HRVOC AOC FINAL REPORT

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EXECUTIVE SUMMARY

In early 2005 the Louisiana Department of Environmental Quality (LDEQ) issued Administrative Orders on Consent (AOC) to 15 facilities in the Baton Rouge Non-Attainment Area that emit highly reactive volatile organic compounds (HRVOC). The purpose of the AOC was to help identify emission sources of HRVOC that were contributing to ozone formation in the five parish area. The companies that received the AOC were: BASF, Chemtura, Dow, DSM, Enterprise, ExxonMobil Chemical, ExxonMobil Plastics, ExxonMobil Polyolefins, ExxonMobil Refinery, Placid, Plantation Pipeline, Occidental, Shell, Syngenta, and Williams Olefins.

The companies were ordered to install HRVOC (and other compounds) monitoring on or near their site boundaries. The monitors were to be put into operation by May 1, 2005, and continue for two years. In addition, six of the companies that are located in the North Baton Rouge area were ordered to perform audits of their HRVOC systems. The due date for the completion of the audits was May 1, 2005.

A total of 22 monitors were installed at the plants. All of the stations included a total hydrocarbon analyzer that sampled the air every three minutes and instrumentation to continuously monitor wind speed and direction. The total hydrocarbon analyzer was configured to provide a trigger whenever the sampled air contained hydrocarbons in excess of a pre-determined set point. When the trigger was initiated, a 20 minute sample was collected. Some of the plants installed gas chromatographs that immediately analyzed the collected sample and sent the information to plant personnel. Other plants sent the collected sample to a lab for analysis - a process that took a couple of weeks before the analysis was known. With each trigger event, plant personnel were required to respond by searching the plant for possible sources causing the trigger. All of the data and response findings were reported to LDEQ monthly.

The plants completed the audits by the due date. With a few minor exceptions, the auditors found that the plants were doing a proper job of identifying and monitoring sources where HRVOC could be emitted to the atmosphere.

The monitoring program resulted in a total of approximately 2,500 samples being analyzed by the plants. A portion of the samples contained significant amounts of HRVOC, especially ethylene and propylene. The majority of the samples contained mostly evaporative gas compounds, namely, butane, isopentane, propane, isobutane, pentane, and other hydrocarbons that are in gasoline. The source of most of the gasoline products was storage tanks that do not have vent collection. The next largest cause of strikes was emissions of various compounds that the plants are permitted to emit. Some strike samples showed compounds that were attributed by the plants to flares, and some strikes were caused by leaks, and maintenance and operating activities.

During the monitoring period, the number of strikes at the ten LDEQ-operated monitoring sites showed a significant decline of 25 percent. Strikes at the four urban Baton Rouge monitoring sites declined by 40 percent. Also, reports to LDEQ of unauthorized releases of HRVOC greater than 100 pounds in 24 hours showed a decrease of 60 percent, and the release quantities were much lower. This improved performance helped the Baton Rouge area to attain the old 1-hour ozone standard in 2006.

The monitoring program was terminated on December 31, 2006, because the affected facilities and LDEQ felt that no new data of any substantial value would be obtained by continuing the monitoring for an additional four months.

I. INTRODUCTION

On October 6, 2004, the Louisiana Department of Environmental Quality (LDEQ) issued Administrative Orders (AO) to 16 facilities in the Baton Rouge Ozone Nonattainment Area (BRNA). The AO required all of the facilities to implement a fenceline ambient air monitoring program by March 1, 2005. Additionally, six of the facilities were ordered to perform a comprehensive environmental audit of their Highly Reactive Volatile Organic Compounds (HRVOC) systems by the same date.

Upon request from all of the affected facilities except Plantation Pipe Line, LDEQ agreed to amend the AO and extend the deadlines for both the monitoring and the audit. The amended AO became an Administrative Order on Consent (AOC) and the deadline for beginning the monitoring program and completing the environmental audit was pushed back to May 1, 2005. The monitoring program was to continue for a two-year period. Plantation Pipe Line accepted the original AO requirements, but, after consultation with plant management, LDEQ revised their timeline to agree with that of the AOC facilities. The AO for the DSM Corporation facility in Addis was rescinded as a decision was made by DSM to shutdown the facility at the end of 2004 for economic reasons.

In December of 2006, after 20 months of monitoring, LDEQ was approached about the possibility of early termination of the monitoring program. The reasoning was that no new data of any substantial value would be obtained by continuing the monitoring for an additional four months. LDEQ concurred and letters were issued to each facility and the monitoring program was discontinued on December 31, 2006.

This Final Report is being written to summarize the events that led up to the AOC, the requirements of the AOC, the data that was collected, the significant findings and finally some conclusions from the program. Details of each facility's data and results can be found in the individual Final Reports included in Appendix D.

II. BACKGROUND

The issuance of the 1990 Clean Air Act resulted in the BRNA being designated in non-attainment of the 1-hour ozone standard and classified as a *serious* area because of the 164 parts per billion (ppb) design value in 1989. The attainment date was November 15, 1999. Emissions were reduced and design values declined, but, attainment was not reached by 1999. For failure to attain by the attainment date, the Environmental Protection Agency (EPA) re-classified the BRNA as a *severe* ozone area with a new attainment date of November 15, 2005. The reclassification to *severe* brought many new requirements such as reformulated gasoline, regulation of smaller businesses, increased offsets for new sources or modification of existing sources, and possible Clean Air Act Section 185 penalty fees if the area failed to attain the standard by 2005. Atmospheric modeling was performed to determine what needed to be done to bring the BRNA into attainment. The modeling determined that about a 30 percent decrease in oxides of nitrogen (NOx) would bring the design value to less than the 125 ppb, 1-hour ozone standard. A state regulation was promulgated that required facilities to add controls on boilers, heaters, furnaces, turbines and internal combustion engines by May 1, 2005 in order to obtain the necessary NOx reductions.

Observations in the years of 2002 to 2003 indicated that 1-hour ozone exceedances would not usually occur with only routine amounts of volatile organic compounds (VOC) and NOx in the atmosphere. However, under certain conditions, rapid ozone formation would occur and result in an exceedance. Monitoring results from many of these exceedances indicated a high rate and efficiency of ozone production that was limited to the immediate Baton Rouge area. These episodes corresponded very well to the kind of episodes that had been identified in the Houston/Galveston area. The Texas Air Quality Study 2000 concluded that the hydrocarbon reactivity during these episodes was often dominated by low molecular weight alkenes and aromatics. Air quality sampling in the Baton Rouge area showed substantial quantities of the same hydrocarbon precursors mentioned in the Texas study. The ozone formation experienced in the BRNA was thought to be the result of non-routine emissions of HRVOC.

Facilities handling HRVOC were asked to look at their operations and devise ways to reduce releases of HRVOC. An HRVOC workgroup of Industry, Environmental Groups and LDEQ was formed to further evaluate the specific causes of the BRNA ozone problem. The goals of the workgroup were to design and oversee studies and recommend solutions to help the area meet the November 2005 attainment date and avoid additional repercussions of continued non-compliance. The workgroup met bi-weekly over a six month period. In general, the workgroup concluded that not enough ozone precursor monitoring was in place and that the data that LDEQ was collecting was not being properly handled and analyzed. The specific recommendations were as follows:

- Upgrade the LDEQ monitoring network to include NOx and VOC monitoring at all BRNA stations
- Record all precursor monitoring data in both 5-minute and 1-hour increments
- Design and implement a database to store all monitoring and lab data together
- Contract a qualified company to perform a statistical analysis of the database

LDEQ accepted these recommendations and implemented them.

In June of 2004, the Environmental Protection Agency (EPA) began implementing the new 8-hour ozone standard, under which the BRNA was designated nonattainment and assigned a *marginal* classification with an attainment date of June 15, 2007. The new rule also provided for the revocation of the 1-hour ozone standard on June 15, 2005.

Monitoring during the 2004 ozone season utilizing the enhanced network showed that non-routine or episodic releases of HRVOC continued to be a problem - over 100 measurements of greater than 100 ppb HRVOC were observed by August. In addition to the unhealthy air, the ozone exceedances experienced during the 2004 ozone season made it impossible for the BRNA to achieve attainment of the 1-hour standard prior to the revocation of the standard in June 2005. Likewise, the lack of significant progress in reducing ozone was expected to make it exceedingly difficult for the BRNA to achieve attainment of the new 8-hour standard by the 2007 attainment date. This failure would likely result in reclassification to *moderate* and bring additional requirements for the area.

For these reasons LDEQ issued the AO in October 2004. As previously mentioned the AO was amended in December 2004 and became an AOC.

III. AOC REQUIREMENTS – Environmental Audit

The following six facilities were ordered to perform environmental audits.

- Enterprise Products Operating L.P., AI# 40198 – Port Allen/West Baton Rouge Parish
- ExxonMobil Chemical Plant (BRCP), AI# 286 – Baton Rouge/East Baton Rouge Parish
- ExxonMobil Plastics Plant (BRPP), AI# 285 – Baton Rouge/East Baton Rouge Parish
- ExxonMobil Polyolefins Plant, AI# 3519 – Baton Rouge/East Baton Rouge Parish
- ExxonMobil Refinery, AI# 2638 – Baton Rouge/East Baton Rouge Parish
- Placid Refining Company, L.L.C., AI# 2366 – Port Allen/West Baton Rouge Parish

The environmental audit covered the following elements.

1. Audit (the Facility) to Document All Units That Handle HRVOC
2. Audit (units in Element 1) to Document All Potential Release Sources of HRVOC
3. Audit the LDAR (Leak Detection and Repair) Program for Those Components That Handle HRVOC
4. Conduct Testing of HRVOC Transport Activities (to confirm that emission estimates that are submitted to LDEQ are accurate)
5. Conduct Testing of Flares That Handle HRVOC (Since there isn't any technology available to measure the destruction efficiency of a flare, this element was to verify that the flare was meeting 40 CFR 60.18.)
6. Conduct Sampling of Cooling Tower Inlets with Potential HRVOC Emissions
7. Conduct Testing of Large Point Sources (to confirm that emission estimates that are submitted to LDEQ are accurate)

All plants submitted their Environmental Audit Report by the agreed upon date. These reports can be found in Appendix A.

IV. AOC REQUIREMENTS – Fenceline Monitoring

The AOC was issued to the following facilities in the BRNA that handle HRVOC

- BASF Corporation, AI# 2049 – Geismar/Ascension Parish
- Crompton Manufacturing Company, AI# 1433 – Geismar/Ascension Parish
- The Dow Chemical Company, AI# 1409 – Plaquemine/Iberville Parish
- DSM Copolymer, Inc., AI# 1395 – Baton Rouge/East Baton Rouge Parish
- Enterprise Products Operating L.P., AI# 40198 – Port Allen/West Baton Rouge Parish
- ExxonMobil Chemical Plant, AI# 286 – Baton Rouge/East Baton Rouge Parish
- ExxonMobil Plastics Plant, AI# 285 – Baton Rouge/East Baton Rouge Parish
- ExxonMobil Polyolefins Plant, AI# 3519 – Baton Rouge/East Baton Rouge Parish
- ExxonMobil Refinery, AI# 2638 – Baton Rouge/East Baton Rouge Parish

- Placid Refining Company, L.L.C., AI# 2366 – Port Allen/West Baton Rouge Parish
- Plantation Pipe Line Company, AI# 582 – Baton Rouge/East Baton Rouge Parish
- Shell Chemical LP, AI# 1136 – Geismar/Ascension Parish
- Syngenta Crop Protection, Inc., AI# 2367 – Geismar/Iberville Parish
- Vulcan Materials Company, AI# 3400 – Geismar/Ascension Parish
- Williams Olefins L.L.C., AI# 5565 – Geismar/Ascension Parish

The following name changes occurred after the AOC was issued.

- Crompton to Chemtura Corporation on December 31, 2005
- DSM to Lion Copolymer, LLC on November 10, 2005
- Vulcan to Occidental Chemical Corporation in April 2005

These 15 facilities were ordered to install fenceline monitoring as follows:

- A minimum of four air monitoring stations at or near the property boundary with a station positioned on each of the four main compass points
- At each station a continuous total non-methane organic carbon (TNMOC) analyzer capable of detecting VOC concentrations of 100 ppb or less for each 10-minute period
- With each TNMOC analyzer, a Summa canister sampler system capable of automatically collecting a 20-minute air sample when the analyzer exceeds a predetermined set point
- At one of the stations, a second Summa canister sampler system capable of collecting a 24-hour integrated sample once every six days for air toxics (This requirement was in the original AO, but, was removed from the AOC. The details of this requirement have been omitted from this report.)
- Supplement at least two of the stations with a 10-meter meteorological tower with sensors to continuously measure wind speed and direction as 10-minute averages

The predetermined set point for the main Summa canister sampler system was to be adjusted to insure at least an average of five samples per month. Each canister was to be analyzed by gas chromatography/flame ionization detection for all ozone precursors VOC on a list provided by LDEQ (see Appendix B). The analytical and quality assurance procedures were to be consistent with EPA analysis method 600-R-98/161. The minimum detection limits for the analysis as calculated by the method in 40 CFR Part 36(b) were to be no greater than 10 ppbCarbon for each of the VOC precursors on the list.

Each facility was ordered to develop procedures for responding to episodes when the canister system was triggered by TNMOC values at or above the set point and the wind direction indicated that the plant was upwind of the station. The procedures were to be used by plant personnel to help locate the likely source of the emission and were to include, as a minimum, a review of current unit operations, notation of special operations and activities, and a plant walk-through with a portable leak detector.

All data and response plan findings were to be reported to LDEQ on a monthly basis beginning June 15, 2005. An annual report was to be submitted at the end of each calendar year. The annual report for 2006 was replaced by the individual Final Reports included in the appendix.

After several negotiations with the individual affected facilities, LDEQ agreed to allow facilities to vary from the requirements spelled out in the AOC. Following is a summary of what was ultimately installed. Additional details can be found in the individual Final Reports.

- **Dow** – Two stations were installed upwind and downwind of the predominant wind direction at the plant. The stations were located a few miles away from the plant site in Addis and Plaquemine. Instead of the Summa canister sampler systems, gas chromatographs (GC) that were triggered by a high reading from the TNMOC analyzer were installed. NOx analyzers were installed at both sites.
- **Enterprise** - Two stations were installed upwind and downwind of the predominant wind direction at the plant. The stations were located at the plant boundaries. Instead of the Summa canister sampler systems, gas chromatographs that were triggered by a high reading from the TNMOC analyzer were installed.
- **ExxonMobil Chemical Plant and Refinery** – A total of five systems were installed for the two adjacent plants on the fencelines. In order to have units upwind and downwind of the plants year around, the units were moved three times per year. Instead of the Summa canister sampler systems, gas chromatographs that were triggered by a high reading from the TNMOC analyzer were installed.
- **ExxonMobil Polyolefins** - Two stations were installed upwind and downwind of the predominant wind direction at the plant. The stations were located at the plant boundaries. Instead of the Summa canister sampler systems, gas chromatographs that were triggered by a high reading from the TNMOC analyzer were installed.
- **ExxonMobil Plastics** – Two stations were installed on the fencelines. In order to have units upwind and downwind of the plants year around, the units were moved two times per year. Instead of the Summa canister sampler systems, gas chromatographs that were triggered by a high reading from the TNMOC analyzer were installed.
- **Geismar 6 (G6)** – BASF, Chemtura, Shell, Syngenta, Occidental and Williams committed to work together as one group called G6. Two new stations were installed a few miles away from the plant sites at Darrow and Hunt Correctional Institute. These stations were integrated with LDEQ's stations at Carville and Dutchtown thus putting stations in all directions from the six plant sites. All of the stations had a TNMOC analyzer, a Summa Canister sampler system and wind speed and direction indicators. G6 also installed NOx analyzers at the two new stations.
- **Lion** – Lion already had a continuously operating gas chromatograph unit in the main process area. The system drew samples from 14 locations on a sequential basis and analyzed the air for styrene, 1,3-Butadiene and acrylonitrile. One new station that conformed to the AOC requirements was installed on the Northwest fenceline.
- **Placid** – Three stations that conformed to the AOC requirements were installed on the Northwest, Northeast and South central fencelines.
- **Plantation** - Two stations that conformed to the AOC requirements were installed on the Northwest and Southwest fencelines.

The maps in Appendix C show the locations of the new monitoring stations.

V. ENVIRONMENTAL AUDIT SUMMARY

Following is a brief summary of the key points from the audits. The full reports are included in the appendix.

- The audits found components missing from the LDAR program in all plants except BRPP.
- One plant modified its flare blower in order to improve the ratio of air-assist to fuel flow in the flare and improve destruction efficiency. (Enterprise)
- Several recommendations were made by the audit team to improve the way that emissions are quantified. (ExxonMobil)
- Some plants were found to have open-ended lines without control. (BRCP, BRPP)
- The comparative monitoring audit in one plant identified a significant difference between the audit team leak rates and the plant's historical leak rates. (BRCP)
- All plants scored well in most phases of the audit.

VI. FENCELINE MONITORING – Significant Findings and Results

A. Following is a brief summary of the findings and results for each plant. Details can be found in the full reports in the appendix.

- **Dow** – Seven strikes occurred during the monitoring period with the trigger set at the minimum value of 1.0 ppm. Only one of the strikes occurred when Dow was upwind. Typical TNMOC values were around 0.5 ppm. Due to the lack of strikes and in order to gather background data, the GCs were manually triggered on six-day cycles beginning in September 2005. The analyses usually showed low levels of ethane, propane and sometimes ethylene. The lack of trigger activity brings into question whether or not the stations were located too far from the plant site to be effective for monitoring plant emissions. Dow reported two unauthorized discharges (RQ) that were greater than 100 pounds of ethylene in 2006,
- **Enterprise** – Approximately 160 strikes occurred with the set points at 3 ppm. The vast majority of the strikes had an evaporative gasoline profile and were with the wind coming from offsite in the Southerly direction. For the few strikes that originated in the plant, the source was not found except for a leak on an exchanger in July 2006. Instrumentation problems occurred off and on throughout the course of the monitoring period with the GC and TNMOC analyzers and with the wind sensors.

  In June 2004 propylene strikes occurred at the Capitol and LSU monitors with the wind coming from the direction of Enterprise. Upon investigation it was determined that Enterprise was flaring propylene at the time. As a result Enterprise performed an engineering analysis of the flare system that showed that excess air was being used on the flare to minimize smoking. As part of the AOC, Enterprise modified the system such that the air flow to the flare was adjusted in relation to the gas flow at three set points of low, medium and high gas flow. Since the modification, only one significant propylene strike at the Capitol site occurred in the 2-year period of 2005-06 with the wind coming from the direction of Enterprise. In 2004 alone there were four such propylene strikes at the Capitol monitor. Enterprise does continue to flare on a regular basis. Alternatives to

flaring such as reducing the amounts going to the flare and/or recycling to the process should continue to be explored.

- **ExxonMobil Chemical Plant and Refinery** – Approximately 500 actionable strikes occurred with set points at the five monitors ranging from 3.5 to 9 ppm. About 30 percent of these were later determined to be from offsite sources. Several tools were developed to help the response team to locate the likely source. These tools included back-track trajectories, scatter-plots, infra-red camera technology and categorizations of 15 typical refinery streams. The response team was very successful in locating the likely, or contributing, source about 50 percent of the time. This was a remarkable success rate considering that the site is spread over 2200 acres. Sources located included storage tank-top components, heat exchanger leaks into steam and water systems, permitted operations such as sampling/tank clearing/maintenance, component and piping leaks, and loading/unloading activities. The Chemical Plant and Refinery reported a total of eight unauthorized discharges (RQ) of HRVOC greater than 100 pounds in 2006 – one for a mixture of toluene and xylenes, four for propylene, one for toluene, and two for ethylene.

  As already stated, about 30 percent of the strikes were caused by offsite sources. Many of these strikes were a higher concentration than the typical highs from the facilities. The Department of Public Works refueling yard at the Southwestern corner of the refinery was believed to be a contributor to some of these strikes.
- **ExxonMobil Plastics** – There were approximately 170 strikes with the set points at 2.41 and 4.61 ppm. No process leaks occurred during the monitoring period. Approximately 50 percent of the triggers were caused by offsite evaporative gasoline emissions coming from the Southeasterly direction. The actionable strikes were attributed to permitted emissions from the product finishing sections and the flare. The plant utilizes a purge gas recycle system to recover and re-use process vapors. Ethylene emissions from emergency releases from the reactors are being reduced through reliability improvements of reactor instrumentation systems. The frequency of these episodes has been significantly reduced - nine in 2006 versus a high of 55 in 1997. The plant reported eight unauthorized discharges (RQ) of ethylene greater than one hundred pounds in 2006.
- **ExxonMobil Polyolefins** – There were a total of 59 strikes with the set points at 2.48 and 3.52 ppm. No process leaks that contributed to the strikes were reported for the monitoring period. Most of the strikes were low-level and attributed to permitted emissions, usually the flare, or nothing was found. A few were caused by offsite emissions. In 2005 the plant voluntarily installed a regenerative thermal oxidizer to destruct inert vent emissions, resulting in a 30 percent site-wide emissions reduction.
- **G6** – There were approximately 130 actionable strikes at the four monitors with the set points at 1.0 to 1.25 ppm. About 70 percent of the strikes were at the Carville monitor. Many of these strikes were caused by refueling operations at the military base on which the station is located. The Carville station was re-located in May 2006 to reduce this local influence, however, nuisance strikes related to agricultural activities near the new site continued to plague the Carville site. Some of the strikes when the plants were upwind occurred while flaring or other emissions from the plants were taking place, but, nothing conclusive was ever found during the individual plant responses. This raises the question as to whether or not the monitors were located too far from the plants to be effective for monitoring plant emissions. The G6 plants reported five unauthorized discharges (RQ) of

HRVOC greater than 100 pounds in 2006 – Occidental: ethylene, Chemtura: toluene, Syngenta: toluene, Williams: one for ethylene and one for propylene.

Through the course of the program, some of the G6 facilities identified ways to reduce emissions. Chemtura discovered and repaired several minor leaks on railcars. They also found and repaired a leak on a compressor using the HAWK camera. Occidental installed a containment project to eliminate ethylene emissions related to one of their processes. Syngenta replaced leaking relief devices on two toluene storage tanks.

- **Lion** – There were over 700 strikes with the set points at 5 (GC) and 10 (TNMOC) ppm. This total includes numerous strikes from offsite. In August 2006 the GC system was modified to eliminate some of the local sample points. About 20 percent of the strikes that were investigated were attributed to operations and maintenance activities such as purging or draining equipment and flushing lines. About 25 of the strikes were attributed to process leaks or process upsets. The leaks were immediately repaired when possible otherwise a work order was written for the repair. For the remaining actionable strikes, the source was not found. The GC was configured to show only 1,3-Butadiene and styrene from the Ozone Precursor VOC List. The canister analyses showed mostly chemicals that are not handled in the plant except for some that showed 1,3-Butadiene and styrene. The plant changed ownership in 2005 and there were some interruptions in the monitoring program due to the transition.
- **Placid** – There were over 800 strikes with the set points at 13, 15 and 17 ppm. About half of the strikes were attributed to emissions from general tank operations and loading-unloading operations which, in many instances, were taking place just a short distance from the monitors. For most of the remaining strikes, no emission source was found by the response team or the report did not describe the response actions that were taken. From the fenceline data, Placid has discerned a potential relationship between product movements through certain tanks and VOC strikes at the monitors. Consequently, as part of a proposed refinery expansion, Placid is proposing to install vent collection and treatment on 13 tanks.
- **Plantation** – Approximately 250 strikes occurred with the set points at 5.5 and 6 ppm. The tanks are either floating roof, both internal and external, or normal atmospheric tanks – none have vent collection. Most monitored emissions are the result of routine operations of filling, storing and emptying the gasoline products that are handled by the facility. The South monitor was impacted by a gasoline source to the Southeast – possibly Metro Airport. Plantation has reduced emissions from about 1,800 tons per year to less than 700 tons per year by modifying operational practices.

B. The fenceline monitoring program had a positive impact on LDEQ monitors and on the unauthorized releases (RQs) that are reported to the agency. The following table shows the number of strikes and the number that contained significant amounts of HRVOC.

Strikes at LDEQ Monitors

	Total Strikes			HRVOC >100 PPB Strikes		
	2004	2005	2006	2004	2005	2006
Baker	31	27	33	26	18	15
B Plaquemine	3	5	1	0	0	1
Capitol	86	66	64	11	16	6
Carville	23	57	60	0	8	8
Dutchtown	1	3	6	0	1	5
F Settlement	0	0	2	0	0	0
G Tete	0	0	0	0	0	0
LSU	28	22	4	1	0	0
P Allen	80	64	73	18	15	18
Pride	0	0	1	0	0	0
Southern	113	32	36	21	4	7
Total	365	276	280	77	62	60

The table shows that during the fenceline monitoring program years of 2005 and 2006, there was a decrease in total strikes of about 25 percent and a similar decrease in strikes with significant amounts of HRVOC. Southern and LSU were the two sites that showed the greatest improvement. The other two urban area monitors, Port Allen and Capitol, also showed good improvement. Baker and the rural sites at Bayou Plaquemine, Dutchtown, French Settlement, Grosse Tete and Pride were relatively unchanged. The increase at Carville was addressed earlier in this section. Not shown in the table is another significant improvement. The number of 1,3-Butadiene strikes decreased from eight in 2004 to just one in 2005 and 2006. This improvement allowed the state to meet the 1,3-butadiene toxic standard for the first time.

The next table shows the unauthorized releases reported to LDEQ from facilities in the BRNA.

Chapter 39 HRVOC Reportable Quantities: >100 lbs

	Number	Total Amount (lbs)	>1000 (lbs)	>10,000 (lbs)	Largest (lbs)
2003 (1)	24	64,600	10	1	18,000
2004	71	250,000	25	3	66,000
2005	24	80,000	10	3	21,000
2006	31	57,617	11	0	9,820

(1) from October 15

The table shows that both the number and the severity of the unauthorized releases during the fenceline monitoring years were significantly improved when compared to 2004.

VII. ON-GOING EMISSION REDUCTION PROGRAMS

As a result of the fenceline monitoring program, several facilities have initiated on-going programs to further identify and reduce emissions.

- **BASF** – The facility is participating in a voluntary pilot project to evaluate the application of gas imaging technology to improve VOC leak detection.
- **Chemtura** – The facility plans to continue to use the procedures and experiences gained from the fenceline monitoring program to identify and correct releases as they may occur.
- **Enterprise** – Besides the improvements to the flare air blower mentioned earlier in this report, the facility also modified the procedure for recharging a treater. The procedure now requires that the vessel be depressured more slowly in order to not slug propane and propylene to the flare.
- **ExxonMobil Chemical Plant and Refinery** – The facilities have worked with barge fleet companies and independent surveyors to modify the procedures to provide closed hatch sampling and gauging of marine vessels. Also, due to the success in locating emission sources during strike responses, an infra-red camera has been purchased and its use will be incorporated into daily operations for finding leaks and emissions.
- **ExxonMobil Plastics** – Plans include the following: 1) replace several pumps in VOC service due to their poor leak history; 2) continue root-cause investigations and reliability efforts to reduce flaring events and accidental releases; 3) transition to the HAWK in lieu of Method 21 as the technology matures.
- **ExxonMobil Polyolefins** – Plans include the following: 1) continue reliability efforts to reduce flaring events and accidental releases; 2) evaluate the feasibility of routing streams to the oxidizer that are currently going to the flare.
- **Lion** – The facility plans to continue using the GC to identify and mitigate excess emissions of 1,3-Butadiene, styrene and acrylonitrile as they may occur within the plant.
- **Placid** – As stated earlier in this report, Placid is proposing to install vent collection and treatment on 13 VOC tanks.
- **Plantation** – The facility intends to continue with current operational practices in order to maintain the emission reductions described in Section VI of this report.
- **Shell** – The facility has joined an industry sub-group that will study emissions associated with port activities.
- **Syngenta** – The facility plans to continue with programs for monitoring cooling towers and tank roof tops for VOC emissions. Additionally, the facility plans to continue to use the procedures and experiences gained from the fenceline monitoring program to identify and correct releases as they may occur.
- **Williams** – Plans include the following: 1) upgrade control valve bodies to a lower emission design type; 2) conduct post-turnaround leak surveys of the facility with the HAWK; 3) move plant turn-arounds to outside of the ozone season.

VIII. CONCLUSIONS

Following are conclusions from the program.

- The program had a significant positive impact on both the number of strikes at the LDEQ monitors and on the number and severity of HRVOC RQs being reported to LDEQ.
- Facilities that performed the Environmental Audit are properly accounting for HRVOC emission sources. While some individual fugitive emissions locations were found missing from the LDAR program, the number was very small when compared to the total number of components that are being monitored.
- Floating roof tanks, both internal and external, that vent directly to the atmosphere are a very significant source of VOC emissions. The mechanical seals, if not maintained properly, allow vapors to escape and whenever the roof is landed on its legs for any reason, the vapors that accumulate beneath the roof are vented through the relief valve as the tank is re-filled. The facilities in the program that have a large number of floating roof tanks had higher monitor set points and many more strikes than the other facilities. Although the stored liquids contain only small amounts of HRVOC, all of the chemicals are ozone precursors and have the capability of forming ozone, albeit at a slower rate.
- Flares appear to be emitting some unburned compounds, including HRVOC, that could be more than what is estimated by flare manufacturers, at least under some conditions. Many strikes were attributed to flares. Also, due to the height of the flares, some of the unburned emissions may not be picked up by the monitors on the fenceline.
- Many strikes were attributed to loading and unloading operations. Regulations for these operations need to be reviewed to determine if revisions are needed.
- While only a few of the strike samples contained significant amounts of HRVOC, many of the samples showed low levels of HRVOC, especially ethylene and propylene. A separate study[1] by EPA showed that the ethylene and propylene in the atmosphere at the Capitol and Bayou Plaquemine monitoring stations has increased in the period of 2001-2005 over the period of 1996-2000. Reduction of HRVOC may be necessary to bring the area into attainment with the 8-hour ozone standard and should be considered.
- Facilities that installed GCs instead of a canister system were much more successful in finding the likely source. This was due to the fact that the GC provided near-real-time speciation and the response team was able to immediately search for the emission source in the areas of the plant that contained the chemicals that showed up on the GC rather than randomly checking the whole plant.
- Where the monitors were located on the fencelines, higher set points were needed to keep the number of strikes in range. These monitors also had a lot higher level of activity and it was easier to locate the potential source.
- The fenceline program demonstrated that GCs in a trigger mode are viable options for transient emission monitoring.
- Meteorological instrumentation, especially wind direction monitors, needs to be checked for accuracy on a routine basis.

