	65	7/21/07	2	7	14
7_21 2	1.5	66	7/21/07	2	7	25
7_21 2	1.5	67	7/21/07	2	7	15
7_21 2	1.5	68	7/21/07	2	7	3
7_21 2	1.5	69	7/21/07	2	7	9
	no. of scans:	10			mean:	12.4
			Sample standard deviation:			7.5

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
7_17 2	1.2	26	7/17/07	2	61	1
7_17 2	1.2	27	7/17/07	2	61	4
7_17 2	1.2	28	7/17/07	2	61	4
7_17 2	1.2	29	7/17/07	2	61	3
7_18 2	1.3	3	7/18/07	2	61	5
7_18 2	1.3	5	7/18/07	2	61	3
7_18 2	1.3	6	7/18/07	2	61	7
7_18 2	1.3	7	7/18/07	2	61	10
7_18 2	1.3	13	7/18/07	2	61	4
7_18 2	1.3	16	7/18/07	2	61	3
7_18 2	1.3	17	7/18/07	2	61	3
7_18 2	1.3	18	7/18/07	2	61	6
7_19 2	1.4	31	7/19/07	2	61	1
7_19 2	1.4	32	7/19/07	2	61	0.5
7_19 2	1.4	35	7/19/07	2	61	5
7_19 2	1.4	39	7/19/07	2	61	4
7_21 2	1.5	49	7/21/07	2	61	1
7_21 2	1.5	50	7/21/07	2	61	1
7_21 2	1.5	51	7/21/07	2	61	1
7_21 2	1.5	54	7/21/07	2	61	1
7_21 2	1.5	55	7/21/07	2	61	2
7_21 2	1.5	56	7/21/07	2	61	0.5
7_21 2	1.5	72	7/21/07	2	61	1
	no. of scans:	23			mean:	3.1
					Sample standard deviation:	2.4

Grouping of scan data for the refinery.

DIAL results are summarized in the tables below by grouping scans taken from the same location and in the same direction, regardless of date. The column headings should be understood as follows:

Scan Set: This is a label assigned by TGB for a group of scans taken from the same location and in the same direction on a given date.

NPL Table: This is the table number in the NPL report.

NPL Location: This is the DIAL location in the NPL report.

Scan Direction: This is the approximate compass direction of the scans, as scaled from the figures in the NPL report.

NPL Emission Rate: This is the emission rate reported by NPL. Values listed as '<1' are taken as 0.5.

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
7_25 1	2.2	79	7/25/07	1	50	2
7_25 1	2.2	80	7/25/07	1	50	3
7_25 1	2.2	82	7/25/07	1	50	2
7_25 1	2.2	84	7/25/07	1	50	0.5
7_26 1a	2.2	89	7/26/07	1	?	0.5
7_26 1a	2.2	90	7/26/07	1	?	1
7_26 1a	2.2	91	7/26/07	1	?	0.5
7_26 1a	2.2	92	7/26/07	1	?	0.5
7_26 1a	2.2	93	7/26/07	1	?	0.5
7_26 1b	2.2	96	7/26/07	1	50	4
7_26 1b	2.2	97	7/26/07	1	50	2
7_26 1b	2.2	98	7/26/07	1	50	2
7_26 1b	2.2	99	7/26/07	1	50	0.5
7_26 1b	2.2	100	7/26/07	1	50	2
7_26 1b	2.2	101	7/26/07	1	50	1
7_26 1b	2.2	102	7/26/07	1	50	7
7_26 1b	2.2	106	7/26/07	1	50	5
7_26 1b	2.2	107	7/26/07	1	50	14
7_26 1b	2.2	108	7/26/07	1	50	6
	no. of scans:	19			mean:	2.8
					Sample standard deviation:	3.3

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
8_07 5	2.2	377	8/7/07	5	68	13
8_07 5	2.2	378	8/7/07	5	68	32
8_07 5	2.2	379	8/7/07	5	68	29
8_07 5	2.2	380	8/7/07	5	68	21
	no. of scans:	4			mean:	23.8
					Sample standard deviation:	8.5

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
7_28 2_99	2.4	138	7/28/07	2	99	3
7_28 2_99	2.4	139	7/28/07	2	99	6
7_28 2_99	2.4	140	7/28/07	2	99	8
7_28 2_99	2.4	141	7/28/07	2	99	5
7_28 2_99	2.4	148	7/28/07	2	99	5
7_29 2_99	2.4	173	7/29/07	2	99	12
7_29 2_99	2.4	174	7/29/07	2	99	13
7_29 2_99	2.4	175	7/29/07	2	99	8
7_29 2_99	2.4	176	7/29/07	2	99	9
8_05 2_99	2.4	319	8/5/07	2	99	5
8_05 2_99	2.4	320	8/6/07	2	99	4
8_05 2_99	2.4	321	8/6/07	2	99	0.5
8_05 2_99	2.4	322	8/6/07	2	99	2
	no. of scans:	13			mean:	6.2
			Sample standard deviation:			3.7

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
7_29 2_78	2.4	178	7/29/07	2	78	15
7_29 2_78	2.4	179	7/29/07	2	78	5
7_29 2_78	2.4	180	7/29/07	2	78	15
7_29 2_78	2.4	181	7/29/07	2	78	14
8_06 2_78a	2.4	323	8/6/07	2	78	4
8_06 2_78a	2.4	324	8/6/07	2	78	11
8_06 2_78a	2.4	325	8/6/07	2	78	4
8_06 2_78b	2.4	338	8/6/07	2	78	1
8_06 2_78b	2.4	340	8/6/07	2	78	1
	no. of scans:	9			mean:	7.8
			Sample standard deviation:			5.9

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
7_31 2C_60	2.4	235	7/31/07	2C	60	0.5
7_31 2C_60	2.4	236	7/31/07	2C	60	2
7_31 2C_60	2.4	241	7/31/07	2C	60	0.5
7_31 2C_60	2.4	242	7/31/07	2C	60	0.5
7_31 2C_60	2.4	243	7/31/07	2C	60	3
	no. of scans:	5			mean:	1.3
			Sample standard deviation:			1.2

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
7_28 2_266	2.4	156	7/28/07	2	266	7
7_28 2_266	2.4	157	7/28/07	2	266	13
7_28 2_266	2.4	158	7/28/07	2	266	23
7_28 2_266	2.4	159	7/28/07	2	266	31
7_29 2_266	2.4	163	7/29/07	2	266	3
7_29 2_266	2.4	164	7/29/07	2	266	6
7_29 2_266	2.4	165	7/29/07	2	266	5
7_29 2_266	2.4	166	7/29/07	2	266	6
7_29 2_266	2.4	167	7/29/07	2	266	7
7_29 2_266	2.4	168	7/29/07	2	266	5
7_31 2_266	2.4	231	7/31/07	2	266	0.5
7_31 2_266	2.4	232	7/31/07	2	266	3
7_31 2_266	2.4	233	7/31/07	2	266	1
8_06 2_266	2.4	328	8/6/07	2	266	44
8_06 2_266	2.4	329	8/6/07	2	266	22
8_06 2_266	2.4	330	8/6/07	2	266	12
8_06 2_266	2.4	331	8/6/07	2	266	19
	no. of scans:	17			mean:	12.2
					Sample standard deviation:	12.0

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
8_02 4_5	2.4	279	8/2/07	4	5	39
8_02 4_5	2.4	280	8/2/07	4	5	19
8_02 4_5	2.4	281	8/2/07	4	5	20
8_02 4_5	2.4	282	8/2/07	4	5	24
8_02 4_5	2.4	283	8/2/07	4	5	18
	no. of scans:	5			mean:	24.0
					Sample standard deviation:	8.7

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
8_02 4_328	2.4	284	8/2/07	4	328	37
8_02 4_328	2.4	285	8/2/07	4	328	54
8_02 4_328	2.4	286	8/2/07	4	328	39
8_02 4_328	2.4	287	8/2/07	4	328	39
8_02 4_328	2.4	288	8/2/07	4	328	29
	no. of scans:	5			mean:	39.6
					Sample standard deviation:	9.0

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
7_30 3_335	2.5	196	7/30/07	3	335	2
7_30 3_335	2.5	198	7/30/07	3	335	5
8_07 3_335	2.5	356	8/7/07	3	335	1
no. of scans:		3			mean:	2.7
			Sample standard deviation:			2.1

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
7_30 3_313a	2.5	205	7/30/07	3	313	2
7_30 3_313a	2.5	207	7/30/07	3	313	13
7_30 3_313a	2.5	208	7/30/07	3	313	11
7_30 3_313b	2.5	218	7/30/07	3	313	5
7_30 3_313b	2.5	220	7/30/07	3	313	18
7_30 3_313b	2.5	221	7/30/07	3	313	5
7_30 3_313b	2.5	224	7/30/07	3	313	16
8_07 3_313	2.5	347	8/7/07	3	313	8
8_07 3_313	2.5	353	8/7/07	3	313	1
8_07 3_313	2.5	354	8/7/07	3	313	0.5
8_07 3_313	2.5	355	8/7/07	3	313	0.5
no. of scans:		11			mean:	7.3
			Sample standard deviation:			6.4

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
8_08 6_265a	2.9	382	8/8/07	6	265	3
8_08 6_265a	2.9	383	8/8/07	6	265	2
8_08 6_265a	2.9	384	8/8/07	6	265	1
8_08 6_265b	2.9	388	8/8/07	6	265	8
8_08 6_265b	2.9	389	8/8/07	6	265	13
8_08 6_265b	2.9	390	8/8/07	6	265	7
no. of scans:		6			mean:	5.7
			Sample standard deviation:			4.5

Scan Set	NPL Table	Scan ID	Date	NPL Location	Scan Direction	NPL Emission Rate (lb/hr)
8_08 7_90	2.9	399	8/8/07	7	90	9
8_08 7_90	2.9	400	8/8/07	7	90	12
8_08 7_90	2.9	401	8/8/07	7	90	15
8_08 7_90	2.9	402	8/8/07	7	90	4
8_08 7_90	2.9	403	8/8/07	7	90	9
8_08 7_90	2.9	404	8/8/07	7	90	5
	no. of scans:	6			mean:	9.0
					Sample standard deviation:	4.1

Summary of tank data for the bulk terminal.

Tank ID No.	22	23	27	28	29	3792	Comments
Diameter (feet)	219	150	116	135	135	150	
Height (feet)	40	40	60	60	60	20	
Fixed Roof Type	no fixed roof	column-supported	column-supported	column-supported	column-supported	column-supported	
	(open top)	(cone)	(cone)	(cone)	(cone)	(cone)	
Tank shell color	white	white	white	white	white	white	* Tank 3792 had dark mold on
Tank shell condition	good	good	good	good	good	poor *	the outside, rendering the paint
Tank roof color	white	white	white	white	white	white	condition effectively 'poor' with
Tank roof condition	good	good	good	good	good	poor *	respect to reflectivity.
Operating pressure (psig)	*	*	*	*	*	0	* The floating roof tanks were
Minimum pressure (psig)	*	*	*	*	*	-0.003	freely vented, and thus vent
Maximum pressure (psig)	*	*	*	*	*	0.062	settings were not an issue.
Floating Roof Type	steel pontoon	aluminum bolted	aluminum bolted	aluminum bolted	aluminum bolted	no floating roof	
	EFR	IFR	IFR	IFR	IFR	(Fixed-Roof Tank)	
Rim Seal: Primary	mechanical-shoe	vapor-mounted	mechanical-shoe	mechanical-shoe	mechanical-shoe	N/A	
Secondary	rim-mtd secondary	rim-mtd secondary	rim-mtd secondary	rim-mtd secondary	rim-mtd secondary		
Guidepole control status	gasket, pole wiper,	gasket, pole wiper,	gasket, pole wiper,	gasket, pole wiper,	gasket, pole wiper,	N/A	* 2 slotted poles with flexible
	& pole float *	no float or sleeve	no float or sleeve	no float or sleeve	no float or sleeve		enclosures & one unslotted pole;
Guidepole quantity	3	1	3	3	3	0	all three modeled as 'with float.'
Access Hatch	gasketed, bolted	gasketed, bolted	gasketed cover	gasketed cover	gasketed cover	N/A	
quantity	1	1	2	2	2	0	
Gauge Float	gasketed, bolted	gasketed, bolted	gasketed cover	gasketed cover	gasketed cover	N/A	
quantity	1	1	1	1	1	0	
Gauge Hatch	gasketed cover	slit fabric seal	slit fabric seal	slit fabric seal	slit fabric seal	N/A	
quantity	1	1	1	1	1	0	
Vacuum Breaker	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	N/A	
quantity	3	1	4	4	4	0	
Deck Drain		IFR 1" stub drain *	IFR 1" stub drain *	IFR 1" stub drain *	IFR 1" stub drain *	N/A	* IFR drains have ball valves, but
quantity	0	180	29	32	32	0	emission factor is for open drains.
Deck Support Leg	pontoon leg w/sock	IFR type *	IFR type *	IFR type *	IFR type *	N/A	* IFR decks suspended by cables
quantity	32	58	98	126	126	0	that pass through sleeves.
Deck Support Leg	center leg w/sock					N/A	
quantity	83	0	0	0	0	0	
Rim Vent	gasketed cover					N/A	
quantity	1	0	0	0	0	0	
Column, round pipe		gasketed cover	gasketed cover	gasketed cover	gasketed cover	N/A	
quantity	0	9	7	8	8	0	
Column, built-up						N/A	
quantity	0	0	0	0	0	0	
Ladder (vertical)						N/A	
quantity	0	0	0	0	0	0	
Heated tank?	N	N	N	N	N	N	
Stock description	naphtha	naphtha	naphtha	naphtha	naphtha	butanol	
True vapor pressure (psia)	3.9	3.9	3.9	4	4		TVP values given by facility.
Molecular wt. (vapors)	80	80	80	80	80	74.12	
Molecular wt. (liquid)	120	120	120	120	120	74.12	
Antoine A						7.421	
Antoine B						1351.6	
Antoine C						179.81	
Pump rate (bbl/hr)	0	0	0	0	0	0	No pumping took place during the time of the measurements.

Summary of tank data for the refinery.

Tank ID No.	TK53	TK54	TK55	TK56	TK66	TK80	TK98	TK1020	TK1021	TK1024
Diameter (feet)	120	120	150	150	70	120	150	219	219	219
Height (feet)	39.96	39.79	39.44	39.35	46.4	39.67	48	47.54	47.6	47.63
Fixed Roof Type	column-supported (cone)	column-supported (cone)	column-supported (cone)	column-supported (cone)	column-supported (cone)	column-supported (cone)	no fixed roof (open top)	no fixed roof (open top)	no fixed roof (open top)	no fixed roof (open top)
Tank shell color	white	white	white	white	white	white	white	white	white	white
Tank shell condition	good	poor	good	good	good	good	poor	good	good	good
Tank roof color	white	white	white	white	white	white	white	white	white	white
Tank roof condition	good	poor	good	good	good	good	poor	good	good	good
Operating pressure (psig)	0	0	0	0	0	0	0	0	0	0
Minimum pressure (psig)	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Maximum pressure (psig)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Floating Roof Type	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	steel pontoon EFR	steel pontoon EFR	steel pontoon EFR	steel pontoon EFR
Rim Seal: Primary							mechanical-shoe	mechanical-shoe	mechanical-shoe	mechanical-shoe
Secondary							shoe-mtd sec	rim-mtd secondary	rim-mtd secondary	rim-mtd secondary
Guidepole control status							slotted pole with gasket, pole wiper, & pole sleeve	unslotted pole with gasket, pole sleeve, but no wiper	slotted pole with gasket, pole wiper, no float or sleeve	slotted pole with gasket, pole sleeve, but no wiper
Guidepole quantity							1	2	2	1
Access Hatch							gasketed, bolted	gasketed, bolted	gasketed, bolted	gasketed, bolted
quantity							2	4	3	3
Gauge Float									gasketed, bolted	
quantity							0	0	1	0
Gauge Hatch							gasketed cover	gasketed cover	ungasketed cover	gasketed cover
quantity							1	1	1	1
Vacuum Breaker							gasketed cover	gasketed cover	gasketed cover	gasketed cover
quantity							2	3	3	3
Deck Drain										
quantity							0	0	0	0
Deck Support Leg							pontoon-area leg	pontoon-area leg	pontoon-area leg	pontoon-area leg
quantity							24	22	22	22
Deck Support Leg							center-area leg	center-area leg	center-area leg	center-area leg
quantity							36	73	73	80
Rim Vent							ungasketed cover	gasketed cover	gasketed cover	gasketed cover
quantity							2	3	2	3
Column, round pipe										
quantity							0	0	0	0
Column, built-up										
quantity							0	0	0	0
Ladder (vertical)										
quantity							0	0	0	0
Liquid Bulk Temperature deg F (if elevated)	102.9	87.7	106.2	95.8		105.1				
Heated tank?	No	No	No	No	No	No	No	No	No	No
Stock description	LCCO	LCCO	LCCO	LCCO	LCCO	kerosene	light cat naphtha	crude oil	crude oil	crude oil
Molecular wt. (vapors)	163	163	163	163	163	130	92	50	50	50
Molecular wt. (liquid)	261	261	261	261	261	162	123	217	217	217
Reid vapor pressure (psi)	0.06	0.06	0.06	0.06	0.06	0.05	12.3	9	9	9
Distillation slope, S	2.05	2.05	2.05	2.05	2.05	1.5	0.77			

Tank ID No.	TK1025	TK1052	TK1053	TK1055	TK501	TK502	TK503	TK504	TK11	TK12
Diameter (feet)	219	345	345	345	144	144	144	144	117	117
Height (feet)	47.65	47.54	47.27	47.96	40.44	40.17	40.04	40.29	41.8	41.8
Fixed Roof Type	no fixed roof (open top)	no fixed roof (open top)	no fixed roof (open top)	no fixed roof (open top)	no fixed roof (open top)	no fixed roof (open top)	no fixed roof (open top)	no fixed roof (open top)	no fixed roof (open top)	no fixed roof (open top)
Tank shell color	white	white	white	white	white	white	white	white	white	white
Tank shell condition	good	good	good	poor	good	good	good	good	good	good
Tank roof color	white	white	white	white	white	white	white	white	white	white
Tank roof condition	good	good	good	poor	good	good	good	good	good	good
Operating pressure (psig)	0	0	0	0	0	0	0	0	0	0
Minimum pressure (psig)	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Maximum pressure (psig)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Floating Roof Type	steel pontoon EFR	double deck EFR	double deck EFR	double deck EFR	steel pontoon EFR	steel pontoon EFR	steel pontoon EFR	steel pontoon EFR	steel pontoon EFR	steel pontoon EFR
Rim Seal: Primary	mechanical-shoe	mechanical-shoe	mechanical-shoe	mechanical-shoe	mechanical-shoe	mechanical-shoe	mechanical-shoe	mechanical-shoe	mechanical-shoe	mechanical-shoe
Secondary	rim-mtd secondary	rim-mtd secondary	rim-mtd secondary	rim-mtd secondary	rim-mtd secondary	rim-mtd secondary	rim-mtd secondary	rim-mtd secondary	rim-mtd secondary	rim-mtd secondary
Guidepole control status	unslotted pole with gasket, pole wiper, no float or sleeve	unslotted pole with gasket, pole wiper, no float or sleeve	unslotted pole with gasket, pole wiper, no float or sleeve	unslotted pole with gasket, pole wiper, no float or sleeve	unslotted pole with gasket, pole wiper, no float or sleeve	slotted pole with gasket, pole wiper, no float or sleeve	slotted pole with gasket, pole wiper, & pole sleeve	unslotted pole with gasket, pole sleeve, but no wiper	unslotted pole with gasket, pole wiper, no float or sleeve	unslotted pole with gasket, pole wiper, no float or sleeve
Guidepole quantity	2	1	1	1	1	1	1	1	1	1
Access Hatch	gasketed, bolted	gasketed, bolted	gasketed, bolted	gasketed, bolted	gasketed, bolted	gasketed, bolted	gasketed, bolted	gasketed, bolted	gasketed, bolted	gasketed, bolted
quantity	3	3	3	5	1	2	2	2	1	2
Gauge Float	gasketed cover			gasketed cover						
quantity	1	0	0	1	0	0	0	0	0	0
Gauge Hatch	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover
quantity	1	3	2	5	1	1	1	1	1	1
Vacuum Breaker	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover
quantity	3	3	3	5	2	3	3	0	2	2
Deck Drain		open drain	open drain	open drain						
quantity	0	8	12	14	0	0	0	0	0	0
Deck Support Leg	pontoon-area leg				pontoon-area leg	pontoon-area leg	pontoon-area leg	pontoon-area leg	pontoon-area leg	pontoon-area leg
quantity	22	0	0	0	10	10	10	10	8	8
Deck Support Leg	center-area leg	double deck leg	double deck leg	double deck leg	center-area leg	center-area leg	center-area leg	center-area leg	center-area leg	center-area leg
quantity	74	212	212	295	25	28	28	28	17	17
Rim Vent	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	gasketed cover	ungasketed cover	gasketed cover	gasketed cover
quantity	2	3	3	2	2	2	2	1	2	2
Column, round pipe										
quantity	0	0	0	0	0	0	0	0	0	0
Column, built-up										
quantity	0	0	0	0	0	0	0	0	0	0
Ladder (vertical)										
quantity	0	0	0	0	0	0	0	0	0	0
Liquid Bulk Temperature deg F (if elevated)	88.5							90	90.2	
Heated tank?	No	No	No	No	No	No	No	No	No	No
Stock description	crude oil	crude oil	crude oil	crude oil	gasoline	gasoline	gasoline	gasoline	light cat naphtha	light cat naphtha
Molecular wt. (vapors)	50	50	50	50	64	64	64	64	92	92
Molecular wt. (liquid)	217	217	217	217	92	92	92	92	123	123
Reid vapor pressure (psi)	9	9	9	9	13	13	13	13	12.3	12.3
Distillation slope, S					3	3	3	3	0.77	0.77

Tank ID No.	TK17	TK18	TK42	TK43A	TK44	TK59	TK60A	TK61	TK63	TK64
Diameter (feet)	117	117	117	117	117	117	117	117	117	117
Height (feet)	41.29	41.8	41.8	41.67	41.8	41.8	41.67	41.8	41.8	41.8
Fixed Roof Type	column-supported (cone)	column-supported (cone)	column-supported (cone)	column-supported (cone)	column-supported (cone)	column-supported (cone)	column-supported (cone)	column-supported (cone)	column-supported (cone)	column-supported (cone)
Tank shell color	white	white	black	black	black	black	black	black	black	black
Tank shell condition	poor	good	poor	poor	poor	good	good	poor	poor	poor
Tank roof color	white	white	black	black	black	black	black	black	black	black
Tank roof condition	poor	good	poor	poor	poor	good	good	poor	poor	poor
Operating pressure (psig)	0	0	0	0	0	0	0	0	0	0
Minimum pressure (psig)	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Maximum pressure (psig)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Floating Roof Type	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)	no floating roof (Fixed-Roof Tank)
Rim Seal: Primary										
Secondary										
Guidepole control status										
Guidepole quantity										
Access Hatch										
quantity										
Gauge Float										
quantity										
Gauge Hatch										
quantity										
Vacuum Breaker										
quantity										
Deck Drain										
quantity										
Deck Support Leg										
quantity										
Deck Support Leg										
quantity										
Rim Vent										
quantity										
Column, round pipe										
quantity										
Column, built-up										
quantity										
Ladder (vertical)										
quantity										
Liquid Bulk Temperature deg F (if elevated)			125	150			88.6	98.8	96.6	
Heated tank?	No	No	No	No	No	No	No	No	No	No
Stock description	Out of Service	kerosene	LCCO	LCCO	Out of Service	Out of Service	LCCO	LCCO	LCCO	Out of Service
Molecular wt. (vapors)	0	130	163	163	0	0	163	163	163	0
Molecular wt. (liquid)		162	261	261			261	261	261	
Reid vapor pressure (psi)		0.05	0.06	0.06			0.06	0.06	0.06	
Distillation slope, S		1.5	2.05	2.05			2.05	2.05	2.05	

Tank ID No.	**TK65**
Diameter (feet)	117
Height (feet)	41.5
Fixed Roof Type	column-supported (cone)
Tank shell color	black
Tank shell condition	good
Tank roof color	black
Tank roof condition	good
Operating pressure (psig)	0
Minimum pressure (psig)	-0.03
Maximum pressure (psig)	0.03
Floating Roof Type	no floating roof (Fixed-Roof Tank)
Rim Seal: Primary	
Secondary	
Guidepole control status	
Guidepole quantity	
Access Hatch quantity	
Gauge Float quantity	
Gauge Hatch quantity	
Vacuum Breaker quantity	
Deck Drain quantity	
Deck Support Leg quantity	
Deck Support Leg quantity	
Rim Vent quantity	
Column, round pipe quantity	
Column, built-up quantity	
Ladder (vertical) quantity	
Liquid Bulk Temperature deg F (if elevated)	130
Heated tank?	No
Stock description	furnace oil
Molecular wt. (vapors)	163
Molecular wt. (liquid)	217
Reid vapor pressure (psi)	0.0019
Distillation slope, S	0.85

Estimated Emissions from TankESP for the Bulk Terminal.

Scan Set: 7_16 1

Tank Identification Number:	22	23	27	28	29	3792
Tank Diameter (feet) =	219	150	116	135	135	150
Liquid surface temperature (F):	83.3	83.3	83.3	83.3	83.3	85.5
Calculated TVP (psia):	3.90	3.90	3.90	4.00	4.00	0.18
Fill/Discharge rate (gph):	0	0	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	6.1524	6.1524	6.1524	6.3372	6.3372	0.2293
Ke = vapor space expansion factor:	0.0584	0.0584	0.0584	0.0598	0.0598	0.0297
Ks = vented vapor saturation factor:	0.1784	0.1833	0.1342	0.1306	0.1306	0.9002
Wv = density of stock vapors:	0.0535	0.0535	0.0535	0.0549	0.0549	0.0023
Short-Term Standing Loss (lb/hr) =	**1.63**	**1.35**	**1.16**	**1.48**	**1.48**	**0.52**
Total Short-Term Loss (lb/hr) =	**1.63**	**1.35**	**1.16**	**1.48**	**1.48**	**0.52**

Scan Set: 7_17 1

Tank Identification Number:	22	23	27	28	29	3792
Tank Diameter (feet) =	219	150	116	135	135	150
Liquid surface temperature (F):	87.6	87.6	87.6	87.6	87.6	89.3
Calculated TVP (psia):	3.90	3.90	3.90	4.00	4.00	0.21
Fill/Discharge rate (gph):	0	0	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	6.1524	6.1524	6.1524	6.3372	6.3372	0.2656
Ke = vapor space expansion factor:	0.0479	0.0479	0.0479	0.0491	0.0491	0.0228
Ks = vented vapor saturation factor:	0.1784	0.1833	0.1342	0.1306	0.1306	0.8863
Wv = density of stock vapors:	0.0531	0.0531	0.0531	0.0545	0.0545	0.0026
Short-Term Standing Loss (lb/hr) =	**2.10**	**1.35**	**1.16**	**1.48**	**1.48**	**0.45**
Total Short-Term Loss (lb/hr) =	**2.10**	**1.35**	**1.16**	**1.48**	**1.48**	**0.45**

Scan Set: 7_18 2

Tank Identification Number:	22	23	28	29
Tank Diameter (feet) =	219	150	135	135
Liquid surface temperature (F):	81.2	81.2	81.2	81.2
Calculated TVP (psia):	3.90	3.90	4.00	4.00
Fill/Discharge rate (gph):	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	6.1524	6.1524	6.3372	6.3372
Ke = vapor space expansion factor:	0.0358	0.0358	0.0367	0.0367
Ks = vented vapor saturation factor:	0.1784	0.1833	0.1306	0.1306
Wv = density of stock vapors:	0.0538	0.0538	0.0551	0.0551
Short-Term Standing Loss (lb/hr) =	**1.11**	**1.35**	**1.48**	**1.48**
Total Short-Term Loss (lb/hr) =	**1.11**	**1.35**	**1.48**	**1.48**

Scan Set: 7_19 2

Tank Identification Number:	22	23	28	29
Tank Diameter (feet) =	219	150	135	135
Liquid surface temperature (F):	80.2	80.2	80.2	80.2
Calculated TVP (psia):	3.90	3.90	4.00	4.00
Fill/Discharge rate (gph):	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	6.1524	6.1524	6.3372	6.3372
Ke = vapor space expansion factor:	0.0357	0.0357	0.0366	0.0366
Ks = vented vapor saturation factor:	0.1784	0.1833	0.1306	0.1306
Wv = density of stock vapors:	0.0539	0.0539	0.0552	0.0552
Short-Term Standing Loss (lb/hr) =	**1.07**	**1.35**	**1.48**	**1.48**
Total Short-Term Loss (lb/hr) =	**1.07**	**1.35**	**1.48**	**1.48**

Scan Set: 7_21 2

Tank Identification Number:	22	23	28	29
Tank Diameter (feet) =	219	150	135	135
Liquid surface temperature (F):	78.4	78.4	78.4	78.4
Calculated TVP (psia):	3.90	3.90	4.00	4.00
Fill/Discharge rate (gph):	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	6.1524	6.1524	6.3372	6.3372
Ke = vapor space expansion factor:	0.0267	0.0267	0.0274	0.0274
Ks = vented vapor saturation factor:	0.1784	0.1833	0.1306	0.1306
Wv = density of stock vapors:	0.0540	0.0540	0.0554	0.0554
Short-Term Standing Loss (lb/hr) =	**0.66**	**1.35**	**1.48**	**1.48**
Total Short-Term Loss (lb/hr) =	**0.66**	**1.35**	**1.48**	**1.48**

Scan Sets for Location 2, Direction 61 – Downwind only of Tank 22:

Scan Set:	7_17 2_61	7_18 2_61	7_19 2_61	7_21 2_61
Tank Identification Number:	**22**	**22**	**22**	**22**
Tank Diameter (feet) =	219	219	219	219
Liquid surface temperature (F):	83.4	80.8	80.9	78.1
Calculated TVP (psia):	3.90	3.90	3.90	3.90
Fill/Discharge rate (gph):	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	6.1524	6.1524	6.1524	6.1524
Ke = vapor space expansion factor:	0.0546	0.0361	0.0343	0.0268
Ks = vented vapor saturation factor:	0.1784	0.1784	0.1784	0.1784
Wv = density of stock vapors:	0.0535	0.0538	0.0538	0.0541
Short-Term Standing Loss (lb/hr) =	**1.03**	**1.14**	**0.95**	**0.82**
Total Short-Term Loss (lb/hr) =	**1.03**	**1.14**	**0.95**	**0.82**

Estimated Emissions from TankESP for the Refinery.

Scan Set: 7_25 1

Tank Identification Number:	TK54	TK55	TK56	TK98
Tank Diameter (feet) =	120	150	150	150
Liquid surface temperature (F):	89.9	97.8	92.0	87.0
Calculated TVP (psia):	0.04	0.06	0.05	10.14
Fill/Discharge rate (gph):	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	0.1222	0.1560	0.1304	26.1693
Ke = vapor space expansion factor:	0.0395	0.0228	0.0230	0.5144
Ks = vented vapor saturation factor:	0.9564	0.9425	0.9528	0.0685
Wv = density of stock vapors:	0.0012	0.0015	0.0013	0.1590
Short-Term Standing Loss (lb/hr) =	**0.42**	**0.50**	**0.42**	**7.21**
Total Short-Term Loss (lb/hr) =	**0.42**	**0.50**	**0.42**	**7.21**

Scan Set: 7_26 1a

Tank Identification Number:	TK54	TK55	TK56	TK98
Tank Diameter (feet) =	120	150	150	150
Liquid surface temperature (F):	89.4	97.3	91.5	85.9
Calculated TVP (psia):	0.04	0.06	0.05	9.92
Fill/Discharge rate (gph):	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	0.1203	0.1536	0.1283	25.1792
Ke = vapor space expansion factor:	0.0395	0.0229	0.0230	0.4850
Ks = vented vapor saturation factor:	0.9571	0.9433	0.9535	0.0699
Wv = density of stock vapors:	0.0012	0.0015	0.0013	0.1559
Short-Term Standing Loss (lb/hr) =	**0.42**	**0.49**	**0.41**	**2.11**
Total Short-Term Loss (lb/hr) =	**0.42**	**0.49**	**0.41**	**2.11**

Scan Set: 7_26 1b

Tank Identification Number:	TK54	TK55	TK56	TK98
Tank Diameter (feet) =	120	150	150	150
Liquid surface temperature (F):	89.4	97.2	91.4	85.8
Calculated TVP (psia):	0.04	0.06	0.05	9.90
Fill/Discharge rate (gph):	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	0.1201	0.1533	0.1281	25.0717
Ke = vapor space expansion factor:	0.0395	0.0229	0.0230	0.4819
Ks = vented vapor saturation factor:	0.9571	0.9434	0.9536	0.0700
Wv = density of stock vapors:	0.0012	0.0015	0.0013	0.1556
Short-Term Standing Loss (lb/hr) =	**0.42**	**0.49**	**0.41**	**9.63**
Total Short-Term Loss (lb/hr) =	**0.42**	**0.49**	**0.41**	**9.63**

Scan Set: 8_07 5

Tank Identification Number:	TK53	TK54	TK55	TK56
Tank Diameter (feet) =	120	120	150	150
Liquid surface temperature (F):	94.7	88.7	96.6	90.7
Calculated TVP (psia):	0.05	0.04	0.05	0.05
Fill/Discharge rate (gph):	57,792	0	0	0
Short-Term Working Loss (lb/hr) =	**10.81**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	0.1418	0.1175	0.1502	0.1253
Ke = vapor space expansion factor:	0.0229	0.0395	0.0229	0.0230
Ks = vented vapor saturation factor:	0.9493	0.9580	0.9445	0.9545
Wv = density of stock vapors:	0.0014	0.0012	0.0015	0.0012
Short-Term Standing Loss (lb/hr) =	**0.28**	**0.41**	**0.48**	**0.40**
Total Short-Term Loss (lb/hr) =	**11.10**	**0.41**	**0.48**	**0.40**

Scan Sets for Location 2, Direction 99 – Downwind only of Tank 1025:

Scan Set:	7_28 2_99	7_29 2_99	8_05 2_99
Tank Identification Number:	**TK1025**	**TK1025**	**TK1025**
Tank Diameter (feet) =	219	219	219
Liquid surface temperature (F):	90.5	90.1	88.0
Calculated TVP (psia):	10.53	10.46	10.13
Fill/Discharge rate (gph):	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**
P* Mv Kc:	6.0935	6.0195	5.6758
Ke = vapor space expansion factor:	0.2900	0.2844	0.2597
Ks = vented vapor saturation factor:	0.0646	0.0650	0.0669
Wv = density of stock vapors:	0.0891	0.0886	0.0862
Short-Term Standing Loss (lb/hr) =	**0.62**	**0.84**	**0.67**
Total Short-Term Loss (lb/hr) =	**0.62**	**0.84**	**0.67**

Scan Sets for Location 2, Direction 78 – Downwind only of Tanks 1024 & 1025:

Scan Set:	7_29 2_78		8_06 2_78a		8_06 2_78b	
Tank Identification Number:	**TK1024**	**TK1025**	**TK1024**	**TK1025**	**TK1024**	**TK1025**
Tank Diameter (feet) =	219	219	219	219	219	219
Liquid surface temperature (F):	86.7	89.1	83.8	87.8	83.1	87.5
Calculated TVP (psia):	9.93	10.30	9.49	10.10	9.39	10.05
Fill/Discharge rate (gph):	0	0	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	5.4791	5.8510	5.0735	5.6485	4.9820	5.6012
Ke = vapor space expansion factor:	0.2465	0.2721	0.2211	0.2579	0.2157	0.2546
Ks = vented vapor saturation factor:	0.0716	0.0659	0.0746	0.0671	0.0753	0.0674
Wv = density of stock vapors:	0.0847	0.0874	0.0814	0.0860	0.0806	0.0856
Short-Term Standing Loss (lb/hr) =	**1.00**	**0.78**	**1.01**	**0.80**	**0.68**	**0.60**
Total Short-Term Loss (lb/hr) =	**1.00**	**0.78**	**1.01**	**0.80**	**0.68**	**0.60**

Scan Set: 7_31 2C_60

Tank Identification Number:	TK1020	TK1021	TK1024	TK1025
Tank Diameter (feet) =	219	219	219	219
Liquid surface temperature (F):	91.5	91.5	91.5	91.2
Calculated TVP (psia):	10.68	10.68	10.68	10.63
Fill/Discharge rate (gph):	105,368	0	272,143	0
Short-Term Working Loss (lb/hr) =	**0.46**	**0.00**	**1.19**	**0.00**
P* Mv Kc:	6.2635	6.2635	6.2635	6.2112
Ke = vapor space expansion factor:	0.3033	0.3033	0.3033	0.2991
Ks = vented vapor saturation factor:	0.0671	0.0680	0.0668	0.0639
Wv = density of stock vapors:	0.0903	0.0903	0.0903	0.0899
Short-Term Standing Loss (lb/hr) =	**0.83**	**1.55**	**1.12**	**0.81**
Total Short-Term Loss (lb/hr) =	**1.29**	**1.55**	**2.31**	**0.81**

Scan Sets for Location 2, Direction 266 – Downwind only of Tanks 1052 & 1053:

Scan Set:	7_28 2_266		7_29 2_266		7_31 2_266		8_06 2_266	
Tank Identification Number:	TK1052	TK1053	TK1052	TK1053	TK1052	TK1053	TK1052	TK1053
Tank Diameter (feet) =	345	345	345	345	345	345	345	345
Liquid surface temperature (F):	84.9	84.9	88.2	88.2	89.8	89.8	82.9	82.9
Calculated TVP (psia):	9.66	9.66	10.17	10.17	10.41	10.41	9.36	9.36
Fill/Discharge rate (gph):	0	112,243	35,006	0	44,849	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.31**	**0.10**	**0.00**	**0.12**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	5.2291	5.2291	5.7155	5.7155	5.9673	5.9673	4.9562	4.9562
Ke = vapor space expansion factor:	0.2306	0.2306	0.2625	0.2625	0.2805	0.2805	0.2142	0.2142
Ks = vented vapor saturation factor:	0.0664	0.0684	0.0633	0.0652	0.0619	0.0638	0.0684	0.0704
Wv = density of stock vapors:	0.0827	0.0827	0.0865	0.0865	0.0883	0.0883	0.0804	0.0804
Short-Term Standing Loss (lb/hr) =	**1.17**	**1.18**	**1.17**	**1.18**	**1.10**	**1.11**	**0.97**	**0.98**
Total Short-Term Loss (lb/hr) =	**1.17**	**1.50**	**1.27**	**1.18**	**1.22**	**1.11**	**0.97**	**0.98**

Scan Set: 8_02 4_5

Tank Identification Number:	TK1052	TK1053	TK1055
Tank Diameter (feet) =	345	345	345
Liquid surface temperature (F):	85.8	85.8	88.9
Calculated TVP (psia):	9.80	9.80	10.27
Fill/Discharge rate (gph):	58,780	0	0
Short-Term Working Loss (lb/hr) =	**0.16**	**0.00**	**0.00**
P* Mv Kc:	5.3541	5.3541	5.8175
Ke = vapor space expansion factor:	0.2384	0.2384	0.4407
Ks = vented vapor saturation factor:	0.0655	0.0675	0.0677
Wv = density of stock vapors:	0.0837	0.0837	0.0872
Short-Term Standing Loss (lb/hr) =	**0.99**	**1.01**	**1.22**
Total Short-Term Loss (lb/hr) =	**1.16**	**1.01**	**1.22**

Scan Set: 8_02 4_328

Tank Identification Number:	TK1052
Tank Diameter (feet) =	345
Liquid surface temperature (F):	87.7
Calculated TVP (psia):	10.09
Fill/Discharge rate (gph):	73,903
Short-Term Working Loss (lb/hr) =	**0.20**
P* Mv Kc:	5.6361
Ke = vapor space expansion factor:	0.2570
Ks = vented vapor saturation factor:	0.0638
Wv = density of stock vapors:	0.0859
Short-Term Standing Loss (lb/hr) =	**1.15**
Total Short-Term Loss (lb/hr) =	**1.36**

Scan Set: 7_30 3_335

Tank Identification Number:	TK501	TK502	TK503	TK504
Tank Diameter (feet) =	144	144	144	144
Liquid surface temperature (F):	87.1	87.1	87.1	90.1
Calculated TVP (psia):	11.24	11.24	11.24	11.82
Fill/Discharge rate (gph):	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	22.1645	22.1645	22.1645	24.7135
Ke = vapor space expansion factor:	0.4071	0.4071	0.4071	0.5032
Ks = vented vapor saturation factor:	0.0726	0.0735	0.0701	0.0698
Wv = density of stock vapors:	0.1226	0.1226	0.1226	0.1282
Short-Term Standing Loss (lb/hr) =	**1.29**	**2.13**	**1.38**	**1.46**
Total Short-Term Loss (lb/hr) =	**1.29**	**2.13**	**1.38**	**1.46**

Scan Set: 8_07 3_335

Tank Identification Number:	TK501	TK502	TK503	TK504
Tank Diameter (feet) =	144	144	144	144
Liquid surface temperature (F):	84.0	84.0	84.0	88.7
Calculated TVP (psia):	10.66	10.66	10.66	11.55
Fill/Discharge rate (gph):	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	19.9724	19.9724	19.9724	23.4993
Ke = vapor space expansion factor:	0.3393	0.3393	0.3393	0.4548
Ks = vented vapor saturation factor:	0.0763	0.0771	0.0736	0.0712
Wv = density of stock vapors:	0.1170	0.1170	0.1170	0.1256
Short-Term Standing Loss (lb/hr) =	**1.26**	**2.15**	**1.36**	**1.52**
Total Short-Term Loss (lb/hr) =	**1.26**	**2.15**	**1.36**	**1.52**

Scan Set: 7_30 3_313a

Tank Identification Number:	TK501	TK502	TK504
Tank Diameter (feet) =	144	144	144
Liquid surface temperature (F):	85.9	85.9	89.6
Calculated TVP (psia):	11.01	11.01	11.72
Fill/Discharge rate (gph):	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**
P* Mv Kc:	21.2714	21.2714	24.2305
Ke = vapor space expansion factor:	0.3780	0.3780	0.4833
Ks = vented vapor saturation factor:	0.0740	0.0749	0.0703
Wv = density of stock vapors:	0.1204	0.1204	0.1272
Short-Term Standing Loss (lb/hr) =	**2.02**	**3.97**	**2.37**
Total Short-Term Loss (lb/hr) =	**2.02**	**3.97**	**2.37**

Scan Set: 7_30 3_313b

Tank Identification Number:	TK501	TK502	TK504
Tank Diameter (feet) =	144	144	144
Liquid surface temperature (F):	86.5	86.5	89.8
Calculated TVP (psia):	11.12	11.12	11.77
Fill/Discharge rate (gph):	0	64,205	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.08**	**0.00**
P* Mv Kc:	21.7103	21.7103	24.4699
Ke = vapor space expansion factor:	0.3921	0.3921	0.4931
Ks = vented vapor saturation factor:	0.0733	0.0742	0.0700
Wv = density of stock vapors:	0.1215	0.1215	0.1277
Short-Term Standing Loss (lb/hr) =	**1.93**	**3.72**	**2.25**
Total Short-Term Loss (lb/hr) =	**1.93**	**3.81**	**2.25**

Scan Set: 8_07 3_313

Tank Identification Number:	TK501	TK502	TK504
Tank Diameter (feet) =	144	144	144
Liquid surface temperature (F):	84.1	84.1	88.8
Calculated TVP (psia):	10.68	10.68	11.56
Fill/Discharge rate (gph):	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**0.00**
P* Mv Kc:	20.0540	20.0540	23.5462
Ke = vapor space expansion factor:	0.3416	0.3416	0.4566
Ks = vented vapor saturation factor:	0.0761	0.0770	0.0712
Wv = density of stock vapors:	0.1172	0.1172	0.1257
Short-Term Standing Loss (lb/hr) =	**1.31**	**2.26**	**1.57**
Total Short-Term Loss (lb/hr) =	**1.31**	**2.26**	**1.57**

Scan Sets for Location 2, Direction 61 – Downwind only of Tank 43:

Scan Set:	8_08 6_265a	8_08 6_265b
Tank Identification Number:	**TK43A**	**TK43A**
Tank Diameter (feet) =	117	117
Liquid surface temperature (F):	132.0	131.7
Calculated TVP (psia):	0.15	0.15
Fill/Discharge rate (gph):	43,180	38,782
Short-Term Working Loss (lb/hr) =	**22.23**	**19.83**
P* Mv Kc:	0.4179	0.4148
Ke = vapor space expansion factor:	0.0982	0.0981
Ks = vented vapor saturation factor:	0.8518	0.8527
Wv = density of stock vapors:	0.0039	0.0038
Short-Term Standing Loss (lb/hr) =	**3.16**	**3.14**
Total Short-Term Loss (lb/hr) =	**25.39**	**22.96**

Scan Set: 8_08 7_90

Tank Identification Number:	**TK11**	**TK12**	**TK18**	**TK42**	**TK60A**	**TK61**	**TK63**	**TK65**
Tank Diameter (feet) =	117	117	117	117	117	117	117	117
Liquid surface temperature (F):	86.9	79.6	85.0	118.1	97.7	103.4	102.2	120.9
Calculated TVP (psia):	10.12	8.81	0.03	0.10	0.06	0.07	0.06	0.00
Fill/Discharge rate (gph):	0	0	27,293	0	0	0	0	0
Short-Term Working Loss (lb/hr) =	**0.00**	**0.00**	**2.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
P* Mv Kc:	26.0786	20.6793	0.0679	0.2839	0.1555	0.1849	0.1782	0.0122
Ke = vapor space expansion factor:	0.3141	0.2259	0.0234	0.0982	0.0995	0.0990	0.0991	0.0925
Ks = vented vapor saturation factor:	0.0781	0.0888	0.9654	0.8936	0.9351	0.9264	0.9256	0.9950
Wv = density of stock vapors:	0.1587	0.1401	0.0007	0.0027	0.0015	0.0018	0.0017	0.0001
Short-Term Standing Loss (lb/hr) =	**1.12**	**0.89**	**0.15**	**2.32**	**1.49**	**1.66**	**1.68**	**0.10**
Total Short-Term Loss (lb/hr) =	**1.12**	**0.89**	**2.64**	**2.32**	**1.49**	**1.66**	**1.68**	**0.10**

APPENDIX C: HAWK PASSIVE INFRARED CAMERA GROUND SURVEY DATA

Refinery

File #	Date	Process Area	Description of Leak	Stream	Avg. Wind	Temperature	Roof Temperature per Temp Gun (if measured)	Shell Temperature per Temp Gun (if measured)
TCEQGW1	7/26/2007	Tank Farm	Vent on Tank #55	Diesel	5.1	86		
TCEQGW2	7/26/2007	Tank Farm	Vent on Tank #56	Diesel	5.1	86		
TCEQGW3	7/28/2007	Tank Farm	Vent on Tank #1020	Crude	4	82.8	83	81
TCEQGW4	7/28/2007	Tank Farm	Pop Up Vent on Tank #1021	Crude	4	82.8	80	79
TCEQGW5	7/28/2007	Tank Farm	Legs & Seal on Tank #1025	Crude	3.2	82.8	85	84
TCEQGW6	7/28/2007	Tank Farm	Environmental Sewer Facility Vent	N/A	2.5	82.7		
TCEQGW7	7/28/2007	Tank Farm	Vent on Tank #1055	Crude	2.5	90		
TCEQGW8	7/28/2007	Tank Farm	Vent & Seal on Tank #1052	Crude	4.1	89.5		
TCEQGW9	7/28/2007	Tank Farm	Vent on Tank #1053	Crude	3	93.3		
TCEQGW10	7/28/2007	Tank Farm	Vents & Seal on Tank #1021	Crude	7	86.9		
TCEQGW11	7/29/2007	Tank Farm	Legs & Seal on Tank #1023	Crude	3.2	88.4		
TCEQGW12	7/29/2007	Tank Farm	Vent on Tank #1051	Crude	4	88.6		
TCEQGW13	7/29/2007	Tank Farm	Lift Station Vent on Enviro. Facility	N/A	3.5	87.7		
TCEQGW14	7/30/2007	Tank Farm	Seal on Tank #501	Gasoline	N/A	N/A		
TCEQGW15	7/30/2007	Tank Farm	Seal on Tank #504	Gasoline	N/A	N/A		
TCEQGW16	7/31/2007	Tank Farm	Waste Water Vent Pipes	N/A	N/A	N/A		
TCEQGW17	7/31/2007	Tank Farm	Waste Water Vent Pipes	N/A	N/A	N/A		
TCEQGW18	8/2/2007	Tank Farm	Seal on Tank #1053	Crude	N/A	N/A		
TCEQGW19	8/2/2007	Tank Farm	PVRV Seal on Tank #1052	Crude	N/A	N/A		
TCEQGW20	8/2/2007	Tank Farm	Guide Pole -Rusted out	Crude	N/A	N/A		
TCEQGW21	8/2/2007	Waste Water Area	Hatch Opened by Operator	Waste Water	N/A	N/A		
TCEQGW22	8/2/2007	Waste Water Area	Hatch on East Side Separator #2	Waste Water	N/A	N/A		
TCEQGW23	8/2/2007	Waste Water Area	Seal on Facing Plate on Roof	Waste Water	1.8	91.2		
TCEQGW24	8/2/2007	Waste Water Area	Hatch on Lid Separator #2	Waste Water	1.8	91.2		

			Bulk Terminal			N/A
File #	**Date**	**Process Area**	**Description of Leak**	**Stream**	**Avg. Wind**	**Temperature**
TCEQGW25	7/16/2007	Tank Farm	Vents on Tank #23	Naptha	N/A	82.2
TCEQGW26	7/16/2007	Tank Farm	Vent on Tank #28	Naptha	16	82.2
TCEQGW27	7/16/2007	Tank Farm	Vent on Tank #23	Naptha	16	86
TCEQGW28	7/17/2007	Tank Farm	Vent on Tank #23	Naptha	6	86
TCEQGW29	7/17/2007	Tank Farm	Vent on Tank #23	Naptha	6	N/A
TCEQGW30	7/17/2007	Tank Farm	Vent on Tank #23	Naptha	N/A	N/A
TCEQGW31	7/17/2007	Tank Farm	Floating Roof on Tank #22	Naptha	N/A	N/A
TCEQGW32	7/17/2007	Tank Farm	Vent on South Side of Tank #23	Naptha	N/A	N/A
TCEQGW33	7/17/2007	Tank Farm	Vent Left of Landing on Tank #28	Naptha	N/A	N/A
TCEQGW34	7/17/2007	Tank Farm	Vent on Tank #28	Naptha	N/A	N/A
TCEQGW35	7/17/2007	Tank Farm	Vents on Tank #29	Naptha	N/A	84
TCEQGW36	7/17/2007	Tank Farm	Vents on Tank #23	Naptha	13	N/A
TCEQGW37	7/17/2007	Tank Farm	Vent on Tank #28	Naptha	N/A	N/A
TCEQGW38	7/17/2007	Tank Farm	Vent on Tank #23	Naptha	N/A	83.6
TCEQGW39	7/18/2007	Tank Farm	Seal on Tank #22	Naptha	16.7	84
TCEQGW40	7/18/2007	Tank Farm	Vents on Tank #28	Naptha	7	84
TCEQGW41	7/18/2007	Tank Farm	Vents on Tank #23	Naptha	7	N/A
TCEQGW42	7/18/2007	Tank Farm	Ship at Loading Docks	N/A	N/A	N/A
TCEQGW43	7/18/2007	Tank Farm	Ship at Loading Docks	N/A	N/A	80
TCEQGW44	7/19/2007	Tank Farm	Vent on Tank #23	Naptha	1.5	80
TCEQGW45	7/19/2007	Tank Farm	Vent on Tank #28	Naptha	1.5	80
TCEQGW46	7/19/2007	Tank Farm	Vent on Tank #23	Naptha	1.5	

APPENDIX D: INDEPENDENT ANALYSIS OF FLARE DATA

Date: June 30, 2009
To: Danielle Nesvacil,
Texas Commission on Environmental Quality
From: Eastern Research Group
Subject: Comparison of Measured Emissions and Calculated Emissions from Flares

1.0 Introduction

The TCEQ used differential absorption lidar (DIAL) technology in the Houston-Galveston-Brazoria non-attainment area in 2007 to measure VOC emissions from storage tanks, flares, wastewater treatment, and coking units. The measurements obtained by DIAL are intended to be compared to hourly emissions calculated using conventional emission estimation methods. This memorandum discusses the comparison of measured flare emissions to emissions calculated using process data and mass balances.