1 *M. Sather and K Cavender, Trends analysis of ambient 8 hour ozone and precursor monitoring data in the south central U.S., Journal of Environmental Monitoring, 2007, 9, 143-150.*

IX. APPENDICES

Appendix A – Environmental Audits

Enterprise Products Operating L.P.

Note: Report in EDMS: https://edms.deq.louisiana.gov/app/doc/querydef.aspx
Document ID 32897191,
Date: 5/19/2005

Appendix A – Environmental Audits

ExxonMobil Polyolefins Plant

BRPO

HRVOC AUDIT REPORT

ExxonMobil Chemical Company
Baton Rouge Chemical Plant (BRCP)

Shaw Project No. 115121-02
RTPLA Project No. 2005-007-002
June 2005

Prepared for:

ExxonMobil Chemical Company
Baton Rouge Chemical Plant
4999 Scenic Highway
Baton Rouge, LA

Prepared by:

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4171 Essen Lane
Baton Rouge, LA 70809

RTP Environmental Associates, Inc.
285 West Esplanade Ave., Ste 308
Kenner, LA 70065

HRVOC AUDIT REPORT

Shaw Project No. 115121-02
RTPLA Project No. 2005-007-002

June 2005

Prepared for:

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Executive Summary

Pursuant to an Administrative Order issued by the Louisiana Department of Environmental Quality (LDEQ) on October 6, 2004, Exxon Mobil Corporation's (ExxonMobil) Baton Rouge Chemical Plant (BRCP) was required to conduct a comprehensive environmental audit of the facility's operations for the purposes of documenting all potential sources of releases of highly reactive volatile organic compounds (HRVOC). To accomplish this objective, ExxonMobil commissioned a third-party systems audit by recognized environmental professionals. In selecting the audit team, ExxonMobil sought to identify recognized individual environmental professionals, rather than companies, and sought individuals who had no prior work experience related to BRCP. The audit team was charged to verify that all potential sources of emissions have been identified and accounted for, and to confirm that calculation techniques employed reflect the most appropriate and accurate methodologies for the respective emission sources. To this end, the audit team reviewed pertinent air permits, permit applications, process descriptions, process flow diagrams (PFDs), piping and instrumentation diagrams (P&IDs) and conducted interviews with BRCP environmental staff to gain an understanding of the processes and emission sources in place at the BRCP.

The audit team conducted site visits to BRCP several times during April 2005. The audit was a "systems audit", and since there are numerous operating facilities within BRCP, the auditors conducted a preliminary review and from that review identified two operating units from each of the four business lines operating at BRCP. The four business lines are: Olefins, Intermediates/Aromatics, Polymers, and Infrastructure. The units selected from the business lines were:

Olefins:	- Maintrain Ethylene Production Facilities - Butadiene Extraction Unit (BELA-5)
Intermediates/Aromatics:	- Isopropyl Alcohol Unit (IPA), -sec-Butyl Alcohol/Methyl Ethyl Ketone Unit (SBA/MEK)
Polymers:	- Halobutyl Production Facilities, - Vistalon Production Facilities
Infrastructure:	- Flares, - Wastewater Improvement Unit (WILA)

An overview of each process was provided and discussions were held regarding the various emissions units, their potential to emit HRVOC, and the manner in which the emissions were calculated from both a permitting and an actual basis perspective. Representative samplings of calculations were checked to verify the calculation methodology.

The process utilized by BRCP to identify emission sources is very thorough. The audit team conducted a "systems audit", focusing on assuring that proper practices and procedures were in place to identify potential emission sources and accurately account for emissions from these sources. Therefore, while the audit did not confirm that all sources of HRVOC have been identified by ExxonMobil and that all calculation techniques reflect the most appropriate and accurate methodologies, the audit did seek to ascertain if the practices and procedures employed by ExxonMobil were rigorous and appropriate. A qualitative assessment scale was used to judge each individual area as well as the system as a whole. The following is a table of classifications used.

Rating	Meaning
★★★★★	Meets industry standard , *no improvements identified*
★★★★	Meets industry standard, *only minor improvements needed*
★★★	Meets industry standard, *improvements needed*
★★	Improvements needed to meet industry standard
★	Below industry standard, major improvements needed

From the standpoint of the identification of sources of HRVOC emissions, the audit team concluded that it is highly probable that ExxonMobil has identified all such sources. From the standpoint of evaluating calculation methodologies and techniques, the audit team assessed an overall evaluation of ★★★★ (Meets industry standard, *only minor improvements needed.*) Information on the assessment of individual areas is provided in more detail in the body of the report.

1.0 Introduction

1.1 Objective and Purpose

Pursuant to an Administrative Order issued by the Louisiana Department of Environmental Quality (LDEQ) on October 6, 2004, ExxonMobil Corporation's (ExxonMobil) Baton Rouge Chemicals Plant (BRCP) was required to conduct a comprehensive environmental audit of the facility's operations for the purposes of documenting all potential sources of releases of highly reactive volatile organic compounds (HRVOC) and to perform testing of certain specified emissions sources. Since ExxonMobil believed that its in-house air permitting and emission reporting efforts were thorough and accurate, and they were required to comply with the Administrative Order, ExxonMobil commissioned a third-party systems audit by recognized environmental professionals. In selecting the audit team, ExxonMobil sought to identify recognized individual environmental professionals, rather than companies, and sought individuals who had no prior work experience related to the BRCP.

1.2 Audit Team Composition

The audit team was composed of Mr. Gerald Brouillette, P.E. of the Shaw Group (Shaw) and Mr. William Palermo, P.E. of RTP Environmental Associates, Inc. (RTP). Mr. Brouillette is a Senior Project Manager with Shaw's Baton Rouge, Louisiana office and is a Louisiana Registered Professional Engineer. Mr. Brouillette has worked as an environmental engineer and manager in the petrochemical industry in Louisiana for over 14 years, and has worked as an environmental consultant for an additional three years. His industrial work background provides an excellent insight into plant operations, and he has extensive experience in developing and employing emission calculations for both permitting and reporting purposes. Mr. Palermo is a Principal of RTP and is Manager of RTP's Louisiana office. Mr. Palermo is a Louisiana Registered Professional Engineer and he has been employed in Louisiana as an environmental consultant in excess of 30 years. He has a comprehensive knowledge of Louisiana air permitting processes and requirements and with the procedures for identifying and quantifying sources of air emissions.

1.3 Methodology

The audit team reviewed pertinent air permits, permit applications, process descriptions, process flow diagrams (PFDs), and piping and instrumentation diagrams (P&IDs) to gain an understanding of the processes and emission sources in place at the various units within BRCP. Emphasis was placed on those sources that had the potential to emit any of the seven identified HRVOCs (ethylene, propylene, 1,3-butadiene, butenes and isomers, acetaldehyde, toluene, and xylene and isomers). Following this review, the team met with knowledgeable personnel from

the various BRCP units to review the processes that were in place for identifying emissions sources and emissions, including emergency releases, and the quantification of emissions from both a permitting basis and from the standpoint of reporting actual emissions on an annual and ongoing basis. Calculation procedures were evaluated with emphasis being placed on those emissions sources that had the greatest potential to emit HRVOC and those for which multiple possible quantification techniques were possible. A representative sampling of calculation methodologies was also performed.

1.4 Assessment

ExxonMobil requested a "systems audit" focused on assuring that proper practices and procedures were in place to identify potential emission sources and accurately account for emissions from these sources. Therefore, the audit itself did not include detailed plant walkthroughs, drawing review, and/or plant personnel interview to ensure all potential emission sources had been identified. Neither did the audit involve a thorough review of all emission calculations for each emission source. Thus, while the audit did not confirm that all sources of HRVOC have been identified by ExxonMobil and that all calculation techniques reflect the most appropriate and accurate methodologies, the audit did seek to ascertain if the practices and procedures employed by ExxonMobil were rigorous and appropriate. Accordingly, the audit team, with the agreement of ExxonMobil, embarked upon a subjective assessment of the extent to which ExxonMobil had identified and quantified all sources of HRVOC. Two different subjective methodologies were employed. A qualitative assessment scale was used to judge each individual area as well as the system as a whole. The following is a table of classifications used:

Rating	Meaning
★★★★★	Meets industry standard, *no improvements identified*
★★★★	Meets industry standard, *only minor improvements needed*
★★★	Meets industry standard, *improvements needed*
★★	Improvements needed to meet industry standard
★	Below industry standard, major improvements needed

2.0 Methodology

2.1 Approach

The audit team's task was to conduct a system's review of how ExxonMobil identifies and quantifies its emission sources of HRVOCs. ExxonMobil believes that its air permitting and emission reporting efforts are thorough and that it utilizes the most current information, emission factors, and other best practices in its permitting and compliance programs, consequently ExxonMobil sought the assistance of consultants to provide third party verification of the approaches that are currently in place at each facility. To this end, the audit team conducted a thorough review of ExxonMobil's approach in identifying and quantifying sources of HRVOC and representative spot checks of actual calculations and reports.

The audit team conducted a project kickoff meeting on March 9, 2005, at which representatives of each of the four ExxonMobil facilities were present and the manner in which the audit(s) would be conducted was defined and an audit schedule was developed. An initial needs list was provided to ExxonMobil identifying the types of information that would be reviewed prior to the respective site visit. The needs list information included items such as process descriptions, existing permits, permit applications, process flow diagrams, and supporting emission calculations methodology not included in the application(s).

The audit team conducted several site visits to BRCP during April, 2005. An overview of the processes was provided and discussions were held regarding the various emissions units, their potential to emit HRVOC, and the manner in which the emissions were calculated from both a permitting and an actual basis perspective.

2.2 Resources

Various resources were utilized to conduct the audit. Process flow diagrams for the different processes were reviewed to confirm the identification of potential sources of emissions. Facility permits and applications were reviewed to ensure proper assessment of all emission points including insignificant activities and "General Condition XVII" items. Emission calculation bases were discussed with knowledgeable plant personnel and spot checks were conducted to confirm the methodology employed was consistent with the generally accepted hierarchal approach for emission basis and regulatory requirements. The generally accepted hierarchy for calculating emissions is presented below:

Hierarchal Order	Calculation Basis	Examples
1	Direct Measurement	Emissions Monitoring, Stack Testing, Stream Sampling
2	Emission Factors/Studies	AP-42, Tanks 4.09, Water 9, ToxChem, API studies, etc.
3	Material Balances	Inlets minus Outlets, Materials Used, etc.
4	Manufacturers Specifications & Guarantees	
5	Engineering Judgment	

In assessing the calculation methodology employed by ExxonMobil, the calculation hierarchy was considered. Additionally, where vendor information for pollution control equipment (flares, thermal oxidizers) was part of the emission calculation basis, this information/documentation was reviewed and discussed.

2.3 Interviews

The audit team conducted interviews of the BRCP facility environmental staff personnel responsible for the various business lines. Ms. Paula Taylor and Mr. Derek Reese represented Intermediates/Aromatics, Mr. George Holder and Ms. Mandie Bosch represented Polymers, Mr. Stan Labat and Mr. Mike Brice represented Olefins; and Mr. Ed Caputo represented Infrastructure. In addition, discussions were held with Mr. Tom Morrill regarding emissions from storage tanks, Mr. Mark Hofmeyer regarding accidental releases; and Ms. Meredith Moe regarding emissions from wastewater operations. Mr. Morrill, Mr. Hofmeyer, and Ms. Moe assist in calculating actual emissions from their respective disciplines for the entire BRCP facility. The various representatives were able to provide an in-depth review of the actions employed by BRCP to identify emission sources and quantify those sources. Information on how changes to the process that may add or otherwise change an emission source was provided as well as how non-permitted activities (i.e. emergency releases) are addressed.

3.0 Findings

3.1 Background

BRCP is comprised of four business lines that each contain several production or service processes. The four business lines are: Olefins, Intermediates/Aromatics, Polymers, and Infrastructure. From each of the four business lines two processes were selected for auditing purposes. The units selected from the business lines were:

Olefins:	Main Train, Butadiene
Intermediates/Aromatics:	Isopropyl Alcohol (IPA); sec-Butyl Alcohol (SBA)
Polymers:	Halobutyl, Vistalon
Infrastructure:	Flares, Wastewater

The Maintrain Ethylene Production Facility (Maintrain) produces ethylene by high temperature pyrolysis of liquid and/or gas petroleum fractions in tubular cracking furnaces and recovered in downstream distillation operations. Distillation and/or cryogenic processes separate the products that are formed in the cracking furnaces. Process vents generally are routed to the BRCP Flare Gas Recovery System where the hydrocarbons are compressed and recovered to be used as a fuel source in the facility. Other sources of emissions are from storage tanks, fugitive sources, combustion source, cooling towers, secondary wastewater emissions, and General Condition 17 and insignificant activities.

The Butadiene Extraction Unit (BELA-5) is designed to recover 1,3-butadiene from steam cracked naphtha or imported as crude butadiene and purified. The feedstocks for BELA-5 are butadiene streams that are produced in the BRCP or from imported streams. In addition to 1,3-butadiene, 1,2-butadiene and raffinate may be routed either to another BRCP unit, the Baton Rouge refinery (BRRF) or to a third party. Process vents generally are routed to the BRCP Flare Gas Recovery System where the hydrocarbons are compressed and recovered to be used as a fuel source in the facility. Other sources of emissions are from storage tanks, fugitive sources, cooling towers, secondary wastewater emissions, and General Condition 17 and insignificant activities.

Isopropyl Alcohol (IPA) and a coproduct, isopropyl ether, are produced in the IPA unit. The unit is a continuous operation, in which propylene is reacted using a sulfuric acid absorption process. IPA is separated via distillation. Final purification to 99.9% purity is achieved via dehydration.

Sec-butyl alcohol (SBA) is produced from butylene also by a sulfuric acid absorption process. Formation of co-products occurs due to the presence of impurities in the butylene feed. Crude SBA is produced and purified by distillation.

Halobutyl rubber is made by the reaction of isobutylene, isoprene and a block copolymer to form a polymer that is then halogenated in a hexane carrier. Refrigerated, stirred reactors, operated on a flow through basis, are used in carrying out the polymerization. The exothermic heat of reaction is removed by circulating a refrigerant through the jackets of the reactors. The polymer is dissolved in hexane as it leaves the reactors and then undergoes stripping to remove unreacted monomers. The polymer is concentrated and halogenated. Next the halogenated polymer is precipitated to form a crumb rubber in water slurry by the introduction of steam and hot water. The steam and water flash the hexane for recovery. The rubber slurry is then pumped to the Halobutyl Finishing Unit (HFU) for dewatering, drying, and product packaging. Successive stripping operations at the co-polymerization unit recover 99.8% of the entering volatile organic compounds, however some of the VOCs are retained in the pores of the slurried rubber. The majority of the residual VOC is vaporized and exhausted along with air and steam dewatering and drying. The HFU Thermal Treatment Unit (TTU) collects the highest VOC concentration exhaust streams and thermally treats them to reduce VOC emissions. Other sources of emissions are from storage tanks, fugitive sources, cooling towers, secondary wastewater emissions, and General Condition 17 and insignificant activities.

Vistalon rubber is made by polymerizing ethylene and propylene to form a polymer in a hexane carrier. Liquid filled, stirred reactors operated on a flow through basis, are used in carrying out the polymerization. The exothermic heat of reaction is removed by feed pre-chilling. Catalyst residues are then removed from the polymer. Next, the polymer is precipitated to form a crumb rubber in water slurry by the introduction of steam and hot water. The steam and hot water flash off the hexane carrier and unreacted monomers for recovery. The rubber slurry is then pumped to the Vistalon Finishing Unit for dewatering and product packaging. Successive stripping operations at the polymerization unit recover more than 99.8% of the entering hexane and unreacted monomers, however some of the VOCs are retained in the pores of the slurried polymer. Most of these VOCs vaporize and are exhausted to the atmosphere along with steam during dewatering. The VOC concentration in these exhaust streams range from 0 to 200 ppm, where most of the VOC is hexane (a non-HRVOC).

The Flare systems consist of a Flare Gas Recovery Unit that controls the routine and non-routine emissions of vapors vented from the manufacturing units at BRCP. The hydrocarbons in the vapor streams are recovered through compression and condensation and sent to the Refinery Mixing Manifold (RMM) for use as fuel in the BRRF. The vapors not recovered in the recovery unit are routed to one of four flares where a destruction efficiency of 99.5% is achieved.

The Wastewater Improvement Unit (WILA) recovers hydrocarbons from a variety of wastewater streams via a series of solids settling, density separation, and filtration steps followed by steam stripping. This unit was originally built as the treatment process to comply with 40 CFR 61 Subpart FF - Benzene Waste Operations NESHAP. The hydrocarbons are primarily routed to

the WILA area via pipeline. Wastewater that leaves this unit is sent to the BRCP Wastewater Treatment Unit (AWT Unit)

3.2 Emission Sources

The process utilized by BRCP to identify emission sources is very thorough. The BRCP plant personnel have conducted numerous surveys of the facility (including PFD reviews, actual plant walk throughs, etc.) to ensure all potential emission sources have been identified. BRCP environmental personnel conducted interviews with operations and maintenance personnel to address potential Insignificant Activity items as well as GC-17 issues.

The primary source of HRVOC emissions from BRCP from the units reviewed were emissions from flaring operations (55 tons of HRVOC reported from the selected units in 2004), The second highest source of HRVOC emissions are from fugitive sources (38 tons of HRVOC), followed by accidental releases (24 tons), and then cooling towers (12 tons) and secondary wastewater emissions (10 tons).

The BRCP has very comprehensive Release Reporting Procedures. All unauthorized releases are reported to the Chemical Plant Superintendent (CPS) promptly upon discovery. The CPS, in concert with the environmental person on call, are responsible for determining which releases should be reported to regulatory agencies. The CPS is normally responsible for notifying the Louisiana State Police (State Emergency Response Commission) (SERC)) and Baton Rouge Fire Department (Local Emergency Planning Committee (LEPC)). If a release requires notification to the National Response Center or the LDEQ, the environmental person on duty is contacted and provided with the information relating to the release for reporting. The environmental contact for the operating area is responsible for securing a final estimate of the release quantity and composition as well as for filling out a first pass of the form used for written follow-up with the regulatory agencies, based on information available at the time, and providing the form to Site Environmental. For any release that was reported to a regulatory agency, Site Environmental works with the environmental contact for the operating area to facilitate development of the written agency follow-up report. Site Environmental completes a final draft of the form and cover letter, arranges for review and submits the report to the regulatory agency.

Detailed in the tables below is a listing of the different emission a description of how the permitted and actual emissions are determined, comments and recommendations regarding the calculations, and a qualitative grade for the calculation methodology employed. The following types of emission points were identified associated with the BRCP processes:

- Flares,
- Fugitive Emissions,
- General Condition-17/ Insignificant Activity,
- Accidental Releases,
- Secondary Wastewater Emissions,

- Process Vents,
- Cooling Towers,
- Storage Tanks, and
- Combustion Sources.

3.3 Emission Calculations

Source Description	Flares (4) (55 tons of HRVOC in 2004)
Contributors	Approximately 10% of lines tied into the flare headers are process lines that vent (either continuously or intermittently) to the flare system. The remaining tie-ins are from process safety valves used to protect equipment during periods of unexpected overpressure situations. BRCP has four flare systems: high pressure (HP), low pressure (LP) low pressure vent gas (LP-VG) and the halogenated flare.
Permit Methodology	Samples are collected on the various flare headers on a periodic basis. Historical flow measurements were obtained by use of orifice calculations. Emissions from flare operations are based on historical average flow and concentration data over 2000 through 2004 data with two standard deviations added to the average. A 99.5% destruction efficiency is applied to the flare operations. Several contributors to the flare systems tie in directly at the flare tip, and therefore bypass the sampling of flow measurement section of the headers. These contributors are accounted for based on historical information on the composition of the contributing equipment and flow measurement based directly on pressure differential. These contributors are then added to the historical information identified above to define the total permitted values.
Actual Methodology	Samples are collected weekly for the HP flare, weekly for the LPVG flare streams and quarterly for the LP flare to define speciations. Flow measurements (historically based on orifice calculations, now use Panameterics system installed in 2004) are then identified and combined with the speciation data prior to applying a 99.5% control. When potential increases over normal events are anticipated (i.e. startup, shutdown, maintenance activity), sampling frequency of the flare header is increased

Source Description	Flares (4) (55 tons of HRVOC in 2004)
Comments/ Recommendations	BRCP has four flare systems: high pressure (HP), low pressure (LP) low pressure vent gas (LP-VG) and the halogenated flare. The flare systems are interconnected and equipped with a recovery compressor. The recovery compressor continually operates to recover hydrocarbons prior to flaring that are then used as a fuel in the Refinery Mixing Manifold (RMM) system to feed fired equipment in the refinery process. BRCP utilizes a "Panametrics" system that was recently upgraded in November 2004. The Panametrics is an ultrasonic flow measuring device that is used to measure both the flow and the average molecular weight of the materials that are being controlled by the flares. Each of the flares are steam assisted to ensure proper mixing within the flame zone in order to optimize destruction efficiency. The steam flow to each flare unit is controlled with input from the Panametrics system in order to maintain an optimal ratio of steam to hydrocarbons based on vendor data, other studies and plant operating experience. BRCP has undertaken a strong effort to fully define the flare system operations and to upgrade the systems to achieve optimal operation. BRCP has worked with flare manufacturers to ensure the flares are operated correctly. BRCP has ensured that flare operations will consistently meet the NSPS requirements of 300 btu/scf. A 99.5% destruction efficiency has been applied by BRCP to the flare system based on the control systems in place and written performance guarantees from flare tip vendors. The 99.5% destruction efficiency for the flare is considered to be reasonably conservative for the following reasons: 1) the Panametrics system is an advanced system that ensures optimal steam addition to the flare tip – not too much that it dampens the efficiency of the flare and not too little so that proper mixing and turbulence is lacking; 2) a review of EPA's Flare Efficiency Study, July 1983, confirms that with proper operation of a flare, destruction efficiencies in excess of 99.5% would be expected for a properly functioning flare gas system that is controlling HRVOCs; and 3) the written performance guarantees from the flare tip manufacturers .
Evaluation: ★★★★★ - Meets industry standard , *no Improvements identified*	BRCP utilizes EPA studies (2) (Flare Efficiency Study) and vendor guarantees (4) to quantify these emissions. The methods employed are determined to meet industry standards.

Source Description	Fugitives (38 tons HRVOC in 2004)
Contributors	• Valves • Connectors • Compressors • Pumps • Process analyzers
Permit Methodology	BRCP uses historical maximum measured leak rate information with the component count for the facility to define the potential to emit from fugitives. Stream speciation is based on process knowledge for the individual streams with component counts defined by stream type. BRCP uses the EPA correlation equations along with the historical data and component counts for permitting purposes.
Actual Methodology	To define actual emissions, BRCP takes the EPA correlation equations and applies the actual fugitive monitoring results from that year to the equations to determine the reported number. Speciation is based on design process stream composition.
Comments/ Recommendations	EPA identifies a hierarchy to estimate fugitive emissions. The method employed by BRCP is the most stringent method short of conducting bagging studies. For most conventional facilities, this is the recommended method to define fugitive emissions.
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRCP utilizes EPA emission factors (2) and applies direct measurement data (1) to the factors. The manner to define actual emissions from this activity meets industry standards with no improvements identified.

Source Description	GC-17 / Insignificant Activities (6 tons HRVOC in 2004)
Contributors	• Sampling • Tank Servicing • Opening of equipment • Equipment maintenance • Chemical Cleaning • Turnaround Activities • Catalyst dust from reactor preparation • Additive chemicals • P/V and Safety Valve Servicing • Tote Bins • Truck Unloading • Tankcar Cleaning • Startup Emissions • Bluff Tank Condenser Maintenance • Tank Vapor Recovery System Maintenance
Permit Methodology	BRCP conservatively quantified the frequency for the various activities, and based on this quantification, determined the volume available for release from *each activity after accounting for proper operation and clearing of equipment* based on procedures and work practices used at the facility.
Actual Methodology	BRCP identified potential emissions per activity and works closely with operations personnel to define the frequency of actual events during the calendar year. If there is any uncertainty as to the frequency of a specific activity, a conservative number is selected. Once the frequency is defined, BRCP then multiplies the number of times that activity was undertaken during the year to the developed factor. These numbers are reported within BRCP's internal reporting figures as "Sitewide Emissions" for the respective operating facility.
Comments/ Recommendations	BRCP employs appropriate means to determine emissions from these sources. Judicious effort is undertaken to identify the actual frequency of events, and potential emissions per event are conservative.
Evaluation: ★★★★★ - Meets industry standard, *no improvements identified*	BRCP uses material balances (3) to determine these emissions. Appropriate conservativeness is applied to these calculations, therefore, the manner to define actual emissions from this activity meets industry standards with no identified improvements needed.

Source Description	Emergency Releases (24 tons HRVOC in 2004)
Contributors	BRCP calculates quantities emitted from all known releases whether "Reportable Quantity" level is attained or not.
Permit Methodology	Not a permitted source.
Actual Methodology	The procedures employed by BRCP for emergency releases are appropriate for this type industry. When an event if identified (typically by a unit operator), the shift supervisor is informed, who in turn notifies the BRCP superintendent. The BRCP superintendent is an individual with significant experience within BRCP who has a firm understanding of the various types of releases and the importance of accurately estimating the quantity released. The BRCP superintendent is responsible for investigating the release, logging it, and determining an initial estimate of quantity and speciation of the release. Based on the superintendent's comfort level, plant engineers and management may be enlisted to aid in defining the quantity and speciation. Once quantified and speciated, a form is filled out with details on the nature of the release, cause, actions to prevent recurrence, as well as quantity and speciation. This form is provided to the appropriate BRCP environmental staff personnel for review and documentation. If there are any concerns or questions within the environmental staff, the issue is resolved with the appropriate management and operations personnel. The typical approach is to be conservative in the estimates of potential quantities released.
Comments/ Recommendations	BRCP has a written, well documented, procedure that appears to be strictly followed when any release occurs. The procedure is complete in that it requires investigation and quantification for all releases, regardless of whether they are thought to be of "Reportable Quantity" or not. Employing personnel with extensive experience and knowledge of the respective processes in calculating emissions from releases is the best manner to follow since these personnel have intimate knowledge of the operations and the systems employed by BRCP.
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRCP uses engineering calculation and process knowledge (3) to determine emissions from emergency releases. Appropriate engineering data and assumptions are utilized; consequently, the methods used in this area meet industry standards with no improvements identified.

Source Description	Secondary Wastewater Emissions (10 tons HRVOC in 2004)
Contributors	• Condensible Blowdown Drum WAD-07 • Condensible Blowdown Drum WBD-07 • Condensible Blowdown Drum WCD-07 • Acid Disengaging Drum
Permit Methodology	Historical samples (updated in 2003) are used with either ToxChem wastewater modeling software or EPA's Water8 model. Emissions are based on the respective model utilizing design flowrates.
Actual Methodology	Actual emissions are based on historical sample results with actual flowrates for the year. The ToxChem or EPA Water8 model is run with this input data to obtain emission numbers.
Comments/ Recommendations	BRCP accounts for emissions from conventional sources related to wastewater systems. There are two different approaches utilized. The primary method is based on historical sampling conducted at BRCP during the 1990's. A wastewater emission study was conducted within BRCP by collecting numerous samples throughout BRCP's wastewater systems and applying conservative factors to the results of this sampling exercise. Based on the results of the sampling activity, a conservative estimate of 22.6 pounds of VOC's per year is estimated to be emitted per average gallon per minute of flow of wastewater (5.16 ppm). Speciation for emissions is based on historical sampling of the various streams and/or process knowledge. Actual emissions are then calculated by applying the "22.6" factor to the actual flow rate for the respective wastewater stream considering its sampled speciation. BRCP has conducted some comparative analysis where results of Water8 emission predictive modeling software for wastewater emissions were compared to results using the 22.6 factor. The BRCP defined factor is equal to or more conservative in most cases. BRCP is currently undertaking a new sampling exercise around the facility's wastewater treatment system and will "back-calculate" concentrations (and thereby potential emissions) by use of the ToxChem model. Preliminary results indicate that the BRCP defined factor is appropriately conservative. When the study is completed, BRCP will make adjustments to the present factor, if deemed necessary. The second method employed by BRCP to determine secondary wastewater emissions is used only in the Intermediates area. In this area, BRCP collects actual wastewater speciation from the various wastewater streams and using actual flowrates utilizes EPA's Water8 program to estimate emissions. Both mechanisms employed are considered appropriate to define emissions from these type activities.
Evaluation: ★★★★★ - Meets industry standard, *no improvements needed*	BRCP utilizes a combination of direct measurement (1), site specific defined emission factor (2) and EPA models (2) to quantify these emissions. The methods used in this area meet industry standards with no improvements identified.

Source Description	Process Vents (<1 ton HRVOC in 2004)
Contributors	• IPA Flash Cooler • Halobutyl Chiller • Halobutyl Thermal Treatment Unit (Note: other potential process vents vent directly to the flare recovery system. If material is not recovered, then it is routed to the flare for control. Calculations of emissions from flaring operations are discussed in the Flare section.)
Permit Methodology	Emissions from process vents are permitted based on engineering correlations developed from stack tests, regulatory limits, and EPA and/or industry factors. The IPA Flash Cooler is a single stage flash operation that is used to concentrate sulfuric acid for reuse in the IPA process. The sulfuric acid has trace amounts of organics in it that also flash off. Emissions from this operation are based on process knowledge and engineering correlations that were developed from stack tests on other similar process equipment. The Halobutyl Chiller is used to control emissions from cement storage tanks. Potential emissions are determined by estimating the amount of material emitted from storage tanks, and then calculating what will be condensed and recovered by the chiller based on thermodynamic equations. The Halobutyl Thermal Treatment Unit (TTU) controls emissions from finishing operations in the Halobutyl unit. Emissions from the unit are based on regulatory limits of 97% destruction efficiency. Vent stream to the TTU is based on historical sampling of residual VOC in product that may be emitted. Emissions from the TTU are essentially n-hexane.
Actual Methodology	Actual emissions are determined by applying the generated emission factor to the on-stream time for the unit.
Comments/ Recommendations	The majority of process vents that contain HRVOC is routed to the flare recovery system where the hydrocarbons are either recovered or used as fuel. For the systems that vent directly to the atmosphere, BRCP typically uses design criteria and/or engineering studies to define emission levels. Where stack test data is available (as the case for the IPA Flash Cooler), that information is used. The most effective way to handle emissions from process vents is to recover and reuse the material. BRCP employs systems to minimize the actual emissions to the atmosphere, and where these vents exist, uses appropriate means to determine emissions from these process vents.
Evaluation: ★★★★★ - Meets industry standard, *no improvements needed*	BRCP utilizes some direct measurement (1) (stack test) and engineering design/material balance (3) to quantify these emissions. The methodology used for this source category meets industry standards.

Source Description	Cooling Towers (12 tons HRVOC in 2004)
Contributors	Cooling towers throughout the chemical plant.
Permit Methodology	Cooling towers supply water to different processes within the BRCP. The prorated share of the cooling tower water is apportioned to the IPA unit, and emissions are then calculated based on AP-42 emission factors (see Table 5.1-2 AP-42 (1/95)) multiplied by the prorated recirculation rate. Maximum emissions are based on AP-42 factors for uncontrolled emissions.
Actual Methodology	Actual emissions are based on permitted numbers with speciation for HRVOCs based on the composition of process streams that have a higher operating pressure than the cooling water for equipment that use cooling water. The actual emissions use the actual flow rates for the respective cooling towers for all areas of the chemical plant except for in the Polymers area where design data is used.
Comments/ Recommendations	Cooling tower emission information is based on EPA emission factors with a speciation based on process design (composition in process equipment that operates at a higher pressure than the cooling water system) and cooling tower design recirculation rates. Cooling tower units are tested weekly for conductivity and Total Organic Carbon (TOC) from which BRCP identifies any potential leaks in the system. Additionally, heat exchangers that service "light gas" processes (processes that contain reasonable concentrations of light hydrocarbons) are sampled weekly to identify potential leaks. This data has not been used to quantify emissions from cooling towers. BRCP has an aggressive program to identify potential leaks into the cooling water system early on. Additionally, MACT standards (MON and Ethylene) are requiring additional sampling of the cooling water systems. It is considered that BRCP is taking appropriate means to identify and quantify emissions of HRVOC from cooling tower operations.
Evaluation: ★★★★ - Meets industry standard, *only minor improvements needed*	BRCP utilizes EPA factors (2) based on design and actual recirculation flow rates to define emission rates. Sampling is being conducted in support of the HON regulation, and is in the process of being expanded for MON and Ethylene MACT. The manner to define actual emissions from this activity meets industry standards with no improvements identified.

Source Description	Storage Tanks (<1 ton HRVOC in 2004)
Contributors	• Hexane • Vinyl Acetate • Methanol • Diesel • Slop Oil • Isooctane
Permit Methodology	EPA AP-42 factors are used based on facility capacity throughput.
Actual Methodology	EPA factors using actual annual throughputs for the various chemicals as provided by operations personnel. When conducting the emission calculations, the actual monthly temperatures are used (based on National Weather Service data) and speciation is based on analytical data for each tank. For tanks that are not ambient tanks, operations personnel provide temperature data.
Comments/ Recommendations	The BRCP has approximately 30 storage tanks equipped with floating roofs. Inspectors conduct routine inspections of the tanks and seals (normally twice per year for external floating roofs) to ensure the floating roofs are operating properly. If a deficiency is noted, operations personnel are notified so that repair can be initiated. If a seal failure is observed, emissions are calculated that the failure occurred the day it was discovered until the time repairs are complete. Adjustments are made to the emissions calculation based on the failure type. If a gasket is torn, it is assumed that the entire gasket is missing. If a seal is missing, an approximation of the area of the seal that is compromised is made and the calculation adjusted taking the missing seal into account. For fixed roof tanks, a number of these tanks have vapor recovery systems, and thus no emissions to the atmosphere. For the tanks that breathe to the atmosphere, EPA based calculations are used taking into account actual fluid temperatures, throughput, and composition. BRCP utilizes sound methodology, based on widely accepted practices, to determine emissions from storage tanks. Currently when a deficiency is noted in the floating roof mechanism, BRCP assumes failure occurred the day it was identified. It is recommended that if there is no mechanism by which to determine when the failure occurred, that the failure be assumed to have occurred at the mid-point between the inspection that identified the failure and the previous inspection. These sources have a minimal impact on the total amount of HRVOC emissions from the facility (<1%).
Evaluation: ★★★★ - Meets industry standard, *only minor improvements identified*	BRCP uses EPA AP-42 factors (2) to define emissions from these tanks. Appropriate data and tools are utilized; however, it is recommended the method to account for emissions from tank seal failures be adjusted. Otherwise, the methods used in this area meet industry standards.

Source Description	Combustion Sources (8 tons HRVOC in 2004)
Contributors	• MOX boilers; Steam Crackers
Permit Methodology	HRVOC emissions are based on a cap of design firing rate for the various crackers with a speciation developed from the API/WSPA (American Petroleum Institute/ Western States Petroleum Association) Development of Toxic Emission Factors for Petroleum Industry Combustion Sources, September 1997.
Actual Methodology	Emission factors used for permitting purposes are multiplied by actual firing rate to determine annual reported emissions.
Comments/ Recommendations	Speciation only identifies toluene and xylene as HRVOC emitted. The other HRVOCs are not anticipated to be emitted in any quantity due to the nature of these compounds.
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRCP uses industry generated emission factors (2) to define emissions from combustion sources. Appropriate data and methodology are utilized; consequently, the methods used in this area meet industry standards with no improvements identified.

ExxonMobil Chemical Company
Baton Rouge Chemical Plant
HRVOC Reported Emissions
For calendar Year 2004
(Pounds)

Title
Pounds 2004

Source	Ethylene	Propylene	1,3-butadiene	Butene (+isomers)	acetaldehyde	toluene	Xylene (+isomers)	Total
Flares	16906	46665	4962	39787	0	261	586	109167
Fugitive Emissions	49110	21404	608	4159	0	849	219	76349
GC-17/IA	3842	5500	138	465	0	2669	93	12707
Accidental Releases	40173	5453	843	1353	0	347	2	48171
Wastewater Emissions	7557	6053	1690	983	0	2175	2202	20660
Process Vents	0	949	147	0	0	482	88	1666
Cooling Towers	9732	11414	1368	246	0	591	175	23526
Storage Tanks	0	220	0	0	0	0	0	220
Combustion Sources	0	2734	0	0	0	6041	6920	15695
Total	127320	100392	9756	46993	0	13415	10285	308161

4.0 Assessment

Based on the information reviewed and considered while conducting this audit, the audit team has concluded that BRCP has a high probability of identifying all potential sources of emissions. Furthermore, the audit team finds that the calculation methodologies employed and the practices and procedures followed by BRCP meet or surpass that generally found in the petrochemical industry. Accordingly, an overall evaluation of ★★★★ - Meets industry standard, *only minor improvements needed* was assessed.

LEAK DETECTION AND REPAIR (LDAR) PROGRAM AUDIT – FINAL

ExxonMobil
BATON ROUGE CHEMICAL PLANT

Prepared for:

ExxonMobil Chemical Company
4045 Scenic Highway
Baton Rouge, LA 70805

May 2005

File No. 40818771

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URS Corporation (URS) conducted a third-party audit of the leak detection and repair (LDAR) program at the ExxonMobil Baton Rouge Chemical Plant (BRCP). This audit was part of an Administrative Order agreement between the Louisiana Department of Environmental Quality and ExxonMobil. The audit began on April 18, 2005, and will close with the issuance of the final audit findings report. The URS team included two engineers and a master technician. The audit included a detailed compliance audit and comparative monitoring of random components at selected process units.

The audit focused on areas of the facility that process highly reactive volatile organic compounds (HRVOC). The following scope areas were investigated in accordance with the Administrative Order agreement:

- Component identification;
- Stream speciation;
- Assessment of the monitoring program:
  - Procedures
  - Evaluation of contractor
  - Field assessment of tagging, open-ended lines, sample systems
  - Comparative monitoring;
- Benchmarking leak rates versus other similar facilities; and
- Summary of LDAR program performance.

Based on this in-depth audit of the LDAR program, URS found the program to substantially comply with all Federal and Louisiana regulations, with only a few issues found. The issues identified involved designation of difficult-to-monitor valves above the 3% limit on one unit, some uncontrolled open-ended lines, some components overlooked from the LDAR inventory, and some recordkeeping issues related to repairs and delay of repair. One objective of this audit was to evaluate the overall "health" of the LDAR program. The LDAR program at BRCP was found to be in good health. The program is anchored with well-trained and motivated personnel. Component identification accuracy is better than average, and tags are in good shape. Monitoring results show a mixture of good to poor comparisons to audit results, but there is no conclusive evidence of a problem with monitoring. Records show that the consolidated LDAR rule is well understood and that compliance has been achieved for the 2004 records reviewed in depth.

A summary of the results of the audit is presented by focus area in Table ES-1.

Table ES-1
Summary of Audit Results

Audit Area	Comments
Component Identification	181 components were found without tags that appear to have been overlooked from the LDAR inventory. This represents an error rate of 0.9% based on inspection of 19,771 components. This error rate is better than the average facility that URS has audited.
Stream Speciation	The facility has used composition data from on-line analyzers, laboratory tests, design data, and process simulation to determine applicability of streams to LDAR regulations. The speciation data appears to be of appropriate accuracy for applicability determination and speciation of emissions.
Assessment of the Monitoring Program	**SOPs**: The facility has detailed written SOPs for LDAR provided by negotiation with the monitoring contractor. **Evaluation of Contractor**: Calibration generally followed M21 and manufacturer's recommendations, however, one issue was noted: a single abbreviated probe was used to calibrate all the TVAs. Technicians were observed to check the correct areas for leakage and worked at a pace that should allow good data to be collected. **Field Assessment**: Tagging is reasonably accurate, legible, and appears to be logically routed. 48 open-ended lines were found without control, but this represented an error rate of only 1.2% based on inspecting 3254 potential open-ended lines. Sampling system flushing control appears to be well designed and maintained. **Comparative Monitoring**: The audit monitoring shows mixed results, varying from excellent to poor agreement with historical leak rates reported by the site.
Benchmarking Leak Rates	The agreement between historical leak rates and audit leak rates ranked in the 3rd quartile of facilities that URS has audited.
Summary of LDAR Performance	181 components were identified that appear to be missing from the LDAR inventory. Monitoring of identified components appears to be complete. Leak repair is generally done well, with no repair deadlines missed. Only 32 components are on delay of repair at this large facility. Several older delay of repair forms were missing. BRCP has 12,321 difficult-to-monitor (DTM) components and 1 unsafe-to-monitor (UTM) components. The DTM components were monitored in 2004.

URS conducted a third-party audit of the ExxonMobil Baton Rouge Chemical Plant (BRCP). This audit was part of an Administrative Order agreement between the Louisiana Department of Environmental Quality and ExxonMobil. The audit began on April 18, 2005, and will close with the issuance of the final audit findings report.

The URS team included two engineers and a master technician:

- Graham "Buzz" Harris – field evaluation of tagged components, and observation of site technician calibration and monitoring;
- Lori Pittman – applicability, speciation, SOPs, record-keeping/reporting; and
- David Ranum – comparative monitoring and field evaluation of tagged components.

The audit focused on areas of the facility that process highly reactive volatile organic compounds (HRVOC). The following scope areas were investigated in accordance with the Administrative Order agreement:

- Component identification;
- Stream speciation;
- Assessment of the monitoring program:
  - Procedures
  - Evaluation of contractor
  - Field assessment of tagging, open-ended lines, sample systems
  - Comparative monitoring;
- Benchmarking leak rates versus other similar facilities; and
- Summary of LDAR program performance.

Based on URS experience in other LDAR audits, it is difficult for any LDAR program to achieve perfect compliance. This in-depth audit discovered only a few findings, which are presented in Table 2-1.

Table 2-1
Findings

Finding No.	Priority	Regulatory Citation	Unit	Findings
A	2	HON 40CFR63.167	BELA5 Aromatics RLA3 EPLAW	48 open-ended lines were found without control by cap, plug, blind, or double block valves. This represents an error rate of 1.2% based on inspecting an estimated 3954 potential open-ended lines.
B	2	HON 40CFR63.168	BELA5 Aromatics RLA3 EPLAW	181 components were found without tags that appear to have been overlooked from the LDAR inventory. This represents an error rate of 0.9% based on inspection of 19,771 components.
C	3	HON 40CFR63.171	NRLA	3 delay of repair (DOR) forms (out of the 32 open DORs) were missing, representing an error rate of 9.4%. These 3 DOR components were placed on the DOR list in 2000, but were reviewed in this audit because they are still open.

[1] See Table 2-2 for definition of priority levels used in this table.

Table 2-2
Definitions of Priority Levels

Priority	Missed Monitoring	Repair Problems	OEL Uncontrolled	Sampling Systems w/o Flushing Control	Monitoring Errors	Recordkeeping Problems
1	Thousands of components	Missed 15-day on hundreds or 5-day on thousands of components	Hundreds of components	Tens of sampling systems	Major Systematic	-
2	Hundreds of components	Missed 15-day on tens or 5-day on hundreds of components	Tens of components	Multiple sampling systems	Major Sporadic	Major Systematic
3	Tens of components	Missed 15-day on individual or 5-day on tens of components	Individual components	Individual sampling systems	Minor Systematic	Major Sporadic
4	Individual components	Missed 5-day on individual components	-	-	Minor Sporadic	Minor Systematic
5	-	-	-	-	-	Minor Sporadic

Note: Priority levels are based on potential impact to emissions and/or impact to compliance assurance.

2.1 STATISTICAL ASSESSMENT OF MONITORED COMPONENTS

HRVOC compounds are present in many operating areas at BRCP. The audit did a thorough evaluation of the BELA5, Aromatics, RLA-3, and EPLAW units. Special attention was also placed on areas between units, such as pipe racks, flare drums, and auxiliary processing. The component identification audit covered an estimated 70% to 80% of the subject units. The component identification accuracy was found to be better than average compared with other facilities that URS has audited. A total of 181 components were found that appear to have been overlooked by the program. A number of missing tags were noted that appear to have been included in the inventory, which was verified in a few spot checks. The tags are generally legible, but there are several generations of tags in the field.

2.2 STREAM SPECIATION

BRCP has gathered stream chemical species data from a variety of sources, including:

- On-line analyzers;
- Routine and special laboratory analyses;
- Design data; and
- Process simulation data/engineering analyses.

The audit reviewed these speciation data and found them to be appropriately detailed and accurate for applicability determinations and for emissions speciation.

2.3 ASSESSMENT OF MONITORING PROGRAM

The monitoring program was evaluated based on standard operating procedures (SOPs), contractor procedures, field assessment of tagging, and comparative monitoring. The following subsections discuss the results in each of these areas.

2.3.1 Standard Operating Procedures

BRCP has detailed written SOPs for the LDAR program provided by the monitoring contractor. The procedures were reviewed and appear to follow applicable regulations and good practice for LDAR.

2.3.2 Evaluation of Contractor

The LDAR contractor at BRCP is Environmental Analytics Inc. (EAI). The calibration and monitoring techniques of the contractor were observed as part of this audit. Calibration techniques follow Method 21 requirements and manufacturer's recommended procedures, but one best practice issue was noted. One person calibrates several TVA-1000 analyzers, using a single abbreviated probe assembly for all of the analyzers. This abbreviated probe assembly does not include the entire sampling hose that is used in the field, which could change the sampling rate during calibration vs. monitoring. Four technicians were observed while monitoring, and they generally checked the correct areas for leakage and worked at a pace that should be consistent with generating good quality data. One technician was observed to not monitor the complete circumference of potential leak areas, even when physical access was possible.

2.3.3 Field Assessment

The audit included a field assessment of tagging, control of open-ended lines (OEL), and control of flushing emissions from sampling systems. The areas covered and the accuracy of component identification have already been covered in section 2.1.

OEL control was evaluated in the same areas as tagging, and 48 OELs were found without adequate control by cap, plug, blind, or double block valves. It should be noted that over 3900 potentially open-ended lines were inspected in order to find these 48 without control, which represents an error rate of only 1.2%. This level of compliance in controlling OELs at BRCP is better than the average LDAR program that URS has audited.

Sample systems were inspected for control of emissions related to flushing. Sample systems were found to be well designed and in good condition.

2.3.4 Comparative Monitoring Results

The comparative monitoring showed mixed agreement between the audit team's monitoring results and the historical results obtained by the site LDAR team. Table 2-3 and Figure 2-1 present the results of the audit comparative monitoring by component type by unit versus the site LDAR team monitoring data for 1st quarter 2004 through 1st quarter 2005.

The leak frequencies for both the audit comparative monitoring and the current site LDAR program are determined at a leak definition of 500 ppm for valves and connectors. This leak definition is required for valves and connectors by the HON and Louisiana MACT. The valves at EPLAW were monitored at a leak definition of 1000 ppm per Louisiana Rule 2122.

The monitoring data collected by the URS audit team showed mixed agreement with the historical data from the site LDAR team. The audit team leak rates were higher than the site team for all unit valves and most connectors, but lower than the site team for connectors at the BELA5. The overall average leak rate found by the audit was about twice what has been historically reported for the selected units.

Statistical analyses were performed by URS staff to see if there was a significant difference between the audit team monitoring data and the site LDAR team historical monitoring data. One statistical approach used was to calculate the 95% confidence intervals around the audit team monitoring data. The Chi-Square test was also run to check whether the site data and audit data could reasonably be considered to be drawn from a consistent data set. The confidence intervals and Chi Squared indicate good agreement to the audit results for BELA5 and Aromatics connectors. The confidence intervals and Chi Squared indicate fair agreement for BELA5 and EPLAW valves. The confidence intervals and Chi Squared indicate poor agreement for RLA3 valves and connectors and for Aromatics valves.

It should be noted that one of the primary purposes for doing comparative monitoring is to determine whether the leak frequencies reported by the site LDAR team are accurate enough to support skip-period monitoring. The audit data show such mixed results that it is unclear whether the site historical data are accurate enough to support skip-period monitoring.

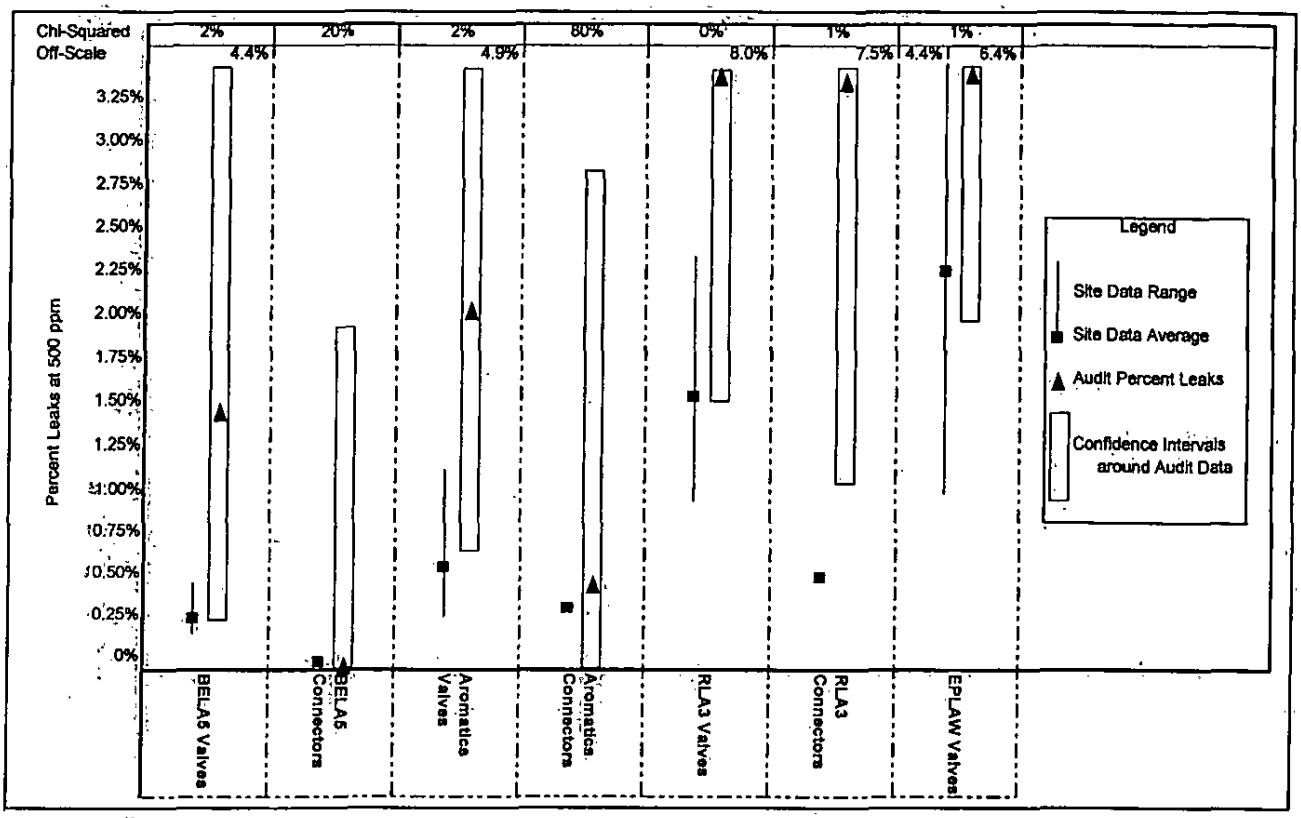
Table 2-3
Summary of Comparative Monitoring Results at 500 ppm

	Site Historical Data[b]				URS Comparative Monitoring Results				
Process	Avg. % Leak @ 500 ppm	Max. % Leak @ 500 ppm	Min. % Leak @ 500 ppm	Total Numbers	# Monitored	# Leak @500 ppm	% Leak[a]	95% Conf. Interval or % Leak[a]	χ2 % Prob.
BELA5 Valves	0.31%	0.53%	0.21%	3688	197	3	***1.5%***	0.3% to 4.4%	2%
BELA5 Conn.	0.05%	0.08%	0.02%	6296	180	0	0.0%	0.0% to 2.0%	20%
Aromatics Valves	0.60%	1.17%	0.31%	4304	235	5	***2.1%***	0.7% to 4.9%	2%
Aromatics Conn.	0.35%	0.35%	0.35%	4167	195	1	***0.5%***	0.0% to 2.8%	80%
RLA3 Valves	1.65%	2.38%	1.07%	5896	176	7	***4.0%***	1.6% to 8.0%	0%
RLA Conn.	0.56%	0.56%	0.56%	7342	153	5	***3.3%***	***1.1% to 7.5%***	1%
EPLAW Valves	2.34%	4.41%	1.16%	7665	322	12	***3.7%***	1.9% to 6.4%	1%
Totals for Selected Units				48692	1458	33			
Totals for Entire Facility				250000					
Percent of All Facility Valves Monitored					0.6%				
Weighted Averages	1.2%						2.3%		

a. Figures in ***Bold Italics*** indicate a higher leak rate by the audit team than reported by the facility or a facility leak rate not within the audit team confidence interval.

b. Site historical data covers the range from the 1st Quarter 2004 through the 4th Quarter 2004. The maximum and minimum leak percents are the highest and lowest semiannual values reported over that period.

Figure 2-1
Comparative Monitoring Chart at 500 ppm



2.4 BENCHMARKING LEAK RATES

The leak rates reported for subject units averaged about 1.2%. This is a typical leak rate when compared to other HRVOC process units.

URS also benchmarks LDAR performance semi-quantitatively for open-ended line control, component identification, comparative monitoring agreement, and components on delay of repair. Tables 2-4, 2-5, 2-6, and 2-7 present these semi-quantitative benchmarks as a ranking of the facilities we have audited, with ExxonMobil Baton Rouge Chemical Plant highlighted. Figure 2-2 presents a bubble chart that attempts to grade the overall LDAR performance. The bubbles represent the significant building blocks of LDAR: component identification, monitoring, repairs, condition issues (covers OEL control, sample systems flushing control, missing tags and tag legibility/order), and recordkeeping/reporting. The size of the bubble is approximately proportional to the importance of that activity in preventing/reducing emissions, except for recordkeeping/reporting, which is important because of compliance demonstration. Grades are assigned to each bubble on a school grade basis of A to F. The grades are performance based rather than being assigned on a curve, so if all facilities excelled in an activity, all would receive "A" grades.

Table 2-4
Benchmarking of Open-Ended Line Control

State	Year	OELs	Inspected	% Open	Quartile Rankings			
Michigan	2003	0	684	0.00%	!			
Texas	2004	0	620	0.00%	!			
California	2003	0	475	0.00%	!			
Kentucky	2004	0	421	0.00%	!			
California	2003	0	384	0.00%	!			
Texas	2004	1	2075	0.05%	!			
Louisiana	2005	2	1919	0.10%	Top 25%			
Louisiana	2005	1	994	0.10%	!			
California	2005	1	654	0.15%	!			
Colorado	2004	1	499	0.20%	!			
Minnesota	2003	1	450	0.22%	!			
Illinois	2005	2	704	0.28%	!			
Texas	2005	6	2096	0.29%	!			
California	2001	3	1000	0.30%	!			
Louisiana	2003	28	8540	0.33%		!		
Texas	2003	20	4749	0.42%		!		
Minnesota	2004	2	347	0.58%		!		
Texas	2004	3	499	0.60%		!		
Ohio	2004	2	330	0.61%		!		
Washington	2004	5	765	0.65%			2nd 25%	
Texas	2003	11	1664	0.66%		!		
Texas	2004	8	1194	0.67%		!		
Louisiana	2004	7	974	0.72%		!		
Louisiana	2004	11	1461	0.75%		!		
Delaware	2002	21	2600	0.81%		!		
Louisiana	2002	5	600	0.83%		!		
Texas	2001	9	1000	0.90%	!			
Ohio	2004	7	748	0.94%	!			
Louisiana	2004	5	430	1.16%	!			
Texas	2002	35	3000	1.17%	!			
Louisiana	2005	48	3954	1.21%	!			
California	2003	4	330	1.21%	!			
California	2003	10	715	1.40%	3rd 25%			
California	2001	11	750	1.47%	!			
Texas	2002	9	600	1.50%	!			
Illinois	2003	22	1435	1.53%	!			
Louisiana	2003	14	900	1.56%	!			
Oklahoma	2004	9	539	1.67%	!			

Ohio	2004	9	492	1.83%	!	
Louisiana	2002	21	1100	1.91%		!
Indiana	2002	20	1000	2.00%		!
Texas	2003	50	2416	2.07%		!
Indiana	2004	29	1270	2.28%		!
California	2001	14	500	2.80%		!
Illinois	2004	230	6306	3.65%		!
Pennsylvania	2004	30	770	3.90%		Bottom 25%
Louisiana	2004	103	2235	4.61%		!
Ohio	2002	19	400	4.75%		!
Washington	2001	39	750	5.20%		!
Montana	2003	23	420	5.48%		!
Washington	2003	50	568	8.80%		!

Summary Statistics for OEL Control	
Count =	51
Average =	1.46%
Median =	0.83%

Table 2-5
Benchmarking of Component Identification

State	Year	Overlooked	Inspected	% Overlooked	Quartile Rankings			
Louisiana	2002	0	6000	0.00%	!			
Minnesota	2003	0	2500	0.00%	!			
Ohio	2002	0	2000	0.00%	!			
Texas	2004	1	10377	0.01%	!			
Texas	2002	2	6000	0.03%	Top 25%			
Texas	2004	3	9235	0.03%	!			
Colorado	2004	1	2493	0.04%	!			
Louisiana	2004	3	7307	0.04%	!			
Illinois	2003	3	7200	0.04%	!			
Louisiana	2004	3	4868	0.06%	!			
Illinois	2004	28	31530	0.09%	!			
Louisiana	2005	10	9595	0.10%	!			
Ohio	2004	4	3739	0.11%	!			
Illinois	2005	4	3518	0.11%	!			
Michigan	2003	5	3380	0.15%			!	
Montana	2003	5	2900	0.17%			!	
Louisiana	2004	20	11175	0.18%			!	
Washington	2004	8	3823	0.21%			!	
California	2001	37	15000	0.25%				2nd 25%
Texas	2001	16	6000	0.27%			!	
California	2003	11	4000	0.28%			!	
Texas	2002	51	15000	0.34%			!	
Delaware	2002	73	19500	0.37%			!	
Texas	2004	12	3102	0.39%			!	
Louisiana	2003	199	42702	0.47%			!	
Louisiana	2002	62	13000	0.48%			!	
Texas	2003	42	8321	0.50%	!			
Texas	2005	55	10481	0.52%	!			
California	2001	97	18000	0.54%	!			
Indiana	2002	59	9000	0.66%	!			
Oklahoma	2004	18	2694	0.67%	3rd 25%			
Texas	2003	83	12082	0.69%	!			
Texas	2004	42	5969	0.70%	!			
Kentucky	2004	18	2105	0.86%	!			
Louisiana	2003	39	4500	0.87%	!			
Louisiana	2005	181	19771	0.92%	!			
Indiana	2004	60	6349	0.95%	!			
California	2003	20	1900	1.05%	!			

Washington	2003	30	2839	1.06%	!	
Texas	2003	255	23744	1.07%		!
Ohio	2004	35	2462	1.42%		!
California	2001	190	13000	1.46%		!
Minnesota	2004	32	1735	1.84%		!
California	2003	89	4800	1.85%		!
Washington	2001	214	10000	2.14%		!
Louisiana	2005	110	4972	2.21%		Bottom 25%
California	2005	78	3270	2.39%		!
Texas	2001	311	10000	3.11%		!
Pennsylvania	2004	133	3850	3.45%		!
California	2003	115	1922	5.98%		!
Ohio	2004	100	1651	6.06%		!
Louisiana	2004	225	2149	10.47%		!

Summary Statistics for Component Identification	
Count =	52
Average =	1.11%
Median =	0.49%

Table 2-6
Benchmarking of Comparative Monitoring

Statistics for LDAR Benchmarking

Comparative Monitoring

State	Year	Score	% Monitored	Ranking		
Louisiana	2003	6.8	>3%	!		
Washington	2004	6.8	>3%	!		
Illinois	2005	6.7	>2.5%	!		
Texas	2001	6.7	>1%	!		
Montana	2003	6.6	>3%	!		
California	2003	6.5	>2%	1st Quartile		
Louisiana	2005	6.5	>2%	!		
Texas	2004	6.5	>1%	!		
California	2001	6.4	>5%	!		
California	2001	6.4	>5%	!		
Ohio	2004	6.0	>2.5%	!		
Texas	2003	6.0	>2.5%		!	
Minnesota	2004	6.0	>2%		!	
Texas	2001	5.9	>5%		!	
Texas	2002	5.8	>1%		!	
Ohio	2002	5.7	>1%		!	
Texas	2003	5.7	<1%		!	
Illinois	2003	5.6	>3%		2nd Quartile	
California	2003	5.5	<1%		!	
Louisiana	2002	5.4	>5%		!	
Louisiana	2002	5.3	>5%		!	
Oklahoma	2004	5.3	>2%		!	
California	2003	5.1	>2%	!		
Louisiana	2004	5.0	>2%	!		
Delaware	2002	4.9	>5%	!		
California	2001	4.9	>5%	!		
Washington	2001	4.5	>5%	!		
Minnesota	2003	4.2	>1%	3rd Quartile		
Michigan	2003	4.0	>3%	!		
Texas	2004	3.7	>6%	!		
Louisiana	2004	3.7	>3%	!		
Indiana	2004	3.7	>2%	!		
California	2003	3.7	>2%	!		
Texas	2002	3.6	>5%	!		