Section 2.0 presents the information measured by the DIAL and also process data provided by the facility measured. Section 3.0 discusses the methodology used to calculate emissions and compare them with measured values. Section 4.0 summarizes the results of the analysis.

2.0 Data Measured and Process Information Gathered

DIAL measurements were documented in the report *Measurements of VOC Emissions From Petrochemical Industry Sites in the Houston Area Using Differential Absorption Lidar (DIAL) During Summer 2007*. Measurements were taken in areas near 3 flares: Flare 6, ULC Flare, and the Temp Flare.

The DIAL report did not provide actual measurements or raw data. Instead, it summarized the mass VOC emissions for each flare calculated from the raw DIAL measurements and the windspeed measured during the test. The report also identified the time and date of the test as well as the wind direction. The report indicates that the Flare 6 emissions ranged from 4 lbs/hr to 22 lbs/hr, temporary flare emissions were approximately 6 lbs/hr, and the combined emissions from the ULC and Temp flare averaged from 147 to 243 lbs/hr per day. Appendix A summarizes the information contained in the DIAL report. A detailed review of DIAL measurements and methodology is presented in another document comparing measured emissions and emission calculation methods for storage vessels.

No process data were provided in the DIAL report. A subsequent request to the facility tested provided information on the stream flowrate and composition entering the ULC and Temp Flares. Consequently, comparison of emissions was only done for these two flares. Documentation on how the information was obtained was not included in the data submittal. Appendix B presents the process data received.

3.0 Comparison Methodology

In order to evaluate the measured DIAL emissions, uncontrolled emissions were calculated using the composition and flowrate entering the flare. As shown in Appendix B, composition information for the stream entering the flare was provided in mole fraction. Additionally the flowrate of the stream was provided in thousands of standard cubic feet per hour (MSCFH). Flowrates were provided for two different cases, a high flow and a low flow to the header. It was unclear as to what each of these flowrates actually meant. To be conservative in this analysis, the highest of the two flowrates for each data time was used. Mass emissions of each compound in the stream entering the flare were calculated using the ideal gas law:

(P)(V)(mole fraction of compound in gas) = (mass emissions)(MW)(R)(T)

Where: P= pressure, atm
V= gas flow rate, MSCFH
MW = molecular weight of compound, lb/lb-mole
R = Ideal gas constant, 0.7302 atm-ft^3/lb-mole-R.
T = Temperature, Rankin

Rearranged to calculate mass emissions:

Mass emissions = [(P)(V)(mole fraction in gas)]/ [(MW)(R)(T)]

For this analysis it was assumed that standard temperature and pressure conditions applied in the gas stream once it reached the header. The molecular weight of unspecified C5+ compounds was calculated as the average of 6 alkanes with carbon contents ranging from C5 to C9.

After the emissions for the speciated compounds were calculated, the mass emissions for the organic compounds were summed to obtain the total organic emissions and total VOC emissions entering the flare. A flare destruction efficiency was calculated from the mass of VOC's entering the flare and the measured DIAL emissions.

4.0 Results

Table 4-1 summarizes the results of this analysis. The range of emissions is also presented as well as the average for each day. As the table shows, the destruction efficiency of the combined ULC and Temp flares, using the DIAL output combined with the process information provided, was calculated to be greater than 98 percent, except during the August 11 testing. The destruction efficiency of the Temp flare alone during the August 11 testing was calculated to be 99.9 percent. Appendix C presents the detailed emissions calculated for each organic species and shows the total organic hydrocarbon content and total VOC content entering the flare. Results are presented for each measurement time. Total organic emissions and total VOC emissions were calculated for the entire time the flares were operating and also specifically for when the DIAL was being operated (concurrent DIAL measurements are highlighted in yellow). The appendices indicate that the uncontrolled emissions sent to the Temp flare comprise 93-98 percent of the uncontrolled emissions sent to the combined ULC and Temp flares. Therefore, the destruction efficiency of the Temp flare will overwhelmingly influence and contribute to the overall destruction efficiency of the combined flares. Table 4-2 shows the same information after similar windspeeds are grouped together. Only windspeeds on August 9 could be separated into distinct groups.

Assuming the calculated destruction efficiency of the Temp Flare and the DIAL measurements are correct, the destruction efficiency of the ULC flare can then be estimated using calculated uncontrolled emissions from the ULC flare and using the following equation:

$$(E_{Temp,U})*(1\text{-efficiency}_{Temp}) + (E_{ULC,U})*(1\text{-efficiency}_{ULC}) = \text{Emissions}_{DIAL}$$

Where: $E_{Temp,U}$ = Uncontrolled emissions from the temporary flare, lb/hr
Efficiency_{Temp} = Efficiency of the temporary flare
$E_{ULC,U}$ = Uncontrolled emissions from the ULC flare, lb/hr
Efficiency_{ULC} = Efficiency of the ULC flare
Emissions_{DIAL} = Measured VOC emissions using DIAL, lb/hr

The equation re-arranges to:

$$\text{efficiency}_{ULC} = 1 - \{[\text{Emissions}_{DIAL} - ((E_{Temp,U})*(1\text{-efficiency}_{Temp}))]/(E_{ULC,U})\}$$

Tables 4-3 and 4-4 show the results of this calculation. Table 4-3 presents results assuming the efficiency of the Temp flare is 99.9 percent as calculated using the DIAL Temp flare measurements only. Table 4-4 presents results assuming the efficiency of the Temp flare is 99.5 percent to serve as a point of comparison for the flare performance. Lower destruction efficiencies, such as 99 percent, do not provide usable results, indicating the Temp flare may indeed be achieving such high destruction efficiency. Tables 4-3 and 4-4 also show the results for all data points, and only for data points when the times for the DIAL measurements were similar to the process information provided for the mass balance calculation. The results of the calculation indicate the ULC flare is achieving low destruction efficiencies ranging from 38-66 percent if the Temp flare is assumed to achieve 99.9 percent destruction, and ranging from 44-79 percent when the Temp flare is assumed to achieve 99.5 percent destruction.

However, it should be noted that this calculation is based on many assumptions discussed earlier, such as assuming the DIAL measurements are accurate, the calculated control efficiency of the Temp flare is accurate, and the calculated uncontrolled emissions from both flares are accurate. To verify this calculation, further testing of the ULC flare is recommended.

While the results of this analysis show a high destruction efficiency of the Temp flare, it is necessary to compare the results with previous studies conducted by EPA and other research organizations to determine whether the results are realistic. The DIAL is not a direct measurement technique where the outlet of the flare is sampled. Instead, the emission rate is calculated from windspeed and concentrations measured using remote-sensing through use of ultraviolet and infrared wavelengths, and therefore, may have factors that bias the results if measurements.

Previous studies show that well-operated flares can achieve greater than 98 percent destruction of organics.[1] However, flares that are not well-operated decrease their combustion efficiency to 60-80 percent, or even lower. Factors that influence proper flare operation and combustion include the types of compounds burned, steam-to-gas ratios (or air-to-gas ratios), and high crosswinds.[1] One study demonstrated that easily burned fuels, such as methane, propane, and natural gas, can result in combustion efficiencies greater than 99 percent, while adding liquid or condensed fuel to the stream entering the flare lowered combustion efficiencies below 70 percent.[2] The majority of the organic compounds burned in the Temp flare are comprised of "easily burned fuels" (ethane, methane, propane, and butane). Other studies categorized low cross-flow velocities as 6 meters per second or less. Low cross-flow allowed the flare to achieve greater than 99 percent destruction efficiency, while greater cross-flow decreased the efficiency to below 80 percent.[3,4] During the DIAL tests, all crosswinds reported were below 4.4 meters per second, indicating wind would not be a factor in combustion efficiency during the tests.

Information was not available on the steam-to-gas ratios (or air-to-gas ratios) of the Temp flare, so this aspect of proper operation could not be compared to the DIAL results. To fully evaluate the DIAL results, it may be necessary to obtain this information.

Based on the information that was provided by the facility or in the DIAL report, the Temp flare destruction efficiencies calculated are achievable considering the results from other flare studies. However, further evaluation of the steam-to-gas (or air-to-gas) ratios are recommended to support the conclusion the flares were operating properly. Additionally, further testing of the ULC flare is recommended.

References

1. Flare Efficiency Study. U.S. Environmental Protection Agency. 1983

2. Characterization of Emissions From Diffusion Flare Systems. Journal of the Air and Waste Management Association. Vol. 50: 1723-1733. October 2000.

3. The Combustion Efficiency of Jet Diffusion Flames in Cross-flow. Johnson, M.R., O. Zastavniuk, J.D. Dale, and L.W. Kostiuk. Presentation for the Joint Meeting of the United States Sections – The Combustion Institute, Washington D.C., March 15-17, 1999.

4. Theoretical and Observational Assessments of Flare Efficiencies. Leahey, D.M., L.M. Preston, and M. Strosher. Journal of Air and Waste Management Association. Vol. 51: 1610-1616. December 2001.

Table 4-1. Comparison of Measured Emissions to Calculated Emissions

Date	All DIAL Downwind VOC emissions							Average Uncontrolled VOC Emissions From Process Data		Destruction Efficiency (DIAL outlet, Process Data inlet)	
	windspeed (f/s)			VOC emissions (lb/hr)			Notes				
	Hi	Lo	Avg	Hi	Lo	Avg		All data points	Similar measurement times	All data points	Similar measurement times
9-Aug	14.3	1.97	7.2	374	43	147	Both ULC and Temp flare	16,209	17,317	99.1%	99.2%
10-Aug	12.46	7.87	9.8	567	24	157	Both ULC and Temp flare	14,354	14,580	98.9%	98.9%
11-Aug	14.1	8.5	11	311	42	232	Both ULC and Temp flare	5,467	5,346	95.8%	95.7%
11-Aug	12.4	11.8	12.3	15	<1[a]	6.7	temp flare only		4,570		99.9%

a Value of 1 was assumed for calculation

Table 4-2. Comparison of Measured Emissions to Calculated Emissions for Similar Downwind Windspeeds

Date	Similar Downwind windspeeds							Average Uncontrolled VOC Emissions From Process Data		Destruction Efficiency (DIAL outlet, Process Data inlet)	
	windspeed (f/s)			VOC emissions (lb/hr)			Notes				
	Hi	Lo	Avg	Hi	Lo	Avg		All data points	Similar measurement times	All data points	Similar measurement times
9-Aug	6	2	4.6	243	43	110	Both ULC and Temp flare	16,209	17,317	99.3%	99.4%
9-Aug	14.4	9.8	13	374	126	231	Both ULC and Temp flare	16,209	17,317	98.6%	98.7%
10-Aug	12.46	7.87	9.8	567	24	157	Both ULC and Temp flare	14,354	14,580	98.9%	98.9%
11-Aug	14.1	8.5	11	311	42	232	Both ULC and Temp flare	5,467	5,346	95.8%	95.7%
11-Aug	12.4	11.8	12.3	15	<1[a]	6.7	temp flare only	-	4,570		99.9%

a Value of 1 was assumed for calculation

Table 4-3. Estimated Destruction Efficiency of ULC Flare Assuming Temp Flare Achieves 99.9 % Destruction of VOC's

	All Data Points				Similar Measurement Time			
Date	Average VOC DIAL Emissions combined ULC and Temp Flare	Average Temp Flare Controlled Emissions from Process Data	Average Uncontrolled VOC Emissions From ULC Flare From Process Data	Calculated VOC Efficiency for ULC Flare	Average VOC DIAL Emissions combined ULC and Temp Flare	Average Temp Flare Controlled Emissions from Process Data	Average Uncontrolled VOC Emissions From ULC Flare From Process Data	Calculated VOC Efficiency for ULC Flare
9-Aug	147	16	290	55%	147	17	264	51%
10-Aug	157	14	424	66%	157	14	401	64%
11-Aug	232	5	368	38%	232	5	423	46%

Table 4-4. Estimated Destruction Efficiency of ULC Flare Assuming Temp Flare Achieves 99.5 % Destruction of VOC's

	All Data Points				Similar Measurement Time			
Date	Average VOC DIAL Emissions combined ULC and Temp Flare	Average Temp Flare Controlled Emissions from Process Data	Average Uncontrolled VOC Emissions From ULC Flare From Process Data	Calculated VOC Efficiency for ULC Flare	Average VOC DIAL Emissions combined ULC and Temp Flare	Average Temp Flare Controlled Emissions from Process Data	Average Uncontrolled VOC Emissions From ULC Flare From Process Data	Calculated VOC Efficiency for ULC Flare
9-Aug	147	80	290	77%	147	85	264	77%
10-Aug	157	70	424	79%	157	71	401	79%
11-Aug	232	25	368	44%	232	25	423	51%

Appendix A. Summary of DIAL Report Measurement Informaton

				windspeed		wind direction	VOC emisions	
Measurement Location	Scan ID	Date	time	m/s	f/s	degrees	lb/hr	ppm
Downwind	407	9-Aug	8:50	1.40	4.59	286.90	76	4.49
Downwind	408	9-Aug	9:01	1.80	5.90	280.30	100	3.92
Downwind	409	9-Aug	9:15	1.80	5.90	312.50	127	3.13
Downwind	410	9-Aug	9:29	1.50	4.92	297.30	129	4.89
Downwind	411	9-Aug	9:43	1.20	3.94	282.70	50	3.81
Downwind	412	9-Aug	9:57	0.60	1.97	233.50	56	4.89
Downwind	413	9-Aug	10:11	1.70	5.58	168.20	243	5.24
Downwind	414	9-Aug	10:27	1.30	4.26	204.60	164	1.86
Downwind	414	9-Aug	11:15	3.00	9.84	119.10	374	4.24
Upwind	415	9-Aug	11:50	3.50	11.48	108.90	7	0.34
Downwind	417	9-Aug	10:57	1.30	4.26	95.30	43	2.14
Background	418	9-Aug	12:29	3.10	14.43	98.70	13	0.36
Upwind	420	9-Aug	12:08	3.50	11.48	91.00	<1	0.40
Downwind	431	9-Aug	14:17	4.10	13.45	113.50	126	1.61
Downwind	432	9-Aug	14:53	4.40	14.43	121.80	243	3.86
Downwind	433	9-Aug	15:11	4.40	14.43	124.70	181	1.69
Upwind	436	9-Aug	15:59	4.40	14.43	122.70	<1	0.28
Background	437	9-Aug	16:18	3.90	14.43	126.50	23	0.29
Downwind	439	10-Aug	9:51	3.8	12.46	325.4	567	8.16
Downwind	441	10-Aug	10:31	3.1	10.17	350.7	172	3.84
Downwind	442	10-Aug	10:40	3.1	10.17	9	190	3.4
Upwind	443	10-Aug	11:00	2.8	9.18	10.9	<1	0.24
Downwind	448	10-Aug	11:32	3	9.84	6	142	4.42
Upwind	449	10-Aug	11:51	3.1	10.17	5.8	<1	0.36
Downwind	450	10-Aug	12:01	2.6	8.53	2.8	95	2.8
Downwind	440	10-Aug	12:12	2.7	8.86	353.7	159	3.84
Background	451	10-Aug	12:20	3.2	10.50	25.7	<1	0.32
Downwind	452	10-Aug	12:29	3	9.84	22.3	102	1.17
Downwind	453	10-Aug	13:11	3.3	10.82	106.9	169	5
Downwind	454	10-Aug	13:30	3.2	10.50	102.7	209	5.45
Downwind	457	10-Aug	13:45	3.1	10.17	94.2	24	0.79
Background	458	10-Aug	14:03	3	9.84	94.6	<1	0.57
Downwind	468	10-Aug	15:23	2.4	7.87	118.4	57	1.87
Downwind	469	10-Aug	15:42	3.2	10.50	123.1	191	1.65
Downwind	470	10-Aug	16:01	3	9.84	124.2	36	1.13
Downwind	471	10-Aug	16:28	2.5	8.20	126.2	80	1.03
Downwind	474	11-Aug	11:30	3.6	11.81	0.6	301	5.03
Downwind	475	11-Aug	11:40	4.3	14.10	6.2	311	4.2
Downwind TEMP only	476	11-Aug	12:00	3.6	11.81	6.4	15	0.75
Downwind TEMP only	477	11-Aug	12:21	3.8	12.46	10.2	4	0.27
Downwind TEMP only	478	11-Aug	12:53	3.8	12.46	359.7	<1	0.2
Downwind	479	11-Aug	13:12	2.6	8.53	13.2	88	1.25
Downwind	480	11-Aug	13:32	3.1	10.17	11.8	244	2.51
Background	481	11-Aug	13:50	3.6	11.81	22.2	<1	0.19
Scan down grant avenue	488	11-Aug	14:32	2.4	7.87	25.1	<1	0.31
Scan down process stack A	493	11-Aug	15:53	2.1	6.89	30.3	<1	0.46
Scan down process stack B	494	11-Aug	16:07	1.4	4.59	37.5	<1	0.39
Scan down process stack C	495	11-Aug	16:23	2.5	8.20	112.3	<1	0.58
Scan down process stack D	496	11-Aug	16:38	2.7	8.86	113.9	<1	0.45
D COVER	497	11-Aug	16:52	3	9.84	111.1	42	0.96
Background	498	11-Aug	17:10	3.3	10.82	121	14	0.37
Downwind	499	11-Aug	17:21	3.8	12.46	125.7	326	4.01
Downwind	500	11-Aug	17:46	3	9.84	109.1	311	5
Background	501	11-Aug	18:04	2.8	9.18	66.1	4	3.04

Scans are downwind or upwind both the temp flare and ulc flare unless otherwise noted.

Emission rates with 1's are actually <1 lb/hr

APPENDIX E: RAW STORAGE TANK PROCESS DATA

TANK OPERATIONS AT TIME OF DIAL MEASUREMENTS

PAGE ___ OF ____

SITE NAME: BULK TERMINAL DATE: 7/18/2007

FIN TANK 22 EPN TANK 22

****Please note units if not consistent with one

MILITARY TIME:	900	1000	1100	1200	1300	1400	1500
CONTENT CHEMICAL:	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA
CAS NUMBER:							
VAPOR PRESSURE (PSIA):	3.9	3.9	3.9	3.9	3.9	3.9	3.9
INLET LIQUID TEMP:							
IN TANK LIQUID TEMP:							
TANK SHELL TEMP:	82 DEGREES F (MEASURED WITH TEMPERATURE GUN)	82 DEGREES F (MEASURED WITH TEMPERATURE GUN)	82 DEGREES F (MEASURED WITH TEMPERATURE GUN)	82 DEGREES F (MEASURED WITH TEMPERATURE GUN)	82 DEGREES F (MEASURED WITH TEMPERATURE GUN)	82.4 DEGREES F (MEASURED WITH TEMPERATURE GUN)	82.4 DEGREES F (MEASURED WITH TEMPERATURE GUN)
TANK OPERATION:	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE
LANDED (Y/N):	NO	NO	NO	NO	NO	NO	NO
# OF TURNOVERS	0	0	0	0	0	0	0
TANK LEVEL (FEET):	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0
TANK LEVEL DELTA (BARRELS):	0	0	0	0	0	0	0
LOADING RATE (BARREL/HR):	0	0	0	0	0	0	0
UNLOADING RATE (BARREL/HR):	0	0	0	0	0	0	0
WEATHER:	PARTLY SUNNY	PARTLY SUNNY	CLOUDY	CLOUDY	STORM APPROACHIN(	CLOUDY	RAIN
VOC EST EMISSIONS							
HAWK OBSERVATIONS:	RIM VENT PLUME ON EAST SIDE OF TANK			NO VISIBLE PLUME			
NOTES:	NAPHTHA FROM INE(	NAPHTHA FROM INE(	NAPHTHA FROM INE(	NAPHTHA FROM INE(	NAPHTHA FROM INEO	NAPHTHA FROM INE(	NAPHTHA FROM INE
SOLAR READINGS (BTU/HR-FT2)	100-200	120-180	80-120		40	2	2

TANK

SITE NAME: BULK TERMINAL		ACCOUNT NUMBER:	
FIN	T16ABW-22	OTHER TANK NAME:	TANK 22
EPN	E16A048		

TANK TYPE:	EFR	
CAPACITY (MGAL):	11271	
DIAMETER (FT):	219	
HEIGHT (FT):	40	
HEATED (Y/N):	N	
SHELL COLOR:	WHITE	
SHELL CONDITION:	GOOD	
VACUUM/PRESSURE SETTING (PSIG):	NA	
FILL METHOD:	B	
ROOF COLOR:	WHITE	
ROOF CONDITION:	GOOD	

VERTICAL FIXED ROOF:

ROOF TYPE (CONE OR DOME):		

HORIZONTAL FIXED ROOF:

TANK LENGTH (FT):		

INTERNAL FLOATING ROOF:

SELF SUPPORTING ROOF (Y/N):		
IF NO # OF COLUMNS:		
IF NO COLUMN DIA:		
INTERNAL SHELL CONDITION:		
PRIMARY SEAL TYPE:		
SECONDARY SEAL TYPE:		
DECK TYPE (WELDED OR BOLTED):		
IF BOLTED DECK CONST (SHEET OR PANEL):		
IF BOLTED DECK SEAM:		
GUIDEPOLE CONTROL TYPE:		
GUIDEPOLE SLOTTED (Y/N):		

EXTERNAL FLOATING ROOF AND DOMED ERF:

INTERNAL SHELL CONDITION:	GOOD, LIGHT RUST	
ROOF TYPE:	CONE	
GUIDEPOLE CONTROL TYPE:	COVER, SLEEVE	
GUIDEPOLE SLOTTED (Y/N):	YES	
PRIMARY SEAL TYPE:	MECH SHOE	
SECONDARY SEAL TYPE:	WIPER	
TANK CONSTRUCTION:	WELDED	

MEASUREMENT DATES AND TIMES:	07/16/07: 4:25 PM TO 6:00PM; 07/17/07: 11:30 AM TO 6:00 PM
	07/18/07: 9:00 AM TO 3:30 PM; 07/19/07 11:30 AM TO 5:00 PM
	07/20/07 (NIGHT): 10 PM TO 5:00 AM
LOCATION OF SOURCE:	SOUTHEAST NAPHTHA TANK AREA

CALCULATION METHOD: __________

NOTES: __________

TANK OPERATIONS AT TIME OF DIAL MEASUREMENTS

PAGE ___ OF ____

SITE NAME: BULK TERMINAL DATE: 07/16, 07/17
FIN TANK 22 EPN TANK 22

****Please note units if not consistent with ones listed

				7/17/2007				
MILITARY TIME:	1600	1700	1800	1100	1200	1300	1400	1500
CONTENT CHEMICAL:	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA
CAS NUMBER:								
VAPOR PRESSURE (PSIA):	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
INLET LIQUID TEMP:								
IN TANK LIQUID TEMP:	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F
TANK SHELL TEMP:								
TANK OPERATION:	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE
LANDED (Y/N):	NO	NO	NO	NO	NO	NO	NO	NO
# OF TURNOVERS	0	0	0	0	0	0	0	0
TANK LEVEL (FEET):	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0
TANK LEVEL DELTA (BARRELS):	0	0	0	0	0	0	0	0
LOADING RATE (BARREL/HR):	0	0	0	0	0	0	0	0
UNLOADING RATE (BARREL/HR):	0	0	0	0	0	0	0	0
WEATHER:	CLOUDY	CLOUDY	CLOUDY	MOSTLY CLEAR	MOSTLY CLEAR	MOSTLY CLEAR	MOSTLY CLEAR	CLOUDY
VOC EST EMISSIONS								
HAWK OBSERVATIONS:	NO VISIBLE PLUME	NO VISIBLE PLUME	NO VISIBLE PLUME	LEAK FROM PORTION OF RIM SEAL	LEAK FROM PORTION OF RIM SEAL	LEAK FROM PORTION OF RIM SEAL		
NOTES:	NAPHTHA FROM INE(	NAPHTHA FROM INE(	NAPHTHA FROM INE(	NAPHTHA FROM INE(	NAPHTHA FROM INEO	NAPHTHA FROM INE(	NAPHTHA FROM INE	NAPHTHA FROM INE

SITE NAME:
FIN

MILITARY TIME:	1600	1700	1800
CONTENT CHEMICAL:	NAPHTHA	NAPHTHA	NAPHTHA
CAS NUMBER:			
VAPOR PRESSURE (PSIA):	3.9	3.9	3.9
INLET LIQUID TEMP:			
IN TANK LIQUID TEMP:	82 DEGRE	82 DEGRE	82 DEGREES F
TANK SHELL TEMP:			
TANK OPERATION:	IDLE	IDLE	IDLE
LANDED (Y/N):	NO	NO	NO
# OF TURNOVERS	0	0	0
TANK LEVEL (FEET):	29' 0" 0	29' 0" 0	29' 0" 0
TANK LEVEL DELTA (BARRELS):	0	0	0
LOADING RATE (BARREL/HR):	0	0	0
UNLOADING RATE (BARREL/HR):	0	0	0
WEATHER:	CLOUDY	CLOUDY	CLOUDY
VOC EST EMISSIONS			
HAWK OBSERVATIONS:			
NOTES:	NAPHTHA	NAPHTHA	NAPHTHA FROM INEOS

TANK OPERATIONS AT TIME OF DIAL MEASUREMENTS

PAGE ___ OF ____

SITE NAME:	BULK TERMINAL	DATE:	7/20/2007-07/21/2007	NIGHT	
FIN	TANK 22	EPN	TANK 22		****Please note units if not consistent with one

MILITARY TIME:	2200	2300	0	100	200	300	400
CONTENT CHEMICAL:	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA
CAS NUMBER:							
VAPOR PRESSURE (PSIA):	3.9	3.9	3.9	3.9	3.9	3.9	3.9
INLET LIQUID TEMP:							
IN TANK LIQUID TEMP:	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F
TANK SHELL TEMP:							
TANK OPERATION:	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE
LANDED (Y/N):	NO	NO	NO	NO	NO	NO	NO
# OF TURNOVERS	0	0	0	0	0	0	0
TANK LEVEL (FEET):	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0	29' 0" 0
TANK LEVEL DELTA (BARRELS):	0	0	0	0	0	0	0
LOADING RATE (BARREL/HR):	0	0	0	0	0	0	0
UNLOADING RATE (BARREL/HR):	0	0	0	0	0	0	0
WEATHER:	NIGHT/PARTLY CLOU	NIGHT/PARTLY CLOU	NIGHT/PARTLY CLOU	NIGHT/PARTLY CLOU	NIGHT/PARTLY CLOUD	NIGHT/PARTLY CLOU	NIGHT/PARTLY CLO
VOC EST EMISSIONS							
HAWK OBSERVATIONS:	NONE						
NOTES:							
SOLAR READINGS (BTU/HR-FT2)							

SITE NAME:
FIN   es listed

MILITARY TIME:	500		
CONTENT CHEMICAL:	NAPHTHA		
CAS NUMBER:			
VAPOR PRESSURE (PSIA):	3.9		
INLET LIQUID TEMP:			
IN TANK LIQUID TEMP:	82 DEGREES F		
TANK SHELL TEMP:			
TANK OPERATION:	IDLE		
LANDED (Y/N):	NO		
# OF TURNOVERS	0		
TANK LEVEL (FEET):	29' 0" 0		
TANK LEVEL DELTA (BARRELS):	0		
LOADING RATE (BARREL/HR):	0		
UNLOADING RATE (BARREL/HR):	0		
WEATHER:	NIGHT/PARTLY CLOUDY		
VOC EST EMISSIONS			
HAWK OBSERVATIONS:			
NOTES:			
SOLAR READINGS (BTU/HR-FT2)			

TANK OPERATIONS AT TIME OF DIAL MEASUREMENTS

PAGE ___ OF ____

SITE NAME: BULK TERMINAL DATE: 07/16, 07/17

FIN TANK 23 EPN TANK 23

****Please note units if not consistent with ones listed

				7/17/2007				
MILITARY TIME:	1630	1700	1800	1100	1200	1300	1400	1500
CONTENT CHEMICAL:	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA
CAS NUMBER:								
VAPOR PRESSURE (PSIA):	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
INLET LIQUID TEMP:								
IN TANK LIQUID TEMP:	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F
TANK SHELL TEMP:								
TANK OPERATION:	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE
LANDED (Y/N):	NO	NO	NO	NO	NO	NO	NO	NO
# OF TURNOVERS	0	0	0	0	0	0	0	0
TANK LEVEL (FEET):	7' 7" 2	7' 7" 2	7' 7" 2	7' 7" 2	7' 7" 2	7' 7" 2	7' 7" 2	7' 7" 2
TANK LEVEL DELTA (BARRELS):	0	0	0	0	0	0	0	0
LOADING RATE (BARREL/HR):	0	0	0	0	0	0	0	0
UNLOADING RATE (BARREL/HR):	0	0	0	0	0	0	0	0
WEATHER:	CLOUDY	CLOUDY	CLOUDY	MOSTLY CLEAR	MOSTLY CLEAR	MOSTLY CLEAR	MOSTLY CLEAR	CLOUDY
VOC EST EMISSIONS								
HAWK OBSERVATIONS:	RIM VENT PLUME	RIM VENT PLUME	RIM VENT PLUME	PLUMES FROM SOME TANK VENTS				
NOTES:	NAPHTHA FROM INEOS	NAPHTHA FROM INEOS	NAPHTHA FROM INEOS	NAPHTHA FROM INEOS	NAPHTHA FROM INEOS	NAPHTHA FROM INEOS	NAPHTHA FROM INEOS	NAPHTHA FROM INEOS
COMMENT:	TANK WAS NEARLY FULL, LEVEL LOWERED ON SUNDAY							

SITE NAME:
FIN

MILITARY TIME:	1600	1700	1800		
CONTENT CHEMICAL:	NAPHTHA	NAPHTHA	NAPHTHA		
CAS NUMBER:					
VAPOR PRESSURE (PSIA):	3.9	3.9	3.9		
INLET LIQUID TEMP:					
IN TANK LIQUID TEMP:	82 DEGREES F	82 DEGREES F	82 DEGREES F		
TANK SHELL TEMP:					
TANK OPERATION:	IDLE	IDLE	IDLE		
LANDED (Y/N):	NO	NO	NO		
# OF TURNOVERS	0	0	0		
TANK LEVEL (FEET):	7' 7" 2	7' 7" 2	7' 7" 2		
TANK LEVEL DELTA (BARRELS):	0	0	0		
LOADING RATE (BARREL/HR):	0	0	0		
UNLOADING RATE (BARREL/HR):	0	0	0		
WEATHER:	CLOUDY	CLOUDY	CLOUDY		
VOC EST EMISSIONS					
HAWK OBSERVATIONS:					
NOTES:	NAPHTHA FROM INEOS	NAPHTHA FROM INEOS	NAPHTHA FROM INEOS		
COMMENT:					

TANK OPERATIONS AT TIME OF DIAL MEASUREMENTS

PAGE ___ OF ____

SITE NAME: BULK TERMINAL DATE: 07/16, 07/17

FIN TANK 23 EPN TANK 23

****Please note units if not consistent with one

				7/17/2007			
MILITARY TIME:	1630	1700	1800	1100	1200	1300	1400
CONTENT CHEMICAL:	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA
CAS NUMBER:							
VAPOR PRESSURE (PSIA):	3.9	3.9	3.9	3.9	3.9	3.9	3.9
INLET LIQUID TEMP:							
IN TANK LIQUID TEMP:	82.8 DEGREES F	82.8 DEGREES F	82.9 DEGREES F	82.6 DEGREES F	82.6 DEGREES F	82.6 DEGREES F	82.6 DEGREES F
TANK SHELL TEMP:							
TANK OPERATION:	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE
LANDED (Y/N):	NO	NO	NO	NO	NO	NO	NO
# OF TURNOVERS	0	0	0	0	0	0	0
TANK LEVEL (FEET):	33' 10" 13	33' 10" 13	33' 10" 13	33' 10" 11	33' 10" 11	33' 10" 11	33' 10" 11
TANK LEVEL DELTA (BARRELS):	0	0	0	0	0	0	0
LOADING RATE (BARREL/HR):	0	0	0	0	0	0	0
UNLOADING RATE (BARREL/HR):	0	0	0	0	0	0	0
WEATHER:	CLOUDY	CLOUDY	CLOUDY	MOSTLY CLEAR	MOSTLY CLEAR	MOSTLY CLEAR	MOSTLY CLEAR
VOC EST EMISSIONS							
HAWK OBSERVATIONS:	NO VISIBLE PLUMES	NO VISIBLE PLUMES	NO VISIBLE PLUMES	NO VISIBLE PLUMES			
NOTES:	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO

TANK OPERATIONS AT TIME OF DIAL MEASUREMENTS

PAGE ___ OF ____

SITE NAME: BULK TERMINAL DATE: 07/16, 07/17

FIN TANK 23 EPN TANK 23

****Please note units if not consistent with one

				7/17/2007			
MILITARY TIME:	1630	1700	1800	1100	1200	1300	1400
COMMENT:					SOLAR AVERAGE 100-200 BTU/(HR-FT2); PEAK: 300 BTU/(HR-FT2)		

SITE NAME:
FIN ɘs listed

MILITARY TIME:	1500	1600	1700	1800
CONTENT CHEMICAL:	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA
CAS NUMBER:				
VAPOR PRESSURE (PSIA):	3.9	3.9	3.9	3.9
INLET LIQUID TEMP:				
IN TANK LIQUID TEMP:	82.6 DEGREES F	82.6 DEGRE	82.8 DEGREES F	82.9 DEGREES F
TANK SHELL TEMP:				
TANK OPERATION:	IDLE	IDLE	IDLE	IDLE
LANDED (Y/N):	NO	NO	NO	NO
# OF TURNOVERS	0	0	0	0
TANK LEVEL (FEET):	33' 10" 11	33' 10" 11	33' 10" 11	33' 10" 11
TANK LEVEL DELTA (BARRELS):	0	0	0	0
LOADING RATE (BARREL/HR):	0	0	0	0
UNLOADING RATE (BARREL/HR):	0	0	0	0
WEATHER:	CLOUDY	CLOUDY	CLOUDY	CLOUDY
VOC EST EMISSIONS				
HAWK OBSERVATIONS:				
NOTES:	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO

SITE NAME:
FIN es listed

MILITARY TIME:	1500	1600	1700	1800
COMMENT:	15:30 BEGAN TANK CIRCULATION; SOLAR AVERAGE 80-120 BTU/(HR-FT2);			

TANK OPERATIONS AT TIME OF DIAL MEASUREMENTS

PAGE ___ OF ____

SITE NAME: BULK TERMINAL   DATE: 07/16, 07/17

FIN: TANK 23   EPN: TANK 23

****Please note units if

					7/17/2007		
MILITARY TIME:	1600	1700	1800	1000	1100	1200	1300
CONTENT CHEMICAL:	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA
CAS NUMBER:							
VAPOR PRESSURE (PSIA):	4	4	4		4	4	4
INLET LIQUID TEMP:							
IN TANK LIQUID TEMP:	86 DEGREES F	86.5 DEGREES F	86.9 DEGREES F	85.8 DEGREES F	85.6 DEGREES F	85.6 DEGREES F	85.6 DEGREES F
TANK SHELL TEMP:							
TANK OPERATION:	FILLING	FILLING	FILLING	FINISH FILLING	IDLE	IDLE	IDLE
LANDED (Y/N):	NO	NO	NO		NO	NO	NO
# OF TURNOVERS	0	0	0		0	0	0
TANK LEVEL (FEET):	18' 7" 6	19' 9" 12	21' 0" 6	35' 10" 1	36' 1" 10	36' 1" 10	36' 1" 10
TANK ~~LEVEL DELTA~~ VOLUME (~~BARRELS~~) GALLONS:	1927169.2	2055375.5	2185812.7		0	0	0
LOADING RATE (~~BARRELS~~ GALLONS/HR):	221846.5	128206.3	130437.2		0	0	0
UNLOADING RATE (BARREL/HR):	0	0	0		0	0	0
WEATHER:	CLOUDY	CLOUDY	CLOUDY	MOSTLY CLEAR	MOSTLY CLEAR	MOSTLY CLEAR	MOSTLY CLEAR
VOC EST EMISSIONS							
HAWK OBSERVATIONS:	PLUMES FROM RIM VENTS	PLUMES FROM RIM VENTS	PLUMES FROM RIM VENTS		PLUMES FROM RIM VENTS	PLUMES FROM RIM VENTS	PLUMES FROM RIM VENTS
NOTES:	NAPHTHA FROM VALERO (2 BARGES)	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO		NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO

TANK OPERATIONS AT TIME OF DIAL MEASUREMENTS

PAGE ___ OF ____

SITE NAME: BULK TERMINAL DATE: 07/16, 07/17

FIN TANK 23 EPN TANK 23

****Please note units if

					7/17/2007		
MILITARY TIME:	1600	1700	1800	1000	1100	1200	1300
COMMENT:				FILLING COMPLETED ~10:30 AM (1030 HOURS)		SOLAR AVERAGE 100-200 BTU/(HR-FT2);	

SITE NAME:
FIN not consistent with ones listed

MILITARY TIME:	1400	1500	1600	1700	1800
CONTENT CHEMICAL:	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA
CAS NUMBER:					
VAPOR PRESSURE (PSIA):	4	4	4	4	4
INLET LIQUID TEMP:					
IN TANK LIQUID TEMP:	85.6 DEGREES F	85.6 DEGREES F	85.6 DEGRE	85.6 DEGREES F	85.6 DEGREES F
TANK SHELL TEMP:					
TANK OPERATION:	IDLE	IDLE	IDLE	IDLE	IDLE
LANDED (Y/N):	NO	NO	NO	NO	NO
# OF TURNOVERS	0	0	0	0	0
TANK LEVEL (FEET):	36' 1" 10	36' 1" 10	36' 1" 10	36' 1" 10	36' 1" 10
TANK ~~LEVEL DELTA~~ VOLUME (~~BARRELS~~) GALLONS:	0	0	0	0	0
LOADING RATE (~~BARRELS~~ GALLONS/HR):	0	0	0	0	0
UNLOADING RATE (BARREL/HR):	0	0	0	0	0
WEATHER:	MOSTLY CLEAR	CLOUDY	CLOUDY	CLOUDY	CLOUDY
VOC EST EMISSIONS					
HAWK OBSERVATIONS:	PLUMES FROM RIM VENTS	PLUMES FROM RIM VENTS	PLUMES FROM RIM VENTS	PLUMES FROM RIM VENTS	PLUMES FROM RIM VENTS
NOTES:	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO

SITE NAME:
FIN not consistent with ones listed

MILITARY TIME:	1400	1500	1600	1700	1800
COMMENT:		SOLAR AVERAGE 80-120 BTU/(HR-FT2);		17:30 BEGAN TANK CIRCULATION;	

TANK OPERATIONS AT TIME OF DIAL MEASUREMENTS

SITE NAME: BULK TERMINAL DATE: 07/16, 07/17
FIN TANK 23 EPN TANK 23

****Please note units if not consistent with one

				7/17/2007			
MILITARY TIME:	1630	1700	1800	1100	1200	1300	1400
CONTENT CHEMICAL:	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA
CAS NUMBER:							
VAPOR PRESSURE (PSIA):	4	4	4	4	4	4	4
INLET LIQUID TEMP:							
IN TANK LIQUID TEMP:	86.2 DEGREES F	86.2 DEGREES F	86.2 DEGREES F	85.6 DEGREES F	85.6 DEGREES F	85.6 DEGREES F	85.6 DEGREES F
TANK SHELL TEMP:							
TANK OPERATION:	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE
LANDED (Y/N):	NO	NO	NO	NO	NO	NO	NO
# OF TURNOVERS	0	0	0	0	0	0	0
TANK LEVEL (FEET):	56' 0" 11	56' 0" 11	56' 0" 11	56' 0" 9	56' 0" 9	56' 0" 9	56' 0" 9
TANK LEVEL DELTA (BARRELS):	0	0	0	0	0	0	0
LOADING RATE (BARREL/HR):	0	0	0	0	0	0	0
UNLOADING RATE (BARREL/HR):	0	0	0	0	0	0	0
WEATHER:	CLOUDY	CLOUDY	CLOUDY	MOSTLY CLEAR	MOSTLY CLEAR	MOSTLY CLEAR	MOSTLY CLEAR
VOC EST EMISSIONS							
HAWK OBSERVATIONS:	NO VISIBLE PLUMES	NO VISIBLE PLUMES	NO VISIBLE PLUMES	NO VISIBLE PLUMES			
NOTES:	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO

TANK OPERATIONS AT TIME OF DIAL MEASUREMENTS

PAGE ___ OF ____

SITE NAME: BULK TERMINAL DATE: 07/16, 07/17

FIN TANK 23 EPN TANK 23

****Please note units if not consistent with one

				7/17/2007			
MILITARY TIME:	1630	1700	1800	1100	1200	1300	1400
COMMENT:					SOLAR AVERAGE 100-200 BTU/(HR-FT2); PEAK: 300 BTU/(HR-FT2)		

SITE NAME:
FIN   es listed

MILITARY TIME:	1500	1600	1700	1800		
CONTENT CHEMICAL:	NAPHTHA	NAPHTHA	NAPHTHA	NAPHTHA		
CAS NUMBER:						
VAPOR PRESSURE (PSIA):	4	4	4	4		
INLET LIQUID TEMP:						
IN TANK LIQUID TEMP:	85.6 DEGREES F	85.6 DEGRE	85.8 DEGREES F	85.8 DEGREES F		
TANK SHELL TEMP:						
TANK OPERATION:	IDLE	IDLE	IDLE	IDLE		
LANDED (Y/N):	NO	NO	NO	NO		
# OF TURNOVERS	0	0	0	0		
TANK LEVEL (FEET):	56' 0" 9	56' 0" 9	56' 0" 9	56' 0" 9		
TANK LEVEL DELTA (BARRELS):	0	0	0	0		
LOADING RATE (BARREL/HR):	0	0	0	0		
UNLOADING RATE (BARREL/HR):	0	0	0	0		
WEATHER:	CLOUDY	CLOUDY	CLOUDY	CLOUDY		
VOC EST EMISSIONS						
HAWK OBSERVATIONS:						
NOTES:	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO	NAPHTHA FROM VALERO		

SITE NAME:
FIN es listed

MILITARY TIME:	1500	1600	1700	1800
COMMENT:	SOLAR AVERAGE 80-120 BTU/(HR-FT2);			

TANK

SITE NAME: BULK TERMINAL
FIN T15A-3792
EPN E15A132

ACCOUNT NUMBER:
OTHER TANK NAME: TANK 3792

TANK TYPE:	VERTICAL FIXED	
CAPACITY (MGAL):	5242	
DIAMETER (FT):	150	
HEIGHT (FT):	20	
HEATED (Y/N):	N	
SHELL COLOR:	WHITE	
SHELL CONDITION:	GOOD	
VACUUM/PRESSURE SETTING (PSIG):		
FILL METHOD:	SUBMERGED	
ROOF COLOR:	WHITE	
ROOF CONDITION:	GOOD	

VERTICAL FIXED ROOF:

ROOF TYPE (CONE OR DOME):	CONE	

HORIZONTAL FIXED ROOF:

TANK LENGTH (FT):		

INTERNAL FLOATING ROOF:

SELF SUPPORTING ROOF (Y/N):		
IF NO # OF COLUMNS:		
IF NO COLUMN DIA:		
INTERNAL SHELL CONDITION:		
PRIMARY SEAL TYPE:		
SECONDARY SEAL TYPE:		
DECK TYPE (WELDED OR BOLTED):		
IF BOLTED DECK CONST (SHEET OR PANEL):		
IF BOLTED DECK SEAM:		
GUIDEPOLE CONTROL TYPE:		
GUIDEPOLE SLOTTED (Y/N):		

EXTERNAL FLOATING ROOF AND DOMED ERF:

INTERNAL SHELL CONDITION:		
ROOF TYPE:		
GUIDEPOLE CONTROL TYPE:		
GUIDEPOLE SLOTTED (Y/N):		
PRIMARY SEAL TYPE:		
SECONDARY SEAL TYPE:		
TANK CONSTRUCTION:		

MEASUREMENT DATES AND TIMES:	07/16/07: 4:25 PM TO 6:00PM; 07/17/07: 11:30 AM TO 6:00 PM
LOCATION OF SOURCE:	SOUTHEAST NAPHTHA TANK AREA

CALCULATION METHOD:

NOTES:

TANK OPERATIONS AT TIME OF DIAL MEASUREMENTS

PAGE ___ OF ____

SITE NAME: BULK TERMINAL DATE: 7/16/2007, 07/17/2007

FIN TANK 3792 EPN TANK 3792

****Please note units if not consistent with ones listed

				7/17/2007				
MILITARY TIME:	1600	1700	1800	1100	1200	1300	1400	1500
CONTENT CHEMICAL:	BUTANOL	BUTANOL	BUTANOL	BUTANOL	BUTANOL	BUTANOL	BUTANOL	BUTANOL
CAS NUMBER:								
VAPOR PRESSURE (PSIA):								
INLET LIQUID TEMP:								
IN TANK LIQUID TEMP:	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F	82 DEGREES F
TANK SHELL TEMP:								
TANK OPERATION:	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE	IDLE
LANDED (Y/N):	NO	NO	NO	NO	NO	NO	NO	NO
# OF TURNOVERS	0	0	0	0	0	0	0	0
TANK LEVEL (FEET):	25' 2" 4	25' 2" 4	25' 2" 4	25' 2" 4	25' 2" 4	25' 2" 4	25' 2" 4	25' 2" 4
TANK LEVEL DELTA (BARRELS):	0	0	0	0	0	0	0	0
LOADING RATE (BARREL/HR):	0	0	0	0	0	0	0	0
UNLOADING RATE (BARREL/HR):	0	0	0	0	0	0	0	0
WEATHER:	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
VOC EST EMISSIONS								
HAWK OBSERVATIONS:	NO VISIBLE PLUME	NO VISIBLE PLUME	NO VISIBLE PLUME	NO VISIBLE PLUME	NO VISIBLE PLUME	NO VISIBLE PLUME	NO VISIBLE PLUME	NO VISIBLE PLUME
NOTES:								

SITE NAME:
FIN

MILITARY TIME:	1600	1700	1800
CONTENT CHEMICAL:	BUTANOL	BUTANOL	BUTANOL
CAS NUMBER:			
VAPOR PRESSURE (PSIA):			
INLET LIQUID TEMP:			
IN TANK LIQUID TEMP:	82 DEGREES F	82 DEGREES F	82 DEGREES F
TANK SHELL TEMP:			
TANK OPERATION:	IDLE	IDLE	IDLE
LANDED (Y/N):	NO	NO	NO
# OF TURNOVERS	0	0	0
TANK LEVEL (FEET):	25' 2" 4	25' 2" 4	25' 2" 4
TANK LEVEL DELTA (BARRELS):	0	0	0
LOADING RATE (BARREL/HR):	0	0	0
UNLOADING RATE (BARREL/HR):	0	0	0
WEATHER:	CLOUDY	CLOUDY	CLOUDY
VOC EST EMISSIONS			
HAWK OBSERVATIONS:	NO VISIBLE PLUME	NO VISIBLE PLUME	NO VISIBLE PLUME
NOTES:			

Tank Number	Product	Tank Type	Shell Capacity Mgallons	Diameter	Height	Heated	Shell Color	Shell Condition	Vac/Press Setting	Roof Color	Roof Condition	Roof Type
BW23	Naphtha	IFR	5,288	150	40	No	White	Good	Scoop/Vent	White	Good	Cone
27	Naphtha	IFR	5,776	128	60	No	White	Good	Scoop/Vent	White	Good	Cone
28	Naphtha	IFR	6,425	135	60	No	White	Good	Scoop/Vent	White	Good	Cone
29	Naphtha	IFR	6,425	135	60	No	White	Good	Scoop/Vent	White	Good	Cone

Tank Number	Product	Tank Type	Shell Capacity Mgallons	Diameter	Height	Heated	Shell Color	Shell Condition	Vac/Press Setting	Roof Color	Roof Condition	Roof Type
BW22	Naphtha	EFR	11,271	219	40	No	White	Good	NA	White	Good	Cone

Self Supporting Roof	Number Columns	Column Diameter	Seal Type	Deck Type Welded/Bolted	Deck Construction Sheet / Panel	Deck Seam	Guidepole Control Type	Guidepole Slotted
No			Double Wiper					Yes
No			MS/Seconday Seal	Bolted	Sheet		Sleeve	Yes
No			MS/Seconday Seal	Bolted	Sheet		Sleeve	Yes
No			MS/Seconday Seal	Bolted	Sheet		Sleeve	Yes
Internal Shell Conditon	Roof Type	Guidepole Control Type	Guidepole Slotted	Seal Type	Tank Construction			
Good		Guidepole Cover	Yes	MS / Secondary Seal	Welded			

	OTK1021.FL	OTK1021.PV	OTK1021.VL	OTK1021.TP
	TANK 1021 FLOW RATE BPH	TANK 1021 LEVEL ft	TANK 1021 GROSS VOLUME Bbl	TANK 1021 TEMPERATURE Deg F
7/27/07 0:00	4674	37.61	244982	85
7/27/07 1:00	4430	38.28	249577	85
7/27/07 2:00	3998	38.88	253640	85
7/27/07 3:00	-4271	38.64	252011	85
7/27/07 4:00	-4873	37.93	247113	85
7/27/07 5:00	-4901	37.20	242162	85
7/27/07 6:00	-5034	36.47	237164	85
7/27/07 7:00	-4993	35.74	232223	85
7/27/07 8:00	-1369	35.25	228823	85
7/27/07 9:00	4817	35.79	232574	85
7/27/07 10:00	4666	36.49	237291	85
7/27/07 11:00	4609	37.17	241968	84
7/27/07 12:00	4703	37.85	246604	85
7/27/07 13:00	2927	38.37	250126	85
7/27/07 14:00	2919	38.79	252978	85
7/27/07 15:00	2556	39.18	255682	85
7/27/07 16:00	2575	39.55	258211	85
7/27/07 17:00	-4709	39.21	255896	85
7/27/07 18:00	-5093	38.48	250835	85
7/27/07 19:00	-1106	38.07	248063	85
7/27/07 20:00	0	38.07	248076	85
7/27/07 21:00	931	38.15	248612	85
7/27/07 22:00	1084	38.31	249696	85
7/27/07 23:00	1094	38.46	250779	85
7/28/07 0:00	1139	38.63	251910	85
7/28/07 1:00	1159	38.80	253062	85
7/28/07 2:00	1131	38.97	254215	85
7/28/07 3:00	1061	39.12	255293	85
7/28/07 4:00	1033	39.27	256322	85
7/28/07 5:00	1059	39.43	257372	85
7/28/07 6:00	-283	39.49	257844	85
7/28/07 7:00	-5005	38.90	253795	85
7/28/07 8:00	-4991	38.16	248727	85
7/28/07 9:00	-5060	37.42	243673	85
7/28/07 10:00	-5051	36.69	238682	85
7/28/07 11:00	-1169	36.25	235673	85
7/28/07 12:00	1100	36.39	236642	85
7/28/07 13:00	1116	36.56	237769	86
7/28/07 14:00	1143	36.72	238892	86
7/28/07 15:00	1153	36.89	240038	86
7/28/07 16:00	1074	37.05	241145	86
7/28/07 17:00	1073	37.21	242226	86
7/28/07 18:00	1048	37.36	243266	86
7/28/07 19:00	1093	37.52	244340	86
7/28/07 20:00	1172	37.69	245505	86
7/28/07 21:00	1164	37.86	246672	86
7/28/07 22:00	1129	38.03	247813	86
7/28/07 23:00	1084	38.19	248918	86
7/29/07 0:00	1050	38.35	249967	86
7/29/07 1:00	1085	38.50	251034	86
7/29/07 2:00	1103	38.66	252143	86
7/29/07 3:00	1122	38.83	253265	86
7/29/07 4:00	1086	38.99	254365	86
7/29/07 5:00	1014	39.14	255391	86
7/29/07 6:00	971	39.28	256370	86
7/29/07 7:00	980	39.42	257356	86
7/29/07 8:00	65	39.50	257904	86
7/29/07 9:00	-4959	38.94	254077	87
7/29/07 10:00	-5009	38.21	249026	87
7/29/07 11:00	-4881	37.49	244123	86
7/29/07 12:00	-4581	37.15	241786	85
7/29/07 13:00	-4581	[-11059] No Good Data For Calculation	241786	[-11059] No Good Data For Calculation
7/29/07 14:00	-4610	35.12	238987	86
7/29/07 15:00	-2486	34.85	226124	86
7/29/07 16:00	1957	35.03	227423	86
7/29/07 17:00	1732	35.30	229214	86
7/29/07 18:00	758	35.48	230470	86
7/29/07 19:00	-4880	[-11059] No Good Data For Calculation	229386	[-11059] No Good Data For Calculation
7/29/07 20:00	-4880	[-11059] No Good Data For Calculation	229386	[-11059] No Good Data For Calculation
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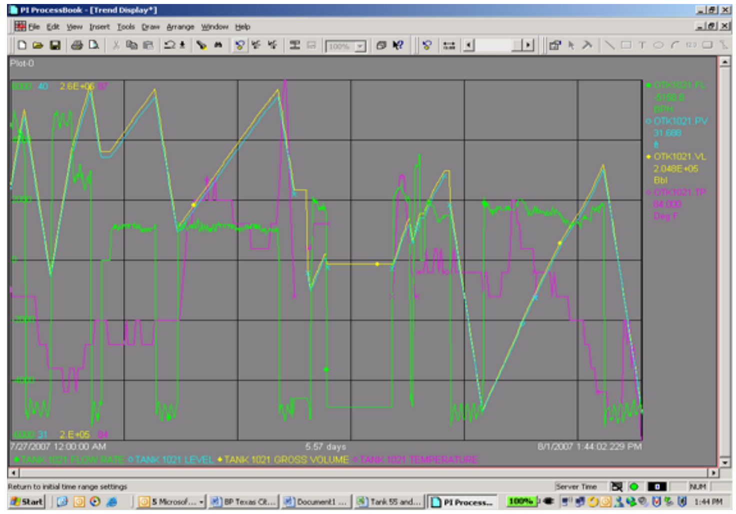
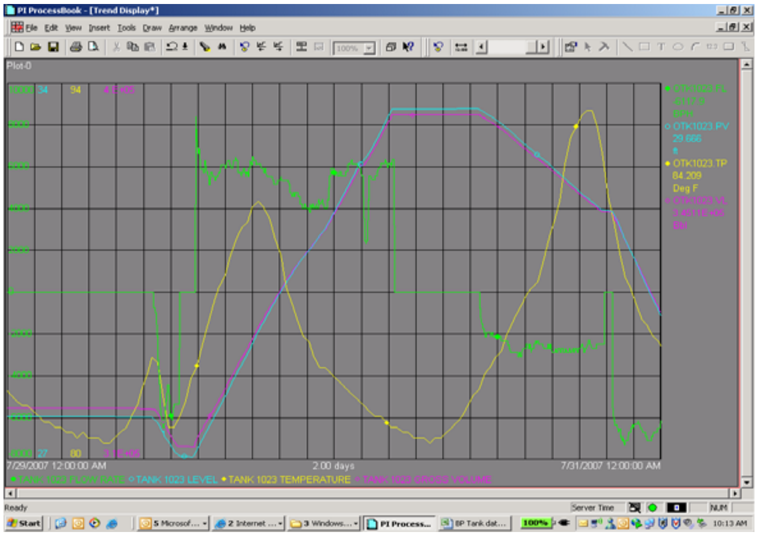
7/30/07 8:00	-3821	35.31	229362	85
7/30/07 9:00	2089	35.51	230624	86
7/30/07 10:00	2431	35.86	233018	86
7/30/07 11:00	2132	36.19	235261	86
7/30/07 12:00	-880	36.27	235841	86
7/30/07 13:00	596	36.07	234427	85
7/30/07 14:00	2340	36.52	237211	85
7/30/07 15:00	722	36.60	238052	85
7/30/07 16:00	1930	36.84	239738	85
7/30/07 17:00	1749	37.11	241561	85
7/30/07 18:00	1339	37.33	243015	86
7/30/07 19:00	1423	37.51	244374	85
7/30/07 20:00	1492	36.86	244639	85
7/30/07 21:00	-4354	36.46	237124	85
7/30/07 22:00	-5157	35.71	232043	85
7/30/07 23:00	-4996	34.97	226988	85
7/31/07 0:00	-4995	34.22	221930	85
7/31/07 1:00	-5102	33.48	216891	85
7/31/07 2:00	-5082	32.74	211871	85
7/31/07 3:00	-4878	32.00	206906	85
7/31/07 4:00	1181	31.88	206081	85
7/31/07 5:00	1695	32.14	207843	85
7/31/07 6:00	1677	32.39	209497	85
7/31/07 7:00	1734	32.64	211220	85
7/31/07 8:00	1720	32.89	212939	85
7/31/07 9:00	1727	33.15	214680	86
7/31/07 10:00	1727	33.41	216389	86
7/31/07 11:00	1934	33.68	218252	86
7/31/07 12:00	1936	33.97	220223	86
7/31/07 13:00	1646	34.23	221950	86
7/31/07 14:00	1602	34.46	223533	86
7/31/07 15:00	1658	34.70	225195	85
7/31/07 16:00	1626	34.95	226835	85
7/31/07 17:00	1546	35.18	228398	85
7/31/07 18:00	1618	35.41	229979	85
7/31/07 19:00	1610	35.65	231605	85
7/31/07 20:00	1475	35.87	233135	85
7/31/07 21:00	1302	36.07	234468	85
7/31/07 22:00	1183	36.25	235694	85
7/31/07 23:00	1227	36.43	236899	85
8/1/07 0:00				



	OTK1023.FL	OTK1023.PV	OTK1023.VL	OTK1023.TP
	TANK 1023 FLOW RATE BPH	TANK 1023 LEVEL ft	TANK 1023 GROSS VOLUME Bbl	TANK 1023 TEMPERATURE Deg F
7/29/07 0:00	0	27.80	322245	82
7/29/07 1:00	0	27.80	322245	82
7/29/07 2:00	0	27.80	322245	82
7/29/07 3:00	0	27.80	322245	81
7/29/07 4:00	0	27.80	322245	81
7/29/07 5:00	0	27.80	322245	81
7/29/07 6:00	0	27.80	322245	81
7/29/07 7:00	0	27.80	322245	81
7/29/07 8:00	0	27.79	322184	81
7/29/07 9:00	0	27.79	322164	82
7/29/07 10:00	-288	27.77	321967	83
7/29/07 11:00	-5071	27.47	318416	82
7/29/07 12:00	-3473	27.11	313792	81
7/29/07 13:00	1434	27.08	313514	83
7/29/07 14:00	5923	27.47	318306	85
7/29/07 15:00	5760	27.94	323957	86
7/29/07 16:00	6129	28.44	330046	88
7/29/07 17:00	5808	28.91	335930	89
7/29/07 18:00	6083	29.41	341987	89
7/29/07 19:00	5409	29.87	347609	88
7/29/07 20:00	5186	30.30	352882	87
7/29/07 21:00	4388	30.68	357512	85
7/29/07 22:00	4106	31.01	361617	84
7/29/07 23:00	4838	31.38	366078	83
7/30/07 0:00	5651	31.84	371654	83
7/30/07 1:00	6103	32.32	377654	82
7/30/07 2:00	4470	32.70	382191	82
7/30/07 3:00	6009	33.15	387852	82
7/30/07 4:00	2463	33.51	392243	81
7/30/07 5:00	0	33.52	392415	81
7/30/07 6:00	0	33.52	392415	81
7/30/07 7:00	0	33.52	392415	81
7/30/07 8:00	0	33.52	392418	81
7/30/07 9:00	0	33.53	392479	82
7/30/07 10:00	-440	33.51	392326	83
7/30/07 11:00	-2023	33.38	390697	84
7/30/07 12:00	-2361	33.20	388472	84
7/30/07 13:00	-2886	32.97	385699	85
7/30/07 14:00	-2564	32.76	383018	86
7/30/07 15:00	-2596	32.55	380462	88
7/30/07 16:00	-2801	32.33	377715	90
7/30/07 17:00	-2785	32.10	374914	92
7/30/07 18:00	-2607	31.88	372244	93
7/30/07 19:00	-2118	31.69	369833	92
7/30/07 20:00	-3468	31.53	367984	89
7/30/07 21:00	-6851	31.02	361633	87
7/30/07 22:00	-6523	30.48	355100	85
7/30/07 23:00	-6755	29.93	348317	85
7/31/07 0:00				



	OTK1024.FL TANK 1024 FLOW RATE BPH	OTK1024.PV TANK 1024 LEVEL ft	OTK1024.VL TANK 1024 GROSS VOLUME Bbl	OTK1024.TP TANK 1024 TEMPERATURE Deg F
7/27/07 0:00	0	33.57	215958	84
7/27/07 1:00	0	33.57	215958	84
7/27/07 2:00	0	33.57	215958	84
7/27/07 3:00	0	33.57	215958	84
7/27/07 4:00	0	33.57	215958	84
7/27/07 5:00	0	33.57	215967	84
7/27/07 6:00	0	33.58	215993	84
7/27/07 7:00	0	33.58	215996	84
7/27/07 8:00	0	33.60	216112	84
7/27/07 9:00	0	33.60	216168	84
7/27/07 10:00	0	33.60	216168	83
7/27/07 11:00	0	33.60	216168	83
7/27/07 12:00	0	33.60	216168	83
7/27/07 13:00	0	33.60	216168	83
7/27/07 14:00	0	33.60	216168	83
7/27/07 15:00	0	33.60	216168	83
7/27/07 16:00	0	33.60	216168	84
7/27/07 17:00	0	33.60	216168	84
7/27/07 18:00	0	33.60	216168	84
7/27/07 19:00	0	33.60	216168	84
7/27/07 20:00	0	33.60	216168	84
7/27/07 21:00	0	33.60	216168	84
7/27/07 22:00	0	33.60	216168	84
7/27/07 23:00	0	33.60	216168	84
7/28/07 0:00	0	33.60	216168	84
7/28/07 1:00	0	33.60	216168	84
7/28/07 2:00	0	33.60	216168	84
7/28/07 3:00	0	33.60	216168	84
7/28/07 4:00	0	33.60	216168	84
7/28/07 5:00	0	33.60	216168	84
7/28/07 6:00	0	33.60	216168	84
7/28/07 7:00	0	33.60	216168	84
7/28/07 8:00	0	33.60	216168	84
7/28/07 9:00	0	33.60	216168	84
7/28/07 10:00	0	33.60	216168	84
7/28/07 11:00	0	33.60	216168	84
7/28/07 12:00	0	33.60	216137	84
7/28/07 13:00	0	33.60	216133	84
7/28/07 14:00	0	33.60	216133	85
7/28/07 15:00	0	33.60	216133	85
7/28/07 16:00	0	33.60	216133	85
7/28/07 17:00	0	33.60	216133	85
7/28/07 18:00	0	33.60	216133	85
7/28/07 19:00	0	33.60	216133	86
7/28/07 20:00	0	33.60	216133	86
7/28/07 21:00	0	33.60	216133	86
7/28/07 22:00	0	33.60	216133	85
7/28/07 23:00	0	33.60	216133	85
7/29/07 0:00	0	33.60	216133	85
7/29/07 1:00	0	33.60	216133	85
7/29/07 2:00	0	33.60	216133	85
7/29/07 3:00	0	33.60	216133	85
7/29/07 4:00	0	33.60	216133	85
7/29/07 5:00	0	33.60	216133	85
7/29/07 6:00	0	33.60	216133	85
7/29/07 7:00	0	33.60	216133	85
7/29/07 8:00	0	33.60	216133	85
7/29/07 9:00	0	33.60	216133	85
7/29/07 10:00	0	33.60	216133	85
7/29/07 11:00	211	33.62	216251	85
7/29/07 12:00	0	33.63	216309	85
7/29/07 13:00	0	[-11059] No Good Data For Calculation	216309	[-11059] No Good Data For Calculation
7/29/07 14:00	0	33.56	216216	85
7/29/07 15:00	0	33.56	215852	85
7/29/07 16:00	0	33.56	215852	85
7/29/07 17:00	0	33.56	215852	85
7/29/07 18:00	0	33.56	215852	86
7/29/07 19:00	0	[-11059] No Good Data For Calculation	215852	[-11059] No Good Data For Calculation
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7/29/07 21:00	0	[-11059] No Good Data For Calculation	215852	[-11059] No Good Data For Calculation
7/29/07 22:00	0	[-11059] No Good Data For Calculation	215852	[-11059] No Good Data For Calculation
7/29/07 23:00	0	[-11059] No Good Data For Calculation	215852	[-11059] No Good Data For Calculation
7/30/07 0:00	0	[-11059] No Good Data For Calculation	215852	[-11059] No Good Data For Calculation
7/30/07 1:00	0	[-11059] No Good Data For Calculation	215852	[-11059] No Good Data For Calculation
7/30/07 2:00	0	[-11059] No Good Data For Calculation	215852	[-11059] No Good Data For Calculation
7/30/07 3:00	0	[-11059] No Good Data For Calculation	215852	[-11059] No Good Data For Calculation
7/30/07 4:00	0	[-11059] No Good Data For Calculation	215852	[-11059] No Good Data For Calculation
7/30/07 5:00	0	[-11059] No Good Data For Calculation	215852	[-11059] No Good Data For Calculation
7/30/07 6:00	0	[-11059] No Good Data For Calculation	215852	[-11059] No Good Data For Calculation
7/30/07 7:00	0	[-11059] No Good Data For Calculation	215852	[-11059] No Good Data For Calculation
7/30/07 8:00	0	33.55	215845	84
7/30/07 9:00	0	33.55	215817	85
7/30/07 10:00	0	33.55	215817	85
7/30/07 11:00	0	33.55	215817	85
7/30/07 12:00	0	33.55	215816	85
7/30/07 13:00	0	33.55	215782	85
7/30/07 14:00	0	33.55	215782	85
7/30/07 15:00	-3692	33.38	214641	86
7/30/07 16:00	-6687	32.46	208486	87
7/30/07 17:00	-6625	31.48	201861	86
7/30/07 18:00	-1085	31.07	199149	85
7/30/07 19:00	0	31.07	199148	85
7/30/07 20:00	0	31.07	199148	85
7/30/07 21:00	0	31.07	199148	85
7/30/07 22:00	0	31.07	199148	85
7/30/07 23:00	0	31.07	199148	85
7/31/07 0:00	0	31.07	199148	85
7/31/07 1:00	0	31.07	199148	85
7/31/07 2:00	0	31.07	199148	85
7/31/07 3:00	-580	31.05	199051	85
7/31/07 4:00	-6695	30.40	194620	85
7/31/07 5:00	-6683	29.40	187930	85
7/31/07 6:00	-6641	28.40	181276	85
7/31/07 7:00	-6654	27.40	174619	85
7/31/07 8:00	-6644	26.41	167985	85
7/31/07 9:00	-6549	25.42	161397	84
7/31/07 10:00	-6563	24.44	154842	84
7/31/07 11:00	-6552	23.47	148291	84
7/31/07 12:00	-6525	22.49	141754	84
7/31/07 13:00	-6544	21.52	135238	84
7/31/07 14:00	-6504	20.56	128722	85
7/31/07 15:00	-6498	19.58	122217	85
7/31/07 16:00	-6547	18.62	115696	85
7/31/07 17:00	-6489	17.65	109205	86
7/31/07 18:00	-6505	16.70	102733	86
7/31/07 19:00	-6435	15.74	96269	87
7/31/07 20:00	-6445	14.79	89836	87
7/31/07 21:00	-6403	13.84	83438	86
7/31/07 22:00	-6354	12.90	77058	87
7/31/07 23:00	-6343	11.97	70721	86
8/1/07 0:00				
8/5/07 22:00	0	17.58	108694	-173
8/5/07 23:00	0	17.58	108694	-17
8/6/07 0:00	0	17.58	108694	-4
8/6/07 1:00	0	17.58	108694	-1
8/6/07 2:00	0	17.58	108694	0
8/6/07 3:00	0	17.58	108694	1
8/6/07 4:00	0	17.58	108694	-2
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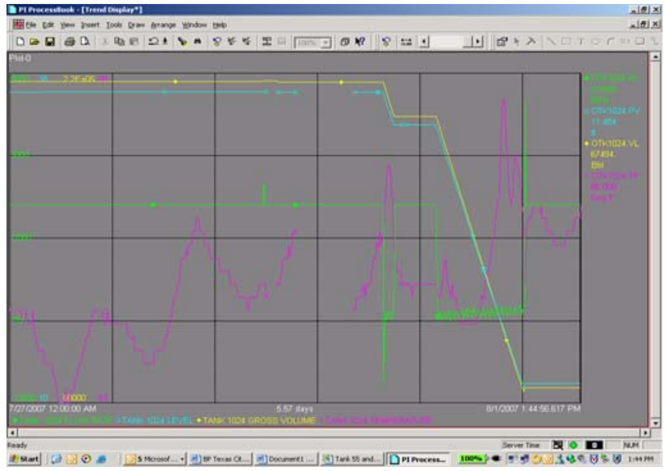
8/6/07 6:00	0	17.58	108695	-272
8/6/07 7:00				



	OTK1025.FL TANK 1025 FLOW RATE BPH	OTK1025.PV TANK 1025 LEVEL ft	OTK1025.VL TANK 1025 GROSS VOLUME Bbl	OTK1025.TP TANK 1025 TEMPERATURE Deg F
7/27/07 0:00	-9533	13.14	78746	89
7/27/07 1:00	-9353	11.74	69323	89
7/27/07 2:00	-8660	10.43	60534	89
7/27/07 3:00	-1005	10.06	58059	89
7/27/07 4:00	0	10.08	58235	89
7/27/07 5:00	116	10.09	58290	89
7/27/07 6:00	0	10.09	58332	89
7/27/07 7:00	0	10.10	58370	89
7/27/07 8:00	69	10.11	58459	89
7/27/07 9:00	69	10.11	58435	89
7/27/07 10:00	0	10.11	58429	89
7/27/07 11:00	0	10.11	58402	89
7/27/07 12:00	0	10.10	58387	89
7/27/07 13:00	1577	10.23	59175	89
7/27/07 14:00	1924	10.51	61126	89
7/27/07 15:00	1889	10.79	63007	89
7/27/07 16:00	1918	11.08	64899	89
7/27/07 17:00	1892	11.36	66811	89
7/27/07 18:00	1636	11.62	68542	89
7/27/07 19:00	0	11.70	69060	89
7/27/07 20:00	0	11.70	69061	89
7/27/07 21:00	0	11.70	69061	89
7/27/07 22:00	0	11.70	69061	89
7/27/07 23:00	0	11.70	69061	89
7/28/07 0:00	0	11.70	69061	89
7/28/07 1:00	0	11.70	69073	89
7/28/07 2:00	0	11.70	69096	89
7/28/07 3:00	0	11.70	69096	89
7/28/07 4:00	0	11.70	69096	89
7/28/07 5:00	13856	12.48	74345	89
7/28/07 6:00	23070	15.72	96162	89
7/28/07 7:00	23309	19.21	119704	89
7/28/07 8:00	18016	22.13	139336	89
7/28/07 9:00	16288	24.64	156038	89
7/28/07 10:00	7323	26.39	167744	89
7/28/07 11:00	4604	26.75	170120	89
7/28/07 12:00	3749	27.53	175332	89
7/28/07 13:00	226	27.64	176042	89
7/28/07 14:00	0	27.64	176043	89
7/28/07 15:00	0	27.64	176048	89
7/28/07 16:00	0	27.64	176044	89
7/28/07 17:00	0	27.65	176078	89
7/28/07 18:00	0	27.65	176086	89
7/28/07 19:00	0	27.65	176102	89
7/28/07 20:00	0	27.65	176078	89
7/28/07 21:00	0	27.65	176078	89
7/28/07 22:00	0	27.65	176078	89
7/28/07 23:00	0	27.65	176078	89
7/29/07 0:00	0	27.65	176078	89
7/29/07 1:00	0	27.65	176078	89
7/29/07 2:00	0	27.65	176078	89
7/29/07 3:00	0	27.65	176078	89
7/29/07 4:00	0	27.65	176078	89
7/29/07 5:00	0	27.65	176078	89
7/29/07 6:00	0	27.65	176078	89
7/29/07 7:00	0	27.65	176078	89
7/29/07 8:00	0	27.65	176078	89
7/29/07 9:00	0	27.65	176078	89
7/29/07 10:00	0	27.64	176065	89
7/29/07 11:00	329	27.67	176243	89
7/29/07 12:00	0	27.68	176286	89
7/29/07 13:00	0	[-11059] No Good Data For Calculation	176286	89
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7/29/07 15:00	0	27.66	176148	89
7/29/07 16:00	0	27.66	176148	89
7/29/07 17:00	0	27.66	176166	89
7/29/07 18:00	0	27.66	176182	89
7/29/07 19:00	0	27.66	176182	89
7/29/07 20:00	0	[-11059] No Good Data For Calculation	176182	89
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7/29/07 23:00	0	[-11059] No Good Data For Calculation	176165	89
7/30/07 0:00	0	[-11059] No Good Data For Calculation	176148	89
7/30/07 1:00	0	[-11059] No Good Data For Calculation	176148	89
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7/30/07 7:00	0	[-11059] No Good Data For Calculation	176148	89
7/30/07 8:00	-1367	18.92	163291	89
7/30/07 9:00	-5897	18.40	114233	89
7/30/07 10:00	-5875	17.52	108385	89
7/30/07 11:00	-6237	16.61	102209	89
7/30/07 12:00	-2531	15.97	97871	89
7/30/07 13:00	-4118	15.65	95716	89
7/30/07 14:00	-6014	14.61	89339	89
7/30/07 15:00	-1434	14.26	86372	89
7/30/07 16:00	1504	14.46	87690	89
7/30/07 17:00	1386	14.65	88958	89
7/30/07 18:00	1644	14.77	89772	89
7/30/07 19:00	7602	15.47	94932	89
7/30/07 20:00	10038	18.55	98736	89
7/30/07 21:00	16863	19.93	124508	89
7/30/07 22:00	18352	22.63	142652	89
7/30/07 23:00	18210	25.36	160857	89
7/31/07 0:00	13150	27.78	176932	89
7/31/07 1:00	2821	28.45	181467	89
7/31/07 2:00	2913	28.89	184339	89
7/31/07 3:00	3108	29.35	187401	89
7/31/07 4:00	2915	29.80	190439	89
7/31/07 5:00	2516	30.18	192953	89
7/31/07 6:00	2189	30.55	195407	89
7/31/07 7:00	1715	30.81	197175	89
7/31/07 8:00	1396	31.03	198624	89
7/31/07 9:00	1404	31.24	200076	89
7/31/07 10:00	2131	31.49	201621	89
7/31/07 11:00	5925	32.24	206714	89
7/31/07 12:00	5963	33.13	212665	89
7/31/07 13:00	5726	34.02	218694	89
7/31/07 14:00	1207	34.38	221022	89
7/31/07 15:00	1193	34.56	222268	89
7/31/07 16:00	1167	34.73	223432	89
7/31/07 17:00	962	34.88	224429	89
7/31/07 18:00	1521	35.08	225765	89
7/31/07 19:00	1426	35.31	227284	89
7/31/07 20:00	1229	35.49	228514	89
7/31/07 21:00	1402	35.70	229897	89
7/31/07 22:00	1202	35.89	231187	89
7/31/07 23:00	1099	36.05	232242	89
8/1/07 0:00				
8/5/07 22:00	1138	8.40	47134	89
8/5/07 23:00	1261	8.59	48386	89
8/6/07 0:00	1033	8.75	49420	89
8/6/07 1:00	1542	8.97	50861	89
8/6/07 2:00	1203	9.16	52155	89
8/6/07 3:00	1416	9.37	53496	89
8/6/07 4:00	1274	9.57	54842	89
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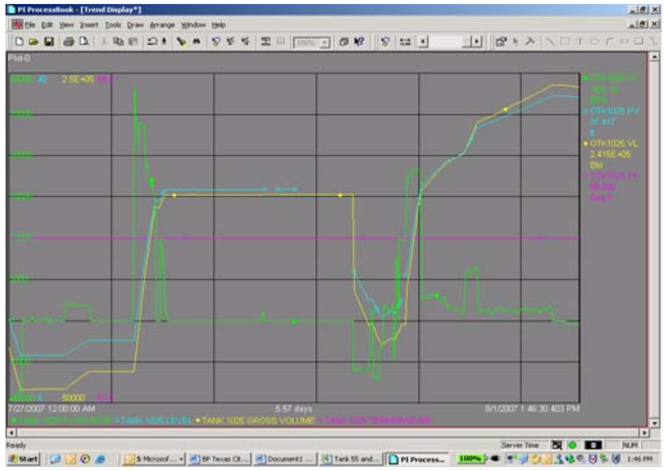
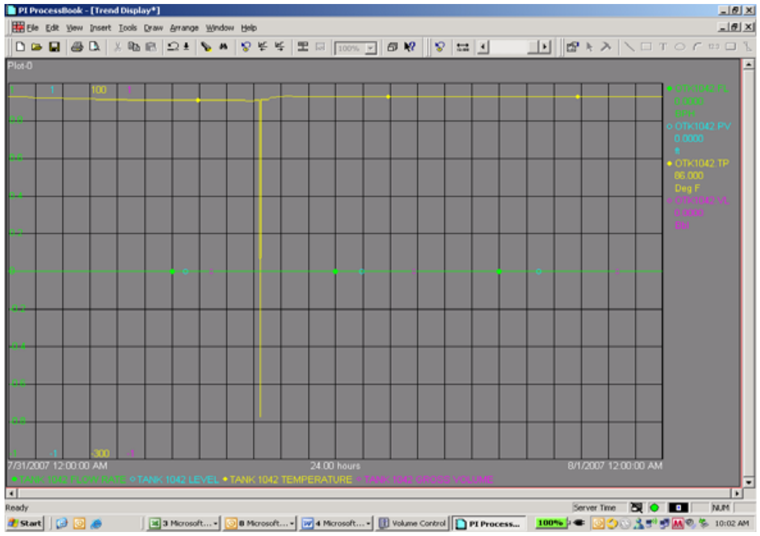
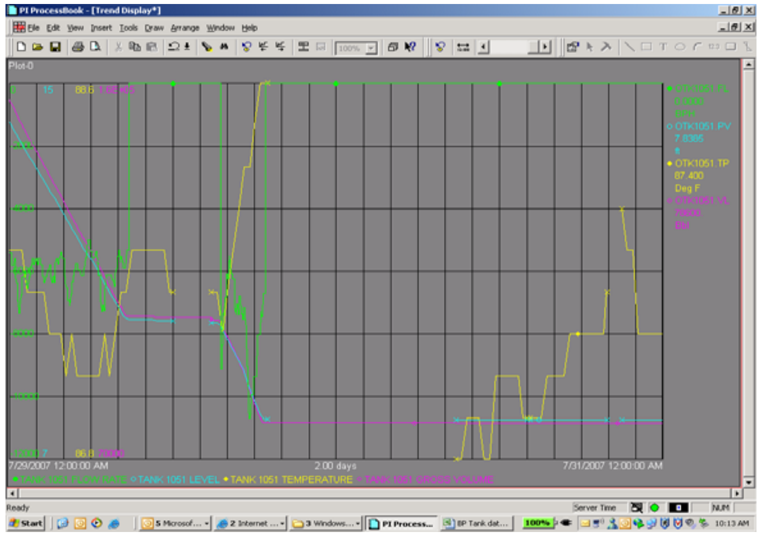
8/6/07 6:00	1318	9.91	57115	89
8/6/07 7:00				



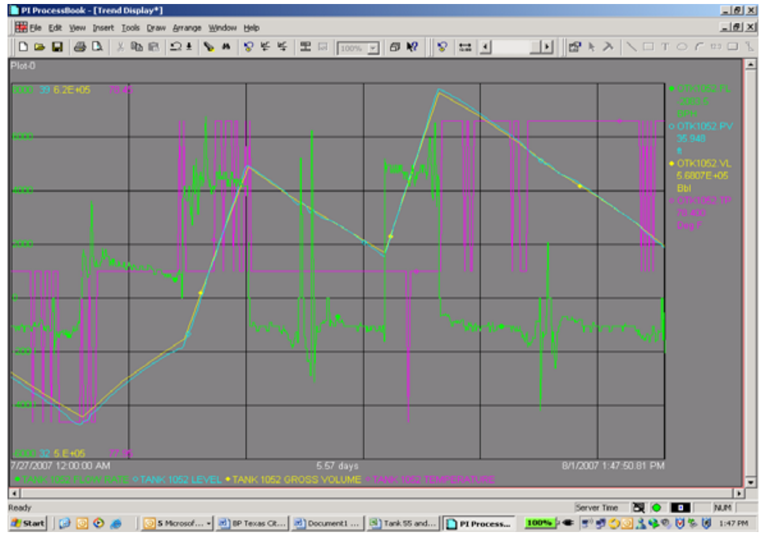
	OTK1042.FL	OTK1042.PV	OTK1042.VL	OTK1042.TP
	TANK 1042 FLOW RATE BPH	TANK 1042 LEVEL ft	TANK 1042 GROSS VOLUME Bbl	TANK 1042 TEMPERATURE Deg F
7/31/07 0:00	0	0.00	0	85
7/31/07 1:00	0	0.00	0	84
7/31/07 2:00	0	0.00	0	84
7/31/07 3:00	0	0.00	0	83
7/31/07 4:00	0	0.00	0	82
7/31/07 5:00	0	0.00	0	82
7/31/07 6:00	0	0.00	0	82
7/31/07 7:00	0	0.00	0	82
7/31/07 8:00	0	0.00	0	82
7/31/07 9:00	0	0.00	0	72
7/31/07 10:00	0	0.00	0	86
7/31/07 11:00	0	0.00	0	86
7/31/07 12:00	0	0.00	0	86
7/31/07 13:00	0	0.00	0	86
7/31/07 14:00	0	0.00	0	86
7/31/07 15:00	0	0.00	0	86
7/31/07 16:00	0	0.00	0	86
7/31/07 17:00	0	0.00	0	86
7/31/07 18:00	0	0.00	0	86
7/31/07 19:00	0	0.00	0	86
7/31/07 20:00	0	0.00	0	86
7/31/07 21:00	0	0.00	0	86
7/31/07 22:00	0	0.00	0	86
7/31/07 23:00	0	0.00	0	86
8/1/07 0:00	0	0.00	0	86
8/1/07 1:00				



	OTK1051.FL	OTK1051.PV	OTK1051.VL	OTK1051.TP
	TANK 1051 FLOW RATE BPH	TANK 1051 LEVEL ft	TANK 1051 GROSS VOLUME Bbl	TANK 1051 TEMPERATURE Deg F
7/29/07 0:00	-6229	13.92	152814	88
7/29/07 1:00	-6002	13.41	146542	88
7/29/07 2:00	-5938	12.94	140670	88
7/29/07 3:00	-5823	12.46	134718	87
7/29/07 4:00	-6385	11.95	128530	87
7/29/07 5:00	-5677	11.47	122590	87
7/29/07 6:00	-6126	11.00	116867	87
7/29/07 7:00	-6174	10.48	110504	87
7/29/07 8:00	-4291	10.05	105210	88
7/29/07 9:00	0	9.97	104247	88
7/29/07 10:00	0	9.96	104176	88
7/29/07 11:00	0	9.95	104057	88
7/29/07 12:00	0	9.95	104057	88
7/29/07 13:00	0	[-11059] No Good Data For Calculation	104057	[-11059] No Good Data For Calculation
7/29/07 14:00	0	9.90	103926	88
7/29/07 15:00	-3674	9.79	102065	88
7/29/07 16:00	-6527	9.29	96036	88
7/29/07 17:00	-8877	8.62	88050	88
7/29/07 18:00	-6193	7.97	80013	89
7/29/07 19:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/29/07 20:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/29/07 21:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/29/07 22:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/29/07 23:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/30/07 0:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/30/07 1:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/30/07 2:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/30/07 3:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/30/07 4:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/30/07 5:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/30/07 6:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/30/07 7:00	0	[-11059] No Good Data For Calculation	78724	[-11059] No Good Data For Calculation
7/30/07 8:00	0	7.84	78710	87
7/30/07 9:00	0	7.84	78616	87
7/30/07 10:00	0	7.84	78600	87
7/30/07 11:00	0	7.84	78600	87
7/30/07 12:00	0	7.84	78600	87
7/30/07 13:00	0	7.84	78600	87
7/30/07 14:00	0	7.84	78600	87
7/30/07 15:00	0	7.84	78600	87
7/30/07 16:00	0	7.84	78600	87
7/30/07 17:00	0	7.84	78600	87
7/30/07 18:00	0	7.84	78600	87
7/30/07 19:00	0	7.84	78600	87
7/30/07 20:00	0	7.84	78600	88
7/30/07 21:00	0	7.84	78600	88
7/30/07 22:00	0	7.84	78600	87
7/30/07 23:00	0	7.84	78600	87
7/31/07 0:00				



	OTK1052.FL	OTK1052.PV	OTK1052.VL	OTK1052.TP
	TANK 1052 FLOW RATE BPH	TANK 1052 LEVEL ft	TANK 1052 GROSS VOLUME Bbl	TANK 1052 TEMPERATURE Deg F
7/27/07 0:00	-1073	33.50	527142	78
7/27/07 1:00	-1096	33.44	526106	78
7/27/07 2:00	-1085	33.37	525110	78
7/27/07 3:00	-1045	33.30	524115	78
7/27/07 4:00	-1044	33.24	523120	78
7/27/07 5:00	-994	33.19	522125	78
7/27/07 6:00	-950	33.13	521130	78
7/27/07 7:00	-1113	33.06	520135	78
7/27/07 8:00	-940	33.02	519140	78
7/27/07 9:00	-1365	32.95	518185	78
7/27/07 10:00	-1274	32.87	517279	78
7/27/07 11:00	-1359	32.79	516372	78
7/27/07 12:00	-1259	32.72	515466	78
7/27/07 13:00	-1028	32.66	514559	78
7/27/07 14:00	670	32.68	513848	78
7/27/07 15:00	1029	32.74	514847	78
7/27/07 16:00	2219	32.85	516245	78
7/27/07 17:00	1244	32.93	517642	78
7/27/07 18:00	1469	33.02	519040	78
7/27/07 19:00	1588	33.11	520437	78
7/27/07 20:00	1348	33.20	521835	78
7/27/07 21:00	1274	33.27	523232	78
7/27/07 22:00	1238	33.35	524589	78
7/27/07 23:00	1193	33.42	525729	78
7/28/07 0:00	1176	33.49	526836	78
7/28/07 1:00	1128	33.56	527943	78
7/28/07 2:00	1140	33.62	529050	78
7/28/07 3:00	1042	33.69	530157	78
7/28/07 4:00	1145	33.76	531264	78
7/28/07 5:00	967	33.81	532371	78
7/28/07 6:00	1028	33.87	533461	78
7/28/07 7:00	865	33.93	534488	78
7/28/07 8:00	818	33.98	535509	78
7/28/07 9:00	747	34.02	536529	78
7/28/07 10:00	840	34.07	537550	78
7/28/07 11:00	3778	34.19	539156	78
7/28/07 12:00	3548	34.41	543209	78
7/28/07 13:00	4286	34.65	547533	78
7/28/07 14:00	4253	34.90	551857	78
7/28/07 15:00	5310	35.20	556180	78
7/28/07 16:00	4336	35.49	560504	78
7/28/07 17:00	4191	35.74	564828	78
7/28/07 18:00	4579	36.01	569152	78
7/28/07 19:00	4536	36.28	573417	78
7/28/07 20:00	4342	36.55	577479	78
7/28/07 21:00	4385	36.81	581524	78
7/28/07 22:00	4320	37.07	585568	78
7/28/07 23:00	4189	37.32	589613	78
7/29/07 0:00	1460	37.46	592797	78
7/29/07 1:00	-968	37.40	592158	78
7/29/07 2:00	-1141	37.34	591062	78
7/29/07 3:00	-1042	37.28	589965	78
7/29/07 4:00	-1112	37.21	588869	78
7/29/07 5:00	-993	37.15	587772	78
7/29/07 6:00	-1084	37.09	586676	78
7/29/07 7:00	-1194	37.02	585580	78
7/29/07 8:00	-1389	36.94	584508	78
7/29/07 9:00	-1706	36.83	583548	78
7/29/07 10:00	-1042	36.76	582600	78
7/29/07 11:00	1292	36.77	581646	78
7/29/07 12:00	-2005	36.68	580679	78
7/29/07 13:00	1083	36.63	579719	78
7/29/07 14:00	-1633	36.57	578810	78
7/29/07 15:00	-992	36.51	577908	78
7/29/07 16:00	-448	36.47	577007	78
7/29/07 17:00	-821	36.44	576106	78
7/29/07 18:00	-863	36.39	575205	78
7/29/07 19:00	-865	36.34	574303	78
7/29/07 20:00	-1037	36.28	573402	78
7/29/07 21:00	-1042	36.22	572493	78
7/29/07 22:00	-1080	36.15	571550	78
7/29/07 23:00	-1022	36.09	570604	78
7/30/07 0:00	-1077	36.03	569658	78
7/30/07 1:00	-1129	35.96	568712	78
7/30/07 2:00	-1120	35.90	567766	78
7/30/07 3:00	-1166	35.83	566820	78
7/30/07 4:00	1941	35.85	566662	78
7/30/07 5:00	4861	36.12	570725	78
7/30/07 6:00	4797	36.41	575414	78
7/30/07 7:00	4819	36.70	580103	78
7/30/07 8:00	4624	36.98	584792	78
7/30/07 9:00	4428	37.25	589481	78
7/30/07 10:00	4494	37.52	594171	78
7/30/07 11:00	4670	37.79	598860	78
7/30/07 12:00	4797	38.08	603540	78
7/30/07 13:00	5321	38.38	608169	78
7/30/07 14:00	4923	38.68	612792	78
7/30/07 15:00	1905	38.87	616491	78
7/30/07 16:00	-616	38.85	616088	78
7/30/07 17:00	-698	38.81	615196	78
7/30/07 18:00	-936	38.75	614303	78
7/30/07 19:00	-869	38.70	613411	78
7/30/07 20:00	-931	38.65	612518	78
7/30/07 21:00	-1069	38.58	611626	78
7/30/07 22:00	-1074	38.52	610734	78
7/30/07 23:00	-1103	38.46	609800	78
7/31/07 0:00	-1074	38.39	608746	78
7/31/07 1:00	-1017	38.33	607684	78
7/31/07 2:00	-1086	38.27	606622	78
7/31/07 3:00	-1090	38.20	605560	78
7/31/07 4:00	-1042	38.14	604499	78
7/31/07 5:00	-1042	38.08	603437	78
7/31/07 6:00	-1077	38.02	602375	78
7/31/07 7:00	-1174	37.95	601275	78
7/31/07 8:00	-1350	37.87	600085	78
7/31/07 9:00	-1593	37.78	598892	78
7/31/07 10:00	-1607	37.68	597699	78
7/31/07 11:00	-968	37.63	596505	78
7/31/07 12:00	-1830	37.55	595312	78
7/31/07 13:00	-351	37.49	594119	78
7/31/07 14:00	-757	37.46	592926	78
7/31/07 15:00	-1802	37.37	591828	78
7/31/07 16:00	-845	37.31	590910	78
7/31/07 17:00	-718	37.27	589995	78
7/31/07 18:00	-774	37.22	589081	78
7/31/07 19:00	-837	37.18	588167	78
7/31/07 20:00	-844	37.12	587253	78
7/31/07 21:00	-1094	37.06	586338	78
7/31/07 22:00	-1112	37.00	585424	78
7/31/07 23:00	-1005	36.93	584441	78
8/1/07 0:00				
8/5/07 22:00	1311	31.21	488394	79
8/5/07 23:00	1248	31.29	489713	79
8/6/07 0:00	1210	31.36	491033	79
8/6/07 1:00	1164	31.43	492353	79
8/6/07 2:00	1123	31.50	493673	79
8/6/07 3:00	1041	31.56	494631	79
8/6/07 4:00	1028	31.62	495243	79
8/6/07 5:00	1019	31.68	495855	79
8/6/07 6:00	783	31.73	496467	79
8/6/07 7:00				