Louisiana	2005	3.6	<1%	!
Ohio	2004	3.0	>5%	!
Washington	2003	3.0	>2%	!
Texas	2004	2.8	>2%	!
Louisiana	2004	2.7	>2%	!
Colorado	2004	2.5	>3%	4th Quartile
California	2005	2.3	>10%	!
Kentucky	2003	1.8	>3%	!
Louisiana	2005	1.5	0.0	!
Kentucky	2004	1.5	0.6%	!
Pennsylvania	2004	0.0	>3%	!
Texas	2005	0.0	>1.8%	!
Indiana	2002	0.0	>1%	!
Summary Statistics for Comparative Monitoring				
	Count =			47
	Average =			4.5
	Median =			5.0

Note: comparative monitoring is ranked semi-quatitatively suing the following scale:

Points System:

7 Close agreement with plant higher than auditor, Chi Square irrelevant

6 Close agreement with auditor higher than plant, Chi Square <=80%

5 Minor spread, significant overlap, audit higher, Chi Square <=70%

4 Minor spread, significant overlap, audit higher, Chi Square <=50%

3 Moderate spread, averages in overlap, audit higher, Chi Square <=20%

2 Moderate spread, moderate range overlap, audit higher, Chi Square <=10%

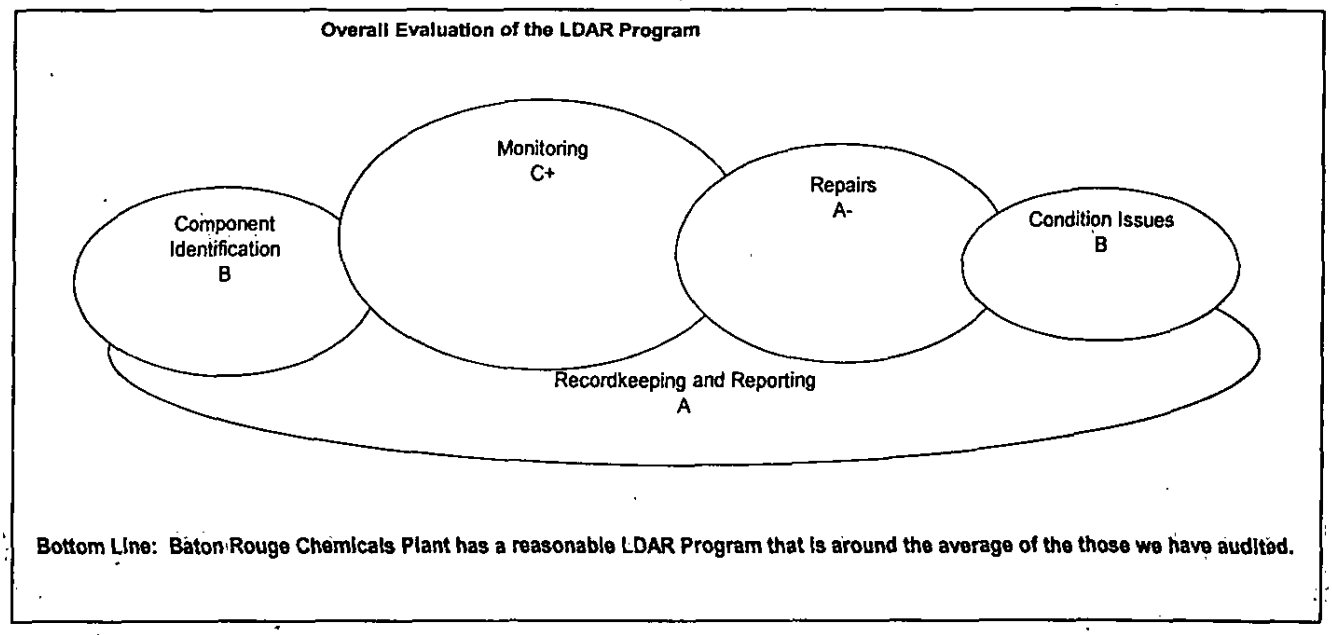
1 Big spread, slight range overlap, audit higher, Chi Square <=5%

0 Big spread, no overlap, audit higher, Chi Square <2%

Table 2-7
Benchmarking of Delay of Repair

State	Year	# of DOR	# Components	% on DOR	Rankings
California	2001	0		0.00%	!
California	2003	0		0.00%	!
California	2003	0		0.00%	!
California	2003	0		0.00%	1st quartile
California	2005	0	7780	0.00%	!
Texas	2004	1	65470	0.002%	!
Washington	2003	1	30000	0.003%	!
Louisiana	2005	1	21627	0.005%	!
Ohio	2004	1	17111	0.006%	!
Illinois	2004	4	36754	0.011%	!
Louisiana	2005	32	250000	0.013%	!
Ohio	2004	3	18659	0.016%	!
Texas	2004	10	56253	0.018%	!
Illinois	2005	12	48086	0.025%	2nd quartile
Texas	2004	21	69050	0.03%	!
Louisiana	2004	17	29779	0.06%	!
Kentucky	2004	40	55500	0.07%	!
Colorado	2004	10	14699	0.07%	!
Texas	2005	123	155000	0.08%	!
Louisiana	2004	87	80921	0.11%	!
Montana	2003	20	15000	0.13%	!
Louisiana	2005	39	27685	0.14%	!
Washington	2004	29	20036	0.14%	!
Ohio	2004	36	24554	0.15%	!
Minnesota	2004	32	20123	0.16%	3rd quartile
Oklahoma	2004	63	36510	0.17%	!
Louisiana	2004	154	81300	0.19%	!
Louisiana	2004	139	58125	0.24%	!
Texas	2004	768	232338	0.33%	!
Louisiana	2003	404	35000	1.15%	4th quartile
Indiana	2004	904	57453	1.57%	!
Summary Statistics for Component Identification					
		Count =		31	
		Average =		0.16%	
		Median =		0.06%	

Figure 2-2
Bubble Chart of Overall LDAR Quality



2.5 BEST PRACTICES

Many aspects of the LDAR program at BRCP are excellent and some are representative of industry best practices. This section highlights three best practices: visual inspections, out of service designations, and reconciliation of monitoring vs. component inventory.

Visual inspections appear to be more effective at BRCP than at most facilities we audit. More than 200 reports of possible leaks resulted from visual inspections in the first quarter of 2005, which demonstrates that visual inspections are treated seriously and done effectively.

The contractor site supervisor is responsible for walking down all components designated as out of service at the time of monitoring each month. If back in service at the end of the month, the components are monitored. If still out of service, then the contractor site supervisor confirms the temporary or permanent out of service designation in the database. This is more formal treatment of this aspect of monitoring than most facilities perform. Fictitious designations of temporary out of service have been used at other facilities URS has audited to hide failure to monitor.

The ExxonMobil staff assigned to LDAR reconcile component population changes (additions and deletions) each quarter. In addition, they review monitoring completion to ensure that all active components have been monitored as scheduled.

2.6 SUMMARY OF LDAR PERFORMANCE

A total of 181 components were found during the audit during the audit that appear to have been overlooked from the LDAR inventory, but this represents only 0.9% of the components inspected. A review of records for 2004 indicates that monitoring of components is complete.

All leaks from 2004 were reviewed. No repair deadlines were missed. Only 32 components remained on DOR at the time of the audit.

BRCP has 12,321 difficult-to-monitor (DTM) components, or just under 5% of total components. This is a common percentage of DTM components, especially for older units that do not need to meet the 3% cap for new units. BRCP has only one unsafe-to-monitor (UTM) component, which is an insignificant number for this large facility.

One objective of this audit was to evaluate the overall "health" of the LDAR program. The LDAR program at BRCP was found to be in good health. The program is anchored with well-trained and motivated personnel. Component identification is reasonably accurate and tags are in good shape. Site monitoring showed mixed results compared to audit monitoring. Comparative monitoring is not a precise science, and it is easy to generate questionable data, especially when dealing with such a small subset of components. Since two unit/component groups showed good results and 2 showed fair results, it is doubtful if the marginal/poor results in other areas are an indication of significant problems. If the site monitoring was significantly flawed, it should have been reflected more uniformly in all of the comparisons. Records show that the consolidated LDAR rule is well understood and that compliance has been generally achieved for the 2004 records reviewed in depth.

The audit included two primary elements: a compliance audit and comparative monitoring. A description of the methodology used by URS for each of these elements follows.

3.1 COMPLIANCE AUDIT

URS performed a check of the leak detection and repair (LDAR) program against the requirements of applicable regulations. The primary areas audited were:

- HON (as referred to by NESHAP Subpart U);
- Louisiana Rule 2122;
- Louisiana Fugitive Emissions Consolidation; and
- EPA Reference Method 21.

Detailed data reviews were done on the units selected for comparative monitoring. Computerized reviews of the monitoring data were done to demonstrate monitoring completion, repair deadline compliance, and to check for monitoring pace and other anomalies.

The compliance audit also included interviews with key staff involved in the LDAR program. At BRCP, the interviews included the LDAR Coordinator, database administrator, contractor monitoring supervisor, and monitoring technicians.

The compliance audit also included observation of the LDAR technicians. Observations were made of the technicians performing instrument warm-up, analyzer maintenance, calibration, monitoring, and repair attempts.

The compliance audit also included an evaluation of component identification and field condition issues. Component identification checks were done in the field, looking for untagged components and trying to determine if they should have been tagged. During this effort, the condition of open-ended line control and sample station flushing control was also evaluated.

The findings related to non-compliance with regulatory requirements were prioritized. The basis for the prioritization scheme was to assign the highest priority to findings that have the potential to result in the greatest increase in emissions. Table 2-2 presents the definitions of the priority levels.

3.2 COMPARATIVE MONITORING

The URS team made independent Method 21 measurements on selected units in the facility. The units to be monitored were selected at BRCP in coordination with the facility. We selected areas with high concentrations of HRVOC components. We also selected some process units subject to the HON regulation and one subject to Louisiana 2122.

The comparative monitoring team utilized their own analyzers (Thermo Environmental HVM680) and certified calibration gases. The instruments were put through the Method 21 performance certification tests before the monitoring began. Multi-point calibrations were done daily using 0, 500, and 9,500 ppm methane in air calibration gases. Drift checks were performed using the 500-ppm standard throughout the day.

The valves and connectors within each selected process unit were selected for monitoring on a random basis within areas where HRVOC streams were present. The URS inspector monitored most accessible valves and the associated connectors in selected areas with HRVOC. No difficult-to-monitor or unsafe-to-monitor components were tested, although a representative sample of elevated components that could be monitored from fixed platforms reachable by stairs or ladders were monitored.

A representative of the facility and the site LDAR crew accompanied the comparative monitoring crew during all monitoring. All leaks found in the audit were verified by the site technician, entered into the database, and tagged for repair.

95% confidence intervals were calculated for the percentage of leaking valves for each process unit. The purpose of these confidence intervals is to estimate the range in which the actual leak rate for valves should fall, based on the fact that the comparative monitoring tested only a sub-sample of components for only a single point in time.

The formula for the confidence interval is from "Statistical Intervals: A Guide for Practitioners" by GJ Hahn and WQ Meeker. In the formula, 'n' represents the number of valves monitored, 'x' represents the number of leaking valves, and F is the F Statistic, whose components are the level of confidence for each bound, degrees of freedom 1, and degrees of freedom 2.

To summarize the leak rates for all the monitored processes, the average of these rates was calculated, and a confidence interval was estimated for this average. The confidence interval for

this average was based on a normal confidence interval. A normal confidence interval is calculated by the following equation: $\bar{x} \pm t_{\alpha/2,n-1}\frac{s}{\sqrt{n}}$, where $\bar{x}$ is the estimated sample mean, n is the number of leak rates, $t_{\alpha/2,n-1}$ is the 97.5th percentile (so that 95% confidence is achieved with both bounds) from the Student-t distribution with $n-1$ degrees of freedom, and s is the estimated standard deviation for the leak rates.

The confidence intervals are based on an assumption that the data are normally distributed. An additional statistical test called the Chi-Square has been done using non-parametric inferential statistics. We used the X^2 (chi-square) test for two independent samples (Cochran, W. G., *The X^2 Test of Goodness of Fit*, Annals of Mathematical Statistics, 23, 1952, pages 315-345.) to determine whether it was reasonable to assume that the historical site monitoring data and the comparative monitoring audit data were drawn from the same underlying distribution. For each test, a 2 by 2 contingency table was constructed as shown:

	Leaking	Not Leaking	
Plant Data	A	B	A + B
Comparative Data	C	D	C + D
Totals	A + C	B + D	N

where A, B, C, and D are the counts of observations in each cell. The chi-square statistic was computed as:

$$X^2 = \frac{N\left(|AD - BC| - N/2\right)^2}{(A+B)(C+D)(A+C)(B+D)}$$

This formula incorporates a correction (Siegel, S. and N. Castellan, *Nonparametric Statistics for the Behavioral Sciences*, Second edition, New York, McGraw-Hill, 1988.) to account for the fact that the variables are discrete rather than continuous. If the probability of X^2 greater than or equal to the observed value was less than 5 percent ($df = 1$), the ratios of leaking to non-leaking components for the plant data and comparative data were deemed to be significantly different.

GLOSSARY

AVO	Audio, Visual, or Olfactory (sensory leak detection)
CFR	Code of Federal Regulations
DOR	Delay of repair
DTM	Difficult-to-monitor
EPA	Environmental Protection Agency (see USEPA)
HAP	Hazardous Air Pollutant
HON	Hazardous Organic NESHAP
HVM-680	Thermo Environmental HVM-680 instrument used for monitoring
LDAR	Leak Detection and Repair
LDEQ	Louisiana Department of Environmental Quality
MACT	Maximum Achievable Control Technology
MOC	Management of Change
NEIC	EPA National Enforcement Investigation Center
NESHAP	National Emissions Standard for Hazardous Air Pollutants
NSPS	New Source Performance Standards
OEL	Open ended line
QA/QC	Quality Assurance/Quality Control
SOP	Standard Operating Procedure
URS	URS Corporation
USEPA	United States Environmental Protection Agency
UTM	Unsafe-to-monitor
VOC	Volatile Organic Compounds

Appendix A – Environmental Audits

ExxonMobil Plastics Plant

BRPP

HRVOC AUDIT REPORT

ExxonMobil Plastics Plant

ShawProject No. 115703-01
RTPLA Project No. 2005-008-001
June 2005

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Executive Summary

Pursuant to an Administrative Order issued by the Louisiana Department of Environmental Quality (LDEQ) on October 6, 2004, ExxonMobil Corporation's (ExxonMobil) Baton Rouge Plastics Plant (BRPP) was required to conduct a comprehensive environmental audit of the facility's operations for the purposes of documenting all potential sources of releases of highly reactive volatile organic compounds (HRVOC). To accomplish this objective, ExxonMobil commissioned a third-party systems audit by recognized environmental professionals. In selecting the audit team, ExxonMobil sought to identify recognized individual environmental professionals, rather than companies, and sought individuals who had no prior work experience related to the BRPP. The audit team was charged to verify that all potential sources of emissions have been identified and accounted for, and to confirm that calculation techniques employed reflect the most appropriate and accurate methodologies for the respective emission sources. To this end, the audit team reviewed pertinent air permits, permit applications, process descriptions, process flow diagrams (PFDs), piping and instrumentation diagrams (P&IDs) and conducted interviews with BRPP environmental staff to gain an understanding of the processes and emission sources in place at the BRPP.

The audit team conducted a site visit to BRPP on March 21, 2005. An overview of the processes was provided and discussions were held regarding the various emissions units, their potential to emit HRVOC, and the manner in which the emissions were calculated from both a permitting and an actual basis perspective. Representative samplings of calculations were checked to verify the calculation methodology.

The process utilized by BRPP to identify emission sources is very thorough. The BRPP process is a very high pressure process where potential sources of emissions to the atmosphere are tightly controlled. There are no atmospheric vents in the high pressure area of the facility with all equipment being protected by rupture discs and/or pressure relief valves. There are a few emission sources in the product handling and storage section of the plant. BRPP plant personnel have conducted numerous surveys of the facility (including PFD reviews, actual plant walk throughs, etc.) to ensure all potential emission sources have been identified.

The audit team conducted a "systems audit", focusing on assuring that proper practices and procedures were in place to identify potential emission sources and accurately account for emissions from these sources. Therefore, while the audit did not confirm that all sources of

HRVOC have been identified by ExxonMobil and that all calculation techniques reflect the most appropriate and accurate methodologies, the audit did seek to ascertain if the practices and procedures employed by ExxonMobil were rigorous and appropriate. A qualitative assessment scale was used to judge each individual area as well as the system as a whole. The following is a table of classifications used.

Rating	Meaning
★★★★★	Meets industry standard , *no improvements identified*
★★★★	Meets industry standard, *only minor improvements needed*
★★★	Meets industry standard, *improvements needed*
★★	Improvements needed to meet industry standard
★	Below industry standard, major improvements needed

From the standpoint of the identification of sources of HRVOC emissions, the audit team concluded that it is highly probable that ExxonMobil has identified all such sources. From the standpoint of evaluating calculation methodologies and techniques, the audit team assessed an overall evaluation of ★★★★- Meets industry standard, *only minor improvements needed.* Information on the assessment of individual areas is provided in more detail in the body of the report.

1.0 Introduction

1.1 Objective and Purpose

Pursuant to an Administrative Order issued by the Louisiana Department of Environmental Quality (LDEQ) on October 6, 2004, ExxonMobil Corporation's (ExxonMobil) Baton Rouge Plastics Plant (BRPP) was required to conduct a comprehensive environmental audit of the facility's operations for the purposes of documenting all potential sources of releases of highly reactive volatile organic compounds (HRVOC) and to perform testing of certain specified emissions sources. Since ExxonMobil believed that its in-house air permitting and emission reporting efforts were thorough and accurate, and they were required to comply with the Administrative Order, ExxonMobil commissioned a third-party systems audit by recognized environmental professionals. In selecting the audit team, ExxonMobil sought to identify recognized individual environmental professionals, rather than companies, and sought individuals who had no prior work experience related to the BRPP.

1.2 Audit Team Composition

The audit team was composed of Mr. Gerald Brouillette, P.E. of the Shaw Group (Shaw) and Mr. William Palermo, P.E. of RTP Environmental Associates, Inc. (RTP). Mr. Brouillette is a Senior Project Manager with Shaw's Baton Rouge, Louisiana office and is a Louisiana Registered Professional Engineer. Mr. Brouillette has worked as an environmental engineer and manager in the petrochemical industry in Louisiana for over 14 years, and has worked as an environmental consultant for an additional three years. His industrial work background provides an excellent insight into plant operations, and he has extensive experience in developing and employing emission calculations for both permitting and reporting purposes. Mr. Palermo is a Principal of RTP and is Manager of RTP's Louisiana office. Mr. Palermo is a Louisiana Registered Professional Engineer and he has been employed in Louisiana as an environmental consultant in excess of 30 years. He has a comprehensive knowledge of Louisiana air permitting processes and requirements and with the procedures for identifying and quantifying sources of air emissions.

1.3 Methodology

The audit team reviewed pertinent air permits, permit applications, process descriptions, process flow diagrams (PFDs), and piping and instrumentation diagrams (P&IDs) to gain an understanding of the processes and emission sources in place at the BRPP. Emphasis was placed on those sources that had the potential to emit any of the seven identified HRVOCs (ethylene, propylene, 1,3-butadiene, butenes and isomers, acetaldehyde, toluene, and xylene and isomers). Following this review, the team met with knowledgeable personnel from the BRPP to review the

processes that were in place for identifying emissions sources and emissions, including emergency releases, and the quantification of emissions from both a permitting basis and from the standpoint of reporting actual emissions on an annual and ongoing basis. Calculation procedures were evaluated with emphasis being placed on those emissions sources that had the greatest potential to emit HRVOC and those for which multiple possible quantification techniques were possible. A representative sampling of calculation methodologies was also performed.

1.4 Assessment

ExxonMobil requested a "systems audit" focused on assuring that proper practices and procedures were in place to identify potential emission sources and accurately account for emissions from these sources. Therefore, the audit itself did not include detailed plant walkthroughs, drawing review, and/or plant personnel interview to ensure all potential emission sources had been identified. Neither did the audit involve a thorough review of all emission calculations for each emission source. Thus, while the audit did not confirm that all sources of HRVOC have been identified by ExxonMobil and that all calculation techniques reflect the most appropriate and accurate methodologies, the audit did seek to ascertain if the practices and procedures employed by ExxonMobil were rigorous and appropriate. Accordingly, the audit team, with the agreement of ExxonMobil, embarked upon a subjective assessment of the extent to which ExxonMobil had identified and quantified all sources of HRVOC. Two different subjective methodologies were employed. . A qualitative assessment scale was used to judge each individual area as well as the system as a whole. The following is a table of classifications used:

Rating	Meaning
★★★★★	Meets industry standard, *no improvements identified*
★★★★	Meets industry standard, *only minor improvements needed*
★★★	Meets industry standard, *improvements needed*
★★	Improvements needed to meet industry standard
★	Below industry standard, major improvements needed

2.0 Methodology

2.1 Approach

The audit team's task was to conduct a system's review of how ExxonMobil identifies and quantifies its emission sources of HRVOCs. ExxonMobil believes that its air permitting and emission reporting efforts are thorough and that it utilizes the most current information, emission factors, and other best practices in its permitting and compliance programs, consequently ExxonMobil sought the assistance of consultants to provide third party verification of the approaches that are currently in place at each facility. To this end, the audit team conducted a thorough review of ExxonMobil's approach in identifying and quantifying sources of HRVOC and representative spot checks of actual calculations and reports.

The audit team conducted a project kickoff meeting on March 9, 2005, at which representatives of each of the four ExxonMobil Baton Rouge facilities were present and the manner in which the audit(s) would be conducted was defined and an audit schedule was developed. An initial needs list was provided to ExxonMobil identifying the types of information that would be reviewed prior to the respective site visit. The needs list information included items such as process descriptions, existing permits, permit applications, process flow diagrams, and supporting emission calculations methodology not included in the application(s).

The audit team conducted a site visit to BRPP on March 21, 2005. An overview of the processes was provided and discussions were held regarding the various emissions units, their potential to emit HRVOC, and the manner in which the emissions were calculated from both a permitting and an actual basis perspective.

2.2 Resources

Various resources were utilized to conduct the audit. Process flow diagrams for the different parts of the process were reviewed to confirm the identification of potential sources of emissions. Facility permits and applications were reviewed to ensure proper assessment of all emission points including insignificant activities and "General Condition XVII" items. Emission calculation bases were discussed with knowledgeable plant personnel and spot checks were conducted to confirm the methodology employed was consistent with the generally accepted hierarchal approach for emission basis and regulatory requirements. The generally accepted hierarchy for calculating emissions is presented below:

Hierarchal Order	Calculation Basis	Examples
1	Direct Measurement	Emissions Monitoring, Stack Testing, Stream Sampling
2	Emission Factors/Studies	AP-42, Tanks 4.09, Water 9, ToxChem, API studies, etc.
3	Material Balances	Inlets minus Outlets, Materials Used, etc.
4	Manufacturers Specifications & Guarantees	
5	Engineering Judgment	

In assessing the calculation methodology employed by ExxonMobil, the calculation hierarchy was considered. Additionally, where vendor information for pollution control equipment (flares, thermal oxidizers) was part of the emission calculation basis, this information/documentation was reviewed and discussed.

2.3 Interviews

The audit team conducted interviews of the BRPP facility environmental staff personnel. Mr. Pat Carrasco (Senior Environmental Coordinator) and Ms. Erin Hall (Environmental Specialist) were interviewed as part of the audit. Mr. Carrasco has been working in the environmental department at the BRPP for over 15 years and has extensive experience and background in the policies and work practices utilized by BRPP in identifying the potential sources of emissions and the basis for the calculation methodologies utilized. Ms. Hall has over 11 years experience in the environmental department at BRPP and has as a primary responsibility determining the actual emissions, by pollutant, for the BRPP. Mr. Carrasco and Ms. Hall were able to provide an in-depth review of the actions employed by BRPP to identify emission sources and quantify those sources. Information on how changes to the process that may add or otherwise change an emission source was provided as well as how non-permitted activities (i.e. emergency releases) are addressed.

3.0 Findings

3.1 Background

BRPP facility consists of seven lines used to manufacture different grades of polyethylene (PE) and ethylene-propylene-diene-monomer (EPDM) polymer. PE is manufactured on one of six lines (Lines A-F) whereas EPDM is manufactured only on Line G. PE is produced under very high pressure conditions where ethylene is introduced into a high pressure reactor along with a catalyst. After polymerization, the polymer stream enters one of two let down stations, (High Pressure and Low Pressure Separators) where free monomer is recovered and routed to the Process Gas Purification Unit (PGPU). The polymer stream is then routed to an extruder where the polymer is extruded into pellets, dried in a rotary dryer and conveyed to silos for storage prior to shipment. In the PGPU, unreacted monomer is purified for recycle.

On Line G, where EPDM is manufactured, ethylene, propylene, and a third monomer (normally ethylidene norbornene) are mixed in one of two reactors in a hexane carrier solvent. After polymerization, the polymer stream is routed to two let down stations (High Pressure and Low Pressure Separators) where free monomer is recovered. Hexane solvent is also recovered and recycled to the process. Like the PE process, the polymer stream is then routed to an extruder where the polymer is extruded into pellets, then fed to a fluidized bed dryer prior to being conveyed to the material handling and shipping.

3.2 Emission Sources

The process utilized by BRPP to identify emission sources is very thorough. The BRPP process is a very high pressure process where potential sources of emissions to the atmosphere are tightly controlled. There are no atmospheric vents in the high pressure area of the facility with all equipment being protected by rupture discs and/or pressure relief valves. There are a few emission sources in the product handling and storage section of the plant. BRPP plant personnel have conducted numerous surveys of the facility (including PFD reviews, actual plant walk throughs, etc.) to ensure all potential emission sources have been identified. BRPP environmental personnel conducted interviews with operations and maintenance personnel to address potential Insignificant Activity items as well as GC-17 issues.

The primary source of HRVOC emissions from BRPP is from the product handling and storage area of the plant (70 tons of HRVOC reported in 2004). In 2003 a regenerative thermal oxidizer (RTO) was installed to control emissions from these sources supporting Lines A and D. The installation of the RTO resulted in a net emissions reduction of approximately 200 tons per year of VOC. The BRPP is anticipating tying in lines B and C to this RTO by the first quarter of 2006. Tie in of B & C lines is anticipated to have a further reduction of over 100 tpy, with a significant fraction of that reduction also being HRVOC.

Emissions from the two flares account for the second highest source of HRVOC (32 tons in 2004), with fugitive sources (16 tons) providing the third highest source.

The BRPP has a comprehensive Emergency Procedures Manual, which includes a chapter that outlines the roles and responsibilities pertaining to Environmental Spills and Releases. A "spotter" is charged with identifying the source of a spill or release and immediately reporting it to the Shift Supervisor of the area. Once informed of a spill or release, The Shift Supervisor is charged with determining the level of response that is required considering on-site impact, off-site impact, chemical(s) involved, the size of the spill or release and the need for external assistance. The site Communications Chief (QC-41) notifies the proper authorities of the spill or release, as applicable, after which the Area Section Supervisor, the Environmental Coordinator and other members of plant management are notified as appropriate.

Detailed in the tables below is a listing of the distinct emission sources with the equipment that contributes to the source, a description of how the permitted and actual emissions are determined, comments and recommendations regarding the calculations, and a qualitative grade for the calculation methodology employed. In assessing the qualitative grade, a numerical representation is included to identify hierarchal order of the calculation methodology (ex. (1) for direct measurement). The following types of emission points were identified associated with the BRPP processes:

- Product Handling and Storage
- Flares,
- Fugitive emissions from piping and equipment components (including valves, connectors, agitators, compressors)
- Maintenance and Sampling Activities (GC-17)
- Emergency releases
- Wastewater
- G-Line Finishing
- Regenerative Thermal Oxidizer
- Insignificant Activities
- Storage Tanks
- Diesel Generators

3.3 Emission Calculations

Source Description	Product Handling & Storage (70 tons HRVOC in 2004)
Source ID Nos.	01-95
Contributors	Vents from B& C Line: • weigh bins • blenders • blowers • pellet dryers • storage bins. A & D Lines are not included here since they are controlled by the RTO. G-Line operation is also not included here since it has its own emission point.
Permit Methodology	BRPP has collected a minimum of five product samples for each product as it enters into the product handling area of the facility. A headspace analysis was conducted for each grade to define the concentrations of unreacted monomers and other volatiles. The results from this historical testing were used with facility line capacity production to define the potential to emit (PTE).
Actual Methodology	Sample results described above that were used to define permitted emission numbers are applied to actual production numbers (by product type) to define the actual emissions. BRPP additionally collects samples to define monomer retained in the final product for shipments. Emissions are determined by subtracting what was retained in the product from what was retained in the polymer as it entered the finishing section of the facility.
Comments/ Recommendations	Calculation basis is the historical average of retained monomer within product based on grade. Assumption that all free (available) monomer and other volatile compounds is emitted minus that which is retained in the final product. BRPP has conducted numerous sampling studies for the various product types manufactured. There has been little variation noted among grades of polymer. Additionally, it has been BRPP's practice to update the sampling history when product or process changes are introduced. When sampling events are conducted, an outside laboratory is used, and BRPP has worked with the lab to ensure samples are collected correctly and that strict holding times are adhered to. This is imperative in order to collect a quality sample due to the high volatility of ethylene.
Evaluation: ★★★★★- Meets industry standard, *no improvements identified.*	BRPP utilizes a material balance (3) (monomer retained in polymer entering finishing minus monomer retained in final product) to quantify these emissions. As stated above, sampling is updated when there are process and/or product changes. The manner to define actual emissions from this activity meets industry standards with no improvements identified

Source Description	Flares (2) (32 tons of HRVOC in 2004)
Source ID Nos.	05-83
Contributors	Intermittent and continuous vent streams site-wide.
Permit Methodology	Flowmeters are maintained on each flare header. In 1992 a study was conducted by BRPP where speciation of the typical flare gases was identified. For permitting purposes, BRPP applied this "sampled" speciation to maximum historically measured flows and requested permitted limits based on these numbers.
Actual Methodology	Flowmeters are maintained on each flare header. BRPP obtains the recorded flow for the respective flare and applies the standard speciation to determine reported emissions after applying a 99.5% destruction efficiency. Detailed speciation of the process was conducted in 1992. Process operations have not changed significantly since then (except for the addition of G-Line in 2003). Flare gas testing will be performed in 2005 to update the speciation. After the new speciation is completed, the actual emission calculation methodology will be modified to reflect the new data.
Comments/ Recommendations	BRPP has two flare headers. Each header is equipped with a continuous BTU analyzer to ensure the minimum BTU value of 300 BTU/scf. If necessary, natural gas is added to increase BTUs. Each flare is steam assisted and the steam provided to each flare is controlled by a "Powertrol System" that automatically adjusts the steam to ensure optimal flame control. BRPP has a very detailed system including the Powertrol control system and BTU analyzers to ensure optimal operation of the flare systems. However, the speciation that is used for estimating emissions from the process is outdated. (A new speciation is scheduled to be completed later in 2005). The historical speciation has identified ethylene to be the most prevalent species in the flare gas. With the addition of G-Line, there is uncertainty as to how this impacts the flare gas speciation, therefore it is recommended that this updated speciation be conducted and applied to the calculation methodology. BRPP has assumed a 99.5% destruction efficiency for the flare. This was considered to be a reasonably conservative estimate for the following reasons: 1) the BTU analyzers ensure that a minimum of 300 BTU/scf is provided to each flare tip, making up with natural gas when necessary; 2) the Powertrol system is an advanced system that ensures optimal steam addition to the flare tip – not too much that it dampens the efficiency of the flare and not too little so that proper mixing and turbulence is lacking; and 3) a review of EPA's Flare Efficiency Study, July 1983, confirms that with proper operation of a flare, destruction efficiencies in excess of 99.5% would be expected for the types of gases found at BRPP.

Evaluation: ★★★★- Meets industry standard, *only minor improvements needed*	BRPP utilizes a combination of direct measurement (1) (historical speciation and BTU analyzers) and EPA studies (2) (Flare Efficiency study) to quantify these emissions. It is recommended that more current speciation be obtained with the installation of G-Line, which is planned by the site's Environmental Department in 2005.

Source Description	Fugitives (16 tons HRVOC in 2004)
Source ID Nos.	06-83
Contributors	• Valves • Connectors • Compressors • Pumps • Process analyzers • Loading/ unloading operations
Permit Methodology	BRPP uses historical maximum measured leak rate information with the component count for the facility to define the potential to emit from fugitives. BRPP uses the EPA correlation equations along with the historical data.
Actual Methodology	To define actual emissions, BRPP takes the EPA correlation equations and applies the actual fugitive monitoring results from that year to the equations to determine the reported number.
Comments/ Recommendations	EPA identifies a hierarchy to estimate fugitive emissions. The method employed by BRPP is the most stringent method short of conducting bagging studies. For most conventional facilities, this is the recommended method to define fugitive emissions.
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRPP utilizes EPA emission factors (2) and applies direct measurement data to the factors. The manner to define actual emissions from this activity meets industry standards with no improvements identified.

Source Description	GC-17 (14 tons HRVOC in 2004)
Source ID Nos.	N/A
Contributors	• Sampling • Tank gauging • Opening of equipment • Equipment maintenance • Catalyst/ initiator handling • "Waxy polymer" activities
Permit Methodology	BRPP conservatively quantified the frequency for the various activities, and based on this quantification, determined the volume available for release from each activity after accounting for proper operation and clearing of equipment based on procedures and work practices used at the facility.

Actual Methodology	BRPP identified potential emissions per activity and then multiplies the number of times that activity was undertaken during the year to the developed factor.
Comments/ Recommendations	BRPP employs appropriate means to determine emissions from these sources.
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRPP uses material balances (3) to determine these emissions. Appropriate conservativeness is applied to these calculations; therefore, the manner to define actual emissions from this activity meets industry standards with no identified improvements needed.

Source Description	Emergency Releases (12 tons HRVOC in 2004)
Source ID Nos.	N/A
Contributors	BRPP calculates quantities emitted from all known releases whether "Reportable Quantity" level is attained or not.
Permit Methodology	Not a permitted source.
Actual Methodology	For safety valve releases: beginning and ending process pressure and temperature for the event are recorded for the respective vessel(s) and the "National Distillers and Chemical Corporation Polyethylene Process Manual" is consulted to determine process data of ethylene present for potential release. Speciation for the entire release is based on process knowledge of the respective grade of polyethylene. For unauthorized discharges (upset/malfunctions) to the flare releases, operations personnel and/or process engineers assist the environmental department personnel to define and calculate the estimated quantity released.
Comments/ Recommendations	BRPP utilizes an appropriate means to identify emissions from emergency releases. Use of the National Distillers and Chemical Corporation data provides the facility with proven data that is nationally recognized. Additionally, employing process and operations personnel in calculating emissions from other type releases is the best manner to follow since these personnel have intimate knowledge of the operations and the systems employed by BRPP.
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRPP uses engineering calculation and studies (2/3) to determine emissions from emergency releases. Appropriate engineering data and assumptions are utilized; consequently, the methods used in this area meet industry standards with no improvements identified.

Source Description	Wastewater System (8 tons HRVOC in 2004)
Source ID Nos.	02-87
Contributors	• Wastewater from pelletizing activity from each line. • Water retention ponds (collects storm water and water streams from the process) • Cooling Tower operations.
Permit Methodology	Historical samples collected at discrete locations (influents to ponds, API separator, equalization basin) were used to define routine levels of VOCs. EPA Water9 was then utilized based on design flowrates throughout the system with the respective sample results to define emissions.
Actual Methodology	Samples are collected on a monthly basis on the inlet to the retention ponds. Sample result speciation is then used with Water9 program to define emissions. If a compound is not identified by the analysis, then ½ the detection limit is used in the Water9 program. For cooling towers, BRPP has collected samples from each of the three towers at the site. For two of the towers (servicing the PE process) monthly sampling is conducted. Data from this analysis and the known circulating rates is used to define emissions. For the G-Line cooling tower (in service since 2003), sampling is also conducted on a monthly basis for the inlet and outlet of the tower. As with the above mentioned towers, sample results are then used to determine emission rates based on cooling tower circulation.
Comments/ Recommendations	BRPP accounts for emissions from conventional sources related to wastewater systems. A detailed sampling system has been employed to account for potential emissions (conservatively taking ½ the detection limit for possible pollutants that are not detected). Water9 is employed based on sampling data to estimate actual emissions. Emissions from cooling towers are determined by historical (for PE process) and current sampling data. Mechanisms employed are considered the most appropriate to define emissions from these type activities.
Evaluation: ★★★★★ - Meets industry standard, *no improvements needed*	BRPP utilizes a combination of direct measurement (1) and EPA models (2) to quantify these emissions. The methods used in this area meet industry standards with no improvements identified.

Source Description	G-Line Finishing (2 tons HRVOC in 2004)
Source ID Nos.	02-2001
Contributors	• Fluid Bed Dryer • Product Handling
Permit Methodology	Emissions from the G-Line dryer are based on stack testing conducted in 2003. Emissions from the rest of the finishing process are based on residual monomer and other volatiles determined to remain in the product after extrusion based on product sampling and head space analysis. Like for the PE process lines, this sampling is conducted by product type. Permitted numbers are based on stack test data and polymer data as applied to capacity production.
Actual Methodology	Actual emissions are determined by applying analytical results on polymer data to the actual production (quantity and type) of polymer on G-Line for that calendar year. Sampling is conducted at the fluid bed dryer and at packout to accurately reflect emissions from finishing activities.
Comments/ Recommendations	Like emissions from the other production lines, emissions are based on product grade and actual sample data. Emissions from the pellet dryer are based on a stack test; however, the stack test was based only on one product grade. It is recommended that correlation based on the tested product's properties to the other product should be developed, or more stack testing for the other products should be considered.
Evaluation: ★★★ - Meets industry standard, *improvements needed*	BRPP utilizes some direct measurement (1) (stack test) and a material balance (3) (monomer retained in polymer entering finishing minus monomer retained in final product) to quantify these emissions. The methodology used for this source category meets industry standards; however, the fluid bed dryer emissions are based on a stack test for only one type of product. A correlation based on the tested product's properties to the other product should be developed, or more stack testing for the other products should be considered.

Source Description	Regenerative Thermal Oxidizer (1 ton HRVOC in 2004)
Source ID Nos.	02-2000
Contributors	• A-Line Finishing • D-Line Finishing
Permit Methodology	Emissions consist of combustion products (CO, NOx, PM10, SO2) and any unburned hydrocarbons at the outlet of the thermal oxidizer stack. A stack test was conducted while the plant was operating on one of the known "higher emitting" product types while the unit was operating at maximum rates. The test consisted of three one-hour runs. To quantify emissions for permitting purposes, BRPP has taken the stack test results (in pounds per hour of VOC) and assumed that emission rate for the entire year (8,760 hours).

Actual Methodology	Emissions consist of combustion products (CO, NOx, PM10, SO2) and any unburned hydrocarbons at the outlet of the thermal oxidizer stack. Emissions have been estimated using the result of the stack test identified above and applying that pound per hour value to the actual number of operating hours for the year.
Comments/ Recommendations	The unit is a pollution control device used for the sole purpose of reducing volatile organic compounds which were historically emitted to the atmosphere from uncontrolled vent stacks on storage bins, blenders and blowers. Installation of the oxidizer resulted in a substantial reduction of emissions to the atmosphere, which was not required under any state or federal regulation. The stack test on which this data is based was conducted on one of the "higher emitting" product types while it was operating at maximum rates. In determining actual emissions, BRPP looks at on-stream time only, and does not make any downward adjustment for times when the plant is operating at less than maximum rates. Additionally, BRPP does not make any downward adjustment for known "lesser emitting" product types. The RTO currently handles vents from A and D lines only. Plans are in place to connect B and C lines to the RTO in calendar year 2006. It is recommended that additional stack sampling be conducted once these lines are introduced. A comparison of the new stack test results with the current results should be made and any adjustments necessary be incorporated into the calculation methodology.
Evaluation: ★★★★★ - Meets industry standard, *no improvements needed*	BRPP utilizes direct measurement (1) (stack test) under a "worse case" condition and applies this to all operating times. The approach is considered a conservative approach and the methodology used for this source category is considered to meet industry standards. There are no improvements needed, however stack testing should be conducted with the addition of B and C line as stated above.

Source Description	Insignificant Activities (1 ton HRVOC in 2004)
Source ID Nos.	N/A
Contributors	• Small quantity storage vessels • Lab emissions • Miscellaneous drums and containers • Painting & solvent cleaning
Permit Methodology	Emissions are based upon a combination of vendor data, mass balance using analytical data, engineering calculations, and the EPA Tanks program.
Actual Methodology	Based on permitted levels adjusted for the actual throughputs and actual number of samples taken and the number of particular events.
Comments/	BRPP employs appropriate means to determine emissions from these

Recommendations	sources.
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRPP uses EPA models (2) and material balances (3) to estimate emissions from IA sources. Appropriate engineering data and assumptions are utilized; consequently, the methods used in this area meet industry standards with no improvements identified.

Source Description	Storage Tanks (<1 tons HRVOC in 2004)
Source ID Nos.	14-68, 15-68, 16-68, 17-68, 1-76, 03-83A, 01-88, 03-88, 04-88, 03-2001, 04-2001, 05-2001
Contributors	• Hexane • Vinyl Acetate • Methanol • Diesel • Slop Oil • Isooctane • Gasoline
Permit Methodology	EPA TANKS 4.09 software based on facility capacity throughput.
Actual Methodology	EPA TANKS 4.09 software using actual annual throughputs for the various chemicals.
Comments/ Recommendations	BRPP utilized sound methodology, based on widely accepted practices, to determine emissions. These sources have a minimal impact on the total amount of HRVOC emissions from the facility (<1%).
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRPP uses an EPA model (2) to define emissions from these tanks. Appropriate data and tools are utilized; consequently, the methods used in this area meet industry standards with no improvements identified.

Source Description	Diesel Generators (<1 HRVOC in 2004)
Source ID Nos.	01-2000
Contributors	• Diesel Generators throughout facility
Permit Methodology	Based on AP-42 factors for each generator accounting for its size, in addition to vendor data.
Actual Methodology	Based on AP-42 factors and/or vendor data and actual on stream time.
Comments/ Recommendations	Not a significant source of HRVOCs. BRPP's method of calculation with the use of the EPA factors is appropriate for this activity.
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRPP uses an EPA factor (2) to define emissions from diesel generators. Appropriate data and methodology are utilized; consequently, the methods used in this area meet industry standards with no improvements identified.

HRVOC Reported Emissions
for Calendar Year 2004
(Pounds)

Source	Ethylene	Propylene	1,3-butadiene	Butene (+isomers)	acetaldehyde	toluene	Xylene (+ isomers)	Total
Thermal Oxidizer	2864	26	0	0	35	0	0	2925
Storage Tanks	0	0	0	0	0	2	0	2
Flares	44004	13115	0	6439	0	0	0	63558
Wastewater System	15106	1481	0	0	115	7	12	16721
Product Handling & Storage	132629	1188	0	5559	6	110	0	139492
G-Line Finishing	240	2899	0	0	0	645	0	3784
Diesel Generators	0	0	0	0	0	0	0	0
Insignificant Activities	0	1074	0	0	0	382	558	2014
GC-17	28494	0	0	0	1	0	0	28495
Emergency Releases	24066	412	0	132	0	0	0	24610
Cooling Towers								
Fugitives	12734	7325	0	12455	62	86	32	32694
Total	260137	27520	0	24585	219	1232	602	314295

4.0 Assessment

Based on the information reviewed and considered while conducting this audit, the audit team has concluded that BRPP has a high probability of identifying all potential sources of emissions. Furthermore, the audit team finds that the calculation methodologies employed and the practices and procedures followed by BRPP meet or surpass that generally found in the petrochemical industry. Accordingly, an overall evaluation of ★★★★ - Meets industry standard, *only minor improvements needed* was assessed.

LEAK DETECTION AND REPAIR (LDAR) PROGRAM AUDIT – FINAL

ExxonMobil
BATON ROUGE PLASTICS PLANT

Prepared for:

ExxonMobil Chemical Company
11675 Scotland-Zachary Highway
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March 16, 2005

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GLOSSARY

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URS Corporation (URS) conducted a third-party audit of the leak detection and repair (LDAR) program at the ExxonMobil Baton Rouge Plastics Plant (BRPP). This audit was part of an Administrative Order agreement between the Louisiana Department of Environmental Quality and ExxonMobil. The audit began on February 14, 2005, and will close with the issuance of the final audit findings report. The URS team included one engineer and a master technician. The audit included a detailed compliance audit and comparative monitoring of random components at selected process units.

The audit focused on areas of the facility that process highly reactive volatile organic compounds (HRVOC). The following scope areas were investigated in accordance with the Administrative Order agreement:

- Component identification;
- Stream speciation;
- Assessment of the monitoring program:
  - Procedures
  - Evaluation of contractor
  - Field assessment of tagging, open-ended lines, sample systems
  - Comparative monitoring;
- Benchmarking leak rates versus other similar facilities; and
- Summary of LDAR program performance.

Based on this in-depth audit of the LDAR program, URS found the program to substantially comply with all Federal and Louisiana regulations, with only a single deficiency found. The deficiency was found in open-ended line control, although the level of performance in that area is better than most facilities that URS has audited. One objective of this audit was to evaluate the overall "health" of the LDAR program. The LDAR program at BRPP was found to be in excellent health, due at least in part to the remarkable consistency of personnel for periods of the last ten to twenty years. The program is anchored with well-trained and motivated personnel. Communications are relatively simple and effective for this small program. Component identification is accurate and tags are in good shape. Monitoring results compare well to audit results. Records show that the consolidated LDAR rule is well understood and that compliance has been achieved for the 2004 records reviewed in depth.

A summary of the results of the audit is presented by focus area in Table ES-1.

Table ES-1
Summary of Audit Results

Audit Area	Comments
Component Identification	The tagging of components subject to LDAR regulations was found to be quite accurate. A review of nearly 10,000 components revealed no clear instances where applicable components had been overlooked.
Stream Speciation	The facility has used composition data from on-line analyzers, laboratory tests, design data, and process simulation to determine applicability of streams to LDAR regulations. Lines were found to be generally well marked to indicate the stream, especially in the newer G Line. The speciation data appears to be of appropriate accuracy for applicability determination and speciation of emissions.
Assessment of the Monitoring Program	**SOPs**: The facility has no written SOPs for LDAR, but interviews were conducted to determine the adequacy of procedures. The procedures were found to be good. **Evaluation of Contractor**: The facility has used the same contractor for LDAR for nearly 20 years, and that consistency has proved beneficial. No deficiencies were noted in contractor procedures. **Field Assessment**: Tagging is accurate, legible, and logically routed. Two open-ended lines were found without control, but this represented an error rate of only 0.1% based on inspecting over 1900 potential open-ended lines. Sampling system flushing control appears to be well designed and maintained. **Comparative Monitoring**: The audit monitoring agrees well with historical leak rates reported by the site.
Benchmarking Leak Rates	Historical leak rates reported for the facility appear somewhat low, generally in the 0.5% to 1% range for all VOC service. Although BRPP handles many volatile components, it also processes a number of less volatile compounds, such as hexane. Leak rates on HRVOC components were found to range from 1% to 2.5%, which compares reasonably to other similar facilities.
Summary of LDAR Performance	No missing components were identified and monitoring of identified components appears to be complete. A total of 151 leaks were found in 2004. 137 of these leaks were repaired successfully within 15 days. 2 leaking components were isolated from VOC service, while another 12 were put on delay of repair (DOR) until the next shutdown. Most of the DOR components have been repaired, with only a single component on delay at the time of the audit. No repair deadlines were missed. BRPP has 639 difficult-to-monitor (DTM) components and 385 unsafe-to-monitor (UTM) components. The DTM components were monitored in 2004.

URS conducted a third-party audit of the ExxonMobil Baton Rouge Plastics Plant (BRPP). This audit was part of an Administrative Order agreement between the Louisiana Department of Environmental Quality and ExxonMobil. The audit began on February 14, 2005, and will close with the issuance of the final audit findings report.

The URS team included one engineer and a master technician:

- Graham "Buzz" Harris – applicability, speciation, SOPs, record-keeping/reporting, field evaluation of tagged components, and observation of site technician calibration;

- David Ranum – comparative monitoring, evaluation of contractor monitoring, and field evaluation of tagged components.

The audit focused on areas of the facility that process highly reactive volatile organic compounds (HRVOC). The following scope areas were investigated in accordance with the Administrative Order agreement:

- Component identification;
- Stream speciation;
- Assessment of the monitoring program:
  - Procedures
  - Evaluation of contractor
  - Field assessment of tagging, open-ended lines, sample systems
  - Comparative monitoring;
- Benchmarking leak rates versus other similar facilities; and
- Summary of LDAR program performance.

Based on URS experience in other LDAR audits, it is difficult for any LDAR program to achieve perfect compliance. This in-depth audit discovered only one finding, which is presented in Table 2-1.

Table 2-1
Findings

Finding No.	Priority	Regulatory Citation	Unit	Findings
A	3	LDEQ Rule 2122	BP&E	2 open-ended lines were found without control by cap, plug, blind, or double block valves. That represents an error rate of 0.1% based on inspecting an estimated 1919 potential open-ended lines.

[1] See Table 2-2 for definition of priority levels used in this table.

Table 2-2
Definitions of Priority Levels

Priority	Missed Monitoring	Repair Problems	OEL Uncontrolled	Sampling Systems w/o Flushing Control	Monitoring Errors	Recordkeeping Problems
1	Thousands of components	Missed 15-day on hundreds or 5-day on thousands of components	Hundreds of components	Tens of sampling systems	Major Systematic	-
2	Hundreds of components	Missed 15-day on tens or 5-day on hundreds of components	Tens of components	Multiple sampling systems	Major Sporadic	Major Systematic
3	Tens of components	Missed 15-day on individual or 5-day on tens of components	Individual components	Individual sampling systems	Minor Systematic	Major Sporadic
4	Individual components	Missed 5-day on individual components	-	-	Minor Sporadic	Minor Systematic
5	-	-	-	-	-	Minor Sporadic

Note: Priority levels are based on potential impact to emissions and/or impact to compliance assurance.

2.1 STATISTICAL ASSESSMENT OF MONITORED COMPONENTS

HRVOC compounds are present in most operating areas at BRPP. The audit did a comprehensive evaluation of the new G Line and about 25 percent of the other areas commonly referred to as the Base Plant. Special attention was placed on areas between units, such as pipe racks, flare drums, and auxiliary processing. The component identification audit covered an estimated 33% of the entire facility, and nearly 50% of the HRVOC components. The component identification accuracy was found to be quite high. No clearly applicable components were found that had been overlooked by the program. Only a very few components were noted with missing tags, all of which were verified to be in the LDAR database. Three new components were found that had been installed recently that had not yet been picked up by the management of change (MOC) program or the next monitoring event in the area; however, these components were tagged before the end of the audit.

2.2 STREAM SPECIATION

BRPP has gathered stream chemical species data from a variety of sources, including:

- On-line analyzers;
- Routine and special laboratory analyses;
- Design data; and
- Process simulation data/engineering analyses.

The audit reviewed these speciation data and found them to be appropriately detailed and accurate for applicability determinations and for emissions speciation.

2.3 ASSESSMENT OF MONITORING PROGRAM

The monitoring program was evaluated based on standard operating procedures (SOPs), contractor procedures, field assessment of tagging, and comparative monitoring. The following subsections discuss the results in each of these areas.

2.3.1 Standard Operating Procedures

BRPP has not developed written SOPs for the LDAR program. This works for the facility because the LDAR program is small with essentially no turnover, so verbal communication of procedures has functioned adequately. Interviews were conducted with Erin Hall, Environmental Specialist with responsibility for LDAR, and Eddie Crow, the lead technician for the LDAR contractor (J. E. Merit). All personnel were found to have a good understanding of the LDAR rule requirements. The LDAR personnel (including the contractor) are tightly integrated into the facility operations. The LDAR contractor is able to perform both first attempts and advanced maintenance on components found leaking. This greatly reduces the number of maintenance work orders that must be written and tracked. While the procedures are less formal than many other facilities, they appear to be well understood and implemented effectively.

2.3.2 Evaluation of Contractor

The LDAR contractor at BRPP has been J. E. Merit for about 19 years, and Eddie Crow has served as the lead technician for that entire time. He is supported part time by Craig Dugas. Robert Rogers has been hired by J. E. Merit to take over as lead technician after Eddie Crow retires, and Mr. Rogers has over 11 years experience in LDAR monitoring and maintenance. The Merit personnel have functioned effectively in the LDAR role, providing all monitoring and most of the repair services for the program. The contractor's calibration and monitoring procedures were observed during the audit. The calibration was done in accordance with EPA Method 21 specifications, and in accordance with the analyzer manufacturer's instructions. The instrument is affixed with an extension probe, and it was calibrated with that probe in place. The technicians were observed to check the correct areas for leakage on a variety of component types and displayed a pace and level of care consistent with generating quality monitoring data. The technicians were also observed performing maintenance, in which they have considerably more authority than in most facilities. The LDAR technicians were able to strip insulation away from components to better isolate the source of leakage, and generally to employ more advanced leak repair methods. Their success in on-line leak repair is quite high.

2.3.3 Field Assessment

The audit included a field assessment of tagging, control of open-ended lines (OEL), and control of flushing emissions from sampling systems. The areas covered and the accuracy of component identification have already been covered in section 2.1. The tags were observed to be easy to

spot, with legible tag numbers. Very few tags were missing. Missing tags are replaced with the same tag number, so the monitoring routes are very nearly in numerical order.

OEL control was evaluated in those same areas, and two OELs were found without adequate control (one missing a plug and the other missing a cap). It should be noted that over 1900 potentially open-ended lines were inspected in order to find these two without control, which represents an error rate of only 0.1%. While having any OELs uncontrolled is not acceptable, the level of compliance in controlling OELs at BRPP is much better than the average LDAR program that URS has audited.

Sample systems were inspected for control of emissions related to flushing. Most sampling is done using online analyzers, which vent into sample recovery and/or flare headers. Sample systems were found to be well designed and in good condition.

2.3.4 Comparative Monitoring Results

The comparative monitoring showed good agreement between the audit team's monitoring results and the historical results obtained by the site LDAR team. Table 2-3 and Figure 2-1 present the results of the audit comparative monitoring by component type for G Line versus the site LDAR team monitoring data for 1st quarter 2004 through 4th quarter 2004.

The leak frequencies for both the audit comparative monitoring and the current site LDAR program are determined at a leak definition of 500 ppm for valves and connectors. This leak definition is required for G Line valves and connectors by the HON (as referred to by MACT Subpart U).

The monitoring data collected by the URS audit team showed good agreement with the historical data from the site LDAR team. The audit team leak rates were slightly higher than the site team for connectors but lower than the site team for valves

Statistical analyses were performed by URS staff to see if there was a significant difference between the audit team monitoring data and the site LDAR team historical monitoring data. One statistical approach used was to calculate the 95% confidence intervals around the audit team monitoring data. The Chi-Square test was also run to check whether the site data and audit data could reasonably be considered to be drawn from a consistent data set. The confidence intervals indicate good agreement to the audit results, with all averages falling within each other's ranges

and a high degree of overlap between the site ranges and the audit confidence intervals. The Chi-Squared statistics showed a 90% probability that data were in agreement.

It should be noted that one of the primary purposes for doing comparative monitoring is to determine whether the leak frequencies reported by the site LDAR team are accurate enough to support skip-period monitoring. The audit data show that the site historical data are accurate enough to support skip-period monitoring.

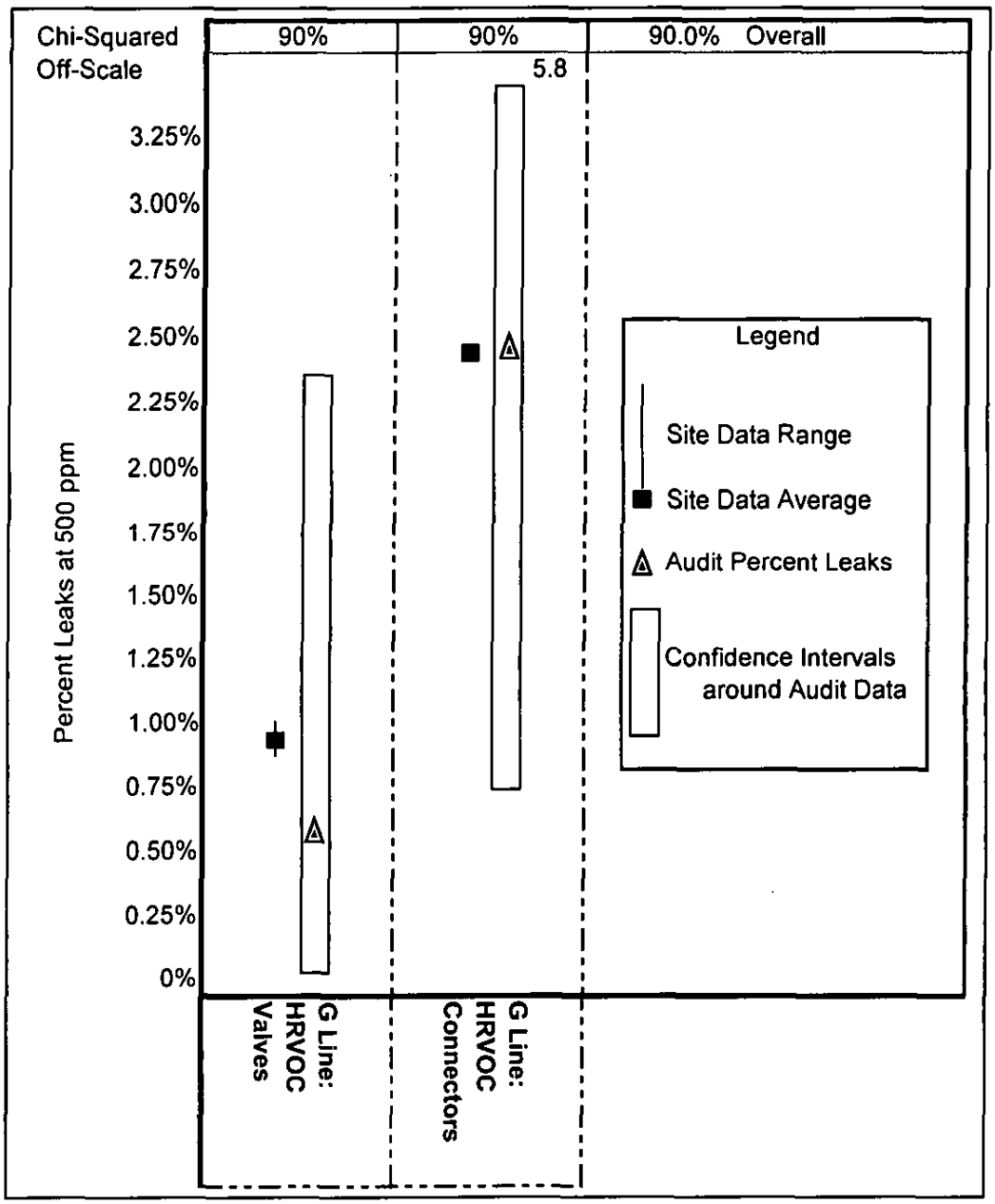
Table 2-3
Summary of Comparative Monitoring Results at 500 ppm

	Site Historical Data[b]				URS Comparative Monitoring Results				
Process	Avg. % Leak @500 ppm	Max. % Leak @500 ppm	Min. % Leak @500 ppm	Total Numbers	# Monitored	# Leak @500 ppm	% Leak[a]	95% Conf. Interval on % Leak[a]	X^2 % Prob.
G Line – HRVOC Valves	0.95%	1.01%	0.89%	2586	303	2	0.66%	0.1% to 2.4%	90%
G Line - HRVOC Connectors	2.46%	2.46%	2.46%	854	199	5	***2.51%***	0.8% to 5.8%	90%
Totals for Selected Units				3440	502	7			
Totals for Entire Facility				21627					
Percent of All Facility Valves Monitored					2.3%				
Weighted Averages	1.16%						1.39%		90%

a. Figures in ***Bold Italics*** indicate a higher leak rate by the audit team than reported by the facility or a facility leak rate not within the audit team confidence interval.

b. Site historical data covers the range from the 1st Quarter 2004 through the 4th Quarter 2004. The maximum and minimum leak percents are the highest and lowest semiannual values reported over that period.