	OTK1053.FL TANK 1053 FLOW RATE BPH	OTK1053.PV TANK 1053 LEVEL ft	OTK1053.VL TANK 1053 GROSS VOLUME Bbl	OTK1053.TP TANK 1053 TEMPERATURE Deg F
7/27/07 0:00	0	15.77	232234	85
7/27/07 1:00	0	15.77	232032	85
7/27/07 2:00	0	15.77	231831	85
7/27/07 3:00	0	15.77	231629	85
7/27/07 4:00	0	15.77	231427	85
7/27/07 5:00	0	15.78	231225	85
7/27/07 6:00	-1497	15.74	231021	85
7/27/07 7:00	-2800	15.58	230119	85
7/27/07 8:00	-1066	15.48	228667	84
7/27/07 9:00	0	15.47	227424	84
7/27/07 10:00	0	15.46	226797	84
7/27/07 11:00	0	15.45	226211	84
7/27/07 12:00	-2225	15.38	225646	84
7/27/07 13:00	-1352	15.27	225379	84
7/27/07 14:00	0	15.26	225204	85
7/27/07 15:00	-687	15.24	225029	85
7/27/07 16:00	687	15.25	224855	85
7/27/07 17:00	0	15.25	224680	85
7/27/07 18:00	0	15.25	224506	85
7/27/07 19:00	0	15.26	224331	85
7/27/07 20:00	0	15.27	224176	84
7/27/07 21:00	0	15.27	224160	84
7/27/07 22:00	0	15.27	224171	84
7/27/07 23:00	0	15.27	224182	84
7/28/07 0:00	0	15.27	224192	84
7/28/07 1:00	0	15.27	224203	84
7/28/07 2:00	0	15.27	224214	84
7/28/07 3:00	0	15.27	224225	84
7/28/07 4:00	0	15.27	224210	84
7/28/07 5:00	0	15.27	224015	84
7/28/07 6:00	0	15.27	223785	84
7/28/07 7:00	0	15.27	223555	84
7/28/07 8:00	0	15.27	223326	84
7/28/07 9:00	0	15.27	223096	84
7/28/07 10:00	0	15.27	222866	84
7/28/07 11:00	-2224	15.20	222479	84
7/28/07 12:00	-3372	15.01	220335	84
7/28/07 13:00	-2724	14.82	217701	84
7/28/07 14:00	-2710	14.66	215067	85
7/28/07 15:00	-2220	14.52	212433	85
7/28/07 16:00	-2349	14.39	209799	85
7/28/07 17:00	-2832	14.22	207165	86
7/28/07 18:00	-2528	14.07	204530	86
7/28/07 19:00	-2499	13.91	202201	85
7/28/07 20:00	-718	13.84	201733	85
7/28/07 21:00	0	13.84	201581	85
7/28/07 22:00	0	13.84	201430	85
7/28/07 23:00	0	13.84	201278	85
7/29/07 0:00	0	13.84	201126	85
7/29/07 1:00	0	13.84	200975	85
7/29/07 2:00	0	13.84	200823	85
7/29/07 3:00	0	13.84	200680	85
7/29/07 4:00	0	13.84	200568	85
7/29/07 5:00	0	13.84	200460	85
7/29/07 6:00	0	13.84	200352	85
7/29/07 7:00	0	13.84	200244	85
7/29/07 8:00	0	13.83	200136	84
7/29/07 9:00	0	13.80	200028	84
7/29/07 10:00	0	13.78	199920	85
7/29/07 11:00	0	13.79	199839	84
7/29/07 12:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/29/07 13:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/29/07 14:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/29/07 15:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/29/07 16:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/29/07 17:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/29/07 18:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/29/07 19:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/29/07 20:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/29/07 21:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/29/07 22:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/29/07 23:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/30/07 0:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/30/07 1:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/30/07 2:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/30/07 3:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/30/07 4:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/30/07 5:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/30/07 6:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/30/07 7:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/30/07 8:00	0	[-11059] No Good Data For Calculation	199834	[-11059] No Good Data For Calculation
7/30/07 9:00	0	12.80	185151	84
7/30/07 10:00	-235	12.78	183828	84
7/30/07 11:00	-271	12.76	183774	84
7/30/07 12:00	0	12.75	183720	84
7/30/07 13:00	163	12.76	183666	84
7/30/07 14:00	7	12.76	183612	85
7/30/07 15:00	0	12.77	183558	85
7/30/07 16:00	0	12.78	183504	86
7/30/07 17:00	0	12.80	183559	86
7/30/07 18:00	740	12.85	183712	86
7/30/07 19:00	802	12.89	183864	87
7/30/07 20:00	-2756	12.79	183380	86
7/30/07 21:00	-2657	12.62	180912	86
7/30/07 22:00	-2779	12.45	178302	85
7/30/07 23:00	-2963	12.28	175692	85
7/31/07 0:00	-2844	12.09	173082	85
7/31/07 1:00	-2890	11.92	170472	85
7/31/07 2:00	-2687	11.75	167861	84
7/31/07 3:00	-2744	11.59	165251	84
7/31/07 4:00	-520	11.54	163294	84
7/31/07 5:00	0	11.54	163055	84
7/31/07 6:00	0	11.54	162906	84
7/31/07 7:00	0	11.54	162757	84
7/31/07 8:00	0	11.53	162608	84
7/31/07 9:00	0	11.51	162459	84
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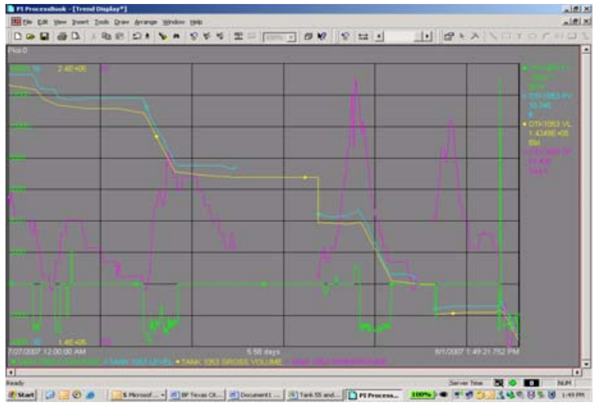
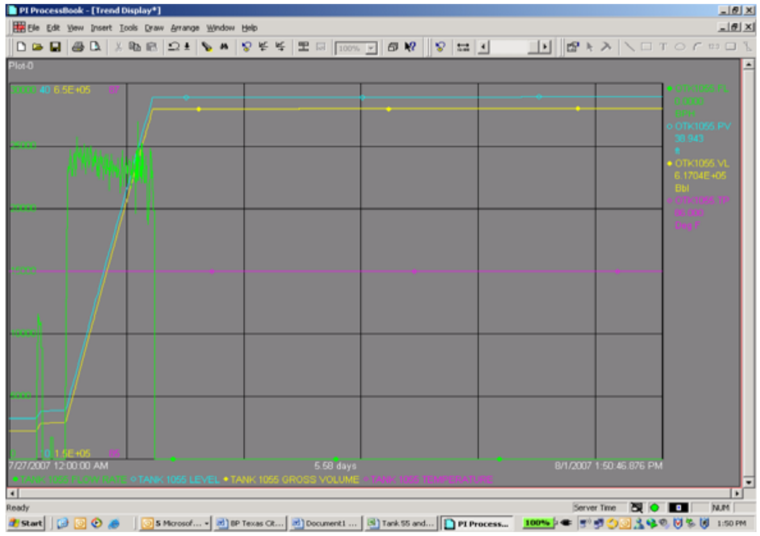
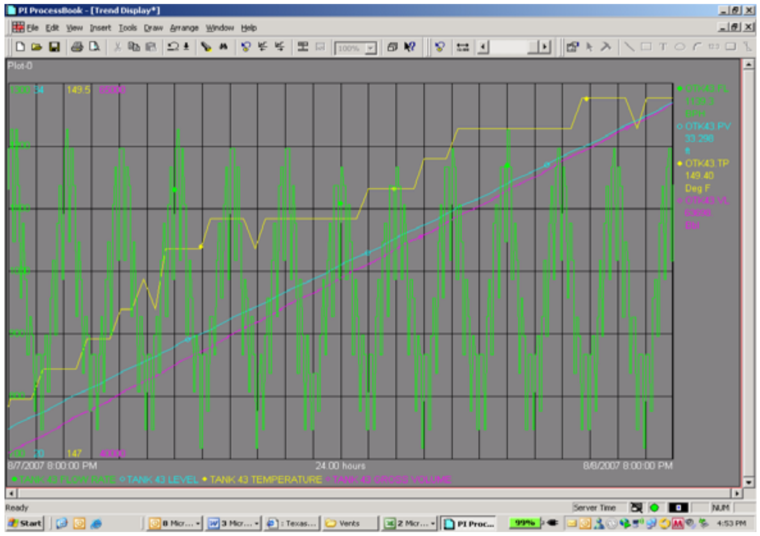
7/31/07 11:00	0	[-11059] No Good Data For Calculation	162162	[-11059] No Good Data For Calculation
7/31/07 12:00	0	[-11059] No Good Data For Calculation	162060	[-11059] No Good Data For Calculation
7/31/07 13:00	0	[-11059] No Good Data For Calculation	162057	[-11059] No Good Data For Calculation
7/31/07 14:00	0	[-11059] No Good Data For Calculation	162057	[-11059] No Good Data For Calculation
7/31/07 15:00	-514	10.81	159349	85
7/31/07 16:00	-163	10.81	151449	85
7/31/07 17:00	0	10.82	151555	86
7/31/07 18:00	0	10.84	151662	86
7/31/07 19:00	0	10.85	151768	86
7/31/07 20:00	0	10.86	151875	86
7/31/07 21:00	0	10.86	151981	85
7/31/07 22:00	0	10.86	152088	85
7/31/07 23:00	0	10.86	152187	85
8/1/07 0:00				
8/5/07 22:00	0	33.58	528705	89
8/5/07 23:00	0	33.58	528727	89
8/6/07 0:00	0	33.58	528727	89
8/6/07 1:00	0	33.58	528727	89
8/6/07 2:00	0	33.58	528727	89
8/6/07 3:00	0	33.58	528727	89
8/6/07 4:00	0	33.58	528727	89
8/6/07 5:00	0	33.58	528727	89
8/6/07 6:00	0	33.57	528617	89
8/6/07 7:00				



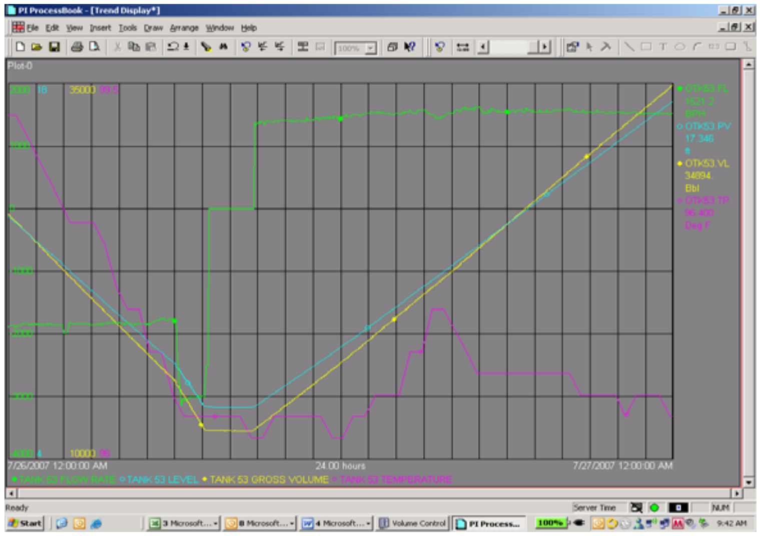
	OTK1055.FL TANK 1055 FLOW RATE BPH	OTK1055.PV TANK 1055 LEVEL ft	OTK1055.VL TANK 1055 GROSS VOLUME Bbl	OTK1055.TP TANK 1055 TEMPERATURE Deg F
7/27/07 0:00	0	13.27	187964	86
7/27/07 1:00	0	13.27	187964	86
7/27/07 2:00	0	13.27	187964	86
7/27/07 3:00	0	13.27	187964	86
7/27/07 4:00	0	13.27	187964	86
7/27/07 5:00	3498	13.36	189506	86
7/27/07 6:00	7854	13.82	197230	86
7/27/07 7:00	0	13.87	198111	86
7/27/07 8:00	714	13.90	198524	86
7/27/07 9:00	0	13.91	198713	86
7/27/07 10:00	0	13.91	198713	86
7/27/07 11:00	7704	14.09	201741	86
7/27/07 12:00	23506	15.30	222089	86
7/27/07 13:00	23959	16.70	245772	86
7/27/07 14:00	24275	18.15	270113	86
7/27/07 15:00	24079	19.59	294249	86
7/27/07 16:00	24115	21.02	318187	86
7/27/07 17:00	23758	22.45	341978	86
7/27/07 18:00	23519	23.86	365569	86
7/27/07 19:00	23355	25.28	389033	86
7/27/07 20:00	23314	26.69	412354	86
7/27/07 21:00	23184	28.09	435556	86
7/27/07 22:00	22966	29.48	458674	86
7/27/07 23:00	23164	30.87	481745	86
7/28/07 0:00	23124	32.26	504816	86
7/28/07 1:00	22888	33.64	527858	86
7/28/07 2:00	23497	35.02	551136	86
7/28/07 3:00	23422	36.42	574492	86
7/28/07 4:00	21588	37.72	596274	86
7/28/07 5:00	15414	38.80	614557	86
7/28/07 6:00	0	38.88	615987	86
7/28/07 7:00	0	38.88	615987	86
7/28/07 8:00	0	38.88	615987	86
7/28/07 9:00	0	38.88	615987	86
7/28/07 10:00	0	38.88	615987	86
7/28/07 11:00	0	38.88	615987	86
7/28/07 12:00	0	38.88	615987	86
7/28/07 13:00	0	38.88	615987	86
7/28/07 14:00	0	38.88	615987	86
7/28/07 15:00	0	38.88	615987	86
7/28/07 16:00	0	38.88	615987	86
7/28/07 17:00	0	38.88	615987	86
7/28/07 18:00	0	38.88	615987	86
7/28/07 19:00	0	38.88	615987	86
7/28/07 20:00	0	38.88	615987	86
7/28/07 21:00	0	38.88	615987	86
7/28/07 22:00	0	38.88	615987	86
7/28/07 23:00	0	38.88	615987	86
7/29/07 0:00	0	38.88	615987	86
7/29/07 1:00	0	38.88	615987	86
7/29/07 2:00	0	38.88	615987	86
7/29/07 3:00	0	38.88	615987	86
7/29/07 4:00	0	38.88	615987	86
7/29/07 5:00	0	38.88	615987	86
7/29/07 6:00	0	38.88	615987	86
7/29/07 7:00	0	38.88	615987	86
7/29/07 8:00	0	38.88	615987	86
7/29/07 9:00	0	38.88	615987	86
7/29/07 10:00	0	38.88	615987	86
7/29/07 11:00	0	38.89	616114	86
7/29/07 12:00	0	38.89	616163	86
7/29/07 13:00	0	38.89	616163	86
7/29/07 14:00	0	38.89	616163	86
7/29/07 15:00	0	38.89	616163	86
7/29/07 16:00	0	38.89	616163	86
7/29/07 17:00	0	38.89	616163	86
7/29/07 18:00	0	38.89	616163	86
7/29/07 19:00	0	38.89	616163	86
7/29/07 20:00	0	38.89	616163	86
7/29/07 21:00	0	38.89	616163	86
7/29/07 22:00	0	38.89	616163	86
7/29/07 23:00	0	38.89	616163	86
7/30/07 0:00	0	38.89	616163	86
7/30/07 1:00	0	38.89	616163	86
7/30/07 2:00	0	38.89	616163	86
7/30/07 3:00	0	38.89	616163	86
7/30/07 4:00	0	38.89	616163	86
7/30/07 5:00	0	38.89	616163	86
7/30/07 6:00	0	38.89	616163	86
7/30/07 7:00	0	38.89	616163	86
7/30/07 8:00	0	38.89	616163	86
7/30/07 9:00	0	38.89	616163	86
7/30/07 10:00	0	38.89	616163	86
7/30/07 11:00	0	38.89	616163	86
7/30/07 12:00	0	38.89	616163	86
7/30/07 13:00	0	38.89	616163	86
7/30/07 14:00	0	38.89	616163	86
7/30/07 15:00	0	38.89	616163	86
7/30/07 16:00	0	38.89	616163	86
7/30/07 17:00	0	38.89	616163	86
7/30/07 18:00	0	38.89	616163	86
7/30/07 19:00	0	38.89	616163	86
7/30/07 20:00	0	38.89	616163	86
7/30/07 21:00	0	38.89	616163	86
7/30/07 22:00	0	38.89	616163	86
7/30/07 23:00	0	38.89	616163	86
7/31/07 0:00	0	38.89	616163	86
7/31/07 1:00	0	38.89	616163	86
7/31/07 2:00	0	38.89	616163	86
7/31/07 3:00	0	38.89	616163	86
7/31/07 4:00	0	38.89	616163	86
7/31/07 5:00	0	38.89	616163	86
7/31/07 6:00	0	38.89	616163	86
7/31/07 7:00	0	38.89	616163	86
7/31/07 8:00	0	38.90	616357	86
7/31/07 9:00	0	38.94	617044	86
7/31/07 10:00	0	38.94	617044	86
7/31/07 11:00	0	38.94	617044	86
7/31/07 12:00	0	38.94	617044	86
7/31/07 13:00	0	38.94	617044	86
7/31/07 14:00	0	38.94	617044	86
7/31/07 15:00	0	38.94	617044	86
7/31/07 16:00	0	38.94	617044	86
7/31/07 17:00	0	38.94	617044	86
7/31/07 18:00	0	38.94	617044	86
7/31/07 19:00	0	38.94	617044	86
7/31/07 20:00	0	38.94	617044	86
7/31/07 21:00	0	38.94	617044	86
7/31/07 22:00	0	38.94	617044	86
7/31/07 23:00	0	38.94	617044	86
8/1/07 0:00				



	OTK43.FL	OTK43.PV	OTK43.VL	OTK43.TP
	TANK 43 FLOW RATE BPH	TANK 43 LEVEL ft	TANK 43 GROSS VOLUME Bbl	TANK 43 TEMPERATURE Deg F
8/7/07 22:00	1016	22.43	42872	148
8/7/07 23:00	943	22.91	43785	148
8/8/07 0:00	999	23.45	44820	148
8/8/07 1:00	953	23.93	45735	148
8/8/07 2:00	991	24.47	46770	148
8/8/07 3:00	963	24.95	47685	149
8/8/07 4:00	981	25.48	48715	149
8/8/07 5:00	958	25.96	49625	149
8/8/07 6:00	961	26.49	50641	149
8/8/07 7:00				



	OTK53.FL	OTK53.PV	OTK53.VL	OTK53.TP
	TANK 53 FLOW RATE BPH	TANK 53 LEVEL ft	TANK 53 GROSS VOLUME Bbl	TANK 53 TEMPERATURE Deg F
7/26/07 0:00	-1854	12.59	25360	99
7/26/07 1:00	-1859	11.67	23508	99
7/26/07 2:00	-1861	10.74	21637	98
7/26/07 3:00	-1837	9.83	19795	98
7/26/07 4:00	-1840	8.91	17961	97
7/26/07 5:00	-1785	8.01	16148	97
7/26/07 6:00	-2893	6.83	13734	96
7/26/07 7:00	-632	5.94	11937	96
7/26/07 8:00	183	5.94	11939	96
7/26/07 9:00	1394	6.41	12861	96
7/26/07 10:00	1409	7.11	14267	96
7/26/07 11:00	1445	7.82	15698	96
7/26/07 12:00	1488	8.55	17167	96
7/26/07 13:00	1522	9.30	18683	97
7/26/07 14:00	1542	10.06	20210	97
7/26/07 15:00	1494	10.81	21729	97
7/26/07 16:00	1586	11.58	23272	97
7/26/07 17:00	1558	12.36	24848	97
7/26/07 18:00	1563	13.14	26407	97
7/26/07 19:00	1558	13.91	27966	97
7/26/07 20:00	1561	14.69	29532	97
7/26/07 21:00	1538	15.46	31076	97
7/26/07 22:00	1527	16.22	32608	97
7/26/07 23:00	1516	16.97	34127	97
7/27/07 0:00	207	22.69	45666	94
7/29/07 0:00				
8/7/07 22:00	1344	20.22	40683	103
8/7/07 23:00	1379	20.90	42047	103
8/8/07 0:00	1390	21.59	43436	103
8/8/07 1:00	1421	22.29	44844	103
8/8/07 2:00	1428	23.00	46270	103
8/8/07 3:00	1448	23.71	47710	102
8/8/07 4:00	1477	24.44	49176	102
8/8/07 5:00	1484	25.18	50657	102
8/8/07 6:00	1494	25.92	52148	102
8/8/07 7:00				



	OTK55.FL	OTK55.PV	OTK55.VL	OTK55.TP
	TANK 55 FLOW RATE BPH	TANK 55 LEVEL ft	TANK 55 GROSS VOLUME Bbl	TANK 55 TEMPERATURE Deg F
7/26/07 0:00	3009	14.61	45893	106
7/26/07 1:00	3017	15.57	48904	106
7/26/07 2:00	3005	16.52	51913	106
7/26/07 3:00	3009	17.48	54931	106
7/26/07 4:00	3012	18.44	57943	106
7/26/07 5:00	3006	19.39	60955	106
7/26/07 6:00	3013	20.35	63968	106
7/26/07 7:00	652	20.90	65742	106
7/26/07 8:00	0	20.90	65756	106
7/26/07 9:00	0	20.90	65756	106
7/26/07 10:00	0	20.90	65756	106
7/26/07 11:00	0	20.90	65756	106
7/26/07 12:00	0	20.90	65756	106
7/26/07 13:00	0	20.90	65756	106
7/26/07 14:00	0	20.90	65756	106
7/26/07 15:00	0	20.90	65756	106
7/26/07 16:00	0	20.90	65756	106
7/26/07 17:00	0	20.90	65756	106
7/26/07 18:00	0	20.90	65756	106
7/26/07 19:00	0	20.90	65756	106
7/26/07 20:00	0	20.90	65756	106
7/26/07 21:00	0	20.90	65756	106
7/26/07 22:00	0	20.90	65740	106
7/26/07 23:00	0	20.90	65740	106
7/27/07 0:00	0	20.90	65740	106
8/7/07 22:00	0	4.35	13674	106
8/7/07 23:00	0	4.35	13674	106
8/8/07 0:00	0	4.35	13674	106
8/8/07 1:00	0	4.35	13674	106
8/8/07 2:00	0	4.35	13674	106
8/8/07 3:00	0	4.35	13674	106
8/8/07 4:00	0	4.35	13674	106
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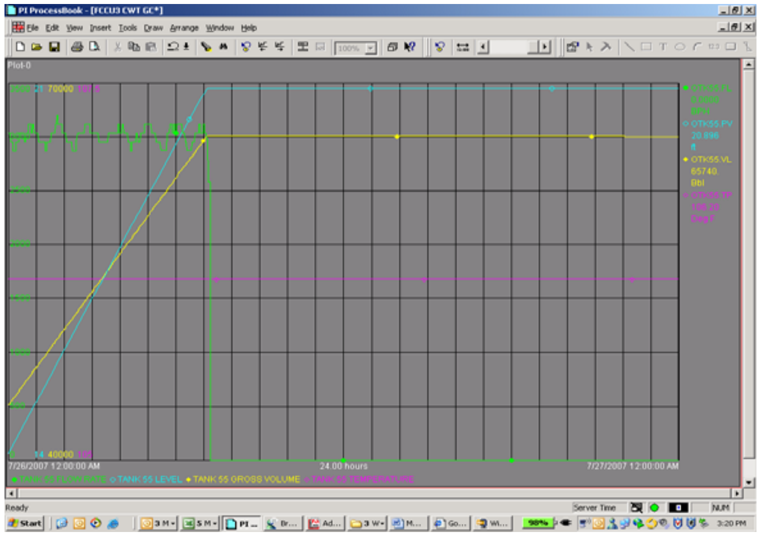
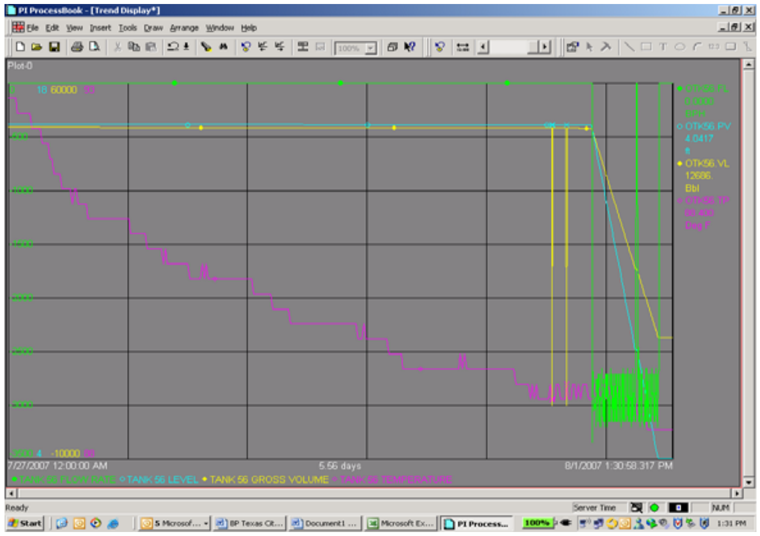
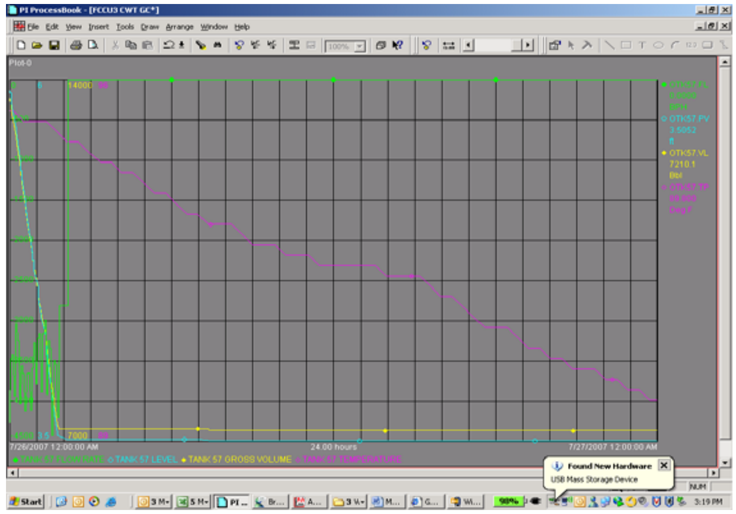
8/8/07 7:00				



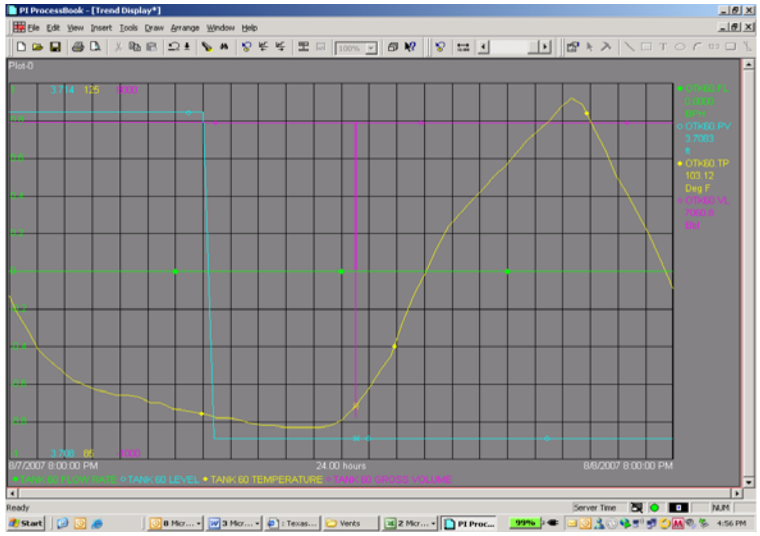
	OTK56.FL	OTK56.PV	OTK56.VL	OTK56.TP
	TANK 56 FLOW RATE	TANK 56 LEVEL	TANK 56 GROSS VOLUME	TANK 56 TEMPERATURE
	BPH	ft	Bbl	Deg F
7/27/07 0:00	0	16.48	51824	93
7/27/07 1:00	0	16.48	51824	93
7/27/07 2:00	0	16.48	51824	93
7/27/07 3:00	0	16.48	51811	93
7/27/07 4:00	0	16.48	51808	93
7/27/07 5:00	0	16.48	51808	92
7/27/07 6:00	0	16.48	51808	92
7/27/07 7:00	0	16.48	51808	92
7/27/07 8:00	0	16.48	51808	92
7/27/07 9:00	0	16.48	51796	92
7/27/07 10:00	0	16.47	51792	92
7/27/07 11:00	0	16.47	51792	92
7/27/07 12:00	0	16.47	51792	92
7/27/07 13:00	0	16.47	51792	92
7/27/07 14:00	0	16.47	51792	91
7/27/07 15:00	0	16.47	51792	91
7/27/07 16:00	0	16.47	51792	91
7/27/07 17:00	0	16.47	51792	91
7/27/07 18:00	0	16.47	51784	91
7/27/07 19:00	0	16.47	51775	91
7/27/07 20:00	0	16.47	51775	91
7/27/07 21:00	0	16.47	51775	91
7/27/07 22:00	0	16.47	51775	91
7/27/07 23:00	0	16.47	51775	91
7/28/07 0:00	0	16.47	51775	91
7/28/07 1:00	0	16.47	51775	91
7/28/07 2:00	0	16.47	51775	91
7/28/07 3:00	0	16.47	51775	91
7/28/07 4:00	0	16.47	51775	91
7/28/07 5:00	0	16.47	51775	91
7/28/07 6:00	0	16.47	51775	91
7/28/07 7:00	0	16.47	51775	91
7/28/07 8:00	0	16.47	51775	91
7/28/07 9:00	0	16.47	51775	91
7/28/07 10:00	0	16.47	51775	91
7/28/07 11:00	0	16.46	51760	91
7/28/07 12:00	0	16.46	51759	90
7/28/07 13:00	0	16.46	51759	90
7/28/07 14:00	0	16.46	51759	90
7/28/07 15:00	0	16.46	51759	91
7/28/07 16:00	0	16.46	51759	90
7/28/07 17:00	0	16.46	51759	90
7/28/07 18:00	0	16.46	51759	90
7/28/07 19:00	0	16.46	51759	90
7/28/07 20:00	0	16.46	51759	90
7/28/07 21:00	0	16.46	51759	90
7/28/07 22:00	0	16.46	51759	90
7/28/07 23:00	0	16.46	51759	90
7/29/07 0:00	0	16.46	51759	90
7/29/07 1:00	0	16.46	51759	90
7/29/07 2:00	0	16.46	51759	90
7/29/07 3:00	0	16.46	51759	90
7/29/07 4:00	0	16.46	51759	90
7/29/07 5:00	0	16.46	51759	90
7/29/07 6:00	0	16.46	51759	90
7/29/07 7:00	0	16.46	51759	90
7/29/07 8:00	0	16.46	51759	90
7/29/07 9:00	0	16.46	51759	90
7/29/07 10:00	0	16.46	51759	90
7/29/07 11:00	0	16.46	51745	90
7/29/07 12:00	0	16.46	51742	90
7/29/07 13:00	0	16.46	51742	90
7/29/07 14:00	0	16.46	51742	90
7/29/07 15:00	0	16.46	51742	90
7/29/07 16:00	0	16.46	51742	90
7/29/07 17:00	0	16.46	51742	90
7/29/07 18:00	0	16.46	51742	90
7/29/07 19:00	0	16.46	51742	90
7/29/07 20:00	0	16.46	51742	90
7/29/07 21:00	0	16.46	51742	90
7/29/07 22:00	0	16.46	51742	90
7/29/07 23:00	0	16.46	51742	90
7/30/07 0:00	0	16.46	51739	90
7/30/07 1:00	0	16.45	51726	90
7/30/07 2:00	0	16.45	51726	90
7/30/07 3:00	0	16.45	51726	90
7/30/07 4:00	0	16.45	51726	89
7/30/07 5:00	0	16.45	51726	89
7/30/07 6:00	0	16.45	51726	89
7/30/07 7:00	0	16.45	51726	89
7/30/07 8:00	0	16.45	51726	89
7/30/07 9:00	0	16.45	51726	89
7/30/07 10:00	0	16.45	51726	89
7/30/07 11:00	0	16.45	51726	89
7/30/07 12:00	0	16.45	51726	89
7/30/07 13:00	0	16.45	51723	89
7/30/07 14:00	0	16.45	51710	89
7/30/07 15:00	0	16.45	51710	89
7/30/07 16:00	0	16.45	51710	89
7/30/07 17:00	0	16.45	51710	89
7/30/07 18:00	0	16.45	51710	89
7/30/07 19:00	0	16.45	51710	89
7/30/07 20:00	0	16.44	51694	89
7/30/07 21:00	0	16.44	51693	89
7/30/07 22:00	0	16.44	51693	89
7/30/07 23:00	0	16.44	51693	89
7/31/07 0:00	0	16.44	51693	89
7/31/07 1:00	0	16.44	51693	89
7/31/07 2:00	0	16.44	51693	89
7/31/07 3:00	0	16.44	51693	89
7/31/07 4:00	0	16.44	51693	89
7/31/07 5:00	0	16.44	51693	89
7/31/07 6:00	0	16.44	51693	89
7/31/07 7:00	0	16.44	51693	89
7/31/07 8:00	0	16.44	51693	89
7/31/07 9:00	0	16.44	51693	89
7/31/07 10:00	0	16.44	51693	89
7/31/07 11:00	0	16.44	51693	89
7/31/07 12:00	0	16.44	51693	89
7/31/07 13:00	0	16.44	49970	89
7/31/07 14:00	0	16.44	51693	89
7/31/07 15:00	0	16.44	51472	89
7/31/07 16:00	0	16.44	48468	89
7/31/07 17:00	0	16.44	51693	89
7/31/07 18:00	0	16.44	51687	89
7/31/07 19:00	0	16.44	51677	89
7/31/07 20:00	0	16.44	51677	89
7/31/07 21:00	-2327	16.06	50533	89
7/31/07 22:00	-3011	15.11	47550	89
7/31/07 23:00	-3006	14.16	44547	89
8/1/07 0:00				
8/7/07 22:00	-2919	12	38284	96
8/7/07 23:00	-2903	11	35376	96
8/8/07 0:00	-2918	10	32457	96
8/8/07 1:00	-2918	9	29547	96
8/8/07 2:00	-2908	8	26630	96
8/8/07 3:00	-2801	8	23781	95
8/8/07 4:00	-102	7	22825	95
8/8/07 5:00	0	7	22825	95
8/8/07 6:00	0	7	22825	95
8/8/07 7:00				



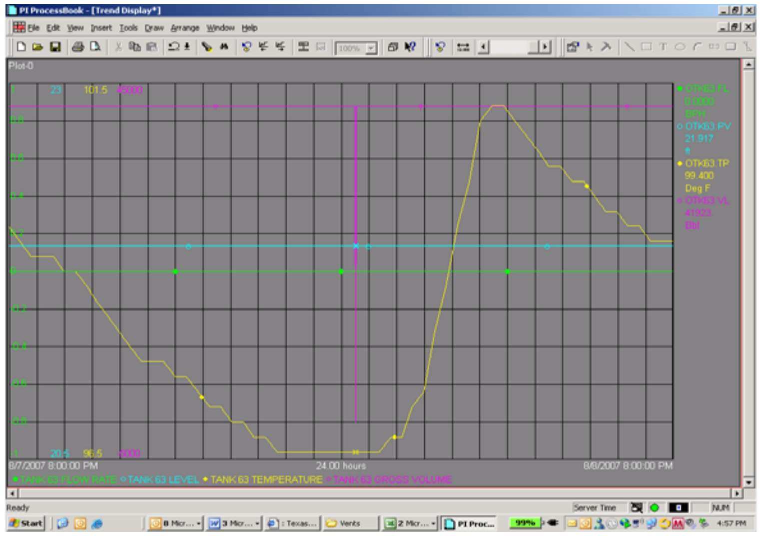
	OTK57.FL	OTK57.PV	OTK57.VL	OTK57.TP
	TANK 57 FLOW RATE BPH	TANK 57 LEVEL ft	TANK 57 GROSS VOLUME Bbl	TANK 57 TEMPERATURE Deg F
7/26/07 0:00	-3645	5.26	11856	95
7/26/07 1:00	-3438	3.96	8381	95
7/26/07 2:00	-460	3.52	7237	95
7/26/07 3:00	0	3.52	7237	94
7/26/07 4:00	0	3.52	7237	94
7/26/07 5:00	0	3.52	7237	94
7/26/07 6:00	0	3.52	7237	93
7/26/07 7:00	0	3.51	7220	93
7/26/07 8:00	0	3.51	7210	93
7/26/07 9:00	0	3.51	7210	93
7/26/07 10:00	0	3.51	7210	93
7/26/07 11:00	0	3.51	7210	92
7/26/07 12:00	0	3.51	7210	92
7/26/07 13:00	0	3.51	7210	92
7/26/07 14:00	0	3.51	7210	92
7/26/07 15:00	0	3.51	7210	92
7/26/07 16:00	0	3.51	7210	92
7/26/07 17:00	0	3.51	7210	91
7/26/07 18:00	0	3.51	7210	91
7/26/07 19:00	0	3.51	7210	91
7/26/07 20:00	0	3.51	7210	91
7/26/07 21:00	0	3.51	7210	90
7/26/07 22:00	0	3.51	7210	90
7/26/07 23:00	0	3.51	7210	90
7/27/07 0:00	0	3.51	7210	90
8/7/07 22:00	0	24	62047	99
8/7/07 23:00	0	24	62047	99
8/8/07 0:00	0	24	62047	99
8/8/07 1:00	0	24	62047	99
8/8/07 2:00	0	24	62047	99
8/8/07 3:00	0	24	62047	99
8/8/07 4:00	0	24	62047	99
8/8/07 5:00	0	24	62047	99
8/8/07 6:00	0	24	62047	99
8/8/07 7:00				



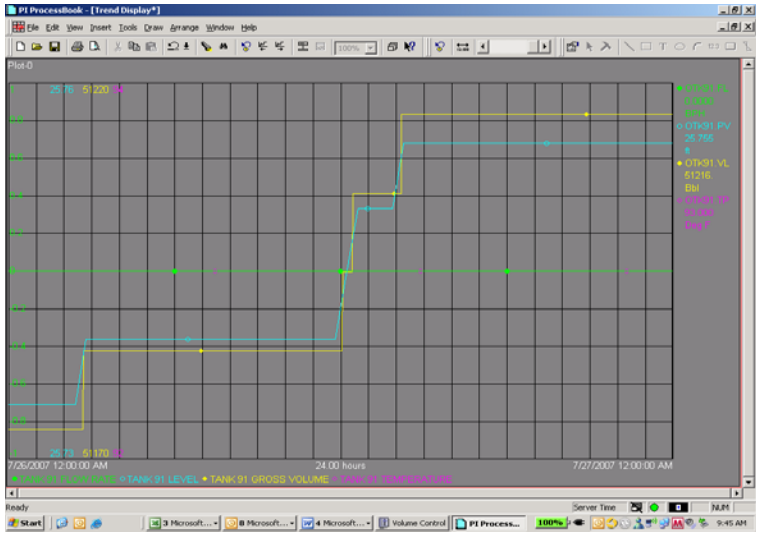
	OTK60.FL	OTK60.PV	OTK60.VL	OTK60.TP
	TANK 60 FLOW RATE	TANK 60 LEVEL	TANK 60 GROSS VOLUME	TANK 60 TEMPERATURE
	BPH	ft	Bbl	Deg F
8/7/07 22:00	0	3.71	7071	93
8/7/07 23:00	0	3.71	7071	92
8/8/07 0:00	0	3.71	7071	92
8/8/07 1:00	0	3.71	7071	91
8/8/07 2:00	0	3.71	7071	90
8/8/07 3:00	0	3.71	7062	90
8/8/07 4:00	0	3.71	7061	89
8/8/07 5:00	0	3.71	7061	89
8/8/07 6:00	0	3.71	7061	88
8/8/07 7:00				



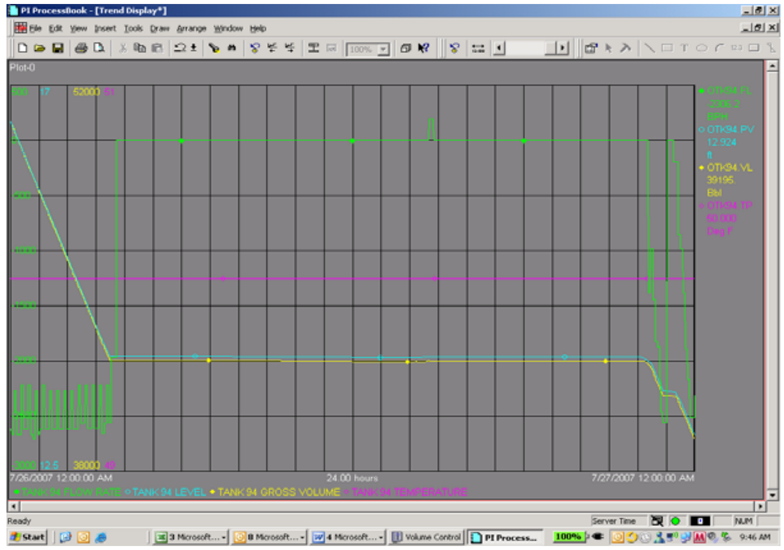
	OTK63.FL	OTK63.PV	OTK63.VL	OTK63.TP
	TANK 63 FLOW RATE	TANK 63 LEVEL	TANK 63 GROSS VOLUME	TANK 63 TEMPERATURE
	BPH	ft	Bbl	Deg F
8/7/07 22:00	0	21.92	41923	99
8/7/07 23:00	0	21.92	41923	98
8/8/07 0:00	0	21.92	41923	98
8/8/07 1:00	0	21.92	41923	98
8/8/07 2:00	0	21.92	41923	98
8/8/07 3:00	0	21.92	41923	97
8/8/07 4:00	0	21.92	41923	97
8/8/07 5:00	0	21.92	41923	97
8/8/07 6:00	0	21.92	41923	97
8/8/07 7:00				



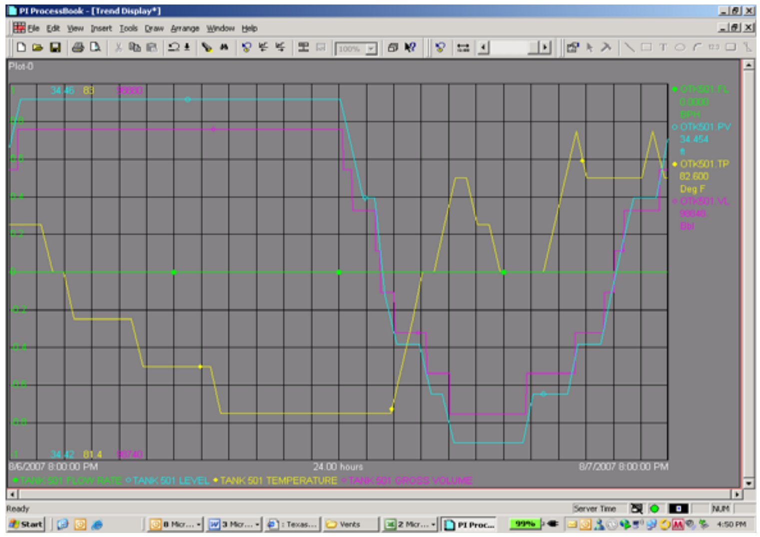
	OTK91.FL	OTK91.PV	OTK91.VL	OTK91.TP
	TANK 91 FLOW RATE	TANK 91 LEVEL	TANK 91 GROSS VOLUME	TANK 91 TEMPERATURE
	BPH	ft	Bbl	Deg F
7/26/07 0:00	0	25.73	51174	93
7/26/07 1:00	0	25.73	51174	93
7/26/07 2:00	0	25.74	51177	93
7/26/07 3:00	0	25.74	51184	93
7/26/07 4:00	0	25.74	51184	93
7/26/07 5:00	0	25.74	51184	93
7/26/07 6:00	0	25.74	51184	93
7/26/07 7:00	0	25.74	51184	93
7/26/07 8:00	0	25.74	51184	93
7/26/07 9:00	0	25.74	51184	93
7/26/07 10:00	0	25.74	51184	93
7/26/07 11:00	0	25.74	51184	93
7/26/07 12:00	0	25.75	51200	93
7/26/07 13:00	0	25.75	51205	93
7/26/07 14:00	0	25.75	51214	93
7/26/07 15:00	0	25.76	51216	93
7/26/07 16:00	0	25.76	51216	93
7/26/07 17:00	0	25.76	51216	93
7/26/07 18:00	0	25.76	51216	93
7/26/07 19:00	0	25.76	51216	93
7/26/07 20:00	0	25.76	51216	93
7/26/07 21:00	0	25.76	51216	93
7/26/07 22:00	0	25.76	51216	93
7/26/07 23:00	0	25.76	51216	93
7/27/07 0:00	0	25.75	51210	93
7/29/07 0:00				



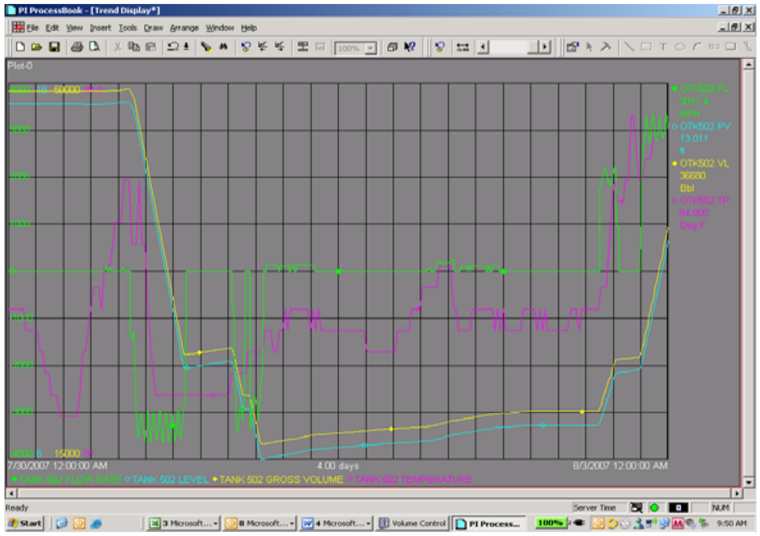
	OTK94.FL	OTK94.PV	OTK94.VL	OTK94.TP
	TANK 94 FLOW RATE BPH	TANK 94 LEVEL ft	TANK 94 GROSS VOLUME Bbl	TANK 94 TEMPERATURE Deg F
7/26/07 0:00	-2516.963597	16.18	49427	50
7/26/07 1:00	-2494.539095	15.38	46928	50
7/26/07 2:00	-2475.463828	14.59	44443	50
7/26/07 3:00	-1675.055262	13.93	42312	50
7/26/07 4:00	0	13.84	42032	50
7/26/07 5:00	0	13.84	42032	50
7/26/07 6:00	0	13.84	42032	50
7/26/07 7:00	0	13.84	42032	50
7/26/07 8:00	0	13.84	42016	50
7/26/07 9:00	0	13.84	42008	50
7/26/07 10:00	0	13.83	41999	50
7/26/07 11:00	0	13.83	41999	50
7/26/07 12:00	0	13.83	41983	50
7/26/07 13:00	0	13.83	41983	50
7/26/07 14:00	32.8125	13.83	41991	50
7/26/07 15:00	0	13.83	41999	50
7/26/07 16:00	0	13.83	41999	50
7/26/07 17:00	0	13.83	41999	50
7/26/07 18:00	0	13.83	41999	50
7/26/07 19:00	0	13.83	41999	50
7/26/07 20:00	0	13.83	41999	50
7/26/07 21:00	0	13.83	41999	50
7/26/07 22:00	-1178.75899	13.68	41524	50
7/26/07 23:00	-1140.363884	13.27	40230	50
7/27/07 0:00	-2403.720411	12.54	37970	50
7/27/07 1:00				
8/7/07 22:00	0	23.68	73054	50
8/7/07 23:00	0	23.68	73054	50
8/8/07 0:00	0	23.68	73054	50
8/8/07 1:00	0	23.68	73054	50
8/8/07 2:00	0	23.68	73054	50
8/8/07 3:00	0	23.68	73054	50
8/8/07 4:00	0	23.68	73054	50
8/8/07 5:00	0	23.68	73054	50
8/8/07 6:00	0	23.68	73054	50
8/8/07 7:00				