Figure 2-1
Comparative Monitoring Chart at 500 ppm



2.4 BENCHMARKING LEAK RATES

The leak rates reported for G Line valves for 2004 were 0.51% and 0.55% in the first and second semiannual periods, respectively, for all VOC service. This is a relatively low leak rate compared to other HRVOC processes and petroleum processes. The G Line does process a significant amount of volatile HRVOC materials, but it also processes a significant amount of less volatile VOC, such as hexane. When the leak rates specific to HRVOC components were calculated, the valve leak rates were 1.01% and 0.89% for the two semiannual periods of 2004. These leak rates compare reasonably to other HRVOC processes and petroleum processes.

The leak rates reported for G Line connectors for 2004 were 1.11% and 2.97% in the first and second semiannual periods, respectively. It should be noted that the bulk of connector monitoring was done during the first period, and the second period leak rate represented a relatively small number of rechecks. The G Line HRVOC connector leak rates were 2.46%. These leak rates are comparable to or higher than other HRVOC processes and petroleum processes. Since G Line was just completed and started up in early 2004, it is not unusual to find a larger number of connector leaks on new equipment.

URS also benchmarks LDAR performance semi-quantitatively for open-ended line control, component identification, comparative monitoring agreement, and components on delay of repair. Tables 2-4, 2-5, 2-6, and 2-7 present these quantitative benchmarks as a ranking of the facilities we have audited, with ExxonMobil, Baton Rouge Plastics Plant highlighted. Figure 2-2 presents a bubble chart that attempts to grade the overall LDAR performance. The bubbles represent the significant building blocks of LDAR: component identification, monitoring, repairs, condition issues (covers OEL control, sample systems flushing control, missing tags and tag legibility/order), and recordkeeping/reporting. The size of the bubble is approximately proportional to the importance of that activity in preventing/reducing emissions, except for recordkeeping/reporting, which is important because of compliance demonstration. Grades are assigned to each bubble on a school grade basis of A to F. The grades are performance based rather than being assigned on a curve, so if all facilities excelled in an activity, all would receive "A" grades.

Table 2-4
Benchmarking of Open-Ended Line Control

State	Year	OELs	Inspected	% Open	Quartile Rankings		
Michigan	2003	0	684	0.00%	!		
Texas	2004	0	620	0.00%	!		
California	2003	0	475	0.00%	!		
Kentucky	2004	0	421	0.00%	!		
California	2003	0	384	0.00%	!		
Texas	2004	1	2075	0.05%	!		
Louisiana	2005	2	1919	0.10%	Top 25%		
Colorado	2004	1	499	0.20%	!		
Minnesota	2003	1	450	0.22%	!		
Illinois	2005	2	704	0.28%	!		
California	2001	3	1000	0.30%	!		
Louisiana	2003	28	8540	0.33%	!		
Texas	2003	20	4749	0.42%		!	
Minnesota	2004	2	347	0.58%		!	
Texas	2004	3	499	0.60%		!	
Ohio	2004	2	330	0.61%		!	
Washington	2004	5	765	0.65%		!	
Texas	2003	11	1664	0.66%		!	
Texas	2004	8	1194	0.67%		2nd 25%	
Louisiana	2004	7	974	0.72%		!	
Louisiana	2004	11	1461	0.75%		!	
Delaware	2002	21	2600	0.81%		!	
Louisiana	2002	5	600	0.83%		!	
Texas	2001	9	1000	0.90%		!	
Ohio	2004	7	748	0.94%	!		
Louisiana	2004	5	430	1.16%	!		
Texas	2002	35	3000	1.17%	!		
California	2003	4	330	1.21%	!		
California	2003	10	715	1.40%	!		
California	2001	11	750	1.47%	!		
Texas	2002	9	600	1.50%	3rd 25%		
Illinois	2003	22	1435	1.53%	!		
Louisiana	2003	14	900	1.56%	!		
Oklahoma	2004	9	539	1.67%	!		
Ohio	2004	9	492	1.83%	!		
Louisiana	2002	21	1100	1.91%	!		
Indiana	2002	20	1000	2.00%		!	
Texas	2003	50	2416	2.07%		!	
Indiana	2004	29	1270	2.28%		!	
California	2001	14	500	2.80%		!	
Illinois	2004	230	6306	3.65%		!	
Pennsylvania	2004	30	770	3.90%		Bottom 25%	
Louisiana	2004	103	2235	4.61%		!	

Ohio	2002	19	400	4.75%	!
Washington	2001	39	750	5.20%	!
Montana	2003	23	420	5.48%	!
Washington	2003	50	568	8.80%	!

Summary Statistics for OEL Control	
Count =	47
Average =	1.54%
Median =	0.90%

Table 2-5
Benchmarking of Component Identification

State	Year	Overlooked	Inspected	% Overlooked	Quartile Rankings	
Louisiana	2002	0	6000	0.00%	!	
Minnesota	2003	0	2500	0.00%	!	
Ohio	2002	0	2000	0.00%	!	
Texas	2004	1	10377	0.01%	!	
Texas	2002	2	6000	0.03%	Top 25%	
Texas	2004	3	9235	0.03%	!	
Colorado	2004	1	2493	0.04%	!	
Louisiana	2004	3	7307	0.04%	!	
Illinois	2003	3	7200	0.04%	!	
Louisiana	2004	3	4868	0.06%	!	
Illinois	2004	28	31530	0.09%	!	
Louisiana	2005	10	9595	0.10%	!	
Ohio	2004	4	3739	0.11%		!
Illinois	2005	4	3518	0.11%		!
Michigan	2003	5	3380	0.15%		!
Montana	2003	5	2900	0.17%		!
Louisiana	2004	20	11175	0.18%		!
Washington	2004	8	3823	0.21%		!
California	2001	37	15000	0.25%		2nd 25%
Texas	2001	16	6000	0.27%		!
California	2003	11	4000	0.28%		!
Texas	2002	51	15000	0.34%		!
Delaware	2002	73	19500	0.37%		!
Texas	2004	12	3102	0.39%		!
Louisiana	2003	199	42702	0.47%	!	
Louisiana	2002	62	13000	0.48%	!	
Texas	2003	42	8321	0.50%	!	
California	2001	97	18000	0.54%	!	
Indiana	2002	59	9000	0.66%	!	
Oklahoma	2004	18	2694	0.67%	3rd 25%	
Texas	2003	83	12082	0.69%	!	
Texas	2004	42	5969	0.70%	!	
Kentucky	2004	18	2105	0.86%	!	
Louisiana	2003	39	4500	0.87%	!	
Indiana	2004	60	6349	0.95%	!	
California	2003	20	1900	1.05%	!	
Washington	2003	30	2839	1.06%		!
Texas	2003	255	23744	1.07%		!
Ohio	2004	35	2462	1.42%		!
California	2001	190	13000	1.46%		!
Minnesota	2004	32	1735	1.84%		!
California	2003	89	4800	1.85%		!
Washington	2001	214	10000	2.14%		Bottom 25%

Texas	2001	311	10000	3.11%	!
Pennsylvania	2004	133	3850	3.45%	!
California	2003	115	1922	5.98%	!
Ohio	2004	100	1651	6.06%	!
Louisiana	2004	225	2149	10.47%	!

Summary Statistics for Component Identification	
Count =	48
Average =	1.08%
Median =	0.43%

Table 2-6
Benchmarking of Comparative Monitoring

State	Year	Score	% Monitored	Ranking	
Louisiana	2003	6.8	>3%	!	
Washington	2004	6.8	>3%	!	
Illinois	2005	6.7	>2.5%	!	
Texas	2001	6.7	>1%	!	
Montana	2003	6.6	>3%	!	
California	2003	6.5	>2%	1st Quartile	
Louisiana	2005	6.5	>2%	!	
Texas	2004	6.5	>1%	!	
California	2001	6.4	>5%	!	
California	2001	6.4	>5%	!	
Ohio	2004	6.0	>2.5%	!	
Texas	2003	6.0	>2.5%		!
Minnesota	2004	6.0	>2%		!
Texas	2001	5.9	>5%		!
Texas	2002	5.8	>1%		!
Ohio	2002	5.7	>1%		!
Texas	2003	5.7	<1%		!
Illinois	2003	5.6	>3%		2nd Quartile
California	2003	5.5	<1%		!
Louisiana	2002	5.4	>5%		!
Louisiana	2002	5.3	>5%		!
Oklahoma	2004	5.3	>2%		!
California	2003	5.1	>2%	!	
Louisiana	2004	5.0	>2%	!	
Delaware	2002	4.9	>5%	!	
California	2001	4.9	>5%	!	
Washington	2001	4.5	>5%	!	
Minnesota	2003	4.2	>1%	3rd Quartile	
Michigan	2003	4.0	>3%	!	
Texas	2004	3.7	>6%	!	
Louisiana	2004	3.7	>3%	!	
Indiana	2004	3.7	>2%	!	
California	2003	3.7	>2%	!	
Texas	2002	3.6	>5%		!
Ohio	2004	3.0	>5%		!
Washington	2003	3.0	>2%		!
Texas	2004	2.8	>2%		!
Louisiana	2004	2.7	>2%		4th Quartile
Colorado	2004	2.5	>3%		!
Kentucky	2003	1.8	>3%		!

Kentucky	2004	1.5	0.6%		!
Pennsylvania	2004	0.0	>3%		!
Indiana	2002	0.0	>1%		!
Summary Statistics for Comparative Monitoring					
	Count =				43
	Average =				4.7
	Median =				5.3

Note: comparative monitoring is ranked semi-quatitatively suing the following scale:

Points System:

7 Close agreement with plant higher than auditor, Chi Square irrelevant

6 Close agreement with auditor higher than plant, Chi Square <=80%

5 Minor spread, significant overlap, audit higher, Chi Square <=70%

4 Minor spread, significant overlap, audit higher, Chi Square <=50%

3 Moderate spread, averages in overlap, audit higher, Chi Square <=20%

2 Moderate spread, moderate range overlap, audit higher, Chi Square <=10%

1 Big spread, slight range overlap, audit higher, Chi Square <=5%

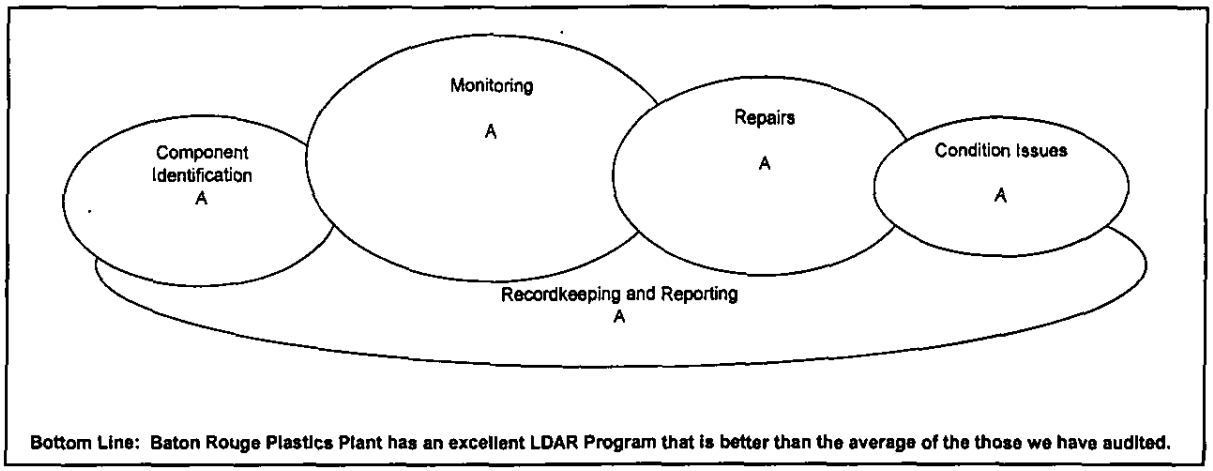
0 Big spread, no overlap, audit higher, Chi Square <2%

Table 2-7
Benchmarking of Delay of Repair

State	Year	# of DOR	# Components	% on DOR	Rankings		Comments		
California	2001	0		0.00%	!		DOR not allowed		
California	2003	0		0.00%	!		DOR not allowed		
California	2003	0		0.00%	!		DOR allowed for only 6 months		
California	2003	0		0.00%	1st quartile		DOR not allowed		
Texas	2004	1	65470	0.002%	!				
Washington	2003	1	30000	0.003%	!				
Louisiana	2005	1	21627	0.005%	!				
Ohio	2004	1	17111	0.006%	!				
Illinois	2004	4	36754	0.011%		!			
Ohio	2004	3	18659	0.016%		!			
Texas	2004	10	56253	0.018%		!			
Illinois	2005	12	48086	0.025%		2nd quartile			
Texas	2004	21	69050	0.03%		!			
Louisiana	2004	17	29779	0.06%		!			
Kentucky	2004	40	55500	0.07%		!			
Colorado	2004	10	14699	0.07%		!			
Louisiana	2004	87	80921	0.11%	!				
Montana	2003	20	15000	0.13%	!				
Washington	2004	29	20036	0.14%	!				
Ohio	2004	36	24554	0.15%	!				
Minnesota	2004	32	20123	0.16%	3rd quartile				
Oklahoma	2004	63	36510	0.17%	!				
Louisiana	2004	154	81300	0.19%	!				
Louisiana	2004	139	58125	0.24%	!				
Texas	2004	768	232338	0.33%	!				
Louisiana	2003	404	35000	1.15%		4th quartile			
Indiana	2004	904	57453	1.57%		!			
Summary Statistics for Component Identification									
	Count =			27					
	Average =			0.17%					
	Median =			0.06%					

Figure 2-2
Bubble Chart of Overall LDAR Quality

2.5



2.5 BEST PRACTICES

Many aspects of the LDAR program at BRPP are excellent and some are representative of industry best practices. This section highlights two best practices: repairs and recordkeeping.

Repairs at BRPP are mostly done by the monitoring technician. This is made possible because the monitoring technician is a fully qualified pipefitter. Normally the monitoring technician only makes a first repair attempt, which is often limited to only a quarter turn of tightening. At BRPP, the technicians make first attempts and advanced maintenance. Very few repairs require a work order to be written to bring out a maintenance crew, which saves time between successive repair attempts and reduces the communications load. The repair effectiveness appears to be quite good, with very few components on delay of repair and less dependence on drill/tap/inject to achieve the repair.

The recordkeeping and tracking of repairs, attempts, monitoring, justifications, signatures, and shut downs was better than we typically see. Most issues are explained well in the records. All potential anomalies were quickly and efficiently explained.

2.6 SUMMARY OF LDAR PERFORMANCE

No missing components were found during the audit. A review of records for 2004 indicates that monitoring of components is complete.

A total of 151 leaks were found in 2004, and 137 of those leaks were repaired successfully within 15 days (generally in a much shorter time). Of the other 14 leaks, 2 were isolated from VOC service and 12 were put on delay of repair (DOR). No repair deadlines were missed. Most of the components put on DOR were repaired during the year, and only one component remained on DOR at the time of the audit.

BRPP has 639 difficult-to-monitor (DTM) components, or just under 3% of total components. This is a relatively low number of DTM components, since many facilities struggle to get their new units under the 3% DTM limit for valves. BRPP has 385 unsafe-to-monitor (UTM) components, or about 1.8% of all components. The UTM components fall into two categories: components around high-pressure reactor bays (20,000 psi to 50,000 psi) and components on pipe racks where there is no place to tie off a climbing harness. The facility has only a general monitoring plan for UTM components that says they will be monitored when it is safe. The

components in high-pressure areas employ a surrogate form of leak testing, since small leaks at those pressures are audible and there are area hydrocarbon monitors that can also detect significant leaks. Leaks in the high-pressure areas are considered significant safety issues, and the units would be shut down to find and repair any such leaks.

One objective of this audit was to evaluate the overall "health" of the LDAR program. The LDAR program at BRPP was found to be in excellent health, due at least in part to the remarkable consistency of personnel for periods of the last ten to twenty years. The program is anchored with well-trained and motivated personnel. Communications are relatively simple and effective for this small program. Component identification is accurate and tags are in good shape. Monitoring results compare well to audit results. Records show that the consolidated LDAR rule is well understood and that compliance has been achieved for the 2004 records reviewed in depth.

The only negative issue related to health of the LDAR program is the truncation of monitoring values at 10,000 ppm in the database. This was common practice when the program was started using OVA-108 analyzers with an analog scale that stopped at 10,000 ppm. The new TVA-1000B analyzers currently used for most monitoring work at BRPP are rated to a maximum reading of 50,000 ppm by the manufacturer and will log considerably higher values before they flame out. Reportedly the entry of concentrations beyond 10,000 ppm disrupted database function at the time the facility started using the TVA, so the truncation to 10,000 ppm was continued. Virtually all modern databases can handle full readings without truncation. Truncating higher readings to 10,000 ppm could cause under-estimation of large leaks.

The audit included two primary elements: a compliance audit and comparative monitoring. A description of the methodology used by URS for each of these elements follows.

3.1 COMPLIANCE AUDIT

URS performed a check of the leak detection and repair (LDAR) program against the requirements of applicable regulations. The primary areas audited were:

- HON (as referred to by NESHAP Subpart U);
- Louisiana Rule 2122;
- Louisiana Fugitive Emissions Consolidation; and
- EPA Reference Method 21.

Detailed data reviews were done on the units selected for comparative monitoring. Computerized reviews of the monitoring data were done to demonstrate monitoring completion, repair deadline compliance, and to check for monitoring pace and other anomalies.

The compliance audit also included interviews with key staff involved in the LDAR program. At BRPP, the interviews included the LDAR Coordinator, contractor monitoring supervisor, and monitoring technicians.

The compliance audit also included observation of the LDAR technicians. Observations were made of the technicians performing instrument warm-up, analyzer maintenance, calibration, monitoring, and repair attempts.

The compliance audit also included an evaluation of component identification and field condition issues. Component identification checks were done in the field, looking for untagged components and trying to determine if they should have been tagged. During this effort, the condition of open-ended line control and sample station flushing control was also evaluated.

The findings related to non-compliance with regulatory requirements were prioritized. The basis for the prioritization scheme was to assign the highest priority to findings that have the potential to result in the greatest increase in emissions. Table 2-2 presents the definitions of the priority levels.

3.2 COMPARATIVE MONITORING

The URS team made independent Method 21 measurements on selected units in the facility. The G Line was selected at BRPP because it is the only area doing full connector monitoring at this time.

The comparative monitoring team utilized their own analyzers (Thermo Environmental HVM680) and certified calibration gases. The instruments were put through the Method 21 performance certification tests before the monitoring began. Multi-point calibrations were done daily using 0, 500, and 9,500 ppm methane in air calibration gases. Drift checks were performed using the 500-ppm standard throughout the day.

The valves and connectors within each selected process unit were selected for monitoring on a random basis within areas where HRVOC streams were present. The URS inspector monitored most accessible valves and the associated connectors in selected areas with HRVOC. No difficult-to-monitor or unsafe-to-monitor components were tested, although a representative sample of elevated components that could be monitored from fixed platforms reachable by stairs or ladders were monitored.

A representative of the facility and the site LDAR crew accompanied the comparative monitoring crew during all monitoring. All leaks found in the audit were verified by the site technician, entered into the database, and tagged for repair.

95% confidence intervals were calculated for the percentage of leaking valves for each process unit. The purpose of these confidence intervals is to estimate the range in which the actual leak rate for valves should fall, based on the fact that the comparative monitoring tested only a sub-sample of components for only a single point in time.

The formula for the confidence interval is from "Statistical Intervals: A Guide for Practitioners" by GJ Hahn and WQ Meeker. In the formula, 'n' represents the number of valves monitored, 'x' represents the number of leaking valves, and F is the F Statistic, whose components are the level of confidence for each bound, degrees of freedom 1, and degrees of freedom 2.

To summarize the leak rates for all the monitored processes, the average of these rates was calculated, and a confidence interval was estimated for this average. The confidence interval for this average was based on a normal confidence interval. A normal confidence interval is

calculated by the following equation: $\bar{x} \pm t_{\alpha/2,n-1}\frac{s}{\sqrt{n}}$, where $\bar{x}$ is the estimated sample mean, n is the number of leak rates, $t_{\alpha/2,n-1}$ is the 97.5th percentile (so that 95% confidence is achieved with both bounds) from the Student-t distribution with $n-1$ degrees of freedom, and s is the estimated standard deviation for the leak rates.

The confidence intervals are based on an assumption that the data are normally distributed. An additional statistical test called the Chi-Square has been done using non-parametric inferential statistics. We used the X^2 (chi-square) test for two independent samples (Cochran, W. G., *The X^2 Test of Goodness of Fit*, Annals of Mathematical Statistics, 23, 1952, pages 315-345.) to determine whether it was reasonable to assume that the historical site monitoring data and the comparative monitoring audit data were drawn from the same underlying distribution. For each test, a 2 by 2 contingency table was constructed as shown:

	Leaking	Not Leaking	
Plant Data	A	B	A + B
Comparative Data	C	D	C + D
Totals	A + C	B + D	N

where A, B, C, and D are the counts of observations in each cell. The chi-square statistic was computed as:

$$X^2 = \frac{N\left(\left|AD - BC\right| - N/2\right)^2}{(A+B)(C+D)(A+C)(B+D)}$$

This formula incorporates a correction (Siegel, S. and N. Castellan, *Nonparametric Statistics for the Behavioral Sciences*, Second edition, New York, McGraw-Hill, 1988.) to account for the fact that the variables are discrete rather than continuous. If the probability of X^2 greater than or equal to the observed value was less than 5 percent (df = 1), the ratios of leaking to non-leaking components for the plant data and comparative data were deemed to be significantly different.

GLOSSARY

AVO	Audio, Visual, or Olfactory (sensory leak detection)
CFR	Code of Federal Regulations
DOR	Delay of repair
DTM	Difficult-to-monitor
EPA	Environmental Protection Agency (see USEPA)
HAP	Hazardous Air Pollutant
HON	Hazardous Organic NESHAP
HVM-680	Thermo Environmental HVM-680 instrument used for monitoring
LDAR	Leak Detection and Repair
LDEQ	Louisiana Department of Environmental Quality
MACT	Maximum Achievable Control Technology
MOC	Management of Change
NEIC	EPA National Enforcement Investigation Center
NESHAP	National Emissions Standard for Hazardous Air Pollutants
NSPS	New Source Performance Standards
OEL	Open ended line
QA/QC	Quality Assurance/Quality Control
SOP	Standard Operating Procedure
URS	URS Corporation
USEPA	United States Environmental Protection Agency
UTM	Unsafe-to-monitor
VOC	Volatile Organic Compounds

Appendix A – Environmental Audits

ExxonMobil Polyolefins Plant

BRPO

Shaw Project No. 115703-02
RTPLA Project No. 2005-007-001
June 2005

RECEIVED
JUL 01 2005
LDEQ/AQAD
Engineering Support

HRVOC Audit Report

ExxonMobil Polyolefins (BRPO)

RECEIVED
JUN 29 2005
LDEQ

Prepared for:

ExxonMobil Polyolefins
12875 Scenic Highway
Baton Rouge, Louisiana

Prepared by:

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Baton Rouge, Louisiana 70809

RTP Environmental Associates, Inc.
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HRVOC AUDIT REPORT

ExxonMobil Polyolefins (BRPO)

Shaw Project No. 115703-02
RTPLA Project No. 2005-007-001
June 2005

Prepared for:

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HRVOC AUDIT REPORT

Shaw Project No. 115703-02
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June 2005

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Executive Summary

Pursuant to an Administrative Order issued by the Louisiana Department of Environmental Quality (LDEQ) on October 6, 2004 and revised on February 9, 2005, Exxon Mobil Corporation's (ExxonMobil) Baton Rouge Polyolefins Plant (BRPO) was required to conduct a comprehensive environmental audit of the facility's operations for the purposes of documenting all potential sources of releases of highly reactive volatile organic compounds (HRVOC). To accomplish this objective, ExxonMobil commissioned a third-party systems audit by recognized environmental professionals. The audit team was charged to verify that all potential sources of emissions have been identified and accounted for, and to confirm that calculation techniques employed reflect the most appropriate and accurate methodologies for the respective emission sources. To this end, the audit team reviewed pertinent air permits, permit applications, process descriptions, process flow diagrams (PFDs), piping and instrumentation diagrams (P&IDs) and conducted interviews with BRPO environmental staff to gain an understanding of the processes and emission sources in place at the BRPO.

The audit team conducted a site visit to BRPO on March 29th. An overview of the processes was provided and discussions were held regarding the various emissions units, their potential to emit HRVOC, and the manner in which the emissions were calculated from both a permitting and an actual basis perspective. Representative samplings of calculations were checked to verify the calculation methodology.

The process utilized by BRPO to identify emission sources is very thorough. The BRPO process is a high-density moderate pressure process where potential sources of emissions to the atmosphere are tightly controlled. There are no atmospheric vents in the moderate pressure area of the facility with all equipment being protected by rupture discs and/or pressure relief valves. There are a few emission sources in the lower pressure (less than 10 psi.) areas. BRPO plant personnel have conducted numerous surveys of the facility (including PFD reviews, actual plant walk throughs, etc.) to ensure all potential emission sources have been identified.

The audit team conducted a "systems audit", focusing on assuring that proper practices and procedures were in place to identify potential emission sources and accurately account for emissions from these sources. Therefore, while the audit did not confirm that all sources of HRVOC have been identified by ExxonMobil and that all calculation techniques reflect the most appropriate and accurate methodologies, the audit did seek to ascertain if the practices and procedures employed by ExxonMobil were rigorous and appropriate. A qualitative assessment scale was used to judge each individual area as well as the system as a whole. The following is a table of classifications used.

Rating	Meaning
★★★★★	Meets industry standard , *no improvements identified*
★★★★	Meets industry standard, *only minor improvements needed*
★★★	Meets industry standard, *improvements needed*
★★	Improvements needed to meet industry standard
★	Below industry standard, major improvements needed

From the standpoint of the identification of sources of HRVOC emissions, the audit team concluded that it is highly probable that ExxonMobil has identified all such sources. From the standpoint of evaluating calculation methodologies and techniques, the audit team assessed an overall evaluation of ★★★★ Meets industry standard, *only minor improvements needed.* Information on the assessment of individual areas is provided in more detail in the body of the report.

1.0 Introduction

1.1 Objective and Purpose

Pursuant to an Administrative Order issued by the Louisiana Department of Environmental Quality (LDEQ) on October 6, 2004 and revised February 9, 2005, Exxon Mobil Corporation's (ExxonMobil) Baton Rouge Polyolefins Plant (BRPO) was required to conduct a comprehensive environmental audit of the facility's operations for the purposes of documenting all potential sources of releases of highly reactive volatile organic compounds (HRVOC) and to perform testing of certain specified emissions sources. Since ExxonMobil believed that its in-house air permitting and emission reporting efforts were thorough and accurate, and because they were required to comply with the Administrative Order, ExxonMobil commissioned a third-party systems audit by recognized environmental professionals. In selecting the audit team, ExxonMobil sought to identify recognized individual environmental professionals, rather than companies, and sought individuals who had no prior work experience related to the BRPO.

1.2 Audit Team Composition

The audit team was composed of Mr. Gerald Brouillette, P.E. of the Shaw Group (Shaw) and Mr. William Palermo, P.E. of RTP Environmental Associates, Inc. (RTP). Mr. Brouillette is a Project Manager with Shaw's Baton Rouge, Louisiana office and is a Louisiana Registered Professional Engineer. Mr. Brouillette has worked as an environmental engineer and manager in the petrochemical industry in Louisiana for over 14 years and has worked as an environmental consultant for an additional three years. His industrial work background provides an excellent insight into plant operations, and he has extensive experience in developing and employing emission calculations for both permitting and reporting purposes. Mr. Palermo is a Principal of RTP and is Manager of RTP's Louisiana office. Mr. Palermo is a Louisiana Registered Professional Engineer and he has been employed in Louisiana as an environmental consultant in excess of 20 years. He has a comprehensive knowledge of Louisiana air permitting processes and requirements and with the procedures for identifying and quantifying sources of air emissions.

1.3 Methodology

The audit team reviewed pertinent air permits, permit applications, process descriptions, process flow diagrams (PFDs), and piping and instrumentation diagrams (P&IDs) to gain an understanding of the processes and emission sources in place at the BRPO. Emphasis was placed on those sources that had the potential to emit any of the seven identified HRVOCs (ethylene, propylene, 1,3-butadiene, butenes and isomers, acetaldehyde, toluene, and xylene and isomers). Following this review, the team met with knowledgeable personnel from the BRPO to

review the processes that were in place for identifying emissions sources and emissions, including emergency releases, and the quantification of emissions from both a permitting basis and from the standpoint of reporting actual emissions on an annual and ongoing basis. Calculation procedures were evaluated with emphasis being placed on those emissions sources that had the greatest potential to emit HRVOC and those for which multiple possible quantification techniques were possible. A representative sampling of calculation methodologies was also performed.

1.4 Assessment

ExxonMobil requested a "systems audit" focused on assuring that proper practices and procedures were in place to identify potential emission sources and accurately account for emissions from these sources. Therefore, the audit itself did not include detailed plant walkthroughs, drawing review, and/or plant personnel interviews to ensure all potential emission sources had been identified. Neither did the audit involve a thorough review of all emission calculations for each emission source. Therefore, while the audit did not confirm that all sources of HRVOC have been identified by ExxonMobil and that all calculation techniques reflect the most appropriate and accurate methodologies, the audit did seek to ascertain if the practices and procedures employed by ExxonMobil were rigorous and appropriate. Accordingly, the audit team, with the agreement of ExxonMobil, embarked upon a subjective assessment of the extent to which ExxonMobil had identified and quantified all sources of HRVOC. Two different subjective methodologies were employed. A qualitative assessment scale was used to judge each individual area as well as the system as a whole. The following is a table of classifications used:

Rating	Meaning
★★★★★	Meets industry standard, *no improvements identified*
★★★★	Meets industry standard, *only minor improvements needed*
★★★	Meets industry standard, *improvements needed*
★★	Improvements needed to meet industry standard
★	Below industry standard, major improvements needed

2.0 Methodology

2.1 Approach

The audit team's task was to conduct a systems review of how ExxonMobil identifies and quantifies its emission sources of HRVOCs. ExxonMobil believes that its air permitting and emission reporting efforts are thorough and that it utilizes the most current information, emission factors, and other best practices in its permitting and compliance programs, consequently ExxonMobil sought the assistance of consultants to provide third party verification of the approaches that are currently in place at each facility. To this end, the audit team conducted a thorough review of ExxonMobil's approach in identifying and quantifying sources of HRVOC and representative spot checks of actual calculations and reports.