	OTK501.FL	OTK501.PV	OTK501.VL	OTK501.TP
	TANK 501 FLOW RATE	TANK 501 LEVEL	TANK 501 GROSS VOLUME	TANK 501 TEMPERATURE
	BPH	ft	Bbl	Deg F
8/6/07 22:00	0	34.46	98863	82
8/6/07 23:00	0	34.46	98863	82
8/7/07 0:00	0	34.46	98863	82
8/7/07 1:00	0	34.46	98863	82
8/7/07 2:00	0	34.46	98863	82
8/7/07 3:00	0	34.46	98863	82
8/7/07 4:00	0	34.46	98863	82
8/7/07 5:00	0	34.46	98863	82
8/7/07 6:00	0	34.46	98863	82
8/7/07 7:00				



	OTK502.FL	OTK502.PV	OTK502.VL	OTK502.TP
	TANK 502 FLOW RATE	TANK 502 LEVEL	TANK 502 GROSS VOLUME	TANK 502 TEMPERATURE
	BPH	ft	Bbl	Deg F
7/30/07 0:00	0	17.35	49254	82
7/30/07 1:00	0	17.35	49254	82
7/30/07 2:00	0	17.35	49254	82
7/30/07 3:00	0	17.35	49254	82
7/30/07 4:00	0	17.35	49254	82
7/30/07 5:00	0	17.35	49254	82
7/30/07 6:00	0	17.35	49254	82
7/30/07 7:00	0	17.35	49254	81
7/30/07 8:00	0	17.35	49254	81
7/30/07 9:00	0	17.35	49254	81
7/30/07 10:00	0	17.34	49240	82
7/30/07 11:00	0	17.34	49224	82
7/30/07 12:00	0	17.34	49224	83
7/30/07 13:00	0	17.34	49226	83
7/30/07 14:00	49	17.36	49275	83
7/30/07 15:00	1	17.37	49321	83
7/30/07 16:00	20	17.39	49379	83
7/30/07 17:00	-348	17.38	49359	83
7/30/07 18:00	-2447	16.85	47827	83
7/30/07 19:00	-3321	15.75	44607	83
7/30/07 20:00	-3293	14.62	41310	82
7/30/07 21:00	-3247	13.49	38031	82
7/30/07 22:00	-3270	12.36	34738	82
7/30/07 23:00	-3280	11.23	31435	82
7/31/07 0:00	-3293	10.10	28144	82
7/31/07 1:00	-2568	9.10	25224	82
7/31/07 2:00	0	8.94	24804	82
7/31/07 3:00	0	8.98	24902	82
7/31/07 4:00	0	9.01	25001	82
7/31/07 5:00	0	9.05	25100	82
7/31/07 6:00	0	9.08	25202	82
7/31/07 7:00	0	9.12	25300	82
7/31/07 8:00	-642	9.05	25138	82
7/31/07 9:00	-3075	8.22	22724	82
7/31/07 10:00	-1046	7.62	20983	82
7/31/07 11:00	-2290	7.22	19855	82
7/31/07 12:00	-2731	6.27	17126	82
7/31/07 13:00	2	6.03	16465	82
7/31/07 14:00	133	6.08	16593	82
7/31/07 15:00	92	6.11	16701	82
7/31/07 16:00	103	6.15	16816	82
7/31/07 17:00	73	6.19	16913	82
7/31/07 18:00	142	6.23	17034	82
7/31/07 19:00	139	6.28	17171	82
7/31/07 20:00	72	6.32	17285	82
7/31/07 21:00	0	6.34	17334	82
7/31/07 22:00	0	6.36	17384	82
7/31/07 23:00	0	6.37	17433	82
8/1/07 0:00	0	6.39	17482	82
8/1/07 1:00	0	6.41	17530	82
8/1/07 2:00	0	6.42	17581	82
8/1/07 3:00	0	6.44	17634	82
8/1/07 4:00	0	6.46	17685	82
8/1/07 5:00	0	6.48	17740	82
8/1/07 6:00	0	6.50	17791	82
8/1/07 7:00	0	6.51	17837	82
8/1/07 8:00	0	6.53	17873	82
8/1/07 9:00	0	6.53	17892	82
8/1/07 10:00	0	6.55	17925	82
8/1/07 11:00	0	6.56	17967	82
8/1/07 12:00	0	6.58	18025	83
8/1/07 13:00	20	6.61	18099	83
8/1/07 14:00	145	6.65	18226	83
8/1/07 15:00	172	6.71	18401	83
8/1/07 16:00	191	6.78	18589	83
8/1/07 17:00	23	6.81	18675	82
8/1/07 18:00	92	6.85	18781	82
8/1/07 19:00	93	6.89	18892	82
8/1/07 20:00	119	6.93	19012	82
8/1/07 21:00	85	6.96	19117	82
8/1/07 22:00	75	7.00	19201	82
8/1/07 23:00	48	7.02	19287	82
8/2/07 0:00	0	7.04	19322	82
8/2/07 1:00	0	7.05	19365	82
8/2/07 2:00	0	7.07	19416	82
8/2/07 3:00	0	7.09	19467	82
8/2/07 4:00	0	7.09	19471	82
8/2/07 5:00	0	7.09	19471	82
8/2/07 6:00	0	7.09	19471	82
8/2/07 7:00	0	7.09	19471	82
8/2/07 8:00	0	7.09	19471	82
8/2/07 9:00	0	7.09	19471	82
8/2/07 10:00	0	7.09	19471	82
8/2/07 11:00	0	7.09	19471	82
8/2/07 12:00	0	7.09	19471	82
8/2/07 13:00	7	7.10	19483	82
8/2/07 14:00	2007	7.50	20630	83
8/2/07 15:00	1921	8.19	22616	83
8/2/07 16:00	1270	8.73	24181	83
8/2/07 17:00	0	8.79	24354	83
8/2/07 18:00	0	8.81	24423	84
8/2/07 19:00	43	8.85	24530	84
8/2/07 20:00	2583	9.39	26129	84
8/2/07 21:00	3022	10.42	29125	84
8/2/07 22:00	2962	11.45	32126	84
8/2/07 23:00	3052	12.48	35131	84
8/3/07 0:00				
8/6/07 22:00	0	9.86	27452	85
8/6/07 23:00	0	9.85	27437	85
8/7/07 0:00	0	9.85	27437	85
8/7/07 1:00	0	9.85	27437	85
8/7/07 2:00	0	9.85	27437	85
8/7/07 3:00	0	9.85	27437	84
8/7/07 4:00	0	9.85	27437	84
8/7/07 5:00	0	9.85	27437	84
8/7/07 6:00	0	9.85	27437	84
8/7/07 7:00				



	OTK503.FL	OTK503.PV	OTK503.VL	OTK503.TP
	TANK 503 FLOW RATE	TANK 503 LEVEL	TANK 503 GROSS VOLUME	TANK 503 TEMPERATURE
	BPH	ft	Bbl	Deg F
7/30/07 0:00	0	7.16	19667	78
7/30/07 1:00	0	7.16	19667	78
7/30/07 2:00	0	7.16	19667	78
7/30/07 3:00	0	7.16	19667	78
7/30/07 4:00	0	7.16	19667	78
7/30/07 5:00	0	7.16	19667	78
7/30/07 6:00	0	7.16	19667	78
7/30/07 7:00	0	7.16	19667	78
7/30/07 8:00	0	7.16	19667	78
7/30/07 9:00	0	7.16	19667	78
7/30/07 10:00	0	7.16	19674	78
7/30/07 11:00	1084	7.38	20311	79
7/30/07 12:00	87	7.63	21020	79
7/30/07 13:00	0	7.76	21392	79
7/30/07 14:00	0	7.78	21457	80
7/30/07 15:00	0	7.78	21457	80
7/30/07 16:00	0	7.78	21463	81
7/30/07 17:00	0	7.79	21472	81
7/30/07 18:00	0	7.79	21489	81
7/30/07 19:00	0	7.80	21502	81
7/30/07 20:00	0	7.80	21502	81
7/30/07 21:00	0	7.80	21502	80
7/30/07 22:00	0	7.80	21502	80
7/30/07 23:00	0	7.80	21502	80
7/31/07 0:00	0	7.80	21502	80
7/31/07 1:00	0	7.80	21502	80
7/31/07 2:00	0	7.80	21502	80
7/31/07 3:00	0	7.80	21502	80
7/31/07 4:00	0	7.80	21502	80
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7/31/07 9:00	0	7.80	21502	80
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7/31/07 21:00	0	7.80	21502	81
7/31/07 22:00	0	7.80	21502	81
7/31/07 23:00	0	7.93	21878	81
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8/1/07 2:00	0	8.35	23090	81
8/1/07 3:00	0	8.35	23090	81
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8/1/07 10:00	0	8.35	23090	81
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8/1/07 14:00	0	8.35	23090	81
8/1/07 15:00	0	8.36	23103	81
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8/1/07 21:00	0	8.39	23195	80
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8/2/07 4:00	0	8.39	23195	80
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8/2/07 7:00	0	8.39	23195	80
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8/2/07 9:00	0	8.39	23195	80
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8/2/07 11:00	0	8.39	23195	81
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8/2/07 19:00	0	8.39	23195	81
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8/2/07 22:00	0	8.39	23195	81
8/2/07 23:00	0	8.39	23195	80
8/3/07 0:00				
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8/6/07 23:00	329	9.55	26560	88
8/7/07 0:00	96	9.70	26989	89
8/7/07 1:00	0	9.70	26989	88
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8/7/07 3:00	0	9.70	26989	88
8/7/07 4:00	0	9.70	26989	88
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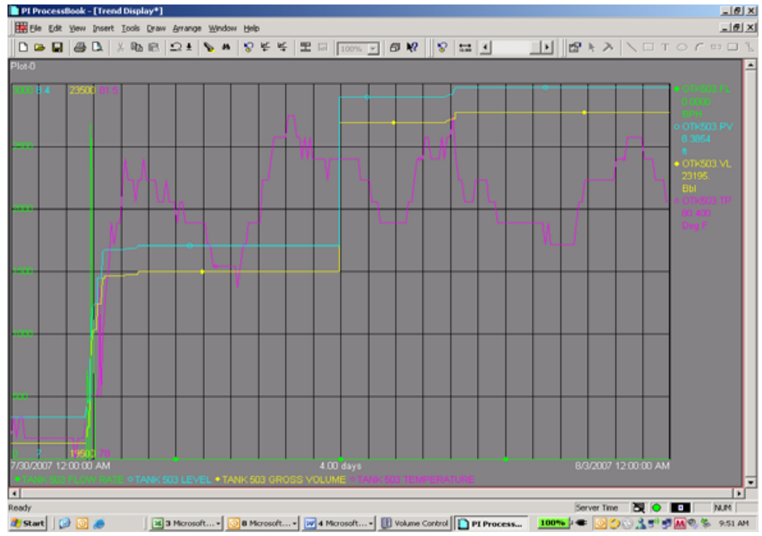

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	BPH	ft	Bbl	Deg F
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7/30/07 2:00	0	6.57	18568	90
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7/30/07 5:00	0	6.57	18568	90
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7/30/07 8:00	0	6.57	18568	90
7/30/07 9:00	0	6.57	18568	90
7/30/07 10:00	0	6.57	18568	90
7/30/07 11:00	0	6.57	18557	90
7/30/07 12:00	0	6.56	18544	90
7/30/07 13:00	0	6.56	18538	90
7/30/07 14:00	0	6.56	18538	90
7/30/07 15:00	0	6.56	18538	90
7/30/07 16:00	0	6.57	18547	90
7/30/07 17:00	0	6.57	18568	90
7/30/07 18:00	0	6.57	18568	90
7/30/07 19:00	0	6.58	18581	90
7/30/07 20:00	0	6.58	18597	90
7/30/07 21:00	0	6.58	18598	90
7/30/07 22:00	0	6.58	18598	90
7/30/07 23:00	0	6.58	18598	90
7/31/07 0:00	0	6.58	18598	90
7/31/07 1:00	0	6.58	18592	90
7/31/07 2:00	0	6.58	18591	90
7/31/07 3:00	0	6.58	18583	90
7/31/07 4:00	0	6.58	18583	90
7/31/07 5:00	0	6.58	18583	90
7/31/07 6:00	0	6.58	18583	90
7/31/07 7:00	0	6.58	18583	90
7/31/07 8:00	0	6.58	18583	90
7/31/07 9:00	0	6.58	18583	90
7/31/07 10:00	0	6.58	18583	90
7/31/07 11:00	0	6.57	18568	90
7/31/07 12:00	0	6.57	18568	90
7/31/07 13:00	0	6.57	18568	90
7/31/07 14:00	0	6.57	18568	90
7/31/07 15:00	0	6.57	18568	90
7/31/07 16:00	0	6.57	18568	90
7/31/07 17:00	0	6.57	18568	90
7/31/07 18:00	0	6.57	18568	90
7/31/07 19:00	0	6.57	18568	90
7/31/07 20:00	0	6.57	18568	90
7/31/07 21:00	0	6.57	18568	90
7/31/07 22:00	0	6.57	18568	90
7/31/07 23:00	0	6.57	18568	90
8/1/07 0:00	0	6.57	18568	90
8/1/07 1:00	0	6.57	18568	90
8/1/07 2:00	0	6.57	18568	90
8/1/07 3:00	0	6.57	18568	90
8/1/07 4:00	0	6.57	18568	90
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8/1/07 11:00	0	6.57	18568	90
8/1/07 12:00	0	6.57	18555	90
8/1/07 13:00	0	6.57	18557	90
8/1/07 14:00	0	6.57	18567	90
8/1/07 15:00	0	6.57	18569	90
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8/2/07 5:00	0	6.60	18643	90
8/2/07 6:00	0	6.60	18643	90
8/2/07 7:00	0	6.60	18643	90
8/2/07 8:00	0	6.60	18638	90
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8/2/07 10:00	0	6.59	18613	90
8/2/07 11:00	0	6.59	18613	90
8/2/07 12:00	0	6.59	18613	90
8/2/07 13:00	0	6.59	18613	90
8/2/07 14:00	0	6.59	18613	90
8/2/07 15:00	0	6.58	18599	90
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8/2/07 20:00	0	6.58	18598	90
8/2/07 21:00	0	6.58	18598	90
8/2/07 22:00	0	6.58	18598	90
8/2/07 23:00	0	6.58	18598	90
8/3/07 0:00				
8/6/07 22:00	0	6.62	18718	90
8/6/07 23:00	0	6.62	18718	90
8/7/07 0:00	0	6.62	18718	90
8/7/07 1:00	0	6.62	18718	90
8/7/07 2:00	0	6.62	18718	90
8/7/07 3:00	0	6.62	18718	90
8/7/07 4:00	0	6.62	18718	90
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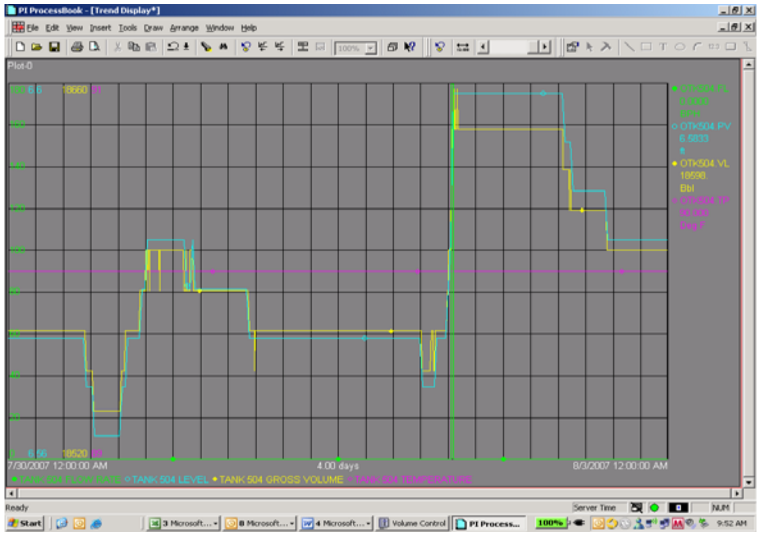
8/7/07 7:00				



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	TK1013 Material Code	TANK 1013 LEVEL ft
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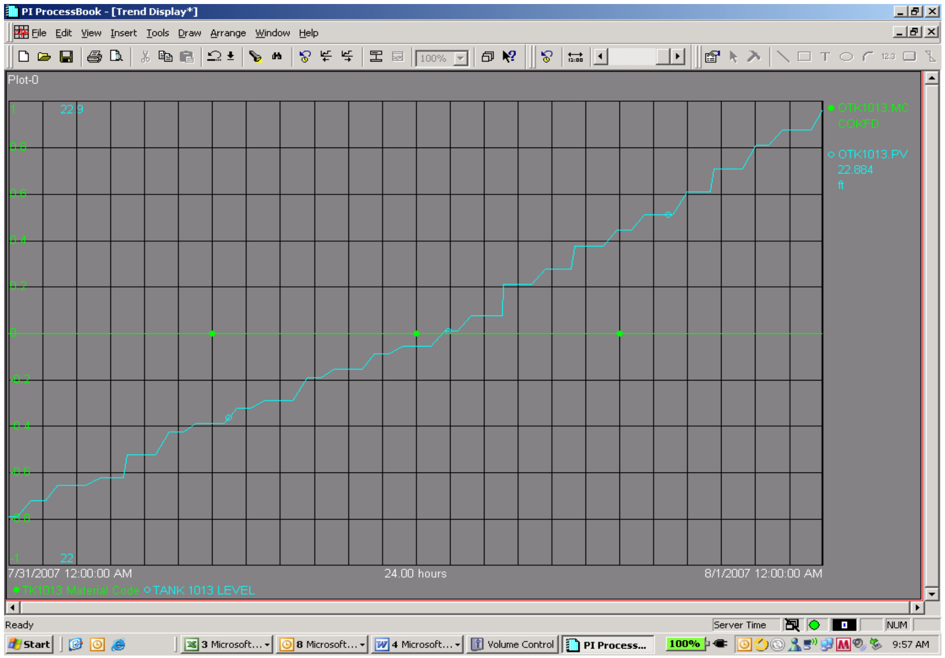
7/31/07 2:00	COKFD	22.16
7/31/07 3:00	COKFD	22.20
7/31/07 4:00	COKFD	22.24
7/31/07 5:00	COKFD	22.27
7/31/07 6:00	COKFD	22.29
7/31/07 7:00	COKFD	22.32
7/31/07 8:00	COKFD	22.34
7/31/07 9:00	COKFD	22.37
7/31/07 10:00	COKFD	22.39
7/31/07 11:00	COKFD	22.42
7/31/07 12:00	COKFD	22.44
7/31/07 13:00	COKFD	22.47
7/31/07 14:00	COKFD	22.51
7/31/07 15:00	COKFD	22.56
7/31/07 16:00	COKFD	22.59
7/31/07 17:00	COKFD	22.63
7/31/07 18:00	COKFD	22.66
7/31/07 19:00	COKFD	22.69
7/31/07 20:00	COKFD	22.74
7/31/07 21:00	COKFD	22.78
7/31/07 22:00	COKFD	22.83
7/31/07 23:00	COKFD	22.85
8/1/07 0:00	COKFD	22.90
8/1/07 1:00		



	OTK1020.FL TANK 1020 FLOW RATE BPH	OTK1020.PV TANK 1020 LEVEL ft	OTK1020.VL TANK 1020 GROSS VOLUME Bbl	OTK1020.TP TANK 1020 TEMPERATURE Deg F
7/27/07 0:00	-2617	38.52	250024	83
7/27/07 1:00	-2455	38.15	247562	83
7/27/07 2:00	-2612	37.77	244983	84
7/27/07 3:00	-2080	37.43	242697	83
7/27/07 4:00	-1874	37.15	240816	83
7/27/07 5:00	-2051	36.86	238829	83
7/27/07 6:00	-2103	36.54	236711	83
7/27/07 7:00	-1955	36.25	234723	83
7/27/07 8:00	-2149	35.95	232689	83
7/27/07 9:00	-2171	35.62	230447	82
7/27/07 10:00	-1935	35.32	228454	82
7/27/07 11:00	-2010	35.03	226496	82
7/27/07 12:00	-2169	34.71	224352	82
7/27/07 13:00	-2369	34.37	222048	82
7/27/07 14:00	-2606	33.99	219542	82
7/27/07 15:00	-2775	33.58	216767	82
7/27/07 16:00	-2376	33.21	214300	82
7/27/07 17:00	-2723	32.82	211711	83
7/27/07 18:00	-2547	32.43	209069	83
7/27/07 19:00	-2729	32.04	206450	83
7/27/07 20:00	2172	32.12	207027	83
7/27/07 21:00	2897	32.55	209886	83
7/27/07 22:00	3038	33.01	212946	83
7/27/07 23:00	2824	33.44	215804	83
7/28/07 0:00	3106	33.89	218833	83
7/28/07 1:00	2811	34.32	221739	83
7/28/07 2:00	3014	34.76	224663	82
7/28/07 3:00	2848	35.19	227615	82
7/28/07 4:00	2901	35.61	230438	82
7/28/07 5:00	2940	36.06	233428	82
7/28/07 6:00	2768	36.47	236204	82
7/28/07 7:00	2984	36.90	239147	82
7/28/07 8:00	2716	37.32	241941	82
7/28/07 9:00	2948	37.74	244783	82
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7/28/07 11:00	587	38.43	249470	82
7/28/07 12:00	-2549	38.12	247368	83
7/28/07 13:00	-2775	37.72	244656	83
7/28/07 14:00	-2510	37.34	242068	83
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7/28/07 16:00	2908	37.68	244372	83
7/28/07 17:00	2881	38.11	247305	83
7/28/07 18:00	2769	38.52	250058	83
7/28/07 19:00	2984	38.96	253009	83
7/28/07 20:00	2715	39.37	255814	83
7/28/07 21:00	2921	39.79	258662	83
7/28/07 22:00	2725	40.21	261471	83
7/28/07 23:00	-5	40.38	262701	83
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7/29/07 6:00	-2726	37.72	244641	82
7/29/07 7:00	-2519	37.33	242040	82
7/29/07 8:00	-2662	36.95	239465	83
7/29/07 9:00	-2734	36.54	236702	83
7/29/07 10:00	-2443	36.18	234224	83
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7/30/07 12:00	-497	28.82	184957	83
7/30/07 13:00	0	28.81	184859	84
7/30/07 14:00	0	28.83	184956	84
7/30/07 15:00	0	28.84	185084	84
7/30/07 16:00	112	28.87	185275	84
7/30/07 17:00	4	28.90	185468	84
7/30/07 18:00	0	28.92	185627	84
7/30/07 19:00	-641	28.93	185677	84
7/30/07 20:00	-2919	29.08	185404	83
7/30/07 21:00	3210	29.38	188651	83
7/30/07 22:00	4159	29.99	192766	83
7/30/07 23:00	3993	30.59	196741	83
7/31/07 0:00	4003	31.20	200826	83
7/31/07 1:00	4108	31.80	204825	83
7/31/07 2:00	3848	32.39	208796	83
7/31/07 3:00	3655	32.96	212618	83
7/31/07 4:00	-2715	32.84	211780	83
7/31/07 5:00	-2559	32.44	209125	83
7/31/07 6:00	-2508	32.07	206635	83
7/31/07 7:00	-2755	31.66	203930	83
7/31/07 8:00	-2510	31.28	201343	83
7/31/07 9:00	-2703	30.89	198743	83
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7/31/07 13:00	-2465	29.36	188529	84
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7/31/07 19:00	385	28.98	186033	84
7/31/07 20:00	368	29.04	186387	84
7/31/07 21:00	282	29.08	186680	84
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7/31/07 23:00	242	29.15	187156	83
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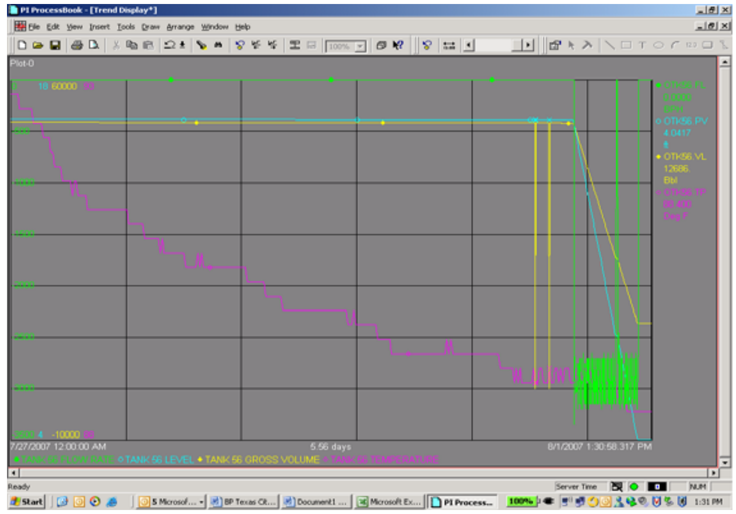

Material Safety Data Sheet

1. Chemical product

Product name Petroleum Crude Oil - Sour

2. Composition/information on ingredients

Ingredient name	CAS #	% by weight	Exposure limits
Petroleum	8002-05-9	100	**ACGIH TLV (United States).** TWA: 5 mg/m^3 8 hour(s). Form: OIL MIST, MINERAL STEL: 10 mg/m^3 15 minute(s). Form: OIL MIST, MINERAL **OSHA PEL (United States, 1971).** TWA: 5 mg/m^3 8 hour(s). Form: OIL MIST, MINERAL
Benzene	71-43-2	0-2	**ACGIH TLV (United States, 2/2003). Skin** STEL: 8 mg/m^3 15 minute(s). Form: All forms STEL: 2.5 ppm 15 minute(s). Form: All forms TWA: 1.6 mg/m^3 8 hour(s). Form: All forms TWA: 0.5 ppm 8 hour(s). Form: All forms **OSHA PEL (United States, 6/1993).** STEL: 5 ppm 15 minute(s). Form: All forms TWA: 1 ppm 8 hour(s). Form: All forms **OSHA PEL 1989 (United States, 3/1989).** STEL: 5 ppm 15 minute(s). Form: All forms TWA: 1 ppm 8 hour(s). Form: All forms
Hydrogen Sulfide	7783-06-4	<1	**ACGIH TLV (United States, 2/2003).** STEL: 21 mg/m^3 15 minute(s). Form: All forms STEL: 15 ppm 15 minute(s). Form: All forms TWA: 14 mg/m^3 8 hour(s). Form: All forms TWA: 10 ppm 8 hour(s). Form: All forms **OSHA PEL 1989 (United States, 3/1989).** STEL: 21 mg/m^3 15 minute(s). Form: All forms

STEL: 15 ppm 15 minute(s). Form: All forms
TWA: 14 mg/m^3 8 hour(s). Form: All forms
TWA: 10 ppm 8 hour(s). Form: All forms
OSHA PEL Z2 (United States, 5/2002).
AMP: 50 ppm 10 minute(s). Form: All forms
CEIL: 20 ppm Form: All forms

3. Hazards identification

Physical state Liquid.

Color Brown. to Black.

Emergency overview DANGER!

Extremely flammable liquid and vapor. Vapor may cause flash fire.
Contains benzene. Cancer hazard. Can cause cancer. Can cause blood disorders
Causes eye irritation.
May cause skin irritation.
Harmful if absorbed through the skin. Prolonged or repeated contact can defat the skin and lead to irritation and/or dermatitis.
Harmful or fatal if inhaled. Vapor may contain hydrogen sulfide (H2S) gas which can be harmful or fatal if inhaled. See Toxicological Information (section 11)
Inhalation of vapor/aerosol concentrations above the recommended exposure limits causes headaches, drowsiness, and nausea, and may lead to unconsciousness or death.
ASPIRATION HAZARD. Harmful or fatal if liquid is aspirated into lungs.

Keep away from sources of ignition. Keep container closed. Do not ingest. If ingested do not induce vomiting. Do not get in eyes, on skin or clothing. Prolonged or repeated contact can defat the skin and lead to irritation and/or dermatitis. Do not breathe vapor or mist. Use only with adequate ventilation. Wash thoroughly after handling. Contains benzene. Risk of cancer depends on duration and level of exposure.

Routes of entry Absorbed through skin. Eye contact. Inhalation. Ingestion.

Potential Health Effects

Eyes Causes eye irritation.

Skin Toxic if absorbed through skin. May cause skin irritation. Prolonged or repeated contact can defat the skin and lead to irritation and/or dermatitis. Contains material which can cause cancer.

Inhalation Toxic if inhaled. May cause respiratory tract irritation. Inhalation causes headaches, dizziness, drowsiness, and nausea, and may lead to unconsciousness. Vapor may contain hydrogen sulfide (H2S) gas which can be harmful or fatal if inhaled. Contains material which can cause cancer.

Ingestion Aspiration hazard if swallowed -- harmful or fatal if liquid is aspirated into lungs. Ingestion may cause gastrointestinal irritation and diarrhea. Contains material which can cause cancer.

Medical conditions aggravated by overexposure: Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

See toxicological Information (section 11)

4. First aid measures

Eye Contact In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention immediately.

Skin Contact Immediately wash exposed skin with soap and water. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Inhalation	If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Ingestion	If swallowed, do NOT induce vomiting. Never give anything by mouth to an unconscious person. Aspiration hazard if swallowed- can enter lungs and cause damage. Get medical attention immediately.

5. Fire-fighting measures

Flammability of the product	Flammable.
Flash point	-42.8 to 100 °C (Closed cup)
Products of combustion	These products are carbon oxides (CO, CO_2). Hydrogen Sulfide, sulfur oxides (SO_2, SO_3...), Smoke as products of incomplete combustion.
Unusual fire/explosion hazards	Extremely flammable liquid and vapor. Vapor may cause flash fire. Vapors may form explosive mixtures with air. Vapors are heavier than air and may spread along floors. Vapors may accumulate in low or confined areas, travel considerable distance to source of ignition and flash back. This material is not explosive as defined by established regulatory criteria.
Fire fighting media and instructions	SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet. Water may be ineffective. Water or foam may cause frothing. Move containing vessels from fire if without risk. DO NOT FIGHT FIRE WHEN IT REACHES MATERIAL. Withdraw from fire and let it burn. Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. Cool containing vessels with flooding quantities of water until well after fire is out.
Protective clothing (fire)	Fire-fighters should wear positive pressure self-contained breathing apparatus (SCBA) and full turnout gear.

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6. Accidental release measures

Personal Precautions	Immediately contact emergency personnel. Eliminate all ignition sources. Keep unnecessary personnel away. Use suitable protective equipment (Section 8). Follow all fire fighting procedures (Section 5). Do not touch or walk through spilled material.
Environmental precautions and clean-up methods	If emergency personnel are unavailable, contain spilled material. For small spills add absorbent (soil may be used in the absence of other suitable materials) and use a non-sparking or explosion proof means to transfer material to a sealed, appropriate container for disposal. For large spills dike spilled material or otherwise contain material to ensure runoff does not reach a waterway. Evacuate surrounding areas. Place spilled material in an appropriate container for disposal. Minimize contact of spilled material with soils to prevent runoff to surface waterways. This product is lighter than water and will float on the surface. Prevent entry into sewers, basements or confined areas. See Section 13 for Waste Disposal Information.
Personal protection in case of a large spill	Splash goggles. Full suit. Boots. Gloves. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

7. Handling and storage

Handling	Keep away from heat, sparks and flame. Keep container closed. Use only with adequate ventilation. To avoid fire or explosion, dissipate static electricity during transfer by grounding and bonding containers and equipment before transferring material. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Aspiration hazard if swallowed- can enter lungs and cause damage. Do not ingest. If ingested do not induce vomiting. Do not get in eyes, on skin or on clothing. Avoid contact with skin and clothing. Avoid breathing vapors or spray mists. Use only with adequate ventilation. Avoid breathing vapor or mist. Vapor may contain hydrogen sulfide (H_2S) gas which can be harmful or fatal if inhaled. Wash thoroughly after

handling.

Storage Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame). Vapors containing hydrogen sulfide may accumulate during storage or transport.

8. Exposure controls/personal protection

Occupational exposure limits

Ingredient name	Occupational exposure limits
Petroleum	**ACGIH TLV (United States).** TWA: 5 mg/m^3 8 hour(s). Form: OIL MIST, MINERAL STEL: 10 mg/m^3 15 minute(s). Form: OIL MIST, MINERAL **OSHA PEL (United States, 1971).** TWA: 5 mg/m^3 8 hour(s). Form: OIL MIST, MINERAL
Benzene	**ACGIH TLV (United States, 2/2003). Skin** STEL: 8 mg/m^3 15 minute(s). Form: All forms STEL: 2.5 ppm 15 minute(s). Form: All forms TWA: 1.6 mg/m^3 8 hour(s). Form: All forms TWA: 0.5 ppm 8 hour(s). Form: All forms **OSHA PEL (United States, 6/1993).** STEL: 5 ppm 15 minute(s). Form: All forms TWA: 1 ppm 8 hour(s). Form: All forms **OSHA PEL 1989 (United States, 3/1989).** STEL: 5 ppm 15 minute(s). Form: All forms TWA: 1 ppm 8 hour(s). Form: All forms
Hydrogen Sulfide	**ACGIH TLV (United States, 2/2003).** STEL: 21 mg/m^3 15 minute(s). Form: All forms STEL: 15 ppm 15 minute(s). Form: All forms TWA: 14 mg/m^3 8 hour(s). Form: All forms TWA: 10 ppm 8 hour(s). Form: All forms **OSHA PEL 1989 (United States, 3/1989).** STEL: 21 mg/m^3 15 minute(s). Form: All forms STEL: 15 ppm 15 minute(s). Form: All forms TWA: 14 mg/m^3 8 hour(s). Form: All forms TWA: 10 ppm 8 hour(s). Form: All forms **OSHA PEL Z2 (United States, 5/2002).** AMP: 50 ppm 10 minute(s). Form: All forms CEIL: 20 ppm Form: All forms

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Control Measures Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective occupational exposure limits. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Hygiene measures Wash hands, forearms, and face thoroughly after handling compounds and before eating, smoking, using lavatory, and at the end of day.

Personal protection

Eyes Avoid contact with eyes. Chemical splash goggles.

Skin and Body Do not get on skin or clothing. Wear clothing and footwear that cannot be penetrated by chemicals or oil.

Respiratory Use only with adequate ventilation. Avoid breathing vapor or mist. Air supplied respiratory protection approved by NIOSH should be worn whenever it is required for the worker's face to be within 3 feet of an open hatch.

Hands	Wear gloves that cannot be penetrated by chemicals or oil. (Viton Gloves.) The correct choice of protective gloves depends upon the chemicals being handled, the conditions of work and use, and the condition of the gloves (even the best chemically resistant glove will break down after repeated chemical exposures). Most gloves provide only a short time of protection before they must be discarded and replaced. Because specific work environments and material handling practices vary, safety procedures should be developed for each intended application. Gloves should therefore be chosen in consultation with the supplier/manufacturer and with a full assessment of the working conditions. Consult your supervisor or S.O.P. for special handling directions

Consult local authorities for acceptable exposure limits.

9. Physical and chemical properties

Physical state	Liquid.
Odor	Petroleum Hydrocarbon, Rotten eggs.
Color	Brown. to Black.
Boiling point / Range	-17.8-537.8°C
Melting point / Range	-60 to -20 °C
Specific Gravity	0.74 to 1.03
Vapor pressure	>0.359 kPa (>2.7 mm Hg) at 20°C
Vapor Density (Air = 1)	>1
Solubility	Insoluble in cold water.
Viscosity	SUS: 31 to 9000 SUS at 20°C

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10. Stability and reactivity

Stability and Reactivity	The product is stable.
Conditions to avoid	Avoid all possible sources of ignition (spark or flame).
Incompatibility with various substances	oxidizing agents, halogenated compounds
Hazardous Decomposition Products	carbon oxides (CO, CO2), Hydrogen Sulfide, sulfur oxides (SO2, SO3...). Smoke as products of incomplete combustion.
Hazardous polymerization	Will not occur.

11. Toxicological information

Chronic toxicity

Carcinogenic effects	CANCER HAZARD CONTAINS MATERIAL WHICH CAN CAUSE CANCER Risk of cancer depends on duration and level of exposure. Classified 2 (Suspected for human.) by European Union [Petroleum]. Classified A1 (Confirmed for human.) by ACGIH, 1 (Proven for human.) by IARC, 1 (Known To Be Human Carcinogens.) by NTP, + (Proven.) by OSHA, 1 (Proven for human.) by European Union [Benzene].
Mutagenic effects	No component of this product at levels greater than 0.1% is classified by established regulatory criteria as a mutagen.

Reproductive effects No component of this product at levels greater than 0.1% is classified by established regulatory criteria as a reproductive toxin.

Teratogenic effects No component of this product at levels greater than 0.1% is classified by established regulatory criteria as teratogenic or embryotoxic.

Other chronic toxicity data To the best of our knowledge, the toxicological properties of this product have not been thoroughly investigated. Based on data available for this or related materials.

Crude oil is a naturally occurring complex mixture of hydrocarbons whose exact composition and physical properties can vary widely depending upon its source.
SKIN: Repeated or prolonged contact may result in defatting, oil acne, redness, itching, inflammation, cracking and possible secondary infections.
From skin-painting studies in laboratory animals, it has been concluded that most, if not all, petroleum crudes, regardless of source, possess carcinogenic activity to some degree. This means that workers who practice poor personal hygiene and who are repeatedly exposed by direct skin contact to crude oil over many years may potentially be at risk of developing skin cancer. However, intermittent or occasional skin contact with petroleum crude oils is not expected to have serious health effects as long as good personal hygiene measures such as those outlined in this material safety data sheet are followed. Crude oil has not been identified as a carcinogen by NTP, IARC or OSHA.

Benzene: Long-term overexposure to benzene has been associated with certain types of leukemia in humans. In addition, the International Agency for Research on Cancer (IARC), the National Toxicology Program, and OSHA consider benzene to be a human carcinogen. Chronic exposures to benzene at levels of 100 ppm and below have been reported to cause adverse blood effects including anemia. Benzene exposure can occur by inhalation and absorption through the skin.

Inhalation and forced feeding studies of benzene in laboratory animals have produced a carcinogenic response in a variety of organs, including possibly leukemia, other adverse effects on the blood, chromosomal changes and some effects on the immune system. Exposure to benzene at levels up to 300 ppm did not produce birth defects in animal studies; however, exposure to the higher dosage levels (greater than 100 ppm) resulted in a reduction of body weight of the rat pups (fetotoxicity). Changes in the testes have been observed in mice exposed to benzene at 300 ppm, but reproductive performance was not altered in rats exposed to benzene at the same level.

Hydrogen sulfide (H2S) gas may accumulate in storage tanks of bulk transport compartments containing this material. Contact with eyes causes painful conjunctivitis, sensitivity to light, tearing and clouding of vision. Inhalation of low concentrations causes a runny nose with a loss of sense of smell, labored breathing and shortness of breath. Direct contact with skin causes pain and redness. Other symptoms of exposure include profuse salivation, nausea, vomiting, diarrhea, giddiness, headache, dizziness, confusion, rapid breathing, rapid heart rate, sweating, weakness, sudden collapse, unconsciousness and death due to respiratory paralysis.

Cardiac neurological effects have also been reported. Prolonged breathing (greater than one hour) of concentrations of H2S around 50 ppm can produce eye and respiratory tract irritation. Levels of 250 to 600 ppm will result in fluid in the lungs, and concentrations around 1,000 ppm will cause unconsciousness and death in a short period of time. Since the sense of smell rapidly becomes insensitive to this toxic, colorless gas, odor cannot be relied upon as an indicator of concentrations of the gas. Always exercise caution when working around closed containers.

Aspiration of this material into the lungs can cause chemical pneumonia and can be fatal. Aspiration into the lungs can occur while vomiting after ingestion of this material.

12. Ecological information

Ecotoxicity Ecological testing has not been conducted on this product by BP.

13. Disposal considerations

Waste information Waste must be disposed of in accordance with federal, state and local environmental control regulations. Consult an environmental professional to determine if local, regional or national regulations would classify spilled or contaminated materials as hazardous waste.
The container for this product can present explosion or fire hazards, even when emptied! To avoid risk of injury, do not cut, puncture, or weld on or near this container. Since the emptied containers retain product residue, follow label warnings even after container is emptied.

Consult your local or regional authorities.

14. Transport information

International transport regulations

Regulatory Information	UN number	Proper shipping name	Class	Packing group	Label	Additional information
DOT Classification	UN1267	PETROLEUM CRUDE OIL	3	II		**<u>Reportable quantity</u>** **10 lbs. (4.536 kg)**
TDG Classification	UN1267	PETROLEUM CRUDE OIL	3	II		Not available.
IMDG Classification	Not determined	-----	-----	-----		-----
IATA Classification	Not determined.	-----	-----	-----		-----

15. Regulatory information

U.S. Federal regulations US INVENTORY (TSCA): In compliance.

SARA Title III Section 302 Extremely Hazardous Substances (40 CFR Part 355): Hydrogen Sulfide

SARA 313

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	Product name	CAS number	Concentration
Form R - Reporting requirements	Benzene	71-43-2	0 - 2
	Hydrogen Sulfide	7783-06-4	0 - 1
Supplier notification	Benzene	71-43-2	0 - 2
	Hydrogen Sulfide	7783-06-4	0 - 1

CERCLA Sections 102a/103 Hazardous Substances (40 CFR Part 302.4):: Benzene: 10 lbs. (4.536 kg); Hydrogen Sulfide: 100 lbs. (45.36 kg);

State regulations	Massachusetts RTK:Petroleum; Benzene; Hydrogen Sulfide New Jersey:Petroleum; Benzene; Hydrogen Sulfide Pennsylvania RTK:Petroleum (generic environmental hazard); Benzene (special hazard, environmental hazard, generic environmental hazard); Hydrogen Sulfide (environmental hazard, generic environmental hazard) **WARNING:** This product contains chemical(s) known to the state of California to cause cancer, birth defects or other reproductive harm: Benzene
Inventories	AUSTRALIAN INVENTORY (AICS): In compliance. CANADA INVENTORY (DSL): In compliance. CHINA INVENTORY (IECS): In compliance. EC INVENTORY (EINECS): In compliance. JAPAN INVENTORY (ENCS): Not determined. KOREA INVENTORY (ECL): In compliance. PHILIPPINE INVENTORY (PICCS): In compliance.

16. Other information

Label Requirements

DANGER!

Extremely flammable liquid and vapor. Vapor may cause flash fire.
Contains benzene. Cancer hazard. Can cause cancer. Can cause blood disorders
Causes eye irritation.
May cause skin irritation.
Harmful if absorbed through the skin. Prolonged or repeated contact can defat the skin and lead to irritation and/or dermatitis.
Harmful or fatal if inhaled. Vapor may contain hydrogen sulfide (H2S) gas which can be harmful or fatal if inhaled. See Toxicological Information (section 11)
Inhalation of vapor/aerosol concentrations above the recommended exposure limits causes headaches, drowsiness, and nausea, and may lead to unconsciousness or death.
ASPIRATION HAZARD. Harmful or fatal if liquid is aspirated into lungs.

HMIS® Rating :

Health	**2**	*
Flammability	**3**	
Physical Hazard	**0**	
Personal protection	**X**	

National Fire Protection Association (U.S.A.)

History

Date of issue	05/03/2004.
Date of previous issue	No Previous Validation.
Prepared by	Product Stewardship

Notice to reader

NOTICE : This Material Safety Data Sheet is based upon data considered to be accurate at the time of its preparation. Despite our efforts, it may not be up to date or applicable to the circumstances of any particular case. We are not responsible for any damage or injury resulting from abnormal use, from any failure to follow appropriate practices or from hazards inherent in the nature of the product.

This Material Safety Data Sheet conforms to the requirements of ANSI Z400.1.