The audit team conducted a project kickoff meeting on March 9th at which representatives of each of the four ExxonMobil facilities were present and the manner in which the audit(s) would be conducted was defined, and an audit schedule was developed. An initial needs list was provided to ExxonMobil identifying the types of information that would be reviewed prior to the respective site visit. The needs list information included items such as process descriptions, existing permits, permit applications, process flow diagrams, and supporting emission calculations methodology not included in the application(s).

The audit team conducted a site visit to BRPO on March 29th. An overview of the processes was provided and discussions were held regarding the various emissions units, their potential to emit HRVOC, and the manner in which the emissions were calculated from both a permitting and an actual basis perspective.

2.2 Resources

Various resources were utilized to conduct the audit. Process flow diagrams for the different parts of the process were reviewed to confirm the identification of potential sources of emissions. Facility permits and applications were reviewed to ensure proper assessment of all emission points including insignificant activities and "General Condition XVII" items. Emission calculation basis were discussed with knowledgeable plant personnel and spot checks were conducted to confirm the methodology employed was consistent with the generally accepted hierarchal approach for emission basis and regulatory requirements. The generally accepted hierarchy for calculating emissions is presented below:

Hierarchal Order	Calculation Basis	Examples
1	Direct Measurement	Emissions Monitoring, Stack Testing, Stream Sampling
2	Emission Factors/Studies	AP-42, Tanks 4.09, Water 9, ToxChem, API studies, etc.
3	Material Balances	Inlets minus Outlets, Materials Used, etc.
4	Manufacturers Specifications & Guarantees	
5	Engineering Judgment	

In assessing the calculation methodology employed by ExxonMobil, the calculation hierarchy was considered. Additionally, where vendor information for pollution control equipment (flares, thermal oxidizers) was part of the emission calculation basis, this information/documentation was reviewed and discussed.

2.3 Interviews

The audit team conducted interviews of the BRPO facility environmental staff personnel. Mr. Frank Bains (Manager of Environmental Affairs), Mr. George Jones (Safety, Health and Environmental Coordinator), and Mr. Gordon Brown (Engineering Associate) were interviewed as part of the audit. Mr. Bains has been working in the environmental department at the BRPO for over 20 years and has extensive experience and background in the policies and work practices utilized by BRPO in identifying the potential sources of emissions and the basis for the calculation methodologies utilized. Mr. Jones has over 14 years experience in the environmental field, 5 years at BRPO, and has as a primary responsibility determining the actual emissions, by pollutant, for the BRPO. Mr. Brown provides support to the BRPO and was extensively involved in preparing the application for and obtaining the Polypropylene process air permit. Mr. Brown has 23 years of environmental experience with ExxonMobil. Mr. Bains and Mr. Jones were able to provide an in-depth review of the actions employed by BRPO to identify emission sources and quantify those sources. Information on how changes to the process that may add or otherwise change an emission source was provided as well as how non-permitted activities (i.e. emergency releases) are addressed.

3.0 Findings

3.1 Background

BRPO facility consists of six lines used to manufacture different grades of polyethylene (PE) and one line that manufactures polypropylene (PP). Each of the polymerization processes operates under relatively low pressures, where after polymerization, the polymer stream enters a let down station where free monomer is recovered. The polymer stream is then routed to an extruder where the polymer is extruded into pellets, dried in a rotary dryer and conveyed to silos for storage prior to shipment. Process vents from the operations are routed to the flare system for control of these emissions.

3.2 Emission Sources

The process utilized by BRPO to identify emission sources is very thorough. The BRPO process is a high-density moderate pressure process where potential sources of emissions to the atmosphere are tightly controlled. There are no atmospheric vents in the moderate pressure area of the facility with all equipment being protected by rupture discs and/or pressure relief valves. There are a few emission sources in the lower pressure areas (less than 10 psi). BRPO plant personnel have conducted numerous surveys of the facility (including PFD reviews, actual plant walk throughs, etc.) to ensure all potential emission sources have been identified. BRPO environmental personnel conducted interviews with operations and maintenance personnel to address potential insignificant activity items as well as GC-17 issues.

The primary source of HRVOC emissions from BRPO is from the flare system (13 tons in 2004). Emissions from Finishing and Drying operations account for the second highest source of HRVOC (3 tons in 2004), with fugitive sources (2 tons) providing the third highest source.

The BRPO has a comprehensive Emergency Procedures Manual, which outlines the roles and responsibilities pertaining to Environmental Spills and Releases. Once informed of a spill or release, The Shift Supervisor is charged with determining the level of response that is required considering on-site impact, off-site impact, chemical(s) involved, the size of the spill or release and the need for external assistance. The Shift Supervisor notifies the proper authorities of the spill or release, as applicable; after which the Area Section Supervisor, the Environmental Manager and other members of plant management are notified, as appropriate.

Detailed in the tables below is a listing of the distinct emission sources with the equipment that contributes to the source, a description of how the permitted and actual emissions are determined, comments and recommendations regarding the calculations, and a qualitative grade for the calculation methodology employed. The following types of emission points were identified associated with the BRPO processes:

- Flares,
- Cooling Towers,
- Fugitive Emissions,
- Wastewater Collection,
- Finishing and Product Finishing Vent,
- Insignificant Activities,
- GC-17, and
- Accidental Releases.

3.3 Emission Calculations

Source Description	Flares (3) (13 tons in 2004)
Source ID Nos.	PECAP 07 (NEDS ID B2, B4)
Contributors	Old Flare (Point 233), New Flare (Point 234), and Remote Contingency Flare (Point PP01). Vents from carbon absorption regeneration process for isobutane recovery process. Vents from mole sieve regeneration process for ethylene supply lines. Vent from ethylene chiller column when BRPP cannot receive ethylene from this system. Vents from reactor dumps from overpressure situation (occurs rarely). Vents from the polypropylene unit and from polyethylene lines E, F, & G are routed to the New Flare (234) and vents from polyethylene lines A-D are routed to the Old Flare (233)
Permit Methodology	Inlet to the Old Flare historically was sampled on a quarterly basis while inlet to the New Flare has been sampled monthly. Flow to the flares is based on the historical sample results (from calendar year 2001) with a safety factor included on total flow. Once the amount of speciated compound to the flare has been defined, a 99.8% destruction efficiency is applied in order to determine permitted potential to emit. Emissions from the Remote Contingency Flare are based on emissions from combustion of the pilot gas (natural gas) only. This flare serves as an emergency backup to the New Flare (234). This flare is not permitted for routine vents.
Actual Methodology	Actual emissions historically were based on the monthly (Flare 234) and quarterly (Flare 233) sampling. BRPO has increased the actual sampling frequency of Flare 233 to a monthly basis. Actual emissions are assumed to address vents from regeneration of raw material treaters and return ethylene from the chillers that are not routed to BRPO. Unusual events such as reactor blowdowns are not included in the actual emission numbers from this point source as these type events are addressed under "Accidental Releases". A 99.8% destruction efficiency is applied to the steam-assisted flare. Emissions for the Remote Contingency Flare are based on the flare permitted numbers (pilot gas usage only – assuming operating for the entire year). Any vents routed to this flare would be addressed through "Accidental Releases".
Comments/ Recommendations	BRPO has three flares, with one operating strictly as a backup flare. The "New Flare" is equipped with a continuous calorimeter analyzer to

	ensure the minimum BTU value of 300 BTU/scf. If necessary, natural gas is added to increase BTUs. The "Old Flare" is not equipped with a calorimeter, but its feed streams are from process operations that generate only organics, so the average BTU value of the stream will easily exceed 1000 BTU/scf. Additionally, each flare is steam assisted and the steam provided to each flare is controlled by a "Powertrol System" that automatically adjusts the steam to ensure optimal flame control. BRPO has a very detailed system including the Powertrol control system and calorimeter analyzers to ensure optimal operation of the flare systems. Sampling of the feed streams is routine monthly for the New Flare and quarterly for the Old Flare. Sampling of the New Flare has been increased to monthly this year. . BRPO uses a 99.8% destruction efficiency for the flare. This was considered to be a reasonable estimate for the following reasons: 1) the calorimeter analyzer ensure that a minimum of 300 BTU/scf is provided to the flare tip, making up with natural gas when necessary; 2) the Powertrol system is an advanced system that ensures optimal steam addition to the flare tip – not too much that it dampens the efficiency of the flare and not too little so that proper mixing and turbulence is lacking; and 3) a review of EPA's Flare Efficiency Study, July 1983, confirms that with proper operation of a flare, destruction efficiencies in excess of 99.8% would be expected for the types of gases found at BRPO and 4) information provided by the flare tip manufacturer supports a 99.8% destruction efficiency.
Evaluation: ★★★★- Meets industry standard, only minor *improvements needed*	BRPO uses direct measurement data (flow rates and speciation) and applies the 99.8% efficiency to determine emissions from the flare operations. While the applied efficiency is high, it is defensible based on a review of the 1983 EPA study, the manufacturers literature, and the control systems that BRPO utilizes (the calorimeter and the Powertrol unit). It is recommended that BRPO proceed as planned to increase the sampling of the feed stream to the New Flare to a monthly basis.

Source Description	Cooling Tower Emissions Cap (<1 tons in 2004)
Source ID Nos.	PECAP 08 (NEDS ID C9, D1, D2, & B5) PP02
Contributors	Four cooling towers in the PE plant and one in the PP plant.
Permit Methodology	Emissions from cooling towers are based on historical sampling of cooling tower inlets and design recirculation rates. For the polyethylene cooling towers, the inlet VOC concentration is set at 20 ppb, while for the polypropylene process cooling towers, the concentration is set at 15 ppb.
Actual Methodology	Actual emissions are calculated based on individual cooling tower

	recirculation rate and the respective monthly sample results. In 2004, samples were analyzed for TOC, and were not speciated, therefore, BRPO utilized 2003 speciation sample data to report 2004 numbers. In 2005, BRPO has re-instituted the practice of obtaining full speciation from cooling tower sampling.
Comments/ Recommendations	Cooling tower emission information is based on actual sampling and cooling tower design recirculation rates. While in 2004, full speciation of sample results were not conducted, the practice has been reinstituted in 2005. There are no recommendations for improvement while sampling for full speciation.
Evaluation: ★★★★★- Meets industry standard, *no improvements needed*	BRPO uses direct measurement (1) to determine emissions from cooling tower operation. BRPO is presently sampling to account for emissions. BRPO's operations are consistent with industry standards and no improvements are identified.

Source Description	Fugitive Emissions (2 tons in 2004)
Source ID Nos.	238 (NEDS ID 81) and PP-03 (NEDS ID B6)
Contributors	• Valves • Connectors • Compressors • Pumps • Process analyzers • Loading/ unloading operations
Permit Methodology	BRPO uses historical maximum measured leak rate information with the component count for the facility to define the potential to emit from fugitives. BRPO uses the EPA correlation equations along with the historical data.
Actual Methodology	To define actual emissions, BRPO takes the EPA correlation equations and applies the actual fugitive monitoring results from that year to the equations to determine the reported number.
Comments/ Recommendations	EPA identifies a hierarchy to estimate fugitive emissions. The method employed by BRPO is the most stringent method short of conducting bagging studies. For most conventional facilities, this is the recommended method to define fugitive emissions.
Evaluation: ★★★★★- Meets industry standard, *no improvements needed*	BRPO utilizes EPA emission factors (2) and applies direct measurement data to the factors. The manner to define actual emissions from this activity meets industry standards with no improvements identified.

Source Description	Purge Water and Wastewater Collection (<1 tons in 2004)
Source ID Nos.	PP10 (NEDS ID C1); PP11 (NEDS ID C2)
Contributors	• Wastewater from pelletizing and conveying of the polypropylene from the extruder to the pellet dryer. • Purge water from the polymerization section purge drum.
Permit Methodology	Historical samples of wastewater from the polypropylene section of the

	plant were collected and used to define routine levels of VOCs. Process knowledge was used to quantify typical flow rates. It is assumed that all VOC contained within the wastewater is emitted to the atmosphere.
Actual Methodology	Samples are collected on an annual basis for the purge water and the pellet carrier water. If VOCs are detected, the sample result is multiplied by the design flow rate to determine annual emissions. However, typically the sample results are non-detect, in which case BRPO reports the permitted number to be conservative.
Comments/ Recommendations	BRPO accounts for emissions from conventional sources related to wastewater systems. Annual sampling is collected to verify the stream composition and determine if there has been any change in the process operations. Taking permit basis in lieu of sample data when such data shows non-detects to estimate VOC emissions is a very conservative approach. Mechanisms employed are considered the most appropriate to define emissions from these type activities.
Evaluation: ★★★★★- Meets industry standard, *no improvements needed*	BRPO utilizes direct measurement (1) and process knowledge for flow rates (3) to quantify these emissions. When non-detects are observed, BRPO conservatively reports the permitted number. The methods used in this area meet or exceeds industry standards with no improvements identified.

Source Description	Finishing and Product Storage Vents (3 tons in 2004)
Source ID Nos.	PPCAP01 (NEDS ID C5)
Contributors	Vents from: • Weigh Feeder Vent (PP07) • Homogenizer Vent (PP08) • Pellet Dryer Vent (PP09) • Pellet Storage Vent (PP12)
Permit Methodology	Emissions from the finishing stage of the Polypropylene plant is based on operational data from a sister ExxonMobil facility related to an emission rate. This operational data is used with capacity production to define the potential to emit (PTE).
Actual Methodology	Sample data is collected from the various contributors on a routine basis (weigh feeder and homogenizer vents – quarterly, pellet dryer and storage vents – annually). Typical results are non-detect, and therefore, to be conservative, annual actual production is multiplied by the emission factor obtained from the sister EM facility. Speciation for HRVOC is based on actual variation in speciation for fugitive emissions based on that year's fugitive emissions monitoring for the polypropylene unit.
Comments/ Recommendations	BRPO uses direct measurement, but the results typically indicate essentially no residual monomer in the vents and therefore, BRPO takes

	a conservative approach by using permitted factors. The polypropylene facility is fairly new and is operating efficiently; it is recommended that BRPO continue to collect samples on their present schedule to identify if degradation in the process begins to result in more emissions.
Evaluation: ★★★★- Meets industry standard, *only minor improvements needed*	BRPO utilizes direct measurement (1) and emission factors (2) to quantify these emissions. The methods used in this area meet industry standards. It is recommended that BRPO continue to develop sample data to identify any degradation of the process.

Source Description	Insignificant Activities (<1 ton in 2004)
Source ID Nos.	INSIG (NEDS ID C7)
Contributors	• Small quantity storage vessels • Lab emissions • Drum washing
Permit Methodology	Storage vessel emissions are based on EPA Tanks 4.09. Lab emissions are calculated based on chemical usage. It is assumed that all materials used are released. Drum washing emissions are based on conservative factors of frequency of drum washing and the volume of material released during the activity.
Actual Methodology	Based on permitted levels.
Comments/ Recommendations	BRPO employs appropriate means to determine emissions from these sources.
Evaluation: ★★★★★- Meets industry standard, *no improvements needed*	BRPO uses EPA models (2) and material balances (3) to estimate emissions from IA sources. Appropriate conservativeness is built into the material balances to assure that emissions are overpredicted. The methods used in this area meet or exceeds industry standards with no improvements identified.

Source Description	GC-17 (<1 tons in 2004)
Source ID Nos.	GC01 (NEDS ID C6)
Contributors	• Sampling • Opening of equipment • Equipment maintenance • Analyzer vents • Pump procedures • Calibration/Service of instruments
Permit Methodology	BRPO conservatively quantified the frequency for the various activities, and based on this quantification, determined the volume available for release from each activity after accounting for proper operation and clearing of equipment based on procedures and work practices used at the facility.
Actual Methodology	BRPO quantifies based on emissions from one startup/shutdown with

	estimated propylene emissions to the flare at 99.8 efficiency. There appears to be additional items identified in the permit application that do not appear to be addressed in actual emissions. The permit is for items identified above (contributors), and total VOC emissions are approximately 1 ton from each permit (2581-V1 and 0840-00003-V0), primarily associated with the analyzer vent. The additional emissions from startup are also minimal (less than 100 lbs.) but do not appear to be addressed in permit.
Comments/ Recommendations	BRPO employs appropriate means to determine emissions from these sources, but does not appear to be including emissions from the GC activities, except for the startup/shutdown that is not listed, in preparing the annual EIS. Would recommend that BRPO consider reporting either emission levels identified in the permit (which would be very conservative), or quantify the frequency of the various activities and report a more accurate number.
Evaluation: ★★★- Meets industry standard, *improvements needed*	BRPO does not appear to be quantifying this item correctly. The methods used in this area needs to be addressed to accurately quantify these emissions. The emissions are rather minor in nature, so there is not expected to be any real impact on total reported HRVOC.

Source Description	Accidental Releases (<1 tons in 2004)
Source ID Nos.	ACREL (NEDS ID OO)
Contributors	BRPO calculates quantities emitted from all known releases whether "Reportable Quantity" level is attained or not.
Permit Methodology	Not a permitted source.
Actual Methodology	Accidental Releases to the atmosphere (either through a safety valve or from a line/system leak) are quantified by process engineers. Actual emissions are determined by a review of system operations and release parameters. Speciation of the release chemicals is based on process design and operational knowledge. For Accidental Releases routed to the flare (during an overpressure event), calculation of the emission is not included in the flare, therefore, engineers determine the speciation and amount of material released and then apply a 99.8% destruction efficiency as it passes through the flare.
Comments/ Recommendations	BRPO utilizes an appropriate means to identify emissions from emergency releases. Employing process and operations personnel in calculating emissions from releases is the best manner to follow since these personnel have intimate knowledge of the operations and the systems employed by BRPO.
Evaluation: ★★★★★- Meets industry standard, *no improvements needed*	BRPO uses engineering calculation and studies (2/3) to determine emissions from emergency releases. Appropriate engineering data and assumptions are utilized in this process. The methods used in this area meet or exceeds industry standards with no improvements identified.

ExxonMobil
Baton Rouge Polyolefins Plant
HRVOC Reported Emissions
For calendar Year 2004
(Pounds)

Source	Ethylene	Propylene	1,3-butadiene	Butene (+isomers)	Acetalde-hyde	toluene	Xylene (+ isomers)	Total	VOCs (tons)
Finishing and Product Storage Vents (PPCAP01)	548	5,271	0	0	0	0	0	5,819	2.9
Flares (PECAP 07)	11,320	14,600	0	0	0	0	0	0	13.0
Fugitive Emissions (EIQ 238 & PP03)	2656	436	0	130	0	0	0	3222	1.6
Cooling Towers (PECAP 08)	312	656	0	0	0	0	0	968	0.5
Wastewater (Purge Water and Wastewater collection) (PP10 & PP11)	40	0	0	0	0	0	0	40	0.0
Insignificant Activities	0	0	0	0	0	0	0	0	0.0
GC-17	0	34	0	0	0	0	0	34	0.0
Accidental Releases	356	0	0	0	0	0	0	356	0.2
Total	15232	20997	0	130	0	0	0	36369	17.8

There were no HRVOC's reported as being emitted from Insignificant Activities for 2004.

4.0 Assessment

Based on the information reviewed and considered while conducting this audit, the audit team has concluded that BRPO has a high probability of identifying all potential sources of emissions. Furthermore, the audit team finds that the calculation methodologies employed and the practices and procedures followed by BRPO meet or surpass that generally found in the petrochemical industry. Accordingly, an overall evaluation of ★★★★ Meets industry standard, *only minor improvements needed* was assessed.

EXXONMOBIL CHEMICAL COMPANY
BATON ROUGE POLYOLEFINS PALNT
BATON ROUGE, LOUISIANA
LDEQ AGENCY INTEREST NO. 3519

RECEIVED
JUL 01 2005
LDEQ/OEA/AQAD
Engineering Support

LEAK DETECTION AND REPAIR AUDIT

JUNE 2005

RECEIVED
JUN 29 2005
LDEQ

SECTION 1

INTRODUCTION

Introduction

ExxonMobil Chemical Company, Baton Rouge Polyolefins Plant (BRPO) operates a high-density polyethylene (HDPE) and a polypropylene production facility in Baton Rouge, Louisiana. The facility operates under Title V permits 2881 V1 and 0840-00003-V0.

1.1 Objective and Process Description

Pursuant to an Administrative Order issued by the Louisiana Department of Environmental Quality (LDEQ) on October 6, 2004 (revised on February 9, 2005) BRPO was required to conduct a comprehensive Leak Detection and Repair (LDAR) audit of the facility's fugitive emissions program. To accomplish this objective, BRPO commissioned third-party recognized environmental professionals. The selected companies were charged to conduct an audit focusing on equipment in HRVOC service. To this end, the audit team reviewed previous site fugitive emissions records, permit applications, process descriptions, process flow diagrams (PFDs), piping and instrumentation diagrams (P&IDs) and conducted interviews with BRPO environmental staff to gain an understanding of the processes and emission sources in place at the BRPO. The BRPO process is a high-density low-pressure process where potential sources of emissions to the atmosphere are controlled.

BRPO is a minor source of Hazardous Air Pollutants and is subject to LAC 33:III.2122, New Source Performance Standards, and the Louisiana Fugitive Emissions Consolidation Agreement. Hazardous Organic NESHAP regulations do not apply.

1.2 Audit Teams and Methodology

The process utilized by BRPO to identify fugitive sources is very thorough. BRPO has approximately 27, 700 components in its LDAR program. The audit team conducted a "systems audit", focusing on assuring that proper practices and procedures were in place to identify potential fugitive sources and accurately account for emissions from these sources. The audits concentrated on components in HRVOC. A review of calculation techniques reflect the most appropriate and accurate methodologies, the audit did seek to ascertain if the practices and procedures employed by ExxonMobil were rigorous and appropriate. A qualitative assessment scale was used to judge each individual area as well as the system as a whole.

BRPO selected URS and Compliance Consultants Inc. to perform the Audit. An overview of the processes was provided and discussions were held regarding the various emissions units, their potential to emit HRVOC, and the manner in which the emissions were calculated from both a permitting and an actual basis perspective. Representative samplings of components calculations were checked to verify the calculation methodology. URS conducted an audit the week of March 28thThe CCI audit was conducted the week of May 11th.

1.3 Methodology test

Method 21 states that the instrument probe inlet remain at the maximum reading location for approximately two times the response time of the instrument. BRPO also conducted a study of the affect of Method 21 with varying response times.. A representative of Eagle Environmental and members of the BRPO environmental staff monitored approximately 75 components at three intervals, two times the response time (6 seconds for the instrument used), 60 seconds, and 90 seconds. Results of this study are contained in Attachment C.

1.4 Results

URS and CCI performed plant walk throughs and comparative monitoring.. The results of the URS Audit are contained in Attachment A. The results of the CCI audit are contained in Attachment B.

As stated in their report, URS identified 110 components that were not tagged. Upon further inspections by plant personnel 34 of these components are associated with streams that are not in 10% VOC service and therefore monitoring is required by regulation. The remaining 76 components have be tagged, monitored and incorporated into the program. None of the components were found to be leaking.

NOT

APPENDIX A

URS LDAR AUDIT

LEAK DETECTION AND REPAIR (LDAR) PROGRAM AUDIT – FINAL

ExxonMobil
BATON ROUGE POLYOLEFINS PLANT

Prepared for:

ExxonMobil Polyolefins Plant
Baton Rouge, Louisiana

May 2005

File No. 40818754

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URS Corporation (URS) conducted a third-party audit of the leak detection and repair (LDAR) program at the ExxonMobil Baton Rouge Polyolefins Plant (BRPO). This audit was part of an Administrative Order agreement between the Louisiana Department of Environmental Quality and ExxonMobil. The audit began on March 30, 2005, and will close with the issuance of the final audit findings report. The URS team consisted of an engineer and a master technician. The audit included a detailed compliance audit and comparative monitoring of random components at selected process units.

The audit focused on areas of the facility that process highly reactive volatile organic compounds (HRVOC). The following elements of the ExxonMobil BRPO LDAR program were investigated in accordance with the Administrative Order agreement:

- Component identification;
- Stream speciation;
- Assessment of the monitoring program:
  - Procedures
  - Evaluation of LDAR contractor
  - Field assessment of tagging, open-ended lines, sample systems
  - Comparative monitoring; and
- Overall LDAR program performance.

Based on this in-depth audit of the LDAR program, URS found the program to substantially comply with all Federal and Louisiana regulations, with only one deficiency noted. The only deficiency was finding 110 untagged components that appear to be missing from the LDAR inventory. This represents an error rate of 2.2% based upon an estimated 5000 components inspected. One objective of this audit was to evaluate the overall "health" of the LDAR program. The LDAR program at BRPO was found to be in reasonable health, with a highly effective program of open-end line control and a good repair program, but below average component identification accuracy and marginal agreement on the comparative monitoring.

The program is anchored with well-trained and motivated personnel. Communications are relatively simple and effective for this small program. Component identification tags are in good shape, however, as noted, some apparent inaccuracies were found in the LDAR inventory. Comparative monitoring was conducted in Polypropylene Unit 1 and in the Polyethylene F and G Treaters area. The audit leak rate is higher in both units then the site's

average historical leak rates. There is some overlap of the audit leak rate's lower 95% confidence interval with the upper range of the site's historical leak rate range in Polypropylene Unit 1, however in the Treaters F and G area there is no such overlap. Review of the program records show that the consolidated LDAR rule is well understood and that compliance has been achieved for the year 2004 records that were reviewed in depth.

A summary of the results of the audit is presented by focus area in Table ES-1.

Table ES-1
Summary of Audit Results

Audit Area	Comments
Component Identification	Some inaccuracies were found in the tagging of components subject to LDAR regulations. A review of nearly 5000 components found 110 components that appear to be missing from the LDAR inventory. This represents an error rate of 2.2%.
Stream Speciation	The facility has used composition data from on-line analyzers, laboratory tests, design data, and process simulation to determine applicability of streams to LDAR regulations. The speciation data appears to be of appropriate accuracy for applicability determination and speciation of emissions.
Assessment of the Monitoring Program	**SOPs**: The facility has no written SOPs for LDAR, but interviews were conducted to determine the adequacy of procedures. The procedures were found to be good. **Evaluation of Contractor**: The facility has a single contractor employee dedicated to LDAR, and several summer students are hired to help complete the larger body of annual monitoring. No deficiencies were noted in contractor procedures reviewed, but the marginal agreement of comparative monitoring raises some questions. **Field Assessment**: Tagging is legible, and logically routed. No open-ended lines were found without control. Sampling system flushing control appears to be well designed and maintained. **Comparative Monitoring**: The audit monitoring produced higher leak rates than the historical leak rates reported by the site. The differences for the Polypropylene unit are not statistically significant, but those for the Polyethylene Treater areas appear to be statistically significant.
Benchmarking Leak Rates	Historical leak rates reported for the facility appear somewhat low, generally in the 0.5% to 1% range for all VOC service. Although BRPO handles many volatile components, it also processes a number of less volatile compounds. Leak rates on HRVOC components around the Ethylene Treaters were found to range from 4% to 5%, which is equal to or higher than reported leak rates from other similar facilities.
Summary of LDAR Performance	Although 110 missing components were identified, monitoring of identified components appears to be complete. Leak repair appears to be done effectively, with only 39 components on delay of repair at the time of the audit. No missed repair deadlines were found.

URS conducted a third-party audit of the ExxonMobil Baton Rouge Polyolefins Plant (BRPO). This audit was part of an Administrative Order agreement between the Louisiana Department of Environmental Quality and ExxonMobil. The audit began on March 30, 2005, and will close with the issuance of the final audit findings report.

The URS team included one engineer and a master technician:

- Graham "Buzz" Harris – applicability, speciation, SOPs, record-keeping/reporting, field evaluation of tagged components, and observation of site technician calibration;

- David Ranum – comparative monitoring, evaluation of contractor monitoring, and field evaluation of tagged components.

The audit focused on Polypropylene I Unit and the Polyethylene F and G Treaters - areas of the facility that process highly reactive volatile organic compounds (HRVOC). In accordance with the Administrative Order agreement, the audit's scope included:

- Component identification;
- Stream speciation;
- Assessment of the monitoring program:
  - Procedures
  - Evaluation of contractor
  - Field assessment of tagging, open-ended lines, sample systems
  - Comparative monitoring;
- Benchmarking leak rates versus other similar facilities; and
- Summary of LDAR program performance.

Based on URS experience in other LDAR audits, it is difficult for any LDAR program to achieve perfect compliance. This in-depth audit discovered only two findings, which are presented in Table 2-1.

Table 2-1
Findings

Finding No.	Priority[1]	Regulatory Citation	Unit	Findings
A	2	LAC33:III.2122	Polypropylene Ethylene Treaters	A total of 110 components were found without tags that appear to have been overlooked from the LDAR inventory. This represents an error rate of 2.2% based on inspecting nearly 5000 components.

[1] *See Table 2-2 for definition of priority levels used in this table.*

Table 2-2
Definitions of Priority Levels

Priority	Missed Monitoring	Repair Problems	OEL Uncontrolled	Sampling Systems w/o Flushing Control	Monitoring Errors	Recordkeeping Problems
1	Thousands of components	Missed 15-day on hundreds or 5-day on thousands of components	Hundreds of components	Tens of sampling systems	Major Systematic	-
2	Hundreds of components	Missed 15-day on tens or 5-day on hundreds of components	Tens of components	Multiple sampling systems	Major Sporadic	Major Systematic
3	Tens of components	Missed 15-day on individual or 5-day on tens of components	Individual components	Individual sampling systems	Minor Systematic	Major Sporadic
4	Individual components	Missed 5-day on individual components	-	-	Minor Sporadic	Minor Systematic
5	-	-	-	-	-	Minor Sporadic

Note: Priority levels are based on potential impact to emissions and/or impact to compliance assurance.

2.1 STATISTICAL ASSESSMENT OF MONITORED COMPONENTS

HRVOC compounds are present in most operating areas at BRPO. The audit did a comprehensive evaluation of the Polypropylene I and Polyethylene F & G Treaters areas of the plant. Special attention was placed on areas between units, such as pipe racks, flare drums, and auxiliary processing. A total of 110 applicable components appear to have been overlooked by the program, or about 2.2% of the components inspected. The average facility that we have audited has about 1.1% of components overlooked. Only a very few components were noted with missing tags, all of which were verified to be in the LDAR database.

2.2 STREAM SPECIATION

BRPO has gathered stream chemical species data from a variety of sources, including:

- On-line analyzers;
- Routine and special laboratory analyses;
- Design data; and
- Process simulation data/engineering analyses.

The audit reviewed these speciation data and found them to be appropriately detailed and accurate for applicability determinations and for emissions speciation.

2.3 ASSESSMENT OF MONITORING PROGRAM

The monitoring program was evaluated based on standard operating procedures (SOPs), contractor procedures, field assessment of tagging, and comparative monitoring. The following subsections discuss the results in each of these areas.