CAMS 620 Monthly Outdoor Temperature Summary Report for August 2007

Texas City 34th St. C620 - EPA Site: 48_167_0056

Outdoor Temperature (POC 1) measured in degrees Fahrenheit

Central Standard Time

Date	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00
8/1/2007	78.1	77.4	76.9	76.5	76	76	76.8	79.2	82	84.5	86.9	87.8	88.3	87.5	85.7	75.4	74.2
8/2/2007	77.8	78.2	77.2	76.9	77	77.2	78	79.3	80.7	79.7	78.7	80.5	78.8	80.2	82.9	85.1	85.8
8/3/2007	76.2	75.9	75.4	75.5	76	77.1	77.3	80	81.7	82.6	83.5	84.1	83.9	83.2	84.5	85.9	84.4
8/4/2007	78.5	78	77.8	77.9	77.4	75.8	76	77.7	80.1	82	82.4	84.1	86.1	86.4	87.3	88.6	87.5
8/5/2007	78.1	78.3	77.7	76.7	77.2	76	76.6	78.3	84.2	87.4	89.7	90.3	90.7	90.7	90.1	89.8	88.5
8/6/2007	81.8	81.4	81.1	81.1	79.7	79	79.1	82.1	86	88.8	90.2	90.7	90.8	90.7	90.6	89.9	88.9
8/7/2007	82.1	81.8	81.5	81.6	81.5	80.3	81.2	83.2	84.9	88.1	90.4	91.9	91.7	92	91.8	91	89.4
8/8/2007	78.6	78	76.9	76.2	76.4	76.4	77.3	81.5	84.6	87.7	88.9	91.4	91.7	91.8	92.2	91.1	89.5
8/9/2007	77.9	76.7	75.8	75.2	75	75	76.4	79.6	82.7	85.5	86.3	86.5	88	89	89.9	90.5	90.5
8/10/2007	78	77.5	76.9	76.8	76.6	76.3	76.9	80.1	83.1	85	86.3	87.1	87.4	88.4	89.9	90	90.8
8/11/2007	78.8	78.4	78	77.5	77.2	77	77.9	81.2	84.6	86.9	88.1	88.6	90.2	91.1	91.7	92	92.2
8/12/2007	80.1	79.7	79.3	79.4	78.3	77.9	79.2	83.2	86.5	88.6	89.9	91.1	92.9	94	94.4	90.7	88
8/13/2007	79.5	79	78.5	78.6	78.8	80.4	80.9	84.8	86.1	88	90.3	91.1	91.5	93.4	94.1	94.2	94.1
8/14/2007	84	83.9	82.3	80.7	79.7	79	79.7	82.3	85.6	86.9	88.2	89.6	90.6	92.3	93.6	93.8	93.2
8/15/2007	84.6	82.3	81.7	81.4	80.9	79.9	82.2	84.5	84.5	84.7	85.5	84	82.6	84.4	84.8	84.4	84.5
8/16/2007	83.9	84	84	83.1	82.9	83.4	82.7	83.3	83.6	83.2	78.5	77.5	80	81.4	78.7	79	81.9
8/17/2007	81.1	81.4	81.7	81.5	81	81.2	81.7	84.4	84.2	87.1	89.1	89.6	87.6	86.9	90.2	89	85.8
8/18/2007	82.5	82.2	82.1	82	82.1	81.5	81.4	83.8	85.7	87.2	81.6	81.3	84.8	85.5	85.8	80.3	82.6
8/19/2007	81.3	81.5	81.6	80.7	80	79.8	81.6	83.3	86	87.7	86.9	87.4	87.8	85.8	85.4	85.4	86.1
8/20/2007	81	80.9	80.3	80.4	80	79.4	80.7	82.7	83.2	86	87.4	87.3	87.5	87.8	86.8	86	85.6
8/21/2007	81.4	81.3	81.2	81.1	81	80.7	81.1	82.9	79.7	83.2	85.1	85.6	87.3	87.7	87.6	87.1	85.5
8/22/2007	83	82.9	82.9	82.6	82.6	82.3	82.8	82.6	84.9	86.4	87.3	87.2	87.7	87.7	87.7	86.8	86.1
8/23/2007	83	82.6	82.5	82.4	82.2	82.1	82.8	85	85.9	87.5	87	88.5	89.4	90.1	89.3	87.5	86.8
8/24/2007	82.1	81.6	80.8	80.8	80.4	80	78.5	81.2	82.6	84.8	86.5	87.5	87.4	88.3	87.9	85.5	85.3
8/25/2007	82	81.4	80.1	80.4	80.5	80.4	80.6	82.2	82.6	86.7	87	86.9	88.2	85.5	87.6	86.9	85.3
8/26/2007	77.7	77.4	78	77	76.4	75.8	76.7	80.1	82.7	82.9	83.7	84.6	85.1	85.6	85.9	87	87.5
8/27/2007	79.7	77.1	77.1	76.7	75.8	75.8	76.5	79.8	82.4	83.2	83.8	85.4	86	87.6	87.9	87.8	85.6
8/28/2007	79	79	77.5	76.7	75.7	74.1	74.2	75.5	76.9	77.4	79.8	81.7	82	82.5	83	82.9	81.7
8/29/2007	75.7	76.1	75.4	75.6	76.1	76.7	76.2	78	81.4	80	75.3	75.3	75.9	76.7	76.7	77.5	77.8
8/30/2007	76.9	77.5	76.7	75.7	76.2	75.8	76.2	77.9	79	80.2	81.6	82.9	82.9	82.6	83.7	84.9	85
8/31/2007	77.7	77.4	76.5	76	76	74.5	74.8	76.4	78.3	80.1	80.9	81.4	82.8	82.6	83.8	83.8	83.1

Monthly Max: 94.4 on August 12 at 14:00

Monthly SH: 94.2 on August 13 at 15:00

Monthly Min: 72.3 on August 31 at 21:00

Monthly Avg: 82.6

Monthly STD: 4.4

Monthly Cap: 100.0

CAMS 620 Monthly Net Radiation Summary Report for August 2007
Texas City 34th St. C620 - EPA Site: 48_167_0056
Net Radiation (POC 1) measured in Langleys per minute
Central Standard Time

Date	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00
8/1/2007	-0.035	-0.027	-0.021	-0.018	-0.016	-0.011	0.078	0.254	0.453	0.651	0.76	0.724	0.637	0.495	0.191	-0.02	0.038
8/2/2007	-0.024	-0.021	-0.014	-0.013	-0.012	-0.009	0.024	0.062	0.217	0.242	0.359	0.337	0.196	0.556	0.568	0.628	0.517
8/3/2007	-0.024	-0.021	-0.02	-0.019	-0.025	-0.018	0.101	0.24	0.452	0.653	0.805	0.8	0.518	0.464	0.312	0.509	0.213
8/4/2007	-0.027	-0.026	-0.026	-0.019	-0.011	-0.017	0.011	0.06	0.212	0.556	0.298	0.513	0.846	0.68	0.643	0.531	0.385
8/5/2007	-0.04	-0.037	-0.032	-0.019	-0.026	-0.035	0.016	0.141	0.499	0.671	0.807	0.898	0.942	0.868	0.684	0.496	0.432
8/6/2007	-0.043	-0.046	-0.043	-0.041	-0.044	-0.031	0.016	0.198	0.363	0.657	0.781	0.874	0.863	0.861	0.747	0.485	0.411
8/7/2007	-0.037	-0.039	-0.038	-0.036	-0.039	-0.038	0.074	0.121	0.302	0.64	0.792	0.869	0.875	0.844	0.728	0.469	0.409
8/8/2007	-0.058	-0.057	-0.048	-0.033	-0.031	-0.024	0.065	0.267	0.402	0.628	0.697	0.908	0.916	0.875	0.757	0.466	0.411
8/9/2007	-0.051	-0.034	-0.026	-0.022	-0.02	-0.016	0.097	0.269	0.45	0.633	0.716	0.632	0.797	0.803	0.727	0.468	0.399
8/10/2007	-0.038	-0.035	-0.032	-0.028	-0.025	-0.022	0.079	0.257	0.413	0.618	0.762	0.835	0.773	0.719	0.542	0.321	0.354
8/11/2007	-0.031	-0.031	-0.028	-0.032	-0.032	-0.027	0.071	0.235	0.416	0.604	0.752	0.853	0.856	0.855	0.754	0.51	0.335
8/12/2007	-0.037	-0.036	-0.036	-0.033	-0.032	-0.025	0.075	0.242	0.421	0.61	0.76	0.834	0.871	0.83	0.764	0.207	0.107
8/13/2007	-0.039	-0.042	-0.036	-0.028	-0.023	-0.033	0.052	0.291	0.42	0.625	0.75	0.771	0.819	0.803	0.694	0.445	0.353
8/14/2007	-0.039	-0.035	-0.038	-0.03	-0.025	-0.021	0.077	0.18	0.345	0.436	0.655	0.737	0.595	0.841	0.643	0.401	0.291
8/15/2007	-0.026	-0.021	-0.019	-0.022	-0.019	-0.028	0.057	0.216	0.309	0.301	0.243	0.078	0.202	0.311	0.201	0.238	0.19
8/16/2007	-0.018	-0.018	-0.017	-0.023	-0.039	-0.029	0.009	0.066	0.108	0.049	-0.007	0.028	0.063	0.068	-0.009	0.039	0.027
8/17/2007	-0.033	-0.031	-0.031	-0.031	-0.032	-0.027	0.017	0.253	0.213	0.523	0.714	0.782	0.524	0.515	0.777	0.421	0.114
8/18/2007	-0.031	-0.03	-0.026	-0.028	-0.028	-0.04	0.005	0.217	0.265	0.332	0.08	0.198	0.227	0.3	0.44	0.103	0.114
8/19/2007	-0.033	-0.035	-0.032	-0.033	-0.032	-0.027	0.104	0.171	0.434	0.584	0.421	0.429	0.469	0.243	0.264	0.232	0.397
8/20/2007	-0.032	-0.041	-0.044	-0.04	-0.04	-0.044	0.042	0.181	0.222	0.492	0.595	0.753	0.708	0.674	0.516	0.28	0.334
8/21/2007	-0.034	-0.037	-0.035	-0.032	-0.026	-0.025	0.105	0.184	0.099	0.204	0.217	0.412	0.82	0.777	0.698	0.377	0.16
8/22/2007	-0.035	-0.033	-0.026	-0.025	-0.022	-0.025	0.062	0.098	0.084	0.533	0.733	0.659	0.753	0.644	0.698	0.267	0.173
8/23/2007	-0.02	-0.027	-0.026	-0.025	-0.026	-0.029	0.087	0.221	0.316	0.504	0.399	0.642	0.74	0.851	0.743	0.462	0.353
8/24/2007	-0.031	-0.034	-0.045	-0.044	-0.053	-0.042	0.068	0.138	0.266	0.455	0.631	0.846	0.873	0.894	0.684	0.151	0.226
8/25/2007	-0.044	-0.058	-0.058	-0.068	-0.064	-0.059	-0.003	0.133	0.174	0.547	0.43	0.446	0.789	0.306	0.67	0.326	0.137
8/26/2007	-0.048	-0.036	-0.024	-0.05	-0.046	-0.031	0.017	0.213	0.41	0.468	0.69	0.785	0.879	0.649	0.64	0.562	0.295
8/27/2007	-0.058	-0.058	-0.059	-0.057	-0.05	-0.038	0.008	0.17	0.395	0.579	0.793	0.883	0.931	0.896	0.628	0.498	0.116
8/28/2007	-0.048	-0.051	-0.046	-0.023	-0.011	-0.017	-0.007	0.038	0.049	0.098	0.421	0.528	0.271	0.319	0.343	0.188	0.032
8/29/2007	-0.015	-0.019	-0.014	-0.018	-0.015	-0.014	-0.003	0.186	0.428	0.23	0.037	0.062	0.086	0.097	0.137	0.164	0.111
8/30/2007	-0.007	-0.019	-0.022	-0.018	-0.018	-0.017	0.03	0.213	0.293	0.645	0.84	0.938	0.635	0.693	0.585	0.586	0.181
8/31/2007	-0.03	-0.039	-0.042	-0.043	-0.04	-0.028	0.023	0.109	0.303	0.501	0.706	0.766	0.85	0.459	0.484	0.42	0.099

Monthly Max: 0.942 on August 5 at 12:00
Monthly SH: 0.938 on August 30 at 11:00
Monthly Min: -0.068 on August 25 at 03:00
Monthly Avg: 0.184
Monthly STD: 0.3
Monthly Cap: 100.0

CAMS 620 M
Texas City 34
Outdoor Tem
Central Stand

Date	17:00	18:00	19:00	20:00	21:00	22:00	23:00	Max	SH	Min	Avg	STD	Cap
8/1/2007	78.2	78.4	77.9	78	77.7	77.9	77.9	88.3	87.8	74.2	79.8	4.3	100
8/2/2007	84.9	81.3	78.4	77.8	77.5	77.4	77	85.8	85.1	76.9	79.5	2.6	100
8/3/2007	83.8	82.6	81.7	81.3	80.5	79.8	79.1	85.9	84.5	75.4	80.7	3.3	100
8/4/2007	86.2	83.6	81.7	80.4	79.5	79.5	78.2	88.6	87.5	75.8	81.4	3.9	100
8/5/2007	87.2	84.7	82.6	81.8	81.5	81.9	81.8	90.7	90.7	76	83.4	5.2	100
8/6/2007	87.2	84.7	83.1	82.3	82.3	82.6	82.5	90.8	90.7	79	84.9	4.1	100
8/7/2007	87.4	84.7	82.4	81.1	80.6	79.4	78.7	92	91.9	78.7	84.9	4.5	100
8/8/2007	87.9	84.7	82.6	81.8	80.6	79.5	78.9	92.2	91.8	76.2	83.6	5.7	100
8/9/2007	88.2	85.2	83.4	81.5	80.6	80	79.2	90.5	90.5	75	82.4	5.3	100
8/10/2007	88.2	85.8	83.8	82.7	81.8	81.4	79.9	90.8	90	76.3	82.9	4.8	100
8/11/2007	88.4	85.8	83.3	82.6	82.4	82.2	81.2	92.2	92	77	84	5.2	100
8/12/2007	91	89.6	86.2	84.4	81.8	80.5	80.1	94.4	94	77.9	85.3	5.4	100
8/13/2007	93.5	91.7	88.9	87.4	86.3	85	85.9	94.2	94.1	78.5	86.7	5.5	100
8/14/2007	90.8	88.1	85.4	84.5	84.5	84.7	85.5	93.8	93.6	79	86.2	4.5	100
8/15/2007	84.2	83.8	83.6	82.3	83.7	84.2	84.1	85.5	84.8	79.9	83.5	1.4	100
8/16/2007	81.2	80.6	80.3	80	80	80.4	80.7	84	84	77.5	81.4	1.9	100
8/17/2007	84.6	83.9	83.5	83.4	83.2	83.2	83	90.2	89.6	81	84.5	2.9	100
8/18/2007	83.5	82.3	81.8	81.6	81.2	81.5	81.2	87.2	85.8	80.3	82.7	1.8	100
8/19/2007	84.6	83.1	82.5	82.1	81.9	81.6	81	87.8	87.7	79.8	83.5	2.5	100
8/20/2007	84.6	82.8	82	81.9	81.5	81.5	81.6	87.8	87.5	79.4	83.3	2.7	100
8/21/2007	85.1	84.1	83.3	82.8	82.9	83.1	83.2	87.7	87.6	79.7	83.5	2.3	100
8/22/2007	85.4	84.2	83.3	83.2	83.4	83.5	83.4	87.7	87.7	82.3	84.6	1.9	100
8/23/2007	85.2	83.8	82.9	82.8	82.8	82.8	82.2	90.1	89.4	82.1	84.9	2.6	100
8/24/2007	85	83.6	83.1	82.9	82.6	82.7	82.4	88.3	87.9	78.5	83.5	2.7	100
8/25/2007	84.3	82.9	81.7	81.6	81.1	81	79	88.2	87.6	79	83.2	2.8	100
8/26/2007	87.1	84.2	82.7	82.7	82.3	82.1	81.2	87.5	87.1	75.8	81.9	3.6	100
8/27/2007	83.6	78.9	79	80.1	80.3	80.1	79.1	87.9	87.8	75.8	81.2	3.9	100
8/28/2007	79.4	79.1	79.2	77.4	74.8	75.1	75.2	83	82.9	74.1	78.3	2.8	100
8/29/2007	77.6	77.2	76.1	75.7	76	76	75.5	81.4	80	75.3	76.7	1.5	100
8/30/2007	84.5	82.2	80.5	79.9	79.7	79.6	78.2	85	84.9	75.7	80	3	100
8/31/2007	82.1	80.5	78.7	73.8	72.3	74.5	74.9	83.8	83.8	72.3	78.5	3.5	100

Monthly Max:
Monthly SH: !
Monthly Min:
Monthly Avg:
Monthly STD
Monthly Cap:

CAMS 620 M
Texas City 34
Net Radiatior
Central Stanc

Date	17:00	18:00	19:00	20:00	21:00	22:00	23:00	Max	SH	Min	Avg	STD	Cap
8/1/2007	0.049	0.002	-0.019	-0.019	-0.023	-0.017	-0.029	0.76	0.724	-0.035	0.17	0.3	100
8/2/2007	0.175	0.032	-0.032	-0.036	-0.032	-0.029	-0.027	0.628	0.568	-0.036	0.153	0.2	100
8/3/2007	0.127	-0.003	-0.03	-0.024	-0.038	-0.036	-0.033	0.805	0.8	-0.038	0.204	0.3	100
8/4/2007	0.226	0.021	-0.041	-0.046	-0.043	-0.04	-0.039	0.846	0.68	-0.046	0.194	0.3	100
8/5/2007	0.226	0.022	-0.048	-0.05	-0.048	-0.044	-0.042	0.942	0.898	-0.05	0.262	0.4	100
8/6/2007	0.219	0.026	-0.043	-0.045	-0.041	-0.028	-0.03	0.874	0.863	-0.046	0.253	0.4	100
8/7/2007	0.199	0.01	-0.059	-0.061	-0.06	-0.061	-0.057	0.875	0.869	-0.061	0.242	0.4	100
8/8/2007	0.22	0.018	-0.056	-0.058	-0.06	-0.06	-0.056	0.916	0.908	-0.06	0.254	0.4	100
8/9/2007	0.2	0.015	-0.044	-0.048	-0.045	-0.044	-0.038	0.803	0.797	-0.051	0.242	0.3	100
8/10/2007	0.095	0.009	-0.038	-0.037	-0.034	-0.03	-0.031	0.835	0.773	-0.038	0.226	0.3	100
8/11/2007	0.024	-0.014	-0.034	-0.031	-0.033	-0.038	-0.038	0.856	0.855	-0.038	0.246	0.3	100
8/12/2007	0.165	-0.011	-0.041	-0.041	-0.044	-0.041	-0.04	0.871	0.834	-0.044	0.228	0.3	100
8/13/2007	0.172	0	-0.041	-0.028	-0.023	-0.03	-0.039	0.819	0.803	-0.042	0.243	0.3	100
8/14/2007	0.126	0.006	-0.048	-0.034	-0.029	-0.028	-0.025	0.841	0.737	-0.048	0.208	0.3	100
8/15/2007	0.087	0.003	-0.026	-0.028	-0.021	-0.02	-0.018	0.311	0.309	-0.028	0.091	0.1	100
8/16/2007	-0.004	-0.019	-0.032	-0.036	-0.039	-0.044	-0.045	0.108	0.068	-0.045	0.003	0	100
8/17/2007	0.062	0.002	-0.02	-0.018	-0.021	-0.022	-0.025	0.782	0.777	-0.033	0.193	0.3	100
8/18/2007	0.095	-0.013	-0.038	-0.023	-0.038	-0.032	-0.025	0.44	0.332	-0.04	0.084	0.1	100
8/19/2007	0.154	0.009	-0.029	-0.037	-0.034	-0.038	-0.039	0.584	0.469	-0.039	0.148	0.2	100
8/20/2007	0.177	-0.002	-0.035	-0.027	-0.034	-0.032	-0.031	0.753	0.708	-0.044	0.19	0.3	100
8/21/2007	0.078	0.006	-0.041	-0.046	-0.044	-0.04	-0.035	0.82	0.777	-0.046	0.156	0.3	100
8/22/2007	0.11	-0.003	-0.043	-0.035	-0.022	-0.021	-0.019	0.753	0.733	-0.043	0.188	0.3	100
8/23/2007	0.12	-0.012	-0.036	-0.038	-0.03	-0.033	-0.041	0.851	0.743	-0.041	0.212	0.3	100
8/24/2007	0.073	-0.03	-0.061	-0.061	-0.059	-0.055	-0.054	0.894	0.873	-0.061	0.197	0.3	100
8/25/2007	0.069	-0.016	-0.032	-0.057	-0.061	-0.056	-0.043	0.789	0.67	-0.068	0.142	0.3	100
8/26/2007	0.091	-0.031	-0.054	-0.056	-0.056	-0.056	-0.054	0.879	0.785	-0.056	0.215	0.3	100
8/27/2007	0.032	-0.026	-0.034	-0.02	-0.042	-0.051	-0.051	0.931	0.896	-0.059	0.224	0.4	100
8/28/2007	0.015	-0.027	-0.035	-0.021	-0.028	-0.033	-0.027	0.528	0.421	-0.051	0.08	0.2	100
8/29/2007	0.034	-0.015	-0.026	-0.015	-0.016	-0.02	-0.015	0.428	0.23	-0.026	0.057	0.1	100
8/30/2007	0.099	-0.024	-0.038	-0.025	-0.024	-0.023	-0.038	0.938	0.84	-0.038	0.228	0.3	100
8/31/2007	0.056	-0.021	-0.029	-0.009	-0.013	-0.011	-0.017	0.85	0.766	-0.043	0.186	0.3	100

Monthly Max:
Monthly SH: (
Monthly Min:
Monthly Avg:
Monthly STD
Monthly Cap:

CAMS 620 Monthly Outdoor Temperature Summary Report for July 2007
Texas City 34th St. C620 - EPA Site: 48_167_0056
Outdoor Temperature (POC 1) measured in degrees Fahrenheit
Central Standard Time

Date	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00
7/1/2007	79.7	80.8	80.8	80.1	78.6	77.1	74.1	75.5	72.9	73.9	74.5	76.5	78.5	82.6	83.1	83.4
7/2/2007	80.3	80.8	80.6	80.4	80.6	80.3	74.8	74.2	72.2	70.5	71.2	71.8	73	76.4	77.2	80.4
7/3/2007	78.8	79.4	79.6	79.5	76.7	75	76.8	80.2	80.5	80.7	81.5	81.3	81.3	81.8	82.3	81.3
7/4/2007	72.6	73.7	73.4	73.1	73.3	74	74.5	74.7	74.2	74.4	74.2	73.6	72.6	73.8	75.2	75.5
7/5/2007	77.6	77.4	75.1	69.9	70.5	71.6	72.1	73.4	76.3	79.3	78.1	77.5	77.5	78.7	83.4	85.2
7/6/2007	79.8	79.7	79.1	78.5	78.6	77.5	76.2	74.7	73.9	72.7	73	72.6	77.8	84.5	83	76.9
7/7/2007	76.8	76.9	77.2	76	75.4	75.5	76.6	78	79.6	81.7	83.5	84.3	85.5	87.1	85.9	86
7/8/2007	77	79.6	79.1	78.1	78.3	78.2	79.1	81.4	83.3	84.9	86.5	88.2	88.3	88.1	87.4	87.7
7/9/2007	80.6	80.4	80.3	79.8	79.8	78.5	79.9	81.9	84.3	85	85.5	87	87.1	88.3	88.2	87.4
7/10/2007	80.8	81.1	80.7	80.6	80.4	80.1	80.7	82.8	85.6	86.8	88.1	88.8	88.9	89	89.1	88.5
7/11/2007	77.8	78	78.7	78.1	78.7	78.7	78.7	81.8	85.5	87.6	89.3	90.2	89.2	83.3	85	87.5
7/12/2007	77.1	76.4	76.1	75.4	75	74.9	76.8	80.3	82.9	85.3	86.5	85.6	88.4	90.8	90.1	89.5
7/13/2007	79.1	79	78.3	77.4	76.6	76.2	78.2	81.7	83.7	85.9	87.5	89	90.1	90.5	90.3	89.2
7/14/2007	78.7	79.5	79.3	79.3	79.5	79.6	80	80.7	81.4	81.7	81.7	81.5	81.4	82.1	83	84.2
7/15/2007	78.5	78.1	78.3	77.4	77.5	77	75.2	73	71.6	71.8	72.3	73.7	76.6	77.3	79.4	80.7
7/16/2007	75	74.4	73.8	73.3	73.3	73.5	75.4	80.2	82.8	85.2	86.4	86.7	86.8	85.6	84.4	83.8
7/17/2007	76.7	76.8	76.2	76.2	76.8	76.7	78.4	80.5	84.8	85.8	85.6	86.6	88.2	87.4	84.7	85.5
7/18/2007	74.6	75.1	77	77.7	77.5	77.6	79.3	81.5	83.3	83.8	84	83.9	80.7	76.9	77.8	76.2
7/19/2007	76.5	77.2	77.3	77.4	77.6	77.1	79.1	81.3	78	72.3	73.8	74.7	75	76.1	78.4	80.8
7/20/2007	80.4	80.1	80.3	79.5	79.2	78.9	79.5	75.6	72.7	72.2	72.7	74.7	76.8	78.3	79.5	79.3
7/21/2007	77.7	78.1	78.2	78	78.2	78.4	78.8	80.1	80.8	82.1	83.2	84.4	84.6	84.5	84.6	84.5
7/22/2007	75.8	75.5	75	74.2	74.1	74.1	75.6	77.6	80	82.1	83.7	84.3	84.2	84.1	83.6	86.4
7/23/2007	75.8	75.7	78.4	77.8	77	76.2	76.8	77.7	78.3	79.6	81.5	82.3	83.2	83.1	83.1	83.9
7/24/2007	73	71.9	71.3	71	71.6	70.5	72.1	77.6	80.7	82	81.8	82.4	83	83.5	83.9	84.5
7/25/2007	77.3	75.6	75.3	75	75.3	75.2	72.3	74.5	76.8	79.2	81.6	83.2	84.2	83.5	83.4	83.7
7/26/2007	78.1	78.4	78.5	78.5	78.9	78.7	80.7	80.9	78	76.8	79.9	82.1	82.7	79.4	76.8	76.4
7/27/2007	78.9	79.3	79.5	79.2	76.2	74.5	74.6	73.9	74	74.6	75.3	76.8	76.8	76	80.5	80.4
7/28/2007	77.4	77.1	77.4	76.9	76	75.6	76.8	79	79.7	79.7	80.7	82.9	85.5	88.2	84.6	79.3
7/29/2007	76.8	77.1	76.4	75.7	75.4	75.3	76.3	80.1	83.6	79.8	75.5	79.1	83.3	85.2	88.5	86.5
7/30/2007	77.6	77.8	76.4	75.9	75.6	75.4	76.3	80.2	84.1	85.7	87.6	86.3	84.6	81.2	87.8	87.3
7/31/2007	77.7	77.3	77	76.4	76	75.7	76.2	78.9	81.4	84.1	86.8	86.9	87.1	87.4	90.1	90.3

Monthly Max: 90.8 on July 12 at 13:00
Monthly SH: 90.5 on July 13 at 13:00
Monthly Min: 69.9 on July 5 at 03:00
Monthly Avg: 79.8
Monthly STD: 4.2
Monthly Cap: 100.0

CAMS 620 Monthly Net Radiation Summary Report for July 2007

Texas City 34th St. C620 - EPA Site: 48_167_0056
Net Radiation (POC 1) measured in Langleys per minute
Central Standard Time

Date	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00
7/1/2007	-0.035	-0.033	-0.029	-0.022	-0.027	-0.021	0.043	0.067	0.02	0.072	0.146	0.193	0.242	0.41	0.328	0.254
7/2/2007	-0.029	-0.022	-0.023	-0.019	-0.018	-0.015	-0.002	0.031	0.01	0.015	0.047	0.099	0.128	0.194	0.398	0.674
7/3/2007	-0.023	-0.02	-0.028	-0.026	-0.01	-0.019	0.012	0.226	0.209	0.242	0.329	0.416	0.342	0.479	0.399	0.288
7/4/2007	-0.005	-0.006	-0.007	-0.013	-0.016	-0.01	-0.001	0.008	0.033	0.036	0.061	0.039	0.054	0.114	0.104	0.14
7/5/2007	-0.017	-0.012	-0.005	-0.002	-0.003	-0.004	0.009	0.087	0.244	0.349	0.172	0.163	0.278	0.522	0.571	0.498
7/6/2007	-0.03	-0.026	-0.025	-0.005	-0.011	-0.005	0.001	0.004	0.007	0.006	0.02	0.031	0.551	0.741	0.273	0.117
7/7/2007	-0.017	-0.015	-0.018	-0.014	-0.009	-0.001	0.087	0.163	0.321	0.463	0.602	0.579	0.814	0.737	0.524	0.333
7/8/2007	-0.017	-0.018	-0.017	-0.019	-0.018	-0.016	0.057	0.182	0.281	0.461	0.67	0.884	0.86	0.808	0.565	0.606
7/9/2007	-0.042	-0.042	-0.039	-0.038	-0.025	-0.012	0.07	0.151	0.343	0.39	0.429	0.615	0.671	0.859	0.741	0.573
7/10/2007	-0.038	-0.025	-0.034	-0.041	-0.034	-0.024	0.039	0.15	0.441	0.554	0.73	0.836	0.817	0.759	0.685	0.578
7/11/2007	-0.026	-0.027	-0.027	-0.017	-0.024	-0.013	0.057	0.154	0.437	0.648	0.793	0.808	0.545	0.174	0.313	0.53
7/12/2007	-0.023	-0.018	-0.017	-0.015	-0.016	-0.013	0.047	0.215	0.365	0.608	0.777	0.311	0.814	0.83	0.74	0.638
7/13/2007	-0.042	-0.044	-0.035	-0.025	-0.019	-0.011	0.041	0.24	0.411	0.632	0.8	0.765	0.832	0.835	0.699	0.506
7/14/2007	-0.03	-0.028	-0.024	-0.022	-0.021	-0.016	0.028	0.079	0.119	0.212	0.19	0.156	0.165	0.146	0.164	0.274
7/15/2007	-0.019	-0.022	-0.024	-0.018	-0.015	-0.008	0.01	0.005	0.001	0.016	0.028	0.123	0.231	0.274	0.398	0.402
7/16/2007	-0.029	-0.022	-0.023	-0.015	-0.011	-0.008	0.06	0.185	0.382	0.634	0.787	0.907	0.838	0.608	0.496	0.377
7/17/2007	-0.037	-0.038	-0.037	-0.034	-0.033	-0.019	0.022	0.139	0.44	0.533	0.524	0.64	0.75	0.596	0.42	0.561
7/18/2007	-0.029	-0.018	-0.019	-0.021	-0.023	-0.017	0.052	0.182	0.325	0.383	0.337	0.224	0.097	0.054	0.099	0.134
7/19/2007	-0.021	-0.018	-0.017	-0.012	-0.014	-0.019	0.081	0.182	0.043	0.012	0.04	0.071	0.072	0.208	0.238	0.289
7/20/2007	-0.011	-0.01	-0.01	-0.005	-0.007	-0.008	0.001	0.001	0.006	0.021	0.117	0.189	0.313	0.302	0.316	0.191
7/21/2007	-0.012	-0.013	-0.015	-0.015	-0.013	-0.01	0.033	0.139	0.192	0.366	0.555	0.636	0.639	0.412	0.487	0.443
7/22/2007	-0.018	-0.016	-0.016	-0.016	-0.017	-0.007	0.083	0.203	0.353	0.703	0.791	0.89	0.829	0.844	0.685	0.649
7/23/2007	-0.029	-0.031	-0.035	-0.038	-0.04	-0.033	0.059	0.249	0.412	0.636	0.797	0.891	0.892	0.777	0.596	0.571
7/24/2007	-0.032	-0.039	-0.033	-0.032	-0.033	-0.031	0.049	0.246	0.468	0.655	0.752	0.846	0.823	0.859	0.688	0.501
7/25/2007	-0.024	-0.022	-0.025	-0.02	-0.023	-0.013	0.001	0.113	0.085	0.476	0.784	0.801	0.818	0.374	0.483	0.383
7/26/2007	-0.023	-0.02	-0.02	-0.024	-0.02	-0.007	0.1	0.069	0.151	0.268	0.24	0.202	0.22	0.095	0.037	0.069
7/27/2007	-0.017	-0.012	-0.007	-0.015	-0.015	-0.007	-0.007	-0.002	0.006	0.011	0.059	0.153	0.104	0.048	0.316	0.271
7/28/2007	-0.027	-0.03	-0.034	-0.033	-0.02	-0.004	0.082	0.182	0.167	0.135	0.3	0.583	0.795	0.775	0.258	0.153
7/29/2007	-0.025	-0.024	-0.017	-0.016	-0.013	-0.007	0.102	0.233	0.241	0.105	0.065	0.428	0.339	0.683	0.622	0.345
7/30/2007	-0.023	-0.028	-0.021	-0.017	-0.014	-0.01	0.076	0.242	0.442	0.602	0.766	0.83	0.433	0.573	0.597	0.384
7/31/2007	-0.029	-0.025	-0.024	-0.02	-0.019	-0.011	0.049	0.231	0.419	0.599	0.761	0.534	0.658	0.55	0.676	0.565

Monthly Max: 0.907 on July 16 at 11:00
Monthly SH: 0.892 on July 23 at 12:00
Monthly Min: -0.060 on July 23 at 19:00
Monthly Avg: 0.153
Monthly STD: 0.3
Monthly Cap: 100.0

CAMS 620 M
Texas City 3
Outdoor Tem
Central Stan

Date	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	Max	SH	Min	Avg	STD	Cap
7/1/2007	83.5	82.6	81.6	80.8	80.6	80.6	80.2	80.7	83.5	83.4	72.9	79.3	3.1	100
7/2/2007	81.7	81.4	79	77.7	77.6	77.2	77.5	78.1	81.7	81.4	70.5	77.3	3.5	100
7/3/2007	81.4	80.8	80	79.1	74.6	73.6	73.7	71.1	82.3	81.8	71.1	78.8	3	100
7/4/2007	73.8	74.6	75.8	75.4	75.2	75.9	76.9	77.6	77.6	76.9	72.6	74.5	1.2	100
7/5/2007	83.5	82.1	81.9	80.9	80.1	80	80.2	79.4	85.2	83.5	69.9	78	4.1	100
7/6/2007	80.6	82.3	80.5	78.9	77.7	77	77.2	77.1	84.5	83	72.6	77.9	3.1	100
7/7/2007	84.6	82	74.4	74	74.7	75.4	76.1	77.4	87.1	86	74	79.4	4.3	100
7/8/2007	87.2	85.6	83.7	81.6	80.9	81.3	81.3	80.8	88.3	88.2	77	82.8	3.7	100
7/9/2007	86.3	85.3	83.7	82.3	81.9	81.4	80.9	81.2	88.3	88.2	78.5	83.2	3	100
7/10/2007	87.7	86.4	84.4	82.6	81.6	80.9	79.6	78.8	89.1	89	78.8	83.9	3.6	100
7/11/2007	88.1	86.7	84.4	81.9	80.3	79.3	78.7	77.8	90.2	89.3	77.8	82.7	4.3	100
7/12/2007	88.4	85.4	83.5	82.5	82.1	81.7	81.3	80	90.8	90.1	74.9	82.3	5	100
7/13/2007	87.3	85.3	83.6	82	81	80.2	79.8	78.9	90.5	90.3	76.2	82.9	4.7	100
7/14/2007	84.8	83.5	82.3	80.7	79.4	79	78.5	78.6	84.8	84.2	78.5	80.8	1.8	100
7/15/2007	80.6	80.7	78	76.9	76.6	76.4	77	75.4	80.7	80.7	71.6	76.7	2.6	100
7/16/2007	82.4	81.4	79.9	78.4	77.6	77.9	77.5	77.2	86.8	86.7	73.3	79.7	4.6	100
7/17/2007	83.5	82.2	81.1	78.9	78.1	76.7	75.8	75.4	88.2	87.4	75.4	80.8	4.3	100
7/18/2007	78.4	77.6	73.8	73.1	73.8	74.4	75.3	76.3	84	83.9	73.1	77.9	3.3	100
7/19/2007	80.5	80	79.4	78.3	78.6	78.8	79.2	80.2	81.3	80.8	72.3	77.8	2.2	100
7/20/2007	78.3	78.5	78.1	77.5	77.1	76.9	76.8	77.4	80.4	80.3	72.2	77.5	2.4	100
7/21/2007	85	84.2	82.7	80.6	79.4	78.4	77.6	76.9	85	84.6	76.9	80.9	2.8	100
7/22/2007	86.8	87.3	85.9	82.9	80.1	75.8	75	75.1	87.3	86.8	74.1	80	4.7	100
7/23/2007	83.8	83.9	82.3	80.1	78.8	78	78.7	75.2	83.9	83.9	75.2	79.6	2.9	100
7/24/2007	84.2	82.5	81.1	79.4	78.6	78	78.4	77.8	84.5	84.2	70.5	78.4	4.8	100
7/25/2007	82.8	82.6	81	80	79.9	79.3	79	78.7	84.2	83.7	72.3	79.1	3.5	100
7/26/2007	77.5	77.9	78	78.1	78.7	78.8	78.9	78.6	82.7	82.1	76.4	78.8	1.5	100
7/27/2007	82.2	81	79.8	79	79.1	78.9	78.7	78.1	82.2	81	73.9	77.8	2.4	100
7/28/2007	83.3	83.5	82.1	79.7	78.7	78.6	78.9	77.6	88.2	85.5	75.6	80	3.2	100
7/29/2007	84.2	83.3	82	80.8	79.9	79	78.5	78	88.5	86.5	75.3	80	3.7	100
7/30/2007	86.7	85.6	83.5	81.8	81.4	80.2	79.6	78.5	87.8	87.6	75.4	81.6	4.2	100
7/31/2007	89.1	87.2	85	82.7	81.5	80.3	79.4	78.8	90.3	90.1	75.7	82.2	4.8	100

Monthly Max
Monthly SH:
Monthly Min:
Monthly Avg
Monthly STD
Monthly Cap

CAMS 620 M

Texas City 3
Net Radiatio
Central Stan

Date	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	Max	SH	Min	Avg	STD	Cap
7/1/2007	0.21	0.118	0.024	-0.018	-0.028	-0.028	-0.027	-0.024	0.41	0.328	-0.035	0.076	0.1	100
7/2/2007	0.452	0.133	0.033	-0.019	-0.025	-0.03	-0.033	-0.03	0.674	0.452	-0.033	0.081	0.2	100
7/3/2007	0.252	0.102	0.032	-0.01	-0.009	-0.012	-0.009	-0.006	0.479	0.416	-0.028	0.132	0.2	100
7/4/2007	0.038	0.055	0.024	-0.018	-0.014	-0.024	-0.032	-0.018	0.14	0.114	-0.032	0.023	0	100
7/5/2007	0.193	0.075	0.055	-0.006	-0.025	-0.027	-0.026	-0.031	0.571	0.522	-0.031	0.127	0.2	100
7/6/2007	0.247	0.092	0.017	-0.022	-0.022	-0.017	-0.021	-0.018	0.741	0.551	-0.03	0.079	0.2	100
7/7/2007	0.155	0.051	-0.01	-0.021	-0.019	-0.023	-0.031	-0.027	0.814	0.737	-0.031	0.193	0.3	100
7/8/2007	0.404	0.06	-0.009	-0.043	-0.041	-0.036	-0.039	-0.044	0.884	0.86	-0.044	0.23	0.3	100
7/9/2007	0.354	0.096	0.014	-0.032	-0.038	-0.028	-0.036	-0.045	0.859	0.741	-0.045	0.205	0.3	100
7/10/2007	0.386	0.057	-0.005	-0.041	-0.046	-0.046	-0.042	-0.035	0.836	0.817	-0.046	0.234	0.3	100
7/11/2007	0.41	0.051	-0.01	-0.037	-0.039	-0.039	-0.036	-0.027	0.808	0.793	-0.039	0.192	0.3	100
7/12/2007	0.407	0.027	-0.011	-0.021	-0.021	-0.025	-0.034	-0.04	0.83	0.814	-0.04	0.23	0.3	100
7/13/2007	0.244	0.109	0.023	-0.035	-0.039	-0.044	-0.045	-0.041	0.835	0.832	-0.045	0.24	0.3	100
7/14/2007	0.308	0.109	0.033	-0.028	-0.033	-0.029	-0.027	-0.024	0.308	0.274	-0.033	0.071	0.1	100
7/15/2007	0.202	0.06	-0.003	-0.032	-0.03	-0.028	-0.03	-0.033	0.402	0.398	-0.033	0.062	0.1	100
7/16/2007	0.199	0.096	0.011	-0.037	-0.039	-0.037	-0.037	-0.039	0.907	0.838	-0.039	0.22	0.3	100
7/17/2007	0.177	0.087	0.026	-0.034	-0.04	-0.035	-0.036	-0.03	0.75	0.64	-0.04	0.189	0.3	100
7/18/2007	0.084	0.062	-0.008	-0.012	-0.015	-0.016	-0.016	-0.019	0.383	0.337	-0.029	0.076	0.1	100
7/19/2007	0.148	0.15	0.066	-0.018	-0.017	-0.016	-0.015	-0.015	0.289	0.238	-0.021	0.059	0.1	100
7/20/2007	0.119	0.089	0.015	-0.016	-0.025	-0.02	-0.012	-0.013	0.316	0.313	-0.025	0.064	0.1	100
7/21/2007	0.443	0.231	0.053	-0.038	-0.042	-0.034	-0.022	-0.017	0.639	0.636	-0.042	0.183	0.2	100
7/22/2007	0.433	0.249	0.044	-0.015	-0.011	-0.017	-0.02	-0.03	0.89	0.844	-0.03	0.274	0.3	100
7/23/2007	0.401	0.226	0.024	-0.06	-0.058	-0.049	-0.047	-0.042	0.892	0.891	-0.06	0.253	0.3	100
7/24/2007	0.229	0.117	0.039	-0.036	-0.034	-0.031	-0.03	-0.037	0.859	0.846	-0.039	0.246	0.3	100
7/25/2007	0.184	0.124	0.008	-0.019	-0.02	-0.031	-0.027	-0.023	0.818	0.801	-0.031	0.183	0.3	100
7/26/2007	0.084	0.046	0.011	-0.01	-0.012	-0.017	-0.02	-0.018	0.268	0.24	-0.024	0.058	0.1	100
7/27/2007	0.284	0.14	0.03	-0.015	-0.017	-0.019	-0.026	-0.029	0.316	0.284	-0.029	0.051	0.1	100
7/28/2007	0.277	0.199	0.042	-0.035	-0.038	-0.037	-0.036	-0.035	0.795	0.775	-0.038	0.151	0.2	100
7/29/2007	0.206	0.114	0.024	-0.035	-0.039	-0.035	-0.031	-0.024	0.683	0.622	-0.039	0.135	0.2	100
7/30/2007	0.311	0.173	0.01	-0.037	-0.041	-0.04	-0.035	-0.034	0.83	0.766	-0.041	0.214	0.3	100
7/31/2007	0.401	0.209	0.051	-0.03	-0.037	-0.037	-0.037	-0.036	0.761	0.676	-0.037	0.225	0.3	100

Monthly Max
Monthly SH:
Monthly Min:
Monthly Avg
Monthly STD
Monthly Cap

Solar radiation data in Btu/ft2-hr

Date	**0:00**	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**	**7:00**	**8:00**	**9:00**	**10:00**	**11:00**	**12:00**	**13:00**	**14:00**	**15:00**
7/1/2007	-7.738984	-7.296756	-6.412301	-4.864504	-5.970073	-4.64339	9.507895	14.81463	4.422277	15.9202	32.28262	42.67497	53.50955	90.65667	72.52534	56.16291
7/2/2007	-6.412301	-4.864504	-5.085618	-4.201163	-3.980049	-3.316707	-0.442228	6.854529	2.211138	3.316707	10.39235	21.89027	28.30257	42.89608	88.0033	149.0307
7/3/2007	-5.085618	-4.422277	-6.191187	-5.74896	-2.211138	-4.201163	2.653366	49.97173	46.21279	53.50955	72.74645	91.98335	75.62093	105.9135	88.22442	63.68078
7/4/2007	-1.105569	-1.326683	-1.547797	-2.87448	-3.537821	-2.211138	-0.221114	1.768911	7.296756	7.960098	13.48794	8.623439	11.94015	25.20698	22.99584	30.95594
7/5/2007	-3.758935	-2.653366	-1.105569	-0.442228	-0.663341	-0.884455	1.990024	19.2369	53.95177	77.16873	38.03158	36.04155	61.46964	115.4214	126.256	110.1147
7/6/2007	-6.633415	-5.74896	-5.527846	-1.105569	-2.432252	-1.105569	0.221114	0.884455	1.547797	1.326683	4.422277	6.854529	121.8337	163.8453	60.36408	25.87032
7/7/2007	-3.758935	-3.316707	-3.980049	-3.095594	-1.990024	-0.221114	19.2369	36.04155	70.97754	102.3757	133.1105	128.0249	179.9867	162.9609	115.8636	73.63091
7/8/2007	-3.758935	-3.980049	-3.758935	-4.201163	-3.980049	-3.537821	12.60349	40.24272	62.13299	101.9335	148.1463	195.4646	190.1579	178.66	124.9293	133.995
7/9/2007	-9.286781	-9.286781	-8.623439	-8.402326	-5.527846	-2.653366	15.47797	33.38819	75.84204	86.23439	94.85783	135.985	148.3674	189.9368	163.8453	126.6982
7/10/2007	-8.402326	-5.527846	-7.51787	-9.065667	-7.51787	-5.306732	8.623439	33.16707	97.5112	122.4971	161.4131	184.8512	180.65	167.8254	151.463	127.8038
7/11/2007	-5.74896	-5.970073	-5.970073	-3.758935	-5.306732	-2.87448	12.60349	34.05153	96.62674	143.2818	175.3433	178.66	120.507	38.47381	69.20863	117.1903
7/12/2007	-5.085618	-3.980049	-3.758935	-3.316707	-3.537821	-2.87448	10.39235	47.53947	80.70655	134.4372	171.8054	68.7664	179.9867	183.5245	163.6242	141.0706
7/13/2007	-9.286781	-9.729009	-7.738984	-5.527846	-4.201163	-2.432252	9.065667	53.06732	90.87778	139.7439	176.8911	169.1521	183.9667	184.63	154.5586	111.8836
7/14/2007	-6.633415	-6.191187	-5.306732	-4.864504	-4.64339	-3.537821	6.191187	17.46799	26.31255	46.87613	42.01163	34.49376	36.48378	32.28262	36.26267	60.58519
7/15/2007	-4.201163	-4.864504	-5.306732	-3.980049	-3.316707	-1.768911	2.211138	1.105569	0.221114	3.537821	6.191187	27.197	51.07729	60.58519	88.0033	88.88776
7/16/2007	-6.412301	-4.864504	-5.085618	-3.316707	-2.432252	-1.768911	13.26683	40.90606	84.46548	140.1862	174.0166	200.5502	185.2934	134.4372	109.6725	83.35991
7/17/2007	-8.181212	-8.402326	-8.181212	-7.51787	-7.296756	-4.201163	4.864504	30.73482	97.29009	117.8537	115.8636	141.5129	165.8354	131.7838	92.86781	124.0449
7/18/2007	-6.412301	-3.980049	-4.201163	-4.64339	-5.085618	-3.758935	11.49792	40.24272	71.86199	84.6866	74.51536	49.5295	21.44804	11.94015	21.89027	29.62925
7/19/2007	-4.64339	-3.980049	-3.758935	-2.653366	-3.095594	-4.201163	17.91022	40.24272	9.507895	2.653366	8.844553	15.69908	15.9202	45.99168	52.62509	63.9019
7/20/2007	-2.432252	-2.211138	-2.211138	-1.105569	-1.547797	-1.768911	0.221114	0.221114	1.326683	4.64339	25.87032	41.79051	69.20863	66.77638	69.87197	42.23274
7/21/2007	-2.653366	-2.87448	-3.316707	-3.316707	-2.87448	-2.211138	7.296756	30.73482	42.45386	80.92766	122.7182	140.6284	141.2917	91.0989	107.6824	97.95343
7/22/2007	-3.980049	-3.537821	-3.537821	-3.537821	-3.758935	-1.547797	18.35245	44.88611	78.05318	155.443	174.901	196.7913	183.3034	186.6201	151.463	143.5029
7/23/2007	-6.412301	-6.854529	-7.738984	-8.402326	-8.844553	-7.296756	13.04572	55.05734	91.0989	140.6284	176.2277	197.0124	197.2335	171.8054	131.7838	126.256
7/24/2007	-7.075643	-8.623439	-7.296756	-7.075643	-7.296756	-6.854529	10.83458	54.394	103.4813	144.8296	166.2776	187.0623	181.9767	189.9368	152.1263	110.778
7/25/2007	-5.306732	-4.864504	-5.527846	-4.422277	-5.085618	-2.87448	0.221114	24.98586	18.79468	105.2502	173.3532	177.1122	180.8711	82.69657	106.798	84.6866
7/26/2007	-5.085618	-4.422277	-4.422277	-5.306732	-4.422277	-1.547797	22.11138	15.25685	33.38819	59.25851	53.06732	44.66499	48.64504	21.00581	8.181212	15.25685
7/27/2007	-3.758935	-2.653366	-1.547797	-3.316707	-3.316707	-1.547797	-1.547797	-0.442228	1.326683	2.432252	13.04572	33.83042	22.99584	10.61346	69.87197	59.92185
7/28/2007	-5.970073	-6.633415	-7.51787	-7.296756	-4.422277	-0.884455	18.13133	40.24272	36.92601	29.85037	66.33415	128.9094	175.7855	171.3632	57.04737	33.83042
7/29/2007	-5.527846	-5.306732	-3.758935	-3.537821	-2.87448	-1.547797	22.55361	51.51952	53.28843	23.21695	14.3724	94.63672	74.95759	151.0207	137.5328	76.28427
7/30/2007	-5.085618	-6.191187	-4.64339	-3.758935	-3.095594	-2.211138	16.80465	53.50955	97.73231	133.1105	169.3732	183.5245	95.74229	126.6982	132.005	84.90771

Solar radiation

Date	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	Max	SH	Min	Avg	STD	Cap
7/1/2007	46.4339	26.09143	5.306732	-3.980049	-6.191187	-6.191187	-5.970073	-5.306732	90.65667					
7/2/2007	99.94345	29.40814	7.296756	-4.201163	-5.527846	-6.633415	-7.296756	-6.633415	149.0307					
7/3/2007	55.72069	22.55361	7.075643	-2.211138	-1.990024	-2.653366	-1.990024	-1.326683	105.9135					
7/4/2007	8.402326	12.16126	5.306732	-3.980049	-3.095594	-5.306732	-7.075643	-3.980049	30.95594					
7/5/2007	42.67497	16.58354	12.16126	-1.326683	-5.527846	-5.970073	-5.74896	-6.854529	126.256					
7/6/2007	54.61512	20.34247	3.758935	-4.864504	-4.864504	-3.758935	-4.64339	-3.980049	163.8453					
7/7/2007	34.27264	11.27681	-2.211138	-4.64339	-4.201163	-5.085618	-6.854529	-5.970073	179.9867					
7/8/2007	89.32999	13.26683	-1.990024	-9.507895	-9.065667	-7.960098	-8.623439	-9.729009	195.4646					
7/9/2007	78.2743	21.22693	3.095594	-7.075643	-8.402326	-6.191187	-7.960098	-9.950122	189.9368					
7/10/2007	85.34994	12.60349	-1.105569	-9.065667	-10.17124	-10.17124	-9.286781	-7.738984	184.8512					
7/11/2007	90.65667	11.27681	-2.211138	-8.181212	-8.623439	-8.623439	-7.960098	-5.970073	178.66					
7/12/2007	89.99333	5.970073	-2.432252	-4.64339	-4.64339	-5.527846	-7.51787	-8.844553	183.5245					
7/13/2007	53.95177	24.10141	5.085618	-7.738984	-8.623439	-9.729009	-9.950122	-9.065667	184.63					
7/14/2007	68.10306	24.10141	7.296756	-6.191187	-7.296756	-6.412301	-5.970073	-5.306732	68.10306					
7/15/2007	44.66499	13.26683	-0.663341	-7.075643	-6.633415	-6.191187	-6.633415	-7.296756	88.88776					
7/16/2007	44.00165	21.22693	2.432252	-8.181212	-8.623439	-8.181212	-8.181212	-8.623439	200.5502					
7/17/2007	39.13715	19.2369	5.74896	-7.51787	-8.844553	-7.738984	-7.960098	-6.633415	165.8354					
7/18/2007	18.57356	13.70906	-1.768911	-2.653366	-3.316707	-3.537821	-3.537821	-4.201163	84.6866					
7/19/2007	32.72485	33.16707	14.59351	-3.980049	-3.758935	-3.537821	-3.316707	-3.316707	63.9019					
7/20/2007	26.31255	19.67913	3.316707	-3.537821	-5.527846	-4.422277	-2.653366	-2.87448	69.87197					
7/21/2007	97.95343	51.07729	11.71903	-8.402326	-9.286781	-7.51787	-4.864504	-3.758935	141.2917					
7/22/2007	95.74229	55.05734	9.729009	-3.316707	-2.432252	-3.758935	-4.422277	-6.633415	196.7913					
7/23/2007	88.66665	49.97173	5.306732	-13.26683	-12.8246	-10.83458	-10.39235	-9.286781	197.2335					
7/24/2007	50.63507	25.87032	8.623439	-7.960098	-7.51787	-6.854529	-6.633415	-8.181212	189.9368					
7/25/2007	40.68494	27.41811	1.768911	-4.201163	-4.422277	-6.854529	-5.970073	-5.085618	180.8711					
7/26/2007	18.57356	10.17124	2.432252	-2.211138	-2.653366	-3.758935	-4.422277	-3.980049	59.25851					
7/27/2007	62.79633	30.95594	6.633415	-3.316707	-3.758935	-4.201163	-5.74896	-6.412301	69.87197					
7/28/2007	61.24853	44.00165	9.286781	-7.738984	-8.402326	-8.181212	-7.960098	-7.738984	175.7855					
7/29/2007	45.54945	25.20698	5.306732	-7.738984	-8.623439	-7.738984	-6.854529	-5.306732	151.0207					
7/30/2007	68.7664	38.25269	2.211138	-8.181212	-9.065667	-8.844553	-7.738984	-7.51787	183.5245					

Solar radiation data in Btu/ft2-hr

Date	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00
7/1/2007	-7.738984	-5.970073	-4.64339	-3.980049	-3.537821	-2.432252	17.24688	56.16291	100.1646	143.9451	168.0465	160.0864	140.8495	109.4513	42.23274	-4.422277
7/2/2007	-5.306732	-4.64339	-3.095594	-2.87448	-2.653366	-1.990024	5.306732	13.70906	47.9817	53.50955	79.37986	74.51536	43.33831	122.9393	125.5927	138.8595
7/3/2007	-5.306732	-4.64339	-4.422277	-4.201163	-5.527846	-3.980049	22.3325	53.06732	99.94345	144.3873	177.9966	176.8911	114.537	102.5968	68.98751	112.5469
7/4/2007	-5.970073	-5.74896	-5.74896	-4.201163	-2.432252	-3.758935	2.432252	13.26683	46.87613	122.9393	65.89192	113.4314	187.0623	150.3574	142.1762	117.4114
7/5/2007	-8.844553	-8.181212	-7.075643	-4.201163	-5.74896	-7.738984	3.537821	31.17705	110.3358	148.3674	178.4389	198.5602	208.2892	191.9268	151.2419	109.6725
7/6/2007	-9.507895	-10.17124	-9.507895	-9.065667	-9.729009	-6.854529	3.537821	43.78054	80.26432	145.2718	172.6899	193.2535	190.8212	190.379	165.172	107.2402
7/7/2007	-8.181212	-8.623439	-8.402326	-7.960098	-8.623439	-8.402326	16.36242	26.75477	66.77638	141.5129	175.1222	192.1479	193.4746	186.6201	160.9709	103.7024
7/8/2007	-12.8246	-12.60349	-10.61346	-7.296756	-6.854529	-5.306732	14.3724	59.03739	88.88776	138.8595	154.1163	200.7714	202.5403	193.4746	167.3832	103.039
7/9/2007	-11.27681	-7.51787	-5.74896	-4.864504	-4.422277	-3.537821	21.44804	59.47962	99.50122	139.9651	158.3175	139.7439	176.2277	177.5544	160.7498	103.4813
7/10/2007	-8.402326	-7.738984	-7.075643	-6.191187	-5.527846	-4.864504	17.46799	56.82625	91.32001	136.6483	168.4887	184.63	170.921	158.9808	119.8437	70.97754
7/11/2007	-6.854529	-6.854529	-6.191187	-7.075643	-7.075643	-5.970073	15.69908	51.96175	91.98335	133.5528	166.2776	188.6101	189.2734	189.0523	166.7198	112.7681
7/12/2007	-8.181212	-7.960098	-7.960098	-7.296756	-7.075643	-5.527846	16.58354	53.50955	93.08892	134.8794	168.0465	184.4089	192.5901	183.5245	168.931	45.77056
7/13/2007	-8.623439	-9.286781	-7.960098	-6.191187	-5.085618	-7.296756	11.49792	64.34412	92.86781	138.1961	165.8354	170.4788	181.0922	177.5544	153.453	98.39565
7/14/2007	-8.623439	-7.738984	-8.402326	-6.633415	-5.527846	-4.64339	17.02576	39.80049	76.28427	96.40563	144.8296	162.9609	131.5627	185.9567	142.1762	88.66665
7/15/2007	-5.74896	-4.64339	-4.201163	-4.864504	-4.201163	-6.191187	12.60349	47.76059	68.32417	66.55526	53.73066	17.24688	44.66499	68.7664	44.44388	52.62509
7/16/2007	-3.980049	-3.980049	-3.758935	-5.085618	-8.623439	-6.412301	1.990024	14.59351	23.88029	10.83458	-1.547797	6.191187	13.93017	15.03574	-1.990024	8.623439
7/17/2007	-7.296756	-6.854529	-6.854529	-6.854529	-7.075643	-5.970073	3.758935	55.9418	47.09725	115.6425	157.8753	172.911	115.8636	113.8736	171.8054	93.08892
7/18/2007	-6.854529	-6.633415	-5.74896	-6.191187	-6.191187	-8.844553	1.105569	47.9817	58.59516	73.40979	17.68911	43.78054	50.19284	66.33415	97.29009	22.77472
7/19/2007	-7.296756	-7.738984	-7.075643	-7.296756	-7.075643	-5.970073	22.99584	37.81046	95.9634	129.1305	93.08892	94.85783	103.7024	53.73066	58.37405	51.29841
7/20/2007	-7.075643	-9.065667	-9.729009	-8.844553	-8.844553	-9.729009	9.286781	40.0216	49.08727	108.788	131.5627	166.4987	156.5486	149.0307	114.0947	61.91187
7/21/2007	-7.51787	-8.181212	-7.738984	-7.075643	-5.74896	-5.527846	23.21695	40.68494	21.89027	45.10722	47.9817	91.0989	181.3133	171.8054	154.3375	83.35991
7/22/2007	-7.738984	-7.296756	-5.74896	-5.527846	-4.864504	-5.527846	13.70906	21.66916	18.57356	117.8537	162.0764	145.714	166.4987	142.3973	154.3375	59.03739
7/23/2007	-4.422277	-5.970073	-5.74896	-5.527846	-5.74896	-6.412301	19.2369	48.86616	69.87197	111.4414	88.22442	141.9551	163.6242	188.1679	164.2876	102.1546
7/24/2007	-6.854529	-7.51787	-9.950122	-9.729009	-11.71903	-9.286781	15.03574	30.51371	58.81628	100.6068	139.5228	187.0623	193.0324	197.6758	151.2419	33.38819
7/25/2007	-9.729009	-12.8246	-12.8246	-15.03574	-14.15129	-13.04572	-0.663341	29.40814	38.47381	120.9493	95.07895	98.61677	174.4588	67.66083	148.1463	72.08311
7/26/2007	-10.61346	-7.960098	-5.306732	-11.05569	-10.17124	-6.854529	3.758935	47.09725	90.65667	103.4813	152.5685	173.5744	194.3591	143.5029	141.5129	124.266
7/27/2007	-12.8246	-12.8246	-13.04572	-12.60349	-11.05569	-8.402326	1.768911	37.58935	87.33996	128.0249	175.3433	195.2435	205.857	198.118	138.8595	110.1147
7/28/2007	-10.61346	-11.27681	-10.17124	-5.085618	-2.432252	-3.758935	-1.547797	8.402326	10.83458	21.66916	93.08892	116.7481	59.92185	70.53531	75.84204	41.5694
7/29/2007	-3.316707	-4.201163	-3.095594	-3.980049	-3.316707	-3.095594	-0.663341	41.12717	94.63672	50.85618	8.181212	13.70906	19.01579	21.44804	30.29259	36.26267
7/30/2007	-1.547797	-4.201163	-4.864504	-3.980049	-3.980049	-3.758935	6.633415	47.09725	64.78635	142.6184	185.7356	207.4048	140.4073	153.2319	129.3516	129.5727

Solar radiation

Date	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	Max	SH	Min	Avg	STD	Cap
7/1/2007	8.402326	10.83458	0.442228	-4.201163	-4.201163	-5.085618	-3.758935	-6.412301	168.0465					
7/2/2007	114.3159	38.69492	7.075643	-7.075643	-7.960098	-7.075643	-6.412301	-5.970073	138.8595					
7/3/2007	47.09725	28.08146	-0.663341	-6.633415	-5.306732	-8.402326	-7.960098	-7.296756	177.9966					
7/4/2007	85.12882	49.97173	4.64339	-9.065667	-10.17124	-9.507895	-8.844553	-8.623439	187.0623					
7/5/2007	95.52117	49.97173	4.864504	-10.61346	-11.05569	-10.61346	-9.729009	-9.286781	208.2892					
7/6/2007	90.87778	48.42393	5.74896	-9.507895	-9.950122	-9.065667	-6.191187	-6.633415	193.2535					
7/7/2007	90.43556	44.00165	2.211138	-13.04572	-13.48794	-13.26683	-13.48794	-12.60349	193.4746					
7/8/2007	90.87778	48.64504	3.980049	-12.38237	-12.8246	-13.26683	-13.26683	-12.38237	202.5403					
7/9/2007	88.22442	44.22277	3.316707	-9.729009	-10.61346	-9.950122	-9.729009	-8.402326	177.5544					
7/10/2007	78.2743	21.00581	1.990024	-8.402326	-8.181212	-7.51787	-6.633415	-6.854529	184.63					
7/11/2007	74.07313	5.306732	-3.095594	-7.51787	-6.854529	-7.296756	-8.402326	-8.402326	189.2734					
7/12/2007	23.65918	36.48378	-2.432252	-9.065667	-9.065667	-9.729009	-9.065667	-8.844553	192.5901					
7/13/2007	78.05318	38.03158	0	-9.065667	-6.191187	-5.085618	-6.633415	-8.623439	181.0922					
7/14/2007	64.34412	27.86034	1.326683	-10.61346	-7.51787	-6.412301	-6.191187	-5.527846	185.9567					
7/15/2007	42.01163	19.2369	0.663341	-5.74896	-6.191187	-4.64339	-4.422277	-3.980049	68.7664					
7/16/2007	5.970073	-0.884455	-4.201163	-7.075643	-7.960098	-8.623439	-9.729009	-9.950122	23.88029					
7/17/2007	25.20698	13.70906	0.442228	-4.422277	-3.980049	-4.64339	-4.864504	-5.527846	172.911					
7/18/2007	25.20698	21.00581	-2.87448	-8.402326	-5.085618	-8.402326	-7.075643	-5.527846	97.29009					
7/19/2007	87.78219	34.05153	1.990024	-6.412301	-8.181212	-7.51787	-8.402326	-8.623439	129.1305					
7/20/2007	73.85202	39.13715	-0.442228	-7.738984	-5.970073	-7.51787	-7.075643	-6.854529	166.4987					
7/21/2007	35.37821	17.24688	1.326683	-9.065667	-10.17124	-9.729009	-8.844553	-7.738984	181.3133					
7/22/2007	38.25269	24.32252	-0.663341	-9.507895	-7.738984	-4.864504	-4.64339	-4.201163	166.4987					
7/23/2007	78.05318	26.53366	-2.653366	-7.960098	-8.402326	-6.633415	-7.296756	-9.065667	188.1679					
7/24/2007	49.97173	16.14131	-6.633415	-13.48794	-13.48794	-13.04572	-12.16126	-11.94015	197.6758					
7/25/2007	30.29259	15.25685	-3.537821	-7.075643	-12.60349	-13.48794	-12.38237	-9.507895	174.4588					
7/26/2007	65.22858	20.12136	-6.854529	-11.94015	-12.38237	-12.38237	-12.38237	-11.94015	194.3591					
7/27/2007	25.6492	7.075643	-5.74896	-7.51787	-4.422277	-9.286781	-11.27681	-11.27681	205.857					
7/28/2007	7.075643	3.316707	-5.970073	-7.738984	-4.64339	-6.191187	-7.296756	-5.970073	116.7481					
7/29/2007	24.54364	7.51787	-3.316707	-5.74896	-3.316707	-3.537821	-4.422277	-3.316707	94.63672					
7/30/2007	40.0216	21.89027	-5.306732	-8.402326	-5.527846	-5.306732	-5.085618	-8.402326	207.4048					

APPENDIX F: RAW FLARE PROCESS DATA

Temporary Flare Raw Data

	DDF9982B.PV	DDF9982A.PV	DDA9599A.PV	DDA9599B.PV	DDA9599C.PV	DDA9599D.PV	DDA9599E.PV	DDA9599F.PV
	Flare Header Flow Tag (High) MSCFH	Flare Header Flow Tag (Low) MSCFH	Carbon Dioxide mole %	Ethylene mole %	Ethane mole %	Acetylene mole %	Hydrogen mole %	Oxygen mole %
8/7/07 22:00	787.42	399.70	0.05	0.01	2.01	0.00	79.74	0.00
8/7/07 23:00	794.14	399.73	0.04	0.01	2.05	0.00	79.25	0.00
8/8/07 0:00	806.68	399.74	0.04	0.01	1.96	0.00	79.76	0.00
8/8/07 1:00	799.03	399.74	0.04	0.01	1.96	0.00	79.66	0.00
8/8/07 2:00	807.72	399.75	0.04	0.00	1.91	0.00	79.99	0.00
8/8/07 3:00	829.66	399.77	0.04	0.00	1.90	0.00	79.44	0.00
8/8/07 4:00	838.44	399.77	0.04	0.00	1.86	0.00	78.84	0.00
8/8/07 5:00	832.90	399.75	0.04	0.01	1.85	0.00	79.01	0.00
8/8/07 6:00	821.96	399.74	0.04	0.01	1.85	0.00	79.16	0.00
8/8/07 7:00								
8/9/07 0:00	858	399.74	0.11	0.00	1.94	0.00	80.48	0.00
8/9/07 1:00	859	399.74	0.11	0.00	1.96	0.00	80.24	0.03
8/9/07 2:00	895	399.74	0.08	0.01	1.96	0.00	80.66	0.04
8/9/07 3:00	892	399.77	0.04	0.01	1.89	0.00	82.05	0.03
8/9/07 4:00	861	399.78	0.05	0.00	1.92	0.00	80.58	0.03
8/9/07 5:00	877	399.78	0.04	0.01	1.95	0.00	80.38	0.03
8/9/07 6:00	872	399.81	0.04	0.00	1.92	0.00	80.59	0.02
8/9/07 7:00	898	399.81	0.04	0.00	1.96	0.00	80.31	0.03
8/9/07 8:00	858	399.78	0.05	0.01	1.96	0.00	79.94	0.04
8/9/07 9:00	859	399.76	0.04	0.00	1.95	0.00	79.87	0.04
8/9/07 10:00	839	399.74	0.04	0.00	2.03	0.00	78.92	0.04
8/9/07 11:00	855	399.72	0.04	0.01	1.99	0.00	79.21	0.04
8/9/07 12:00	842	399.70	0.04	0.00	1.99	0.00	79.06	0.03
8/9/07 13:00	839	399.70	0.04	0.01	2.00	0.00	78.73	0.03
8/9/07 14:00	868	399.68	0.04	0.01	1.99	0.00	79.16	0.03
8/9/07 15:00	856	399.67	0.04	0.01	1.98	0.00	79.67	0.00
8/9/07 16:00	869	399.67	0.04	0.01	1.95	0.00	80.46	0.00
8/9/07 17:00	804	399.64	0.04	0.01	2.38	0.00	77.27	0.00
8/9/07 18:00	753	399.63	0.04	0.00	2.28	0.00	78.02	0.00
8/9/07 19:00	753	399.65	0.04	0.00	2.21	0.00	78.20	0.00
8/9/07 20:00	759	399.68	0.05	0.00	2.19	0.00	78.67	0.00
8/9/07 21:00	767	399.70	0.08	0.00	2.12	0.00	79.27	0.00
8/9/07 22:00	754	399.71	0.09	0.00	2.10	0.00	79.37	0.00
8/9/07 23:00	772	399.72	0.10	0.00	2.07	0.00	79.61	0.00
8/10/07 0:00	753	399.74	0.10	0.00	2.03	0.00	79.88	0.00
8/10/07 1:00	758	399.74	0.10	0.00	2.04	0.00	79.80	0.00
8/10/07 2:00	769	399.75	0.10	0.00	1.99	0.00	80.37	0.00

	DDF9982B.PV	DDF9982A.PV	DDA9599A.PV	DDA9599B.PV	DDA9599C.PV	DDA9599D.PV	DDA9599E.PV	DDA9599F.PV
	Flare Header Flow Tag (High) MSCFH	Flare Header Flow Tag (Low) MSCFH	Carbon Dioxide mole %	Ethylene mole %	Ethane mole %	Acetylene mole %	Hydrogen mole %	Oxygen mole %
8/10/07 3:00	756	399.78	0.10	0.00	2.01	0.00	79.87	0.00
8/10/07 4:00	767	399.78	0.10	0.00	1.95	0.00	80.04	0.00
8/10/07 5:00	769	399.78	0.09	0.00	1.96	0.00	80.21	0.00
8/10/07 6:00	792	399.81	0.08	0.00	1.91	0.00	80.67	0.00
8/10/07 7:00	778	399.81	0.08	0.00	1.90	0.00	80.61	0.00
8/10/07 8:00	776	399.78	0.07	0.01	1.92	0.00	80.43	0.00
8/10/07 9:00	765	399.76	0.07	0.01	1.91	0.00	80.41	0.01
8/10/07 10:00	756	399.74	0.06	0.01	1.89	0.00	79.95	0.01
8/10/07 11:00	761	399.70	0.05	0.01	1.91	0.00	80.00	0.00
8/10/07 12:00	748	399.69	0.05	0.01	1.89	0.00	79.82	0.01
8/10/07 13:00	748	399.67	0.04	0.00	1.90	0.00	79.84	0.01
8/10/07 14:00	755	399.67	0.04	0.01	1.82	0.00	80.69	0.00
8/10/07 15:00	743	399.66	0.04	0.01	1.81	0.00	80.34	0.00
8/10/07 16:00	764	399.66	0.04	0.01	1.75	0.00	81.55	0.00
8/10/07 17:00	756	399.63	0.05	0.01	1.78	0.00	81.66	0.00
8/10/07 18:00	777	399.63	0.04	0.01	1.69	0.00	81.93	0.00
8/10/07 19:00	773	399.64	0.04	0.00	1.69	0.00	81.34	0.00
8/10/07 20:00	777	399.68	0.04	0.00	1.64	0.00	81.80	0.00
8/10/07 21:00	767	399.70	0.04	0.00	1.77	0.00	80.89	0.00
8/10/07 22:00	800	399.70	0.04	0.00	2.22	0.00	77.74	0.00
8/10/07 23:00	825	399.71	0.04	0.00	1.85	0.00	80.71	0.00
8/11/07 0:00	805	399.71	0.07	0.00	1.70	0.00	82.51	0.00
8/11/07 1:00	779	399.74	0.09	0.00	1.69	0.00	82.09	0.00
8/11/07 2:00	800	399.76	0.08	0.00	1.73	0.00	83.83	0.00
8/11/07 3:00	834	399.78	0.08	0.01	1.70	0.00	84.27	0.00
8/11/07 4:00	847	399.78	0.10	0.01	1.66	0.00	83.57	0.00
8/11/07 5:00	839	399.78	0.10	0.01	1.67	0.00	83.95	0.00
8/11/07 6:00	860	399.78	0.12	0.00	1.62	0.00	83.40	0.00
8/11/07 7:00	873	399.78	0.12	0.00	1.65	0.00	83.21	0.00
8/11/07 8:00	865	399.77	0.12	0.01	1.62	0.00	83.46	0.00
8/11/07 9:00	845	399.74	0.12	0.01	1.64	0.00	83.09	0.00
8/11/07 10:00	884	399.71	0.09	0.01	1.68	0.00	84.28	0.00
8/11/07 11:00	904	399.69	0.09	0.01	1.70	0.00	84.22	0.00
8/11/07 12:00	860	399.67	0.11	0.00	1.52	0.00	84.66	0.00
8/11/07 13:00	858	399.65	0.14	0.00	1.65	0.00	82.92	0.00
8/11/07 14:00	872	399.63	0.13	0.00	1.72	0.00	82.64	0.00
8/11/07 15:00	893	399.63	0.10	0.00	1.70	0.00	84.11	0.00
8/11/07 16:00	866	399.62	0.09	0.01	1.70	0.00	84.20	0.00

	DDF9982B.PV	DDF9982A.PV	DDA9599A.PV	DDA9599B.PV	DDA9599C.PV	DDA9599D.PV	DDA9599E.PV	DDA9599F.PV
	Flare Header Flow Tag (High) MSCFH	Flare Header Flow Tag (Low) MSCFH	Carbon Dioxide mole %	Ethylene mole %	Ethane mole %	Acetylene mole %	Hydrogen mole %	Oxygen mole %
8/11/07 17:00	891	399.60	0.10	0.01	1.71	0.00	83.85	0.00
8/11/07 18:00	888	399.63	0.09	0.00	1.71	0.00	84.20	0.00
8/11/07 19:00	906	399.66	0.09	0.00	1.72	0.00	83.79	0.00
8/11/07 20:00	895	399.69	0.10	0.01	1.66	0.00	84.23	0.00
8/11/07 21:00	922	399.70	0.10	0.00	1.67	0.00	84.03	0.00
8/11/07 22:00	934	399.70	0.11	0.00	1.57	0.00	83.67	0.00
8/11/07 23:00	915	399.73	0.11	0.00	1.61	0.00	82.82	0.00
8/12/07 0:00								

	DDA9599G.PV	DDA9599H.PV	DDA9599I.PV	DDA9599J.PV	DDA9599K.PV	DDA9599L.PV	DDA9599M.PV	DDA9599N.PV
	Nitrogen mole %	Methane mole %	Carbon Monoxide mole %	Propane mole %	Isobutane mole %	Hydrogen Sulfide mole %	Butane mole %	1-Butene/ Isobutylene mole %
8/7/07 22:00	0.76	7.23	0.01	3.16	1.36	0.00	1.22	0.02
8/7/07 23:00	0.78	7.27	0.00	3.20	1.41	0.00	1.28	0.02
8/8/07 0:00	0.77	7.21	0.00	3.04	1.36	0.00	1.24	0.02
8/8/07 1:00	0.78	7.16	0.00	3.01	1.37	0.00	1.25	0.02
8/8/07 2:00	0.78	7.07	0.00	2.88	1.36	0.00	1.23	0.02
8/8/07 3:00	1.46	6.96	0.00	2.86	1.34	0.00	1.21	0.02
8/8/07 4:00	2.38	6.96	0.00	2.69	1.30	0.00	1.19	0.02
8/8/07 5:00	2.14	6.97	0.00	2.59	1.30	0.00	1.19	0.02
8/8/07 6:00	1.96	6.96	0.00	2.60	1.32	0.00	1.21	0.02
8/8/07 7:00								
8/9/07 0:00	1.17	6.84	0.00	2.68	1.33	0.00	1.17	0.02
8/9/07 1:00	1.24	6.90	0.01	2.70	1.35	0.00	1.19	0.02
8/9/07 2:00	1.26	6.64	0.01	2.71	1.34	0.00	1.18	0.02
8/9/07 3:00	1.15	5.63	0.00	2.64	1.30	0.00	1.15	0.02
8/9/07 4:00	1.26	6.70	0.01	2.65	1.33	0.00	1.18	0.02
8/9/07 5:00	1.14	7.20	0.00	2.67	1.32	0.00	1.17	0.02
8/9/07 6:00	1.29	7.13	0.00	2.62	1.29	0.00	1.14	0.02
8/9/07 7:00	1.32	7.20	0.00	2.68	1.32	0.00	1.18	0.02
8/9/07 8:00	1.34	7.12	0.01	2.71	1.35	0.00	1.20	0.02
8/9/07 9:00	1.30	7.23	0.01	2.68	1.35	0.00	1.20	0.02
8/9/07 10:00	1.44	7.29	0.01	2.80	1.43	0.00	1.29	0.02
8/9/07 11:00	1.43	7.25	0.00	2.72	1.37	0.00	1.23	0.02
8/9/07 12:00	1.42	7.19	0.01	2.74	1.39	0.00	1.26	0.02
8/9/07 13:00	1.46	7.17	0.00	2.75	1.40	0.00	1.28	0.02
8/9/07 14:00	1.45	7.17	0.00	2.69	1.33	0.00	1.20	0.02
8/9/07 15:00	1.11	7.19	0.00	2.67	1.31	0.00	1.17	0.02
8/9/07 16:00	0.43	7.17	0.00	2.63	1.28	0.00	1.15	0.02
8/9/07 17:00	0.39	8.77	0.00	3.19	1.53	0.00	1.36	0.02
8/9/07 18:00	0.66	8.38	0.00	3.06	1.47	0.00	1.29	0.02
8/9/07 19:00	1.15	8.12	0.00	2.96	1.42	0.00	1.26	0.02
8/9/07 20:00	1.12	8.04	0.00	2.90	1.37	0.00	1.21	0.02
8/9/07 21:00	1.07	7.96	0.00	2.80	1.31	0.00	1.15	0.02
8/9/07 22:00	1.06	7.91	0.00	2.79	1.29	0.00	1.15	0.02
8/9/07 23:00	1.08	7.87	0.00	2.75	1.26	0.00	1.13	0.02
8/10/07 0:00	1.04	7.77	0.00	2.70	1.24	0.00	1.12	0.02
8/10/07 1:00	1.05	7.69	0.00	2.72	1.26	0.00	1.13	0.02
8/10/07 2:00	1.03	7.65	0.00	2.63	1.19	0.00	1.07	0.02

	DDA9599G.PV	DDA9599H.PV	DDA9599I.PV	DDA9599J.PV	DDA9599K.PV	DDA9599L.PV	DDA9599M.PV	DDA9599N.PV
	Nitrogen mole %	Methane mole %	Carbon Monoxide mole %	Propane mole %	Isobutane mole %	Hydrogen Sulfide mole %	Butane mole %	1-Butene/ Isobutylene mole %
8/10/07 3:00	1.06	7.53	0.00	2.71	1.27	0.00	1.15	0.02
8/10/07 4:00	1.00	7.51	0.00	2.65	1.24	0.00	1.12	0.02
8/10/07 5:00	0.96	7.56	0.01	2.65	1.21	0.00	1.09	0.02
8/10/07 6:00	1.02	7.52	0.00	2.56	1.15	0.00	1.01	0.02
8/10/07 7:00	1.05	7.43	0.00	2.58	1.17	0.00	1.04	0.02
8/10/07 8:00	1.01	7.49	0.01	2.60	1.17	0.00	1.03	0.02
8/10/07 9:00	0.94	7.45	0.00	2.60	1.17	0.00	1.03	0.02
8/10/07 10:00	1.20	7.41	0.00	2.59	1.22	0.00	1.17	0.02
8/10/07 11:00	1.13	7.40	0.00	2.60	1.21	0.00	1.14	0.02
8/10/07 12:00	1.34	7.30	0.00	2.61	1.20	0.00	1.10	0.02
8/10/07 13:00	1.22	7.38	0.01	2.61	1.19	0.00	1.05	0.02
8/10/07 14:00	0.82	7.31	0.00	2.51	1.14	0.00	0.98	0.02
8/10/07 15:00	0.87	7.10	0.01	2.52	1.19	0.00	1.01	0.02
8/10/07 16:00	0.83	7.10	0.00	2.39	1.09	0.00	0.92	0.02
8/10/07 17:00	0.84	7.05	0.00	2.44	1.11	0.00	0.94	0.02
8/10/07 18:00	0.74	6.70	0.01	2.32	1.05	0.00	0.87	0.02
8/10/07 19:00	0.75	7.48	0.00	2.30	1.04	0.00	0.87	0.02
8/10/07 20:00	0.53	7.38	0.00	2.26	1.04	0.00	0.86	0.02
8/10/07 21:00	0.20	8.14	0.00	2.40	1.10	0.00	0.91	0.02
8/10/07 22:00	0.21	9.37	0.00	2.98	1.37	0.00	1.13	0.02
8/10/07 23:00	0.25	8.48	0.00	2.54	1.15	0.00	0.90	0.02
8/11/07 0:00	0.48	9.55	0.00	2.32	1.05	0.00	0.81	0.02
8/11/07 1:00	0.53	10.80	0.00	2.29	1.06	0.00	0.83	0.02
8/11/07 2:00	0.54	9.37	0.00	2.40	1.13	0.00	0.89	0.02
8/11/07 3:00	0.54	9.18	0.00	2.32	1.07	0.00	0.83	0.02
8/11/07 4:00	0.52	9.98	0.00	2.26	1.06	0.00	0.82	0.02
8/11/07 5:00	0.51	9.60	0.00	2.26	1.06	0.00	0.82	0.02
8/11/07 6:00	0.50	10.39	0.00	2.16	1.01	0.00	0.78	0.01
8/11/07 7:00	0.51	10.44	0.00	2.20	1.04	0.00	0.81	0.02
8/11/07 8:00	0.50	10.22	0.00	2.19	1.04	0.00	0.81	0.02
8/11/07 9:00	0.50	10.48	0.00	2.23	1.07	0.00	0.84	0.02
8/11/07 10:00	0.51	9.11	0.00	2.32	1.11	0.00	0.89	0.02
8/11/07 11:00	0.49	9.22	0.00	2.31	1.08	0.00	0.86	0.02
8/11/07 12:00	0.48	9.40	0.00	2.07	0.98	0.00	0.77	0.02
8/11/07 13:00	0.50	10.64	0.00	2.21	1.07	0.00	0.85	0.02
8/11/07 14:00	0.49	10.84	0.00	2.26	1.06	0.00	0.84	0.02
8/11/07 15:00	0.49	9.36	0.00	2.28	1.08	0.00	0.85	0.02
8/11/07 16:00	0.51	9.12	0.00	2.32	1.13	0.00	0.90	0.02

	DDA9599G.PV	DDA9599H.PV	DDA9599I.PV	DDA9599J.PV	DDA9599K.PV	DDA9599L.PV	DDA9599M.PV	DDA9599N.PV
	Nitrogen mole %	Methane mole %	Carbon Monoxide mole %	Propane mole %	Isobutane mole %	Hydrogen Sulfide mole %	Butane mole %	1-Butene/ Isobutylene mole %
8/11/07 17:00	0.45	9.60	0.00	2.30	1.10	0.00	0.87	0.02
8/11/07 18:00	0.49	9.21	0.00	2.30	1.10	0.00	0.86	0.02
8/11/07 19:00	0.51	8.80	0.01	2.34	1.14	0.00	0.90	0.02
8/11/07 20:00	0.50	9.23	0.00	2.27	1.11	0.00	0.87	0.02
8/11/07 21:00	0.53	9.32	0.00	2.28	1.14	0.00	0.90	0.02
8/11/07 22:00	0.49	10.23	0.00	2.11	1.02	0.00	0.78	0.02
8/11/07 23:00	0.51	10.81	0.00	2.18	1.09	0.00	0.85	0.02
8/12/07 0:00								

	DDA9599O.PV	DDA9599P.PV	DDA9599Q.PV	DDA9599R.PV	DDA9599S.PV	DDA9599T.PV	DDA9599U.PV	DDA9599V.PV
	Trans - 2 - Butene mole %	Cis - 2 -Butene mole %	1,3 Butadiene mole %	Water mole %	Total C5+ mole %	Propylene mole %	GC Calcated Net Heating Value btu/scf	GC Calcated Molecar Weight mole %
8/7/07 22:00	0.00	0.00	0.00	0.00	4.44	0.01	625.29	10.03
8/7/07 23:00	0.00	0.00	0.00	0.00	4.67	0.01	629.31	10.31
8/8/07 0:00	0.00	0.00	0.00	0.00	4.58	0.01	626.37	10.09
8/8/07 1:00	0.00	0.00	0.00	0.00	4.73	0.01	626.31	10.20
8/8/07 2:00	0.00	0.00	0.00	0.00	4.72	0.00	623.80	10.09
8/8/07 3:00	0.00	0.00	0.00	0.00	4.75	0.00	616.94	10.24
8/8/07 4:00	0.00	0.00	0.00	0.01	4.70	0.00	611.70	10.32
8/8/07 5:00	0.00	0.00	0.00	0.01	4.87	0.00	613.34	10.35
8/8/07 6:00	0.00	0.00	0.00	0.00	4.85	0.00	616.39	10.31
8/8/07 7:00								
8/9/07 0:00	0.00	0.00	0.00	0.00	4.24	0.00	600.69	9.69
8/9/07 1:00	0.00	0.00	0.00	0.00	4.25	0.00	602.53	9.77
8/9/07 2:00	0.00	0.00	0.00	0.00	4.12	0.00	596.16	9.62
8/9/07 3:00	0.00	0.00	0.00	0.00	4.10	0.00	585.10	9.32
8/9/07 4:00	0.00	0.00	0.00	0.01	4.26	0.00	599.33	9.67
8/9/07 5:00	0.00	0.00	0.00	0.00	4.08	0.00	597.29	9.60
8/9/07 6:00	0.00	0.00	0.00	0.00	3.94	0.00	588.28	9.43
8/9/07 7:00	0.00	0.00	0.00	0.00	3.95	0.00	592.59	9.53
8/9/07 8:00	0.00	0.00	0.00	0.00	4.26	0.00	604.76	9.83
8/9/07 9:00	0.00	0.00	0.00	0.00	4.32	0.00	606.10	9.83
8/9/07 10:00	0.00	0.00	0.00	0.00	4.68	0.00	626.99	10.34
8/9/07 11:00	0.00	0.00	0.00	0.00	4.70	0.00	622.32	10.24
8/9/07 12:00	0.00	0.00	0.00	0.00	4.85	0.00	628.22	10.37
8/9/07 13:00	0.00	0.00	0.00	0.00	5.10	0.00	637.42	10.61
8/9/07 14:00	0.00	0.00	0.00	0.00	4.89	0.00	626.57	10.34
8/9/07 15:00	0.00	0.00	0.00	0.00	4.84	0.00	622.70	10.15
8/9/07 16:00	0.00	0.00	0.00	0.00	4.87	0.00	623.06	9.93
8/9/07 17:00	0.00	0.00	0.00	0.00	5.02	0.00	668.02	10.90
8/9/07 18:00	0.00	0.00	0.00	0.00	4.76	0.00	649.23	10.56
8/9/07 19:00	0.00	0.00	0.00	0.00	4.61	0.00	635.33	10.42
8/9/07 20:00	0.00	0.00	0.00	0.00	4.41	0.00	624.03	10.16
8/9/07 21:00	0.00	0.00	0.00	0.00	4.21	0.00	611.02	9.87
8/9/07 22:00	0.00	0.00	0.00	0.00	4.20	0.00	609.23	9.83
8/9/07 23:00	0.00	0.00	0.00	0.00	4.12	0.00	603.06	9.72
8/10/07 0:00	0.00	0.00	0.00	0.00	4.09	0.00	599.36	9.62
8/10/07 1:00	0.00	0.00	0.00	0.00	4.18	0.00	603.41	9.71
8/10/07 2:00	0.00	0.00	0.00	0.00	3.95	0.00	588.97	9.39

	DDA9599O.PV Trans - 2 - Butene mole %	DDA9599P.PV Cis - 2 -Butene mole %	DDA9599Q.PV 1,3 Butadiene mole %	DDA9599R.PV Water mole %	DDA9599S.PV Total C5+ mole %	DDA9599T.PV Propylene mole %	DDA9599U.PV GC Calcated Net Heating Value btu/scf	DDA9599V.PV GC Calcated Molecar Weight mole %
8/10/07 3:00	0.00	0.00	0.00	0.01	4.26	0.00	604.79	9.75
8/10/07 4:00	0.00	0.00	0.00	0.00	4.38	0.00	605.65	9.75
8/10/07 5:00	0.00	0.00	0.00	0.00	4.22	0.00	599.50	9.60
8/10/07 6:00	0.00	0.00	0.00	0.00	4.04	0.00	586.69	9.34
8/10/07 7:00	0.00	0.00	0.00	0.00	4.12	0.00	589.97	9.41
8/10/07 8:00	0.00	0.00	0.00	0.00	4.23	0.00	595.04	9.52
8/10/07 9:00	0.00	0.00	0.00	0.00	4.37	0.01	599.43	9.59
8/10/07 10:00	0.00	0.00	0.00	0.00	4.47	0.00	606.25	9.82
8/10/07 11:00	0.00	0.00	0.00	0.00	4.54	0.00	608.52	9.84
8/10/07 12:00	0.00	0.00	0.00	0.00	4.66	0.00	609.16	9.93
8/10/07 13:00	0.00	0.00	0.00	0.00	4.72	0.00	611.31	9.94
8/10/07 14:00	0.00	0.00	0.00	0.00	4.66	0.00	603.25	9.64
8/10/07 15:00	0.00	0.00	0.00	0.00	5.09	0.00	619.10	10.01
8/10/07 16:00	0.00	0.00	0.00	0.00	4.30	0.00	583.67	9.21
8/10/07 17:00	0.00	0.00	0.00	0.00	4.10	0.00	579.25	9.09
8/10/07 18:00	0.00	0.00	0.00	0.00	4.61	0.00	587.43	9.28
8/10/07 19:00	0.00	0.00	0.00	0.00	4.46	0.00	586.48	9.26
8/10/07 20:00	0.00	0.00	0.00	0.00	4.43	0.00	583.12	9.11
8/10/07 21:00	0.00	0.00	0.00	0.00	4.53	0.00	600.05	9.37
8/10/07 22:00	0.00	0.00	0.00	0.00	4.92	0.00	651.65	10.49
8/10/07 23:00	0.00	0.00	0.00	0.00	4.04	0.00	590.73	9.17
8/11/07 0:00	0.00	0.00	0.00	0.00	1.49	0.00	498.82	7.17
8/11/07 1:00	0.00	0.00	0.00	0.00	0.52	0.00	473.47	6.63
8/11/07 2:00	0.00	0.00	0.00	0.00	0.00	0.00	453.51	6.15
8/11/07 3:00	0.00	0.00	0.00	0.00	0.00	0.00	446.68	6.00
8/11/07 4:00	0.00	0.00	0.00	0.00	0.00	0.00	449.54	6.08
8/11/07 5:00	0.00	0.00	0.00	0.01	0.00	0.00	447.17	6.02
8/11/07 6:00	0.00	0.00	0.00	0.00	0.00	0.00	446.88	6.02
8/11/07 7:00	0.00	0.00	0.00	0.00	0.00	0.00	450.29	6.10
8/11/07 8:00	0.00	0.00	0.00	0.00	0.00	0.00	448.62	6.06
8/11/07 9:00	0.00	0.00	0.00	0.00	0.00	0.00	452.83	6.15
8/11/07 10:00	0.00	0.00	0.00	0.00	0.00	0.00	449.37	6.06
8/11/07 11:00	0.00	0.00	0.00	0.00	0.00	0.00	448.04	6.02
8/11/07 12:00	0.00	0.00	0.00	0.00	0.00	0.00	436.98	5.80
8/11/07 13:00	0.00	0.00	0.00	0.00	0.00	0.00	453.72	6.18
8/11/07 14:00	0.00	0.00	0.00	0.00	0.00	0.00	456.81	6.24
8/11/07 15:00	0.00	0.00	0.00	0.00	0.00	0.00	448.41	6.02
8/11/07 16:00	0.00	0.00	0.00	0.00	0.00	0.00	450.82	6.06

	DDA9599O.PV	DDA9599P.PV	DDA9599Q.PV	DDA9599R.PV	DDA9599S.PV	DDA9599T.PV	DDA9599U.PV	DDA9599V.PV
	Trans - 2 - Butene mole %	Cis - 2 -Butene mole %	1,3 Butadiene mole %	Water mole %	Total C5+ mole %	Propylene mole %	GC Calcated Net Heating Value btu/scf	GC Calcated Molecar Weight mole %
8/11/07 17:00	0.00	0.00	0.00	0.00	0.00	0.00	451.43	6.08
8/11/07 18:00	0.00	0.00	0.00	0.01	0.00	0.00	448.35	6.03
8/11/07 19:00	0.00	0.00	0.00	0.00	0.69	0.00	469.25	6.51
8/11/07 20:00	0.00	0.00	0.00	0.00	0.00	0.00	448.31	6.03
8/11/07 21:00	0.00	0.00	0.00	0.00	0.00	0.00	450.84	6.10
8/11/07 22:00	0.00	0.00	0.00	0.00	0.00	0.00	445.16	5.98
8/11/07 23:00	0.00	0.00	0.00	0.00	0.00	0.00	454.19	6.18
8/12/07 0:00								

Permanent Flare Raw Data

	ULF2191B.PV	ULF2191A.PV	ULA2190A.PV	ULA2190B.PV	ULA2190C.PV	ULA2190D.PV	ULA2190E.PV	ULA2190F.PV
	Flare Low Range Flow	Flare High Range Flow	Flare Gas Carbon Dioxide	Flare Gas Ethylene	Flare Gas Ethane	Flare Gas Acetylene	Flare Gas Hydrogen	Flare Gas Oxygen
	mscfh	mscfh	mole %	mole %	mole %	mole %	mole %	mole %
8/9/07 0:00	56.03	0.00	0.80	0.03	2.26	0.00	13.30	0.17
8/9/07 1:00	56.05	0.00	0.78	0.03	2.18	0.00	13.29	0.17
8/9/07 2:00	55.99	0.00	0.80	0.03	2.16	0.00	13.28	0.17
8/9/07 3:00	56.95	0.00	0.78	0.03	2.30	0.00	13.29	0.18
8/9/07 4:00	55.27	0.00	0.78	0.04	2.19	0.00	13.54	0.18
8/9/07 5:00	55.51	0.00	0.78	0.03	2.27	0.00	13.69	0.18
8/9/07 6:00	57.05	0.00	0.78	0.03	1.89	0.00	13.64	0.18
8/9/07 7:00	60.09	0.00	0.75	0.03	1.57	0.00	14.14	0.17
8/9/07 8:00	63.23	0.00	0.63	0.31	2.01	0.00	18.49	0.17
8/9/07 9:00	58.17	0.00	0.71	0.18	2.31	0.00	15.35	0.18
8/9/07 10:00	56.89	0.00	0.79	0.06	2.16	0.00	13.59	0.16
8/9/07 11:00	60.85	0.00	0.80	0.05	2.15	0.00	12.96	0.15
8/9/07 12:00	59.88	0.00	0.77	0.04	2.11	0.00	12.85	0.15
8/9/07 13:00	63.48	0.00	0.77	0.03	2.05	0.00	12.63	0.14
8/9/07 14:00	62.09	0.00	0.80	0.03	2.28	0.00	12.80	0.15
8/9/07 15:00	140.93	108.07	0.79	0.03	1.86	0.00	10.85	0.16
8/9/07 16:00	78.53	84.72	0.39	0.01	1.07	0.00	58.82	0.09
8/9/07 17:00	92.60	11.95	0.77	0.03	2.22	0.00	13.92	0.13
8/9/07 18:00	114.76	19.22	0.37	0.01	1.78	0.00	24.89	0.11
8/9/07 19:00	74.01	0.00	0.77	0.03	2.36	0.00	12.12	0.15
8/9/07 20:00	61.90	0.00	0.71	0.03	2.08	0.00	13.92	0.17
8/9/07 21:00	61.66	0.00	0.66	0.03	1.85	0.00	14.46	0.18
8/9/07 22:00	60.80	0.00	0.66	0.03	1.97	0.00	14.36	0.18
8/9/07 23:00	61.13	0.00	0.65	0.03	1.84	0.00	14.41	0.18
8/10/07 0:00	60.69	0.00	0.66	0.03	1.91	0.00	14.44	0.18
8/10/07 1:00	61.22	0.00	0.65	0.03	1.84	0.00	14.40	0.18
8/10/07 2:00	60.34	0.00	0.66	0.03	1.86	0.00	14.51	0.18
8/10/07 3:00	59.60	0.00	0.66	0.03	1.90	0.00	14.69	0.18
8/10/07 4:00	60.42	0.00	0.67	0.03	1.84	0.00	14.46	0.18
8/10/07 5:00	58.93	0.00	0.67	0.03	1.99	0.00	14.47	0.18
8/10/07 6:00	58.30	0.00	0.66	0.03	1.86	0.00	14.41	0.18
8/10/07 7:00	59.46	0.00	0.67	0.03	1.85	0.00	14.42	0.18
8/10/07 8:00	59.26	0.00	0.67	0.03	1.88	0.00	14.41	0.18
8/10/07 9:00	65.74	0.00	0.68	0.04	1.89	0.00	14.67	0.16
8/10/07 10:00	60.96	0.00	0.89	0.03	2.26	0.00	12.22	0.15
8/10/07 11:00	61.06	0.00	0.70	0.05	1.98	0.00	13.26	0.16
8/10/07 12:00	65.28	0.00	0.66	0.04	1.84	0.00	13.90	0.16

	ULF2191B.PV	ULF2191A.PV	ULA2190A.PV	ULA2190B.PV	ULA2190C.PV	ULA2190D.PV	ULA2190E.PV	ULA2190F.PV
	Flare Low Range Flow	Flare High Range Flow	Flare Gas Carbon Dioxide	Flare Gas Ethylene	Flare Gas Ethane	Flare Gas Acetylene	Flare Gas Hydrogen	Flare Gas Oxygen
	mscfh	mscfh	mole %	mole %	mole %	mole %	mole %	mole %
8/10/07 13:00	67.42	0.00	0.74	0.04	1.98	0.00	12.88	0.08
8/10/07 14:00	65.73	0.00	0.89	0.03	2.40	0.00	10.46	0.12
8/10/07 15:00	64.00	0.00	0.74	0.03	1.96	0.00	12.48	0.15
8/10/07 16:00	63.73	0.00	0.75	0.03	1.95	0.00	13.20	0.15
8/10/07 17:00	66.57	0.00	0.71	0.03	2.05	0.00	13.54	0.15
8/10/07 18:00	103.42	95.26	0.75	0.03	1.83	0.00	13.31	0.15
8/10/07 19:00	200.00	324.07	1.23	0.01	3.09	0.00	7.42	0.03
8/10/07 20:00	200.00	510.32	1.39	0.00	2.99	0.00	5.53	0.03
8/10/07 21:00	200.00	379.32	1.07	0.00	2.65	0.00	31.40	0.01
8/10/07 22:00	200.00	252.55	1.46	0.00	3.01	0.00	3.12	0.09
8/10/07 23:00	200.00	248.81	1.15	0.00	2.10	0.00	9.89	0.14
8/11/07 0:00	200.00	297.89	1.41	0.00	3.52	0.00	3.19	0.03
8/11/07 1:00	200.00	295.31	1.39	0.00	2.53	0.00	2.93	0.03
8/11/07 2:00	200.00	291.31	1.54	0.00	2.41	0.00	2.88	0.03
8/11/07 3:00	200.00	289.26	1.48	0.00	3.36	0.00	2.83	0.03
8/11/07 4:00	200.00	288.73	1.40	0.00	3.14	0.00	3.01	0.04
8/11/07 5:00	200.00	288.62	1.52	0.00	4.07	0.00	2.96	0.04
8/11/07 6:00	200.00	294.17	1.42	0.00	2.73	0.00	2.88	0.05
8/11/07 7:00	200.00	161.04	1.47	0.00	3.38	0.00	3.50	0.14
8/11/07 8:00	200.00	140.40	1.35	0.00	3.32	0.00	4.38	0.15
8/11/07 9:00	200.00	140.82	1.40	0.00	2.70	0.00	4.27	0.15
8/11/07 10:00	200.00	144.40	1.34	0.00	3.39	0.00	4.78	0.15
8/11/07 11:00	200.00	142.48	1.34	0.00	2.63	0.00	4.27	0.15
8/11/07 12:00	178.32	72.47	1.33	0.00	2.83	0.00	4.86	0.15
8/11/07 13:00	152.50	33.91	1.19	0.00	3.22	0.00	6.34	0.08
8/11/07 14:00	153.68	32.83	1.21	0.00	2.38	0.00	6.13	0.15
8/11/07 15:00	154.48	30.11	1.27	0.00	2.80	0.00	6.33	0.15
8/11/07 16:00	153.64	29.19	1.23	0.00	2.69	0.00	6.34	0.15
8/11/07 17:00	160.91	43.12	1.28	0.00	2.62	0.00	6.30	0.15
8/11/07 18:00	178.30	69.54	1.28	0.00	3.58	0.00	5.39	0.15
8/11/07 19:00	174.11	70.88	1.27	0.00	2.61	0.00	5.30	0.15
8/11/07 20:00	173.40	72.06	1.35	0.00	3.11	0.00	5.48	0.15
8/11/07 21:00	173.62	70.97	1.31	0.00	3.35	0.00	5.33	0.15
8/11/07 22:00	195.08	133.80	1.34	0.00	2.90	0.00	4.80	0.15
8/11/07 23:00	200.00	149.47	1.41	0.00	3.37	0.00	4.13	0.14
8/12/07 0:00								

	ULA2190G.PV	ULA2190H.PV	ULA2190I.PV	ULA2190J.PV	ULA2190K.PV	ULA2190L.PV	ULA2190M.PV	ULA2190N.PV
	Flare Gas Nitrogen	Flare GasMethane	Flare Gas Carbon Monoxide	Flare Gas Propane	Flare Gas Isobutane	Flare Gas Hydrogen Sulfide	Flare Gas Butane	Flare Gas 1-Butene/ Isobutylene
	mole %	mole %	mole %	mole %	mole %	mole %	mole %	mole %
8/9/07 0:00	34.95	46.75	0.00	0.52	0.13	0.05	0.10	0.00
8/9/07 1:00	35.06	46.82	0.00	0.52	0.13	0.05	0.10	0.00
8/9/07 2:00	35.09	46.82	0.00	0.50	0.13	0.05	0.10	0.00
8/9/07 3:00	35.38	46.40	0.00	0.52	0.13	0.05	0.09	0.00
8/9/07 4:00	35.42	46.23	0.00	0.53	0.13	0.05	0.10	0.00
8/9/07 5:00	35.68	45.68	0.00	0.55	0.15	0.05	0.10	0.00
8/9/07 6:00	35.99	45.73	0.00	0.55	0.16	0.05	0.12	0.00
8/9/07 7:00	37.80	43.47	0.00	0.64	0.21	0.05	0.18	0.00
8/9/07 8:00	37.04	38.25	0.00	1.13	0.33	0.09	0.22	0.02
8/9/07 9:00	36.07	42.90	0.00	0.86	0.22	0.06	0.14	0.01
8/9/07 10:00	34.92	46.53	0.00	0.56	0.15	0.05	0.10	0.00
8/9/07 11:00	34.33	47.79	0.00	0.52	0.15	0.05	0.10	0.00
8/9/07 12:00	34.90	47.36	0.00	0.48	0.15	0.05	0.10	0.00
8/9/07 13:00	34.67	47.94	0.00	0.45	0.13	0.05	0.10	0.00
8/9/07 14:00	35.20	46.87	0.00	0.51	0.14	0.05	0.10	0.00
8/9/07 15:00	48.57	35.85	0.00	0.45	0.13	0.04	0.10	0.00
8/9/07 16:00	16.44	22.07	0.00	0.23	0.05	0.01	0.04	0.00
8/9/07 17:00	35.43	45.36	0.00	0.55	0.19	0.06	0.13	0.00
8/9/07 18:00	44.37	23.18	0.00	1.26	0.46	0.02	0.52	0.00
8/9/07 19:00	35.83	46.72	0.00	0.56	0.13	0.04	0.10	0.00
8/9/07 20:00	36.92	43.93	0.00	0.59	0.20	0.09	0.12	0.00
8/9/07 21:00	39.82	40.98	0.00	0.51	0.15	0.09	0.10	0.00
8/9/07 22:00	40.40	40.48	0.00	0.50	0.13	0.08	0.10	0.00
8/9/07 23:00	40.44	40.52	0.00	0.50	0.13	0.08	0.10	0.00
8/10/07 0:00	40.54	40.36	0.00	0.50	0.13	0.08	0.10	0.00
8/10/07 1:00	40.56	40.50	0.00	0.50	0.13	0.07	0.10	0.00
8/10/07 2:00	40.68	40.28	0.00	0.50	0.13	0.07	0.10	0.00
8/10/07 3:00	40.73	40.05	0.00	0.49	0.13	0.07	0.09	0.00
8/10/07 4:00	39.93	41.15	0.00	0.48	0.13	0.07	0.10	0.00
8/10/07 5:00	40.26	40.65	0.00	0.49	0.13	0.07	0.10	0.00
8/10/07 6:00	40.07	41.02	0.00	0.51	0.13	0.06	0.09	0.00
8/10/07 7:00	40.14	40.99	0.00	0.49	0.13	0.06	0.09	0.00
8/10/07 8:00	39.99	41.13	0.00	0.50	0.13	0.07	0.10	0.00
8/10/07 9:00	38.31	41.94	0.00	0.58	0.28	0.13	0.15	0.00
8/10/07 10:00	31.14	49.23	0.00	0.82	0.81	0.25	0.39	0.00
8/10/07 11:00	37.21	44.34	0.00	0.58	0.29	0.10	0.15	0.00
8/10/07 12:00	38.23	42.95	0.00	0.53	0.27	0.10	0.15	0.00

	ULA2190G.PV	ULA2190H.PV	ULA2190I.PV	ULA2190J.PV	ULA2190K.PV	ULA2190L.PV	ULA2190M.PV	ULA2190N.PV
	Flare Gas Nitrogen	Flare GasMethane	Flare Gas Carbon Monoxide	Flare Gas Propane	Flare Gas Isobutane	Flare Gas Hydrogen Sulfide	Flare Gas Butane	Flare Gas 1-Butene/ Isobutylene
	mole %	mole %	mole %	mole %	mole %	mole %	mole %	mole %
8/10/07 13:00	32.55	46.65	0.00	0.90	1.12	0.29	0.54	0.00
8/10/07 14:00	29.53	51.18	0.00	0.87	1.03	0.39	0.50	0.00
8/10/07 15:00	36.71	45.44	0.00	0.51	0.26	0.11	0.16	0.00
8/10/07 16:00	36.33	44.79	0.00	0.58	0.30	0.15	0.18	0.00
8/10/07 17:00	38.01	43.12	0.00	0.52	0.22	0.08	0.13	0.00
8/10/07 18:00	35.89	45.09	0.00	0.63	0.43	0.15	0.22	0.00
8/10/07 19:00	11.68	73.86	0.00	0.83	0.47	0.25	0.21	0.00
8/10/07 20:00	11.63	77.53	0.00	0.47	0.07	0.02	0.04	0.00
8/10/07 21:00	4.52	59.56	0.00	0.36	0.04	0.00	0.03	0.00
8/10/07 22:00	7.76	83.62	0.00	0.52	0.08	0.01	0.06	0.00
8/10/07 23:00	18.19	66.39	0.00	0.84	0.20	0.00	0.23	0.00
8/11/07 0:00	7.43	83.42	0.00	0.65	0.09	0.01	0.05	0.00
8/11/07 1:00	6.89	85.59	0.00	0.31	0.06	0.03	0.03	0.00
8/11/07 2:00	7.07	85.61	0.00	0.23	0.05	0.00	0.03	0.00
8/11/07 3:00	7.12	84.67	0.00	0.30	0.04	0.00	0.03	0.00
8/11/07 4:00	7.57	84.21	0.00	0.38	0.05	0.00	0.03	0.00
8/11/07 5:00	7.13	83.51	0.00	0.43	0.05	0.00	0.03	0.00
8/11/07 6:00	7.20	85.13	0.00	0.31	0.05	0.00	0.03	0.00
8/11/07 7:00	9.36	81.52	0.00	0.29	0.05	0.03	0.03	0.00
8/11/07 8:00	11.46	78.52	0.00	0.37	0.06	0.03	0.05	0.00
8/11/07 9:00	11.44	79.29	0.00	0.34	0.06	0.03	0.03	0.00
8/11/07 10:00	12.38	76.77	0.00	0.43	0.15	0.05	0.08	0.00
8/11/07 11:00	11.38	78.68	0.00	0.41	0.26	0.14	0.12	0.00
8/11/07 12:00	13.40	76.26	0.00	0.36	0.13	0.08	0.07	0.00
8/11/07 13:00	17.96	69.38	0.00	0.46	0.20	0.20	0.11	0.00
8/11/07 14:00	17.56	71.18	0.00	0.35	0.09	0.14	0.07	0.00
8/11/07 15:00	17.22	71.00	0.00	0.32	0.08	0.04	0.05	0.00
8/11/07 16:00	17.14	71.22	0.00	0.33	0.08	0.03	0.05	0.00
8/11/07 17:00	17.11	71.31	0.00	0.38	0.08	0.03	0.05	0.00
8/11/07 18:00	14.79	73.70	0.00	0.39	0.07	0.03	0.05	0.00
8/11/07 19:00	14.45	75.10	0.00	0.38	0.08	0.03	0.05	0.00
8/11/07 20:00	14.74	74.06	0.00	0.43	0.10	0.02	0.06	0.00
8/11/07 21:00	14.27	73.96	0.00	0.52	0.18	0.09	0.10	0.00
8/11/07 22:00	13.01	76.39	0.00	0.44	0.16	0.06	0.09	0.00
8/11/07 23:00	10.84	79.13	0.00	0.43	0.08	0.05	0.05	0.00
8/12/07 0:00								

	ULA2190O.PV	ULA2190P.PV	ULA2190Q.PV	ULA2190R.PV	ULA2190S.PV	ULA2190T.PV	ULFLULCNHV.E	ULA2190V.PV
	Flare Gas Trans - 2 -Butene	Flare Gas Cis - 2 -Butene	Flare Gas 1,3 Butadiene	Flare Gas Water	Flare Gas Total C5+	Flare Gas Propylene	Flare ULC NHV hourly avg	Flare Gas GC Calcd Molecular Weight
	mole %	mole %	mole %	mole %	mole %	mole %	Btu/scf	mole %
8/9/07 0:00	0.00	0.00	0.00	0.00	0.91	0.03	542.33	19.77
8/9/07 1:00	0.00	0.00	0.00	0.00	0.85	0.03	540.49	19.74
8/9/07 2:00	0.00	0.00	0.00	0.00	0.84	0.03	539.00	19.72
8/9/07 3:00	0.00	0.00	0.00	0.00	0.81	0.03	536.08	19.72
8/9/07 4:00	0.00	0.00	0.00	0.00	0.79	0.03	534.50	19.72
8/9/07 5:00	0.00	0.00	0.00	0.00	0.84	0.03	532.91	19.76
8/9/07 6:00	0.00	0.00	0.00	0.00	0.85	0.03	523.52	19.78
8/9/07 7:00	0.00	0.00	0.00	0.00	0.96	0.03	512.85	20.07
8/9/07 8:00	0.01	0.01	0.00	0.00	1.19	0.08	522.19	19.77
8/9/07 9:00	0.00	0.00	0.00	0.00	0.94	0.05	537.29	19.77
8/9/07 10:00	0.00	0.00	0.00	0.00	0.89	0.03	544.07	19.77
8/9/07 11:00	0.00	0.00	0.00	0.00	0.92	0.03	548.70	19.77
8/9/07 12:00	0.00	0.00	0.00	0.00	1.00	0.03	550.74	19.81
8/9/07 13:00	0.00	0.00	0.00	0.00	1.01	0.03	549.74	19.90
8/9/07 14:00	0.00	0.00	0.00	0.00	1.03	0.03	536.49	19.90
8/9/07 15:00	0.00	0.00	0.00	0.00	1.14	0.03	423.18	21.73
8/9/07 16:00	0.00	0.00	0.00	0.00	0.78	0.00	433.45	10.52
8/9/07 17:00	0.00	0.00	0.00	0.00	1.17	0.03	521.67	19.84
8/9/07 18:00	0.00	0.00	0.00	0.00	2.97	0.02	499.23	20.91
8/9/07 19:00	0.00	0.00	0.00	0.00	1.12	0.04	523.63	20.18
8/9/07 20:00	0.00	0.00	0.00	0.00	1.18	0.04	523.67	20.07
8/9/07 21:00	0.00	0.00	0.00	0.00	1.13	0.03	496.21	20.25
8/9/07 22:00	0.00	0.00	0.00	0.00	1.07	0.03	490.48	20.25
8/9/07 23:00	0.00	0.00	0.00	0.00	1.08	0.03	489.03	20.25
8/10/07 0:00	0.00	0.00	0.00	0.00	1.04	0.03	487.70	20.30
8/10/07 1:00	0.00	0.00	0.00	0.00	1.02	0.03	486.25	20.30
8/10/07 2:00	0.00	0.00	0.00	0.00	0.99	0.03	483.64	20.30
8/10/07 3:00	0.00	0.00	0.00	0.00	0.97	0.03	485.11	20.23
8/10/07 4:00	0.00	0.00	0.00	0.00	0.95	0.03	489.27	20.23
8/10/07 5:00	0.00	0.00	0.00	0.00	0.95	0.03	488.89	20.23
8/10/07 6:00	0.00	0.00	0.00	0.00	0.95	0.03	488.28	20.17
8/10/07 7:00	0.00	0.00	0.00	0.00	0.92	0.03	487.31	20.13
8/10/07 8:00	0.00	0.00	0.00	0.00	0.89	0.03	489.09	20.13
8/10/07 9:00	0.00	0.00	0.00	0.00	1.13	0.03	560.06	20.15
8/10/07 10:00	0.00	0.00	0.00	0.00	1.77	0.03	586.22	20.59
8/10/07 11:00	0.00	0.00	0.00	0.00	1.14	0.03	532.18	20.32
8/10/07 12:00	0.00	0.00	0.00	0.00	1.15	0.03	536.75	20.27

	ULA2190O.PV	ULA2190P.PV	ULA2190Q.PV	ULA2190R.PV	ULA2190S.PV	ULA2190T.PV	ULFLULCNHV.E	ULA2190V.PV
	Flare Gas Trans - 2 -Butene	Flare Gas Cis - 2 -Butene	Flare Gas 1,3 Butadiene	Flare Gas Water	Flare Gas Total C5+	Flare Gas Propylene	Flare ULC NHV hourly avg	Flare Gas GC Calcd Molecular Weight
	mole %	mole %	mole %	mole %	mole %	mole %	Btu/scf	mole %
8/10/07 13:00	0.00	0.00	0.00	0.00	2.17	0.03	648.02	20.99
8/10/07 14:00	0.00	0.00	0.00	0.00	2.47	0.07	650.25	21.35
8/10/07 15:00	0.00	0.00	0.00	0.00	1.39	0.03	554.91	20.60
8/10/07 16:00	0.00	0.00	0.00	0.00	1.52	0.03	541.23	20.58
8/10/07 17:00	0.00	0.00	0.00	0.00	1.36	0.03	529.02	20.49
8/10/07 18:00	0.00	0.00	0.00	0.00	1.45	0.03	636.82	20.36
8/10/07 19:00	0.00	0.00	0.00	0.00	0.90	0.01	790.81	18.29
8/10/07 20:00	0.00	0.00	0.00	0.00	0.27	0.01	736.32	17.80
8/10/07 21:00	0.00	0.00	0.00	0.00	0.35	0.00	738.49	13.22
8/10/07 22:00	0.00	0.00	0.00	0.00	0.26	0.00	810.50	17.70
8/10/07 23:00	0.00	0.00	0.00	0.00	0.84	0.01	777.09	18.44
8/11/07 0:00	0.00	0.00	0.00	0.00	0.21	0.00	803.49	17.84
8/11/07 1:00	0.00	0.00	0.00	0.00	0.20	0.00	830.92	17.51
8/11/07 2:00	0.00	0.00	0.00	0.00	0.15	0.00	830.32	17.45
8/11/07 3:00	0.00	0.00	0.00	0.00	0.15	0.00	830.80	17.63
8/11/07 4:00	0.00	0.00	0.00	0.00	0.16	0.00	835.34	17.63
8/11/07 5:00	0.00	0.00	0.00	0.00	0.24	0.00	837.45	17.86
8/11/07 6:00	0.00	0.00	0.00	0.00	0.21	0.00	825.47	17.65
8/11/07 7:00	0.00	0.00	0.00	0.00	0.24	0.00	806.57	17.86
8/11/07 8:00	0.00	0.00	0.00	0.00	0.31	0.00	790.31	18.13
8/11/07 9:00	0.00	0.00	0.00	0.00	0.29	0.00	783.80	17.95
8/11/07 10:00	0.00	0.00	0.00	0.00	0.46	0.00	793.38	18.22
8/11/07 11:00	0.00	0.00	0.00	0.00	0.64	0.00	793.05	18.33
8/11/07 12:00	0.00	0.00	0.00	0.00	0.51	0.00	766.06	18.35
8/11/07 13:00	0.00	0.00	0.00	0.00	0.82	0.00	738.90	18.84
8/11/07 14:00	0.00	0.00	0.00	0.00	0.71	0.00	730.11	18.77
8/11/07 15:00	0.00	0.00	0.00	0.00	0.71	0.00	734.75	18.77
8/11/07 16:00	0.00	0.00	0.00	0.00	0.70	0.01	734.99	18.63
8/11/07 17:00	0.00	0.00	0.00	0.00	0.68	0.00	746.06	18.52
8/11/07 18:00	0.00	0.00	0.00	0.00	0.56	0.00	759.87	18.52
8/11/07 19:00	0.00	0.00	0.00	0.00	0.56	0.00	760.14	18.27
8/11/07 20:00	0.00	0.00	0.00	0.00	0.50	0.00	766.90	18.32
8/11/07 21:00	0.00	0.00	0.00	0.00	0.73	0.00	776.91	18.58
8/11/07 22:00	0.00	0.00	0.00	0.00	0.64	0.00	791.37	18.38
8/11/07 23:00	0.00	0.00	0.00	0.00	0.39	0.00	797.24	18.17
8/12/07 0:00								

APPENDIX G: WASTEWATER PROCESS DATA

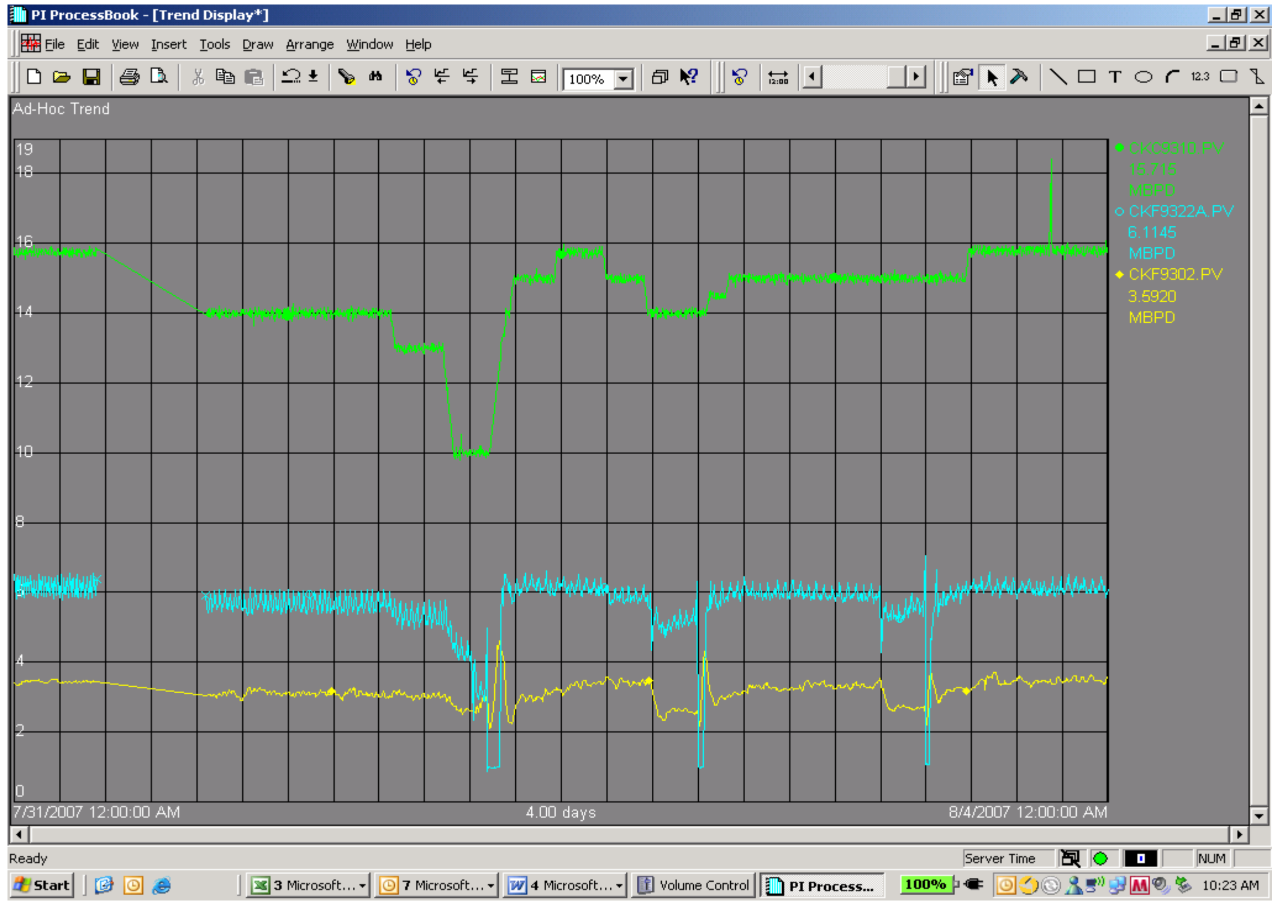
FIRE DRILL GROUNDS
FLARE NO. 6
STORM WATER RET. POND
OLD BUTANE RACK BLDG
503
530
1045
120M
1046
120M
1047
120M
1048
120M
1039
80M
1018
80M
1013
1055
750M
1020
320M
1056
750M
1054
750M
TRACK 17
SURGE BASIN NO. 1
SURGE BASIN NO.1 LIFT STATION
1052
750M
1053
750M
270-F
LIFT STATION NO. 17
275-F
276-F
STORM WATER CANAL
260
F265
263
262
261
291
F214
F200
F201
F216
EQUALIZATION BASIN
SEPAR NO.2
SECONDARY AND TERTIARY EFFLUENT TREATMENT FACILITIES
BALLAST WATER FACILITIES
SHOCK BASIN
INLET WEIR
SURGE BASIN NO.2
OUTLET WEIR
GATE #20
GATE #19
GATE #18
CARBIDE EFFLUENT DITCH
AMOCO CHEMICALS CORPORATION PLANT "B"
EFFLUENT DITCH
TEXAS CITY TERMINAL RAILWAY
J-683

Parameter	Molecular Weight	Vapor Pressure, mmHg at 25oC	Density	Boiling Point (oC)	Antoine's Coefficien a	Antoine's Coefficients, b	Antoine's Coefficien c	Measured-Ind. Yaws &	K, (y/x) at 25oC	K, (y/x) at 100 oC	Dl (cm2/s)	Dv (cm2/s)	Solubility (ppmw)	Hydrolysis Rate (l/s)	Log10 Octanol-Water	Kmax (mg/g-hr)	K1 (l/g-hr)
Generic Organic Material	100	25	1	125	6.859312	1354.71	215.5096	Yang,	1	10	9.57E-06	0.0782	210.297	0	0	19	1.1
Ammonia	17.03	7470	0.6818	-33.4	7.55466	1002.711	247.885	Mackay	3.3799	0	6.93E-05	0.259	4.82E+05	5.60E-10	0.23	19	0.043
Benzene	78.11	95.2	0.874	80	6.905048	1211.033	220.7996	&	308.33	1930	1.02E-05	0.088	1796.573	0	2.15	19.1	120
Ethylbenzene	106.2	10	0.87	136.2	6.975	1424.255	213.21	Shiu	437.807	4270	7.80E-06	0.075	152	0	3.15	6.8	2.1
MTBE	83.1	185.949	0.97	64	6.85249	1103.737	222.72	Kartkopf	34.722	267	1.05E-05	0.1024	3.66E+04	5012	0.94	17.56	0.712684
Naphthalene	128.2	0.23	1.14	218	7.3729	1968.36	222.61	1973	66.693	710	7.50E-06	0.059	80.318	0	3.37	42.47	1
Styrene	104.2	7.3	0.9	145	6.945357	1437.432	208.38	Yaws	150.149	1720	8.00E-06	0.071	300	0	3.16	31.1	0.11
Toluene	92.4	30	0.87	110.7	6.954	1344.8	219.48	&	356.67	2100	8.60E-06	0.087	515	0	2.69	73.48	2.4
1,3,5-TMB	120.2	2.4	1.02	163.037	7.07436	1569.22	209.58	Yang,	326.794	1.13E+05	8.67E-06	0.0602	2	0	3.9997	31.1	4.469394
Xylene	106.2	8.5	1.02	140	7.940135	2090.317	273.16	Yaws	389.684	3786.025	9.34E-06	0.0737	169.334	0.091	3.15	40.8	1.8
m-Xylene	106.2	8	0.86	139	7.009	1462.266	215.11	&	413	3250	7.80E-06	0.07	200	0.07	3.2	31.1	2.219942
o-Xylene	106.17	0.73886	0.88	144.4	6.998	1474.679	213.69	Yang,	269.287	2550	1.00E-05	0.087	175	0.12	2.95	40.79	1.8
Propylbenzene	120.19	2.1	0.876	157.876	6.873484	1465.873	209.2632	Mackay	566.888	6594.797	8.57E-06	0.0643	11.451		3.5953	15.3	3.137307
1,2,4-TMB	120.21			169	8.178473	2342.421	273.16	&	342.21	4285.293	7.92E-06	0.0606	57		3.63	15.3	3.23402

Shiu
Staudingner
1996
Yaws
Yang,
Sanemasa
Henry's
Law
Constants
Estim.
DIPPR911
1992
S
1981
L
S
M
S
RTI
1992
S
1992
S
1981
L
S
Superfund
L
S
DIPPR911
1992
-1982

APPENDIX H: DELAYED COKER PROCESS DATA

	CKC9310.PV	CKF9322.PV	CKF9302.PV
	Total Charge Rate MBPD	Heavy Gas Oil Rundown MBPD	Heavy Heavy Gas Oil Rundown MBPD
7/31/07 0:00	15.74	6.08	3.39
7/31/07 1:00	15.76	6.08	3.46
7/31/07 2:00	15.75	6.05	3.44
7/31/07 3:00	15.74	6.05	3.48
7/31/07 4:00	15.75	6.07	3.42
7/31/07 5:00	15.74	6.02	3.42
7/31/07 6:00	15.74	6.04	3.44
7/31/07 7:00	15.75	6.21	3.43
7/31/07 8:00	15.57	6.22	3.40
7/31/07 9:00	15.37	6.17	3.35
7/31/07 10:00	15.17	6.11	3.31
7/31/07 11:00	14.98	6.05	3.27
7/31/07 12:00	14.78	6.00	3.23
7/31/07 13:00	14.58	5.94	3.18
7/31/07 14:00	14.39	5.89	3.14
7/31/07 15:00	14.19	5.83	3.10
7/31/07 16:00	14.00	5.74	3.06
7/31/07 17:00	14.00	5.58	3.05
7/31/07 18:00	13.99	5.64	3.11
7/31/07 19:00	13.99	5.60	3.05
7/31/07 20:00	14.00	5.52	3.12
7/31/07 21:00	13.98	5.61	3.21
7/31/07 22:00	13.98	5.61	3.13
7/31/07 23:00	13.99	5.56	3.08
8/1/07 0:00	13.99	5.63	3.08
8/1/07 1:00	14.01	5.57	3.10
8/1/07 2:00	14.00	5.56	3.09
8/1/07 3:00	13.98	5.55	3.11
8/1/07 4:00	14.00	5.58	3.06
8/1/07 5:00	13.99	5.58	3.16
8/1/07 6:00	14.01	5.56	3.09
8/1/07 7:00	14.00	5.59	3.05
8/1/07 8:00	14.00	5.58	3.04
8/1/07 9:00	13.25	5.34	3.12
8/1/07 10:00	12.99	5.19	3.05
8/1/07 11:00	12.99	5.18	3.00
8/1/07 12:00	13.01	5.19	3.02
8/1/07 13:00	12.73	5.17	3.02
8/1/07 14:00	10.47	4.53	2.80
8/1/07 15:00	9.98	4.18	2.61
8/1/07 16:00	10.01	3.28	2.63
8/1/07 17:00	10.10	1.88	2.66
8/1/07 18:00	12.25	2.30	4.00
8/1/07 19:00	14.31	6.03	2.51
8/1/07 20:00	14.99	6.09	2.94
8/1/07 21:00	15.00	6.11	2.96
8/1/07 22:00	14.99	6.05	3.05
8/1/07 23:00	15.34	6.05	3.19
8/2/07 0:00	15.75	6.10	3.21
8/2/07 1:00	15.75	6.06	3.37
8/2/07 2:00	15.74	6.07	3.38
8/2/07 3:00	15.64	5.99	3.43
8/2/07 4:00	15.00	5.81	3.41
8/2/07 5:00	14.99	5.80	3.46
8/2/07 6:00	14.99	5.76	3.38
8/2/07 7:00	14.41	5.62	3.42
8/2/07 8:00	13.99	5.03	2.60
8/2/07 9:00	13.98	4.92	2.56
8/2/07 10:00	13.99	5.08	2.63
8/2/07 11:00	14.01	5.16	2.56
8/2/07 12:00	14.08	2.83	3.38
8/2/07 13:00	14.50	5.70	2.94
8/2/07 14:00	14.71	5.86	3.01
8/2/07 15:00	14.99	5.91	3.10
8/2/07 16:00	15.01	6.00	3.23
8/2/07 17:00	14.99	5.86	3.29
8/2/07 18:00	15.01	5.92	3.28



	CKC9310.PV	CKF9322.PV	CKF9302.PV
	Total Charge Rate MBPD	Heavy Gas Oil Rundown MBPD	Heavy Heavy Gas Oil Rundown MBPD
8/2/07 19:00	15.01	5.90	3.20
8/2/07 20:00	15.01	5.95	3.23
8/2/07 21:00	14.99	5.86	3.35
8/2/07 22:00	14.99	5.85	3.39
8/2/07 23:00	15.00	5.87	3.33
8/3/07 0:00	14.99	5.83	3.29
8/3/07 1:00	14.99	5.90	3.33
8/3/07 2:00	15.00	5.81	3.32
8/3/07 3:00	14.99	5.85	3.35
8/3/07 4:00	15.00	5.24	2.94
8/3/07 5:00	15.01	5.28	2.68
8/3/07 6:00	14.99	5.48	2.69
8/3/07 7:00	14.99	5.24	2.67
8/3/07 8:00	14.99	3.62	3.18
8/3/07 9:00	14.99	5.64	3.04
8/3/07 10:00	15.00	5.87	3.22
8/3/07 11:00	15.31	5.99	3.20
8/3/07 12:00	15.80	6.08	3.37
8/3/07 13:00	15.80	6.06	3.53
8/3/07 14:00	15.80	6.05	3.46
8/3/07 15:00	15.77	6.04	3.42
8/3/07 16:00	15.78	6.02	3.48
8/3/07 17:00	15.81	6.01	3.39
8/3/07 18:00	15.84	5.99	3.44
8/3/07 19:00	15.84	6.05	3.46
8/3/07 20:00	15.80	6.04	3.49
8/3/07 21:00	15.79	6.13	3.51
8/3/07 22:00	15.79	6.01	3.53
8/3/07 23:00	15.81	6.03	3.46
8/4/07 0:00	15.80	5.70	3.17
8/4/07 1:00			

Attachment 1
Height and Diameter of Coke Drums for Coker A, B, and C

Source	Height , feet	Diameter (Inner Diameter), feet
Coker A Drum A	77	17.5
Coker A Drum B	77	17.5
Coker B Drum A	66.7	23.8
Coker B Drum B	66.7	23.8
Coker C Drum A	66.7	23.8
Coker C Drum B	66.7	23.8

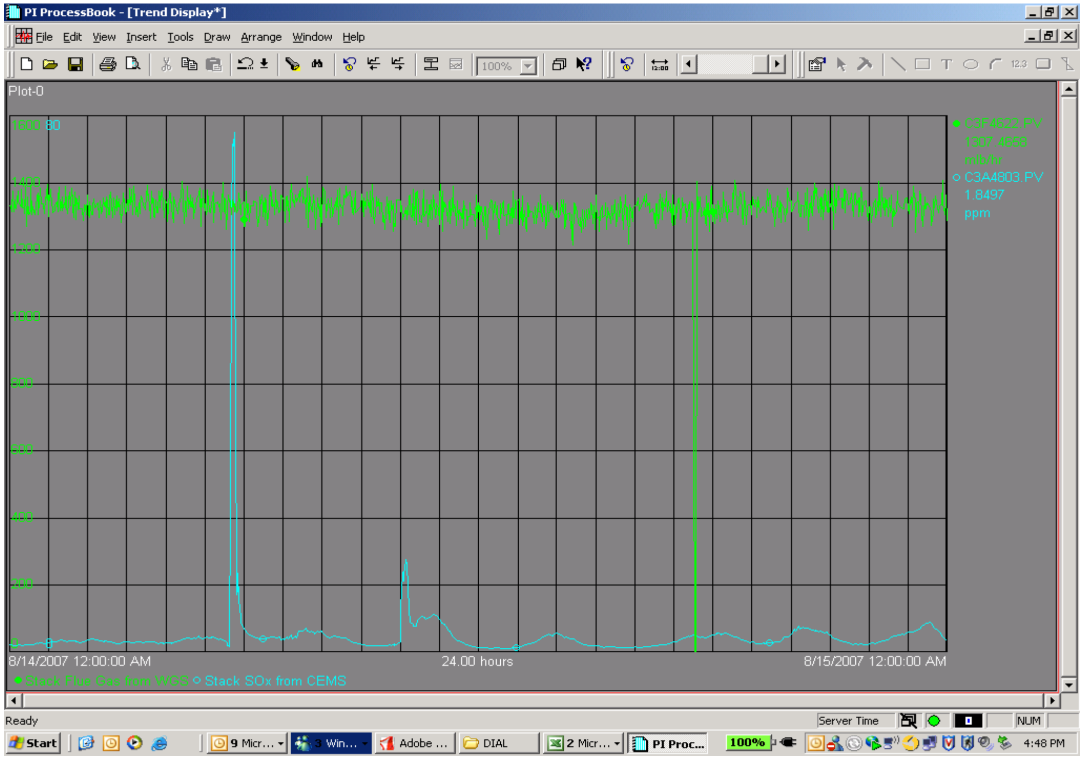
Attachment 2

Composition of Coke, Average of samples taken in 2009 for each pile type

Sample Type	Moisture %	Volatile Matter	Ash %	Fixed Carbon	Sulfur %	HGI	BTU	Shot %	C %	H %	N %	Si ppm	Fe ppm	V ppm	Ni ppm
		%		%											
0-4.5% sulfur piles	11.63	15.02	0.26	84.64	3.42	102.11	15604.65	22.47	90.16	4.26	1.51	188.98	187.07	345.10	171.49
4.51-5.5% sulfur piles	9.82	13.75	0.24	86.02	4.84	91.29	15420.35	67.39	88.91	4.21	1.38	126.45	160.52	482.42	175.42
5.51 and up% sulfur piles	9.98	12.63	0.26	87.09	5.89	84.42	15266.08	88.33	88.04	4.09	1.35	199.27	153.55	710.91	199.82

APPENDIX I: ALL OTHER RAW PROCESS DATA

	C3F4622.PV	C3A4803.PV	C3A4802.PV	C3A4801.PV	C3A4804.PV	C3A4805.PV
	Stack Flue Gas from WGS mlb/hr	Stack SOx from CEMS ppm	Stack O2 from CEMS pct	Stack NOx from CEMS (Raw Value) PPM	Stack CO from CEMS ppm	Stack CO2 From CEMS pct
8/14/07 0:00	1337.56	1.15	2.65	29.82	25.51	15.81
8/14/07 1:00	1336.70	1.60	2.63	18.89	25.91	15.66
8/14/07 2:00	1327.67	1.58	2.54	8.93	26.48	15.70
8/14/07 3:00	1339.24	1.42	2.56	18.88	27.09	15.69
8/14/07 4:00	1338.64	1.81	2.46	14.40	27.11	15.76
8/14/07 5:00	1332.10	12.06	3.08	16.30	67.42	12.54
8/14/07 6:00	1328.60	2.22	2.59	20.94	26.99	15.65
8/14/07 7:00	1340.10	2.73	2.58	7.76	29.35	15.58
8/14/07 8:00	1339.51	1.95	2.68	19.40	24.67	15.73
8/14/07 9:00	1326.84	1.00	2.49	10.99	28.05	15.95
8/14/07 10:00	1319.61	6.27	2.48	15.04	25.95	16.02
8/14/07 11:00	1318.82	2.11	2.42	25.81	25.53	16.03
8/14/07 12:00	1311.74	0.59	2.50	31.28	26.04	15.95
8/14/07 13:00	1311.00	1.73	2.42	24.32	27.47	15.96
8/14/07 14:00	1302.17	1.65	2.32	12.64	28.35	16.33
8/14/07 15:00	1309.96	0.73	2.59	27.61	25.65	15.70
8/14/07 16:00	1328.22	0.95	2.61	30.75	27.15	15.68
8/14/07 17:00	1269.67	2.16	2.62	32.13	27.68	15.73
8/14/07 18:00	1329.41	2.27	2.67	35.05	28.12	15.91
8/14/07 19:00	1331.00	1.59	2.68	35.78	27.50	15.76
8/14/07 20:00	1335.91	3.21	2.73	51.64	28.04	15.64
8/14/07 21:00	1343.77	1.46	2.75	54.09	28.87	15.69
8/14/07 22:00	1332.18	1.97	2.80	52.66	29.10	15.62
8/14/07 23:00	1333.59	3.33	2.78	49.89	29.99	15.56
8/15/07 0:00						



	P2F5806B.PV	P2F5806A.PV	P2A5805A.PV	P2A5805B.PV	P2A5805C.PV	P2A5805D.PV	P2A5805E.PV	P2A5805F.PV	P2A5805G.PV	P2A5805H.PV	P2A5805I.PV
	FLARE 3 FLOW - LOW RANGE MSCFH	FLARE 3 FLOW - HIGH RANGE MSCFH	Flare 3 Carbon Dioxide mole%	Flare 3 Ethylene mole%	Flare 3 Ethane mole%	Flare 3 Acetylene mole%	Flare 3 Hydrogen mole%	Flare 3 Oxygen mole%	Flare 3 Nitrogen mole%	Flare 3 Methane mole%	Flare 3 Carbon Monoxide mole%
8/3/07 0:00	54.42	0.90	0.19	0.19	5.12	0.00	39.56	0.62	12.00	23.74	0.20
8/3/07 1:00	47.63	0.00	0.25	0.25	4.72	0.00	34.30	0.84	15.91	26.29	0.15
8/3/07 2:00	48.05	0.00	0.26	0.26	4.66	0.00	33.59	0.87	16.78	26.45	0.17
8/3/07 3:00	49.43	0.00	0.26	0.26	4.61	0.00	33.41	0.94	16.82	26.53	0.16
8/3/07 4:00	47.27	0.00	0.26	0.26	4.54	0.00	33.91	0.97	16.67	26.63	0.02
8/3/07 5:00	47.57	0.00	0.26	0.26	4.55	0.00	34.74	0.97	16.73	26.22	0.03
8/3/07 6:00	61.02	31.06	0.28	0.28	4.55	0.00	32.11	1.02	18.28	27.18	0.04
8/3/07 7:00	68.67	16.54	0.14	0.14	5.58	0.00	44.20	0.43	9.26	21.25	0.14
8/3/07 8:00	47.89	0.00	0.23	0.23	5.00	0.00	37.60	0.78	14.55	25.26	0.19
8/3/07 9:00	47.19	0.00	0.30	0.30	4.66	0.00	33.68	0.93	16.92	28.21	0.18
8/3/07 10:00	45.80	0.00	0.27	0.27	4.82	0.00	34.68	0.83	16.88	26.54	0.17
8/3/07 11:00	43.98	0.00	0.28	0.28	4.68	0.00	34.24	0.89	16.88	27.27	0.17
8/3/07 12:00	42.79	0.00	0.33	0.33	4.46	0.00	33.15	0.92	16.90	29.22	0.15
8/3/07 13:00	78.30	174.96	0.17	0.17	5.53	0.00	40.05	0.53	11.38	22.93	0.20
8/3/07 14:00	48.00	0.00	0.19	0.19	5.55	0.00	39.86	0.55	12.04	24.08	0.20
8/3/07 15:00	63.50	30.70	0.22	0.22	5.35	0.00	36.63	0.69	14.49	25.30	0.20
8/3/07 16:00	50.49	0.00	0.18	0.18	5.61	0.00	40.32	0.57	12.75	24.03	0.22
8/3/07 17:00	89.50	72.41	0.13	0.13	5.86	0.00	46.04	0.41	8.91	21.59	0.24
8/3/07 18:00	78.83	67.41	0.10	0.10	5.99	0.00	47.82	0.33	7.43	20.07	0.25
8/3/07 19:00	51.32	0.00	0.20	0.20	5.37	0.00	39.34	0.65	13.65	24.54	0.21
8/3/07 20:00	48.57	0.00	0.25	0.25	5.10	0.00	34.56	0.84	16.28	27.01	0.19
8/3/07 21:00	68.38	90.51	0.23	0.23	5.30	0.00	36.18	0.77	14.67	26.00	0.21
8/3/07 22:00	99.96	125.84	0.08	0.08	6.39	0.00	46.31	0.24	5.98	20.01	0.27
8/3/07 23:00	99.43	87.02	0.09	0.09	6.22	0.00	45.35	0.28	6.81	20.43	0.27
8/4/07 0:00	72.92	17.21	0.11	0.11	6.14	0.00	43.76	0.32	7.94	21.14	0.28
8/4/07 1:00											

P2A5805J.PV	P2A5805K.PV	P2A5805L.PV	P2A5805M.PV	P2A5805N.PV	P2A5805O.PV	P2A5805P.PV	P2A5805Q.PV	P2A5805R.PV	P2A5805S.PV	P2A5805T.PV	P2FL3NHV.EVH	P2A5805V.PV
Flare 3 Propane mole%	Flare 3 Isobutane mole%	Flare 3 Hydrogen Sulfide mole%	Flare 3 Butane mole%	Flare 3 1-Butene/ Isobutylene mole%	Flare 3 Trans - 2 -Butene mole%	Flare 3 Cis - 2 - Butene mole%	Flare 3 1,3 Butadiene mole%	Flare 3 Water mole%	Flare 3 Total C5+ mole%	Flare 3 Propylene mole%	Flare 3 NHV hourly avg Btu/scf	Flare 3 GC Calc MW MW
8.34	1.10	0.02	0.88	0.23	0.13	0.09	0.00	0.12	3.90	0.59	843.05	16.78
7.43	1.03	0.03	0.90	0.22	0.12	0.09	0.00	0.08	4.48	0.54	836.48	17.64
7.22	0.98	0.03	0.89	0.22	0.12	0.09	0.00	0.07	4.49	0.56	833.35	17.75
7.10	0.97	0.00	0.89	0.21	0.12	0.08	0.00	0.13	4.60	0.62	830.97	17.77
6.83	0.94	0.02	0.86	0.21	0.11	0.08	0.00	0.14	4.61	0.67	822.57	17.56
6.67	0.93	0.01	0.85	0.20	0.11	0.08	0.00	0.04	4.47	0.63	818.05	17.37
6.64	0.89	0.01	0.84	0.19	0.11	0.08	0.00	0.04	4.68	0.63	829.21	17.90
9.12	1.15	0.01	0.90	0.25	0.14	0.10	0.00	0.08	3.12	0.82	827.69	16.16
6.59	1.00	0.00	0.86	0.21	0.12	0.09	0.00	0.03	3.95	0.73	808.29	16.82
5.24	0.89	0.01	0.85	0.21	0.11	0.07	0.00	0.02	4.53	0.66	802.89	17.16
5.51	0.94	0.00	0.88	0.21	0.12	0.08	0.00	0.02	4.72	0.71	809.54	17.16
5.37	0.92	0.00	0.82	0.21	0.13	0.09	0.00	0.00	4.92	0.71	813.38	17.12
5.17	0.99	0.01	0.78	0.19	0.11	0.08	0.00	0.00	4.94	0.66	828.62	17.14
6.91	1.28	0.01	0.95	0.23	0.14	0.11	0.00	0.00	4.04	2.52	852.10	16.85
6.53	1.33	0.02	0.95	0.23	0.14	0.10	0.00	0.06	4.13	1.02	844.16	16.53
5.99	1.06	0.02	0.80	0.23	0.14	0.10	0.01	0.04	4.42	1.32	823.00	17.02
6.14	1.01	0.01	0.77	0.25	0.14	0.10	0.01	0.03	3.90	0.93	811.51	16.24
6.63	1.09	0.00	0.85	0.26	0.15	0.10	0.00	0.06	3.33	0.88	811.03	15.19
6.94	1.15	0.00	0.91	0.27	0.15	0.10	0.00	0.07	3.05	1.81	810.11	15.15
5.68	0.95	0.00	0.77	0.24	0.13	0.10	0.00	0.04	4.16	0.95	804.76	16.31
5.28	0.88	0.01	0.74	0.22	0.12	0.09	0.00	0.04	4.64	0.89	808.73	17.09
6.25	0.95	0.00	0.78	0.23	0.13	0.09	0.00	0.09	4.24	0.85	838.55	17.01
10.05	1.38	0.00	0.96	0.28	0.16	0.12	0.00	0.09	2.70	0.96	871.60	16.06
9.88	1.38	0.00	0.98	0.27	0.15	0.11	0.00	0.07	2.87	0.90	873.98	16.21
9.50	1.43	0.00	1.00	0.27	0.15	0.11	0.00	0.07	2.93	0.92	862.38	16.49

	ARULUFFD.PE	ARFBENZ.PE	ARF1662.PV	ARF610F.PE	ARF1767.PV	ARF1766.PV	ARFRAFF.PE	ARF1682.PV	ARBTXMAK.PE
	Total Feed MBPD	Additives BPH	Benzene MBPD	Toluene MBPD	XYLEN TO STORG MBPD	C9+ TO STORG MBPD	Raffinate MBPD	Recycle MBPD	BTX Make MBPD
8/17/07 0:00	51.52	154.48	4.90	8.83	7.89	4.55	29.67	7.98	21.39
8/17/07 1:00	51.45	154.93	4.87	9.01	7.89	4.55	29.09	8.21	21.77
8/17/07 2:00	51.55	173.78	4.89	8.84	7.49	4.55	29.87	8.64	21.37
8/17/07 3:00	51.49	179.91	4.96	8.83	7.76	4.55	29.32	7.99	21.36
8/17/07 4:00	51.46	185.01	4.81	8.63	7.49	4.55	29.39	7.89	21.02
8/17/07 5:00	51.53	188.21	4.95	8.93	7.89	4.55	29.43	7.93	21.83
8/17/07 6:00	51.56	188.82	4.82	8.63	7.62	4.55	29.26	7.90	21.01
8/17/07 7:00	51.57	190.77	4.89	8.68	7.68	4.55	29.55	7.83	21.24
8/17/07 8:00	51.43	192.59	4.98	8.74	7.70	4.55	29.74	7.95	21.37
8/17/07 9:00	51.41	193.04	4.83	8.62	7.48	4.55	29.80	7.85	21.02
8/17/07 10:00	51.31	193.76	5.00	8.65	7.43	4.55	30.10	7.92	21.12
8/17/07 11:00	51.39	203.06	4.96	8.72	7.18	4.55	29.96	7.78	21.00
8/17/07 12:00	51.42	202.22	4.88	8.42	7.54	4.55	29.93	7.86	20.87
8/17/07 13:00	51.45	203.24	4.72	8.39	7.51	4.55	30.07	7.77	20.64
8/17/07 14:00	51.30	204.67	4.88	7.92	8.08	4.55	29.45	7.58	20.88
8/17/07 15:00	51.29	204.46	5.08	8.45	7.51	4.55	30.54	7.86	21.10
8/17/07 16:00	51.32	203.14	4.95	8.13	7.55	4.55	29.85	7.68	20.52
8/17/07 17:00	51.33	203.87	5.00	8.16	7.87	4.55	29.89	7.56	21.06
8/17/07 18:00	51.35	204.47	5.02	8.28	7.75	4.55	29.64	7.52	21.02
8/17/07 19:00	51.32	205.82	5.05	8.19	7.81	4.55	29.45	7.43	21.02
8/17/07 20:00	51.32	204.30	5.02	8.22	7.75	4.55	29.27	7.40	21.19
8/17/07 21:00	51.46	205.41	5.16	8.40	7.69	4.55	29.31	7.39	21.20
8/17/07 22:00	51.42	205.66	5.10	8.34	7.52	4.55	29.45	7.31	20.94
8/17/07 23:00	51.40	205.35	5.14	8.39	7.59	4.55	29.51	7.32	20.94
8/18/07 0:00