2.3.1 Standard Operating Procedures

BRPO has not developed written SOPs for the LDAR program. This works for the facility because the LDAR program is small with essentially no turnover, so verbal communication of procedures has functioned adequately. Interviews were conducted with Frank Bains, Manager of

Environmental Affairs with responsibility for LDAR, and with the lead technician for the LDAR contractor. All personnel were found to have a good understanding of the LDAR rule requirements. The LDAR personnel (including the contractor) are tightly integrated into the facility operations. The LDAR contractor is able to perform both first attempts and advanced maintenance on components found leaking. This greatly reduces the number of maintenance work orders that must be written and tracked. While the procedures are less formal than many other facilities, they appear to be well understood and implemented effectively.

2.3.2 Evaluation of Contractor

The LDAR contractor at BRPO has been at the site for many years. There is a single contractor employee dedicated to LDAR, plus several summer students are hired to help complete the large annual monitoring load. The contractor's calibration and monitoring procedures were observed during the audit. The calibration was done in accordance with EPA Method 21 specifications, and in accordance with the analyzer manufacturer's instructions. The technician was observed to check the correct areas for leakage on a variety of component types and displayed a pace and level of care consistent with generating quality monitoring data.

2.3.3 *Field Assessment*

The audit included a field assessment of tagging, control of open-ended lines (OEL), and control of flushing emissions from sampling systems. The areas covered and the accuracy of component identification have already been covered in section 2.1. The tags were observed to be easy to spot, with legible tag numbers. Relatively few tags were missing.

OEL control was evaluated in those same areas, and no OELs were found without adequate control. Control of OELs is very difficult for many facilities, so this result is unusual and excellent.

Sample systems were inspected for control of emissions related to flushing. Most sampling is done using online analyzers, which vent into sample recovery and/or flare headers. Sample systems were found to be well designed and in good condition.

2.3.4 Comparative Monitoring Results

The comparative monitoring resulted in only fair agreement between the audit team's monitoring results and the historical results obtained by the site LDAR team. Table 2-3 and Figure 2-1 present the results of the audit comparative monitoring for Polypropylene I and the Ethylene Treaters versus the site LDAR team monitoring data for 1st quarter 2004 through 4th quarter 2004.

The leak frequencies for both the audit comparative monitoring and the current site LDAR program are determined at a leak definition of 1000 ppm for valves. This leak definition is set by LAC Rule 2122.

As shown in Figure 2-1 and Table 2-3, the audit team's comparative monitoring leak rates are higher than the site's historical average leak rate for the Polypropylene I Unit and considerably higher for the F & G Treaters. Statistical analyses were performed by URS staff to see if there was a significant difference between the audit team's monitoring data and the site LDAR team's historical monitoring data. One statistical approach used is to calculate the 95% confidence intervals around the audit team monitoring data. The Chi-Square test is also run to check whether the site data and audit data could reasonably be considered to be drawn from a consistent data set.

Comparative monitoring in the Polypropylene I Unit produced a 1.6% leak rate (4 leaks found out of 257 valves monitored). Historically (over the previous two years), the site has reported an average leak rate of 0.43% for this unit. The 95% confidence interval around the audit data ranges between 0.4% to 3.9%, while the site's historical leak rate ranges between 0.1% to 0.89%. There is a fair degree of overlap between the lower confidence interval of the audit data and the average/upper range of the site's historical leak rate. The Chi-Squared result of 5% for the Polyproprene I Unit, however, indicates only a marginal degree of agreement between these two data sets (i.e. there is only a 5% probability that the audit leak data and the site's historical leak data are describing the same population). For the F and G Treaters the disparity between site historical leak rate and the audit leak rate is greater. The site's historical average leak rate for this area is 4.5% and ranges from 4.0% to 5.0%. The audit's comparative monitoring resulted in a 10.4% leak rate (21 leaks found out of 201 valves monitored) with a 95% confidence interval ranging from 6.6% to 15.5%. Accordingly the Chi-Squared statistics show only a small probability (1.0%) that the two leak rates are comparable.

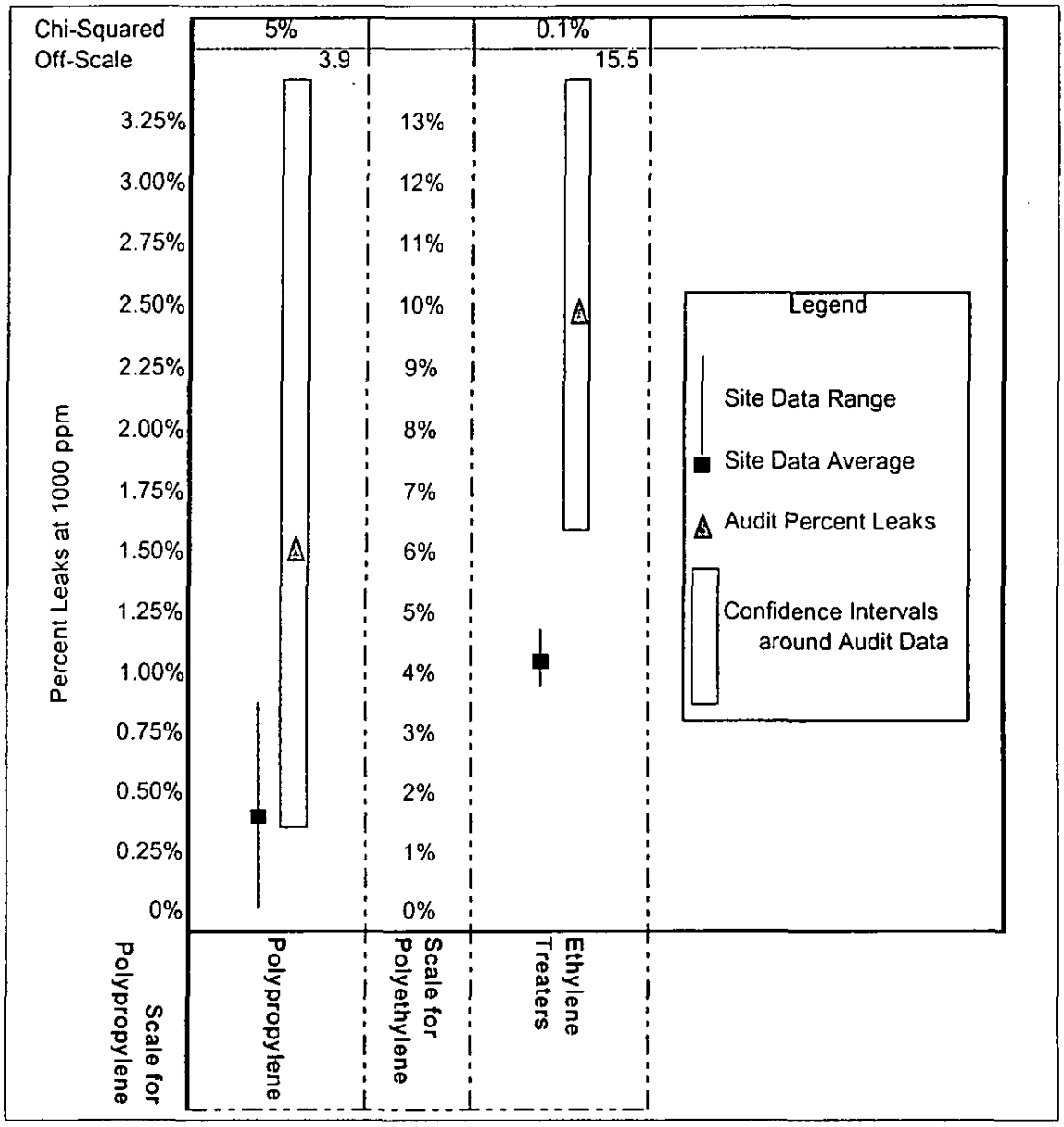
Table 2-3
Summary of Comparative Monitoring Results at 1000 ppm

Process	Site Historical Data[b]				URS Comparative Monitoring Results				
	Avg. % Leak @ 1000 ppm	Max. % Leak @ 1000 ppm	Min. % Leak @ 1000 ppm	Total Numbers	# Monitored	# Leak @1000 ppm	% Leak [a]	95% Conf. Interval on % Leak [a]	X^2 % Prob.
Polypropylene I	0.43%	0.89%	0.10%	1012	257	4	***1.56%***	0.4% to 3.9%	5.0%
F & G Treaters	4.5%	5.0%	4.0%	200	201	21	***10.45%***	6.6% to 15.5%	1.0%
Totals for Selected Units				1212	502	7			
Totals for Entire Facility				12212					
Percent of All Facility Valves Monitored					3.8%				
Weighted Averages	2.5%						6.0%		

a. Figures in ***Bold Italics*** indicate a higher leak rate by the audit team than reported by the facility or a facility leak rate not within the audit team confidence interval.

b. Site historical data covers the range 2002 throug 2004. The maximum and minimum leak percents are the highest and lowest annual values reported over that period.

Figure 2-1
Comparative Monitoring Chart at 1000 ppm



2.4 BEST PRACTICES

Many aspects of the LDAR program at BRPO are excellent and some are representative of industry best practices. This section highlights two best practices: additional component monitoring and open-ended line control.

BRPO voluntarily monitors the plugs and caps used to control open-ended line emissions. Although there is no requirement that these components be monitored, plugs and caps are often a source of leaks. BRPO also voluntarily monitors connectors. These additional monitoring practices are commendable. They cannot fail but to have a positive environmental effect since they catch significant leaks that would likely go unrepaired.

Out of a population of nearly 1000 potential open-ended lines surveyed, only 1 was found without a cap, plug, blind or double-block. This is an outstanding result and places BRPO in the top quartile among 50+ refineries and chemical plants ranked according to their success in open-ended line control.. The facility's practice of routinely using chains to keep plugs handy has contributed to their success in this area.

2.5 SUMMARY OF LDAR PERFORMANCE

110 missing components were found during the audit. A review of records for 2004 indicates that monitoring of components is complete. Leak repair appears to be effective, with only 39 components on delay of repair at the time of the audit. Difficult to monitor components appear to represent an average percentage compared to other facilities.

One objective of this audit was to evaluate the overall "health" of the LDAR program. The LDAR program at BRPO was found to be in reasonable health. The program is anchored with well-trained and motivated personnel who are monitoring the required components and a large number of extra components as well. Communications are relatively simple and effective for this small program. Tagging is in fair shape. Records show that the consolidated LDAR rule is well understood and that compliance has been achieved for the 2004 records reviewed in depth. There are, however, two areas of concern: the relatively high number of components found in the two units surveyed, to be missing from the LDAR program and the disparity in the comparative monitoring results.

The audit included two primary elements: a compliance audit and comparative monitoring. A description of the methodology used by URS for each of these elements follows.

3.1 COMPLIANCE AUDIT

URS performed a check of the leak detection and repair (LDAR) program against the requirements of applicable regulations. The primary areas audited were:

- Louisiana Rule 2122;
- Louisiana Fugitive Emissions Consolidation; and
- EPA Reference Method 21.

Detailed data reviews were done on the units selected for comparative monitoring. Computerized reviews of the monitoring data were done to demonstrate monitoring completion, repair deadline compliance, and to check for monitoring pace and other anomalies.

The compliance audit also included interviews with key staff involved in the LDAR program. At BRPO, the interviews included the LDAR Coordinator and the contractor monitoring supervisor/ technician.

The compliance audit also included observation of the LDAR technician. Observations were made of the technician performing instrument warm-up, analyzer maintenance, calibration, monitoring, and repair attempts.

The compliance audit also included an evaluation of component identification and field condition issues. Component identification checks were done in the field, looking for untagged components and trying to determine if they should have been tagged. During this effort, the condition of open-ended line control and sample station flushing control was also evaluated.

The findings related to non-compliance with regulatory requirements were prioritized. The basis for the prioritization scheme was to assign the highest priority to findings that have the potential to result in the greatest increase in emissions. Table 2-2 presents the definitions of the priority levels.

3.2 COMPARATIVE MONITORING

The URS team made independent Method 21 measurements on selected units in the facility. The Polypropylene 1 Unit and the Polyethylene F and G Treater areas were selected because of their large concentration of HRVOC components.

The comparative monitoring team utilized their own analyzers (Thermo Environmental HVM680) and certified calibration gases. The instruments were put through the Method 21 performance certification tests before the monitoring began. Multi-point calibrations were done daily using 0, 500, and 9,500 ppm methane in air calibration gases. Drift checks were performed using the 500-ppm standard throughout the day.

The valves within each selected process unit were selected for monitoring on a random basis within areas where HRVOC streams were present. The URS inspector monitored accessible valves in selected areas with HRVOC. No difficult-to-monitor or unsafe-to-monitor components were tested, although a representative sample of elevated components that could be monitored from fixed platforms reachable by stairs or ladders were monitored.

A representative of the facility and the site LDAR crew accompanied the comparative monitoring crew during all monitoring. All leaks found in the audit were verified by the site technician, entered into the database, and tagged for repair.

95% confidence intervals were calculated for the percentage of leaking valves for each process unit. The purpose of these confidence intervals is to estimate the range in which the actual leak rate for valves should fall, based on the fact that the comparative monitoring tested only a sub-sample of components for only a single point in time.

The formula for the confidence interval is from "Statistical Intervals: A Guide for Practitioners" by GJ Hahn and WQ Meeker. In the formula, 'n' represents the number of valves monitored, 'x' represents the number of leaking valves, and F is the F Statistic, whose components are the level of confidence for each bound, degrees of freedom 1, and degrees of freedom 2.

To summarize the leak rates for all the monitored processes, the average of these rates was calculated, and a confidence interval was estimated for this average. The confidence interval for this average was based on a normal confidence interval. A normal confidence interval is

calculated by the following equation: $\bar{x} \pm t_{\alpha/2,n-1}\frac{s}{\sqrt{n}}$, where $\bar{x}$ is the estimated sample mean, n is the number of leak rates, $t_{\alpha/2,n-1}$ is the 97.5th percentile (so that 95% confidence is achieved with both bounds) from the Student-t distribution with $n-1$ degrees of freedom, and s is the estimated standard deviation for the leak rates.

The confidence intervals are based on an assumption that the data are normally distributed. An additional statistical test called the Chi-Square has been done using non-parametric inferential statistics. We used the X^2 (chi-square) test for two independent samples (Cochran, W. G., *The X^2 Test of Goodness of Fit*, Annals of Mathematical Statistics, 23, 1952, pages 315-345.) to determine whether it was reasonable to assume that the historical site monitoring data and the comparative monitoring audit data were drawn from the same underlying distribution. For each test, a 2 by 2 contingency table was constructed as shown:

	Leaking	Not Leaking	
Plant Data	A	B	A + B
Comparative Data	C	D	C + D
Totals	A + C	B + D	N

where A, B, C, and D are the counts of observations in each cell. The chi-square statistic was computed as:

$$X^2 = \frac{N\left(\left|AD - BC\right| - N/2\right)^2}{(A+B)(C+D)(A+C)(B+D)}$$

This formula incorporates a correction (Siegel, S. and N. Castellan, *Nonparametric Statistics for the Behavioral Sciences*, Second edition, New York, McGraw-Hill, 1988.) to account for the fact that the variables are discrete rather than continuous. If the probability of X^2 greater than or equal to the observed value was less than 5 percent (df = 1), the ratios of leaking to non-leaking components for the plant data and comparative data were deemed to be significantly different.

GLOSSARY

AVO	Audio, Visual, or Olfactory (sensory leak detection)
CFR	Code of Federal Regulations
DOR	Delay of repair
DTM	Difficult-to-monitor
EPA	Environmental Protection Agency (see USEPA)
HAP	Hazardous Air Pollutant
HON	Hazardous Organic NESHAP
HVM-680	Thermo Environmental HVM-680 instrument used for monitoring
LDAR	Leak Detection and Repair
LDEQ	Louisiana Department of Environmental Quality
MACT	Maximum Achievable Control Technology
MOC	Management of Change
NEIC	EPA National Enforcement Investigation Center
NESHAP	National Emissions Standard for Hazardous Air Pollutants
NSPS	New Source Performance Standards
OEL	Open ended line
QA/QC	Quality Assurance/Quality Control
SOP	Standard Operating Procedure
URS	URS Corporation
USEPA	United States Environmental Protection Agency
UTM	Unsafe-to-monitor
VOC	Volatile Organic Compounds

APPENDIX B

Compliance Consultants, Inc.
LDAR Audit

LEAK DETECTION AND REPAIR (LDAR) MONITORING AUDIT
EXXONMOBIL CHEMICAL COMPANY
BATON ROUGE POLYOLEFINS PLANT
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APPENDIX – MONITORING REPORT

1.0 INTRODUCTION

Compliance Consultants, Inc. (CCI) conducted a third-party monitoring audit of the leak detection and repair (LDAR) program at the ExxonMobil Baton Rouge Polyolefins Plant (BRPO). This audit was conducted to determine the typical leak detection rate an experienced technician would find during the Method 21 monitoring of components at the facility. The audit was performed in response to an Administrative Order agreement between the Louisiana Department of Environmental Quality (LDEQ) and ExxonMobil. The audit was conducted on May 11, 2005.

2.0 QUALIFICATIONS

Master technician, Allen Starns, conducted the CCI monitoring audit. Allen Starns has over twenty years of experience in Method 21 monitoring for LDAR compliance; the past eight years have been with CCI where Allen has provided complete LDAR monitoring services for a local refinery and a hazardous waste facility. During the last five years, Allen's monitoring techniques have been evaluated and approved by EPA and the LDEQ four times. Three of the events were conducted in conjunction with multimedia inspections by both the Federal and/or State agencies, where State and/or Federal Inspectors monitored in parallel with Allen to verify capabilities.

3.0 METHODOLOGY

Method 21 monitoring was conducted at the BRPO facility using techniques acceptable to regulatory agencies and typical to industry standards used to comply with LDAR regulations. The monitoring audit focused on areas of the facility that process highly reactive volatile organic compounds (HRVOC). These areas included the AB and C Treaters and the D and E Treaters. A total of 180 components were monitored according to Method 21.

The leak frequencies for the audit comparative monitoring and the current site LDAR program are determined at a leak definition of 1000 ppm for valves. This leak definition is set by LAC Rule 2122.

CCI used their own Foxboro Flame Ionization Detector (TVA 1000B) and certified calibration gases. The instruments were put through the Method 21 performance certification tests before the monitoring began. Multi-point calibrations were done daily using 0, 500, and 9,500 ppm methane in air calibration gases. Drift checks were performed using the 500-ppm standard throughout the day.

The valves within each selected process unit were selected for monitoring on a random basis within areas where HRVOC streams were present. The CCI inspector monitored accessible valves in selected areas with HRVOC. No difficult-to-monitor or unsafe-to-monitor components were tested, although a representative sample of elevated components that could be monitored from fixed platforms reachable by stairs or ladders were monitored.

A representative of the facility and the site LDAR crew accompanied the comparative monitoring crew during all monitoring. All leaks found in the audit were verified by the site technician, entered into the database, and tagged for repair. Repair monitoring was conducted by BRPO personnel and supplied to CCI for inclusion in this report.

4.0 RESULTS

The complete results of the monitoring conducted by CCI are presented in the Monitoring Report in the Appendix. The leak rate determined from this monitoring event is 1.66 % (three leakers in 180 components monitored).

5.0 CONCLUSIONS

The leak rate determined during the CCI monitoring audit is within the expected low to normal range for LDAR programs. The historical leak rates reported for BRPO treaters is in the range of 4 to 5 percent, whereas the facility's overall historical leak rate is generally in the 0.5% to 1% range for all VOC service.

APPENDIX

LDAR MONITORING REPORT

All Regulations

Percent Leaker Report

Monitor Run ID: 0505

Area: ALL Sub Area: ALL

Equip Type	Chemical State	Total Monitored	Total Left to Monitor	Percent Monitored	Number of Leaks	Percent Leaking	Delay of Repair	Leak Def. (ppm)
PV	Vapor	180	0	100.00%	3	1.66%	0	1000
	TOTALS	180	0	100.00%	3	1.66%	0	

All Regulations

Percent Leaker Report

Monitor Run ID: 0505

Area: ABC TRTR Sub Area: ALL

Equip Type	Chemical State	Total Monitored	Total Left to Monitor	Percent Monitored	Number of Leaks	Percent Leaking	Delay of Repair	Leak Def. (ppm)
PV	Vapor	65	0	100.00%	0	0.00%	0	1000
	TOTALS	65	0	100.00%	0	0.00%	0	

All Regulations

Percent Leaker Report

Monitor Run ID: 0505

Area: D&E TRTR Sub Area: ALL

Equip Type	Chemical State	Total Monitored	Total Left to Monitor	Percent Monitored	Number of Leaks	Percent Leaking	Delay of Repair	Leak Def. (ppm)
PV	Vapor	115	0	100.00%	3	2.60%	0	1000
	TOTALS	115	0	100.00%	3	2.60%	0	

LEAK REPORT

Monitor Run ID: 0505

All Regulations

Area: ALL Sub Area: ALL

Area	Sub Area	Tag ID	Source	Size	Monitor Date	Reading (ppm)	Leak Def. (ppm)	Repair Attempt	Repair Method	Date Repaired	Repair Delay
D&E TRTR	F-2501 B	34526	PV	0.000	05/11/1905	1,600	1,000				No
					05/13/1905	30	1,000	05/13/2005	TIGHT	05/13/2005	No
	V-2505 B	2626	PV	0.000	05/11/1905	7,400	1,000				No
					05/13/1905	50	1,000	05/13/2005	TIGHT	05/13/2005	No
	V-2517 A	41798	PV	0.000	05/11/1905	3,663	1,000				No
					05/13/1905	20	1,000	05/13/2005	TIGHT	05/13/2005	No

Area ABC TRTR

ExxonMobil Chemical Co. BRPO
Recordkeeping Log
May 2005

Sub Area	Tag ID	Equip Type	Opr. ID	Inst. ID	Monitor Date	Monitor Results (ppm)	BKGD (ppm)	Process Stream	V/L/H
V-2250C	1094	PV	ASTARNS	17192941	05/11/1905	135	0		V
V-2250C	1096	PV	ASTARNS	17192941	05/11/1905	50	0		V
V-2250C	1100	PV	ASTARNS	17192941	05/11/1905	22	0		V
V-2250C	1101	PV	ASTARNS	17192941	05/11/1905	34	0		V
V-2250C	1103	PV	ASTARNS	17192941	05/11/1905	4	0		V
V-2250C	1104	PV	ASTARNS	17192941	05/11/1905	16	0		V
V-2250C	1105	PV	ASTARNS	17192941	05/11/1905	3	0		V
V-2250C	1110	PV	ASTARNS	17192941	05/11/1905	7	0		V
V-2250C	1112	PV	ASTARNS	17192941	05/11/1905	11	0		V
V-2250C	1114	PV	ASTARNS	17192941	05/11/1905	3	0		V
V-2250C	1117	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2250C	1118	PV	ASTARNS	17192941	05/11/1905	4	0		V
V-2250C	1119	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2250C	1120	PV	ASTARNS	17192941	05/11/1905	440	0		V
V-2250C	1121	PV	ASTARNS	17192941	05/11/1905	240	0		V
V-2250C	1122	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2250C	1123	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2250C	1124	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2250C	1127	PV	ASTARNS	17192941	05/11/1905	3	0		V
V-2250C	1129	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2250C	1130	PV	ASTARNS	17192941	05/11/1905	4	0		V
V-2250C	1133	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2250C	1142	PV	ASTARNS	17192941	05/11/1905	5	0		V
V-2250C	1144	PV	ASTARNS	17192941	05/11/1905	6	0		V
V-2250C	1145	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2250C	20545	PV	ASTARNS	17192941	05/11/1905	9	0		V
V-2250C	24216	PV	ASTARNS	17192941	05/11/1905	4	0		V
V-2250C	33245	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2250C	33247	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2250C	33249	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2250C	35512	PV	ASTARNS	17192941	05/11/1905	5	0		V
V-2250C	35514	PV	ASTARNS	17192941	05/11/1905	7	0		V
V-2250C	35515	PV	ASTARNS	17192941	05/11/1905	98	0		V
V-2250C	35517	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2250C	35519	PV	ASTARNS	17192941	05/11/1905	5	0		V
V-2250C	35521	PV	ASTARNS	17192941	05/11/1905	22	0		V
V-2250C	35522	PV	ASTARNS	17192941	05/11/1905	18	0		V
V-2250C	35525	PV	ASTARNS	17192941	05/11/1905	22	0		V
V-2250C	35527	PV	ASTARNS	17192941	05/11/1905	35	0		V
V-2250C	35529	PV	ASTARNS	17192941	05/11/1905	7	0		V
V-2250C	35531	PV	ASTARNS	17192941	05/11/1905	4	0		V

Area ABC TRTR

ExxonMobil Chemical Co. BRPO
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May 2005

Sub Area	Tag ID	Equip Type	Opr. ID	Inst. ID	Monitor Date	Monitor Results (ppm)	BKGD (ppm)	Process Stream	V/L/H
V-2250C	35533	PV	ASTARNS	17192941	05/11/1905	5	0		V
V-2250C	35545	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2250C	9775	PV	ASTARNS	17192941	05/11/1905	10	0		V
V-2250D	1055	PV	ASTARNS	17192941	05/11/1905	130	0		V
V-2250D	1057	PV	ASTARNS	17192941	05/11/1905	73	0		V
V-2250D	1059	PV	ASTARNS	17192941	05/11/1905	40	0		V
V-2250D	1060	PV	ASTARNS	17192941	05/11/1905	406	0		V
V-2250D	1061	PV	ASTARNS	17192941	05/11/1905	80	0		V
V-2250D	1062	PV	ASTARNS	17192941	05/11/1905	11	0		V
V-2250D	1063	PV	ASTARNS	17192941	05/11/1905	43	0		V
V-2250D	1064	PV	ASTARNS	17192941	05/11/1905	5	0		V
V-2250D	1066	PV	ASTARNS	17192941	05/11/1905	52	0		V
V-2250D	1068	PV	ASTARNS	17192941	05/11/1905	53	0		V
V-2250D	1070	PV	ASTARNS	17192941	05/11/1905	9	0		V
V-2250D	1072	PV	ASTARNS	17192941	05/11/1905	33	0		V
V-2250D	1073	PV	ASTARNS	17192941	05/11/1905	52	0		V
V-2250D	1074	PV	ASTARNS	17192941	05/11/1905	38	0		V
V-2250D	1078	PV	ASTARNS	17192941	05/11/1905	15	0		V
V-2250D	1079	PV	ASTARNS	17192941	05/11/1905	50	0		V
V-2250D	1080	PV	ASTARNS	17192941	05/11/1905	13	0		V
V-2250D	1081	PV	ASTARNS	17192941	05/11/1905	4	0		V
V-2250D	1083	PV	ASTARNS	17192941	05/11/1905	44	0		V
V-2250D	1085	PV	ASTARNS	17192941	05/11/1905	17	0		V
V-2250D	1087	PV	ASTARNS	17192941	05/11/1905	22	0		V
F-2501 B	34517	PV	ASTARNS	17192941	05/11/1905	33	0		V
F-2501 B	34519	PV	ASTARNS	17192941	05/11/1905	4	0		V
F-2501 B	34521	PV	ASTARNS	17192941	05/11/1905	4	0		V
F-2501 B	34524	PV	ASTARNS	17192941	05/11/1905	2	0		V
F-2501 B	34526	PV	JPRESTRID	20268	05/13/1905	30	0		V
F-2501 B	34526	PV	ASTARNS	17192941	05/11/1905	1600	0		V
F-2501 B	34529	PV	ASTARNS	17192941	05/11/1905	3	0		V
F-2501 B	34531	PV	ASTARNS	17192941	05/11/1905	3	0		V
F-2501 B	34533	PV	ASTARNS	17192941	05/11/1905	1	0		V
F-2501 B	34537	PV	ASTARNS	17192941	05/11/1905	1	0		V
F-2501 B	no tag	PV	ASTARNS	17192941	05/11/1905	3	0		V
V-2505 A	10488	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2505 A	20690	PV	ASTARNS	17192941	05/11/1905	10	0		V
V-2505 A	20691	PV	ASTARNS	17192941	05/11/1905	271	0		V
V-2505 A	20692	PV	ASTARNS	17192941	05/11/1905	5	0		V
V-2505 A	20693	PV	ASTARNS	17192941	05/11/1905	61	0		V
V-2505 A	20694	PV	ASTARNS	17192941	05/11/1905	15	0		V

Area D&E TRTR

ExxonMobil Chemical Co. BRPO
Recordkeeping Log
May 2005

Sub Area	Tag ID	Equip Type	Opr. ID	Inst. ID	Monitor Date	Monitor Results (ppm)	BKGD (ppm)	Process Stream	V/L/H
V-2505 A	2658	PV	ASTARNS	17192941	05/11/1905	16	0		V
V-2505 A	2659	PV	ASTARNS	17192941	05/11/1905	10	0		V
V-2505 A	2660	PV	ASTARNS	17192941	05/11/1905	7	0		V
V-2505 A	2662	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2505 A	2664	PV	ASTARNS	17192941	05/11/1905	114	0		V
V-2505 A	2665	PV	ASTARNS	17192941	05/11/1905	39	0		V
V-2505 A	2666	PV	ASTARNS	17192941	05/11/1905	23	0		V
V-2505 A	2667	PV	ASTARNS	17192941	05/11/1905	5	0		V
V-2505 A	2668	PV	ASTARNS	17192941	05/11/1905	15	0		V
V-2505 A	2670	PV	ASTARNS	17192941	05/11/1905	117	0		V
V-2505 A	2682	PV	ASTARNS	17192941	05/11/1905	5	0		V
V-2505 A	2684	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2505 A	2686	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2505 A	2687	PV	ASTARNS	17192941	05/11/1905	5	0		V
V-2505 A	2688	PV	ASTARNS	17192941	05/11/1905	11	0		V
V-2505 A	2690	PV	ASTARNS	17192941	05/11/1905	4	0		V
V-2505 A	2691	PV	ASTARNS	17192941	05/11/1905	29	0		V
V-2505 A	2693	PV	ASTARNS	17192941	05/11/1905	3	0		V
V-2505 A	30748	PV	ASTARNS	17192941	05/11/1905	198	0		V
V-2505 A	30750	PV	ASTARNS	17192941	05/11/1905	6	0		V
V-2505 B	10485	PV	ASTARNS	17192941	05/11/1905	3	0		V
V-2505 B	19105	PV	ASTARNS	17192941	05/11/1905	230	0		V
V-2505 B	20687	PV	ASTARNS	17192941	05/11/1905	12	0		V
V-2505 B	20688	PV	ASTARNS	17192941	05/11/1905	3	0		V
V-2505 B	2623	PV	ASTARNS	17192941	05/11/1905	3	0		V
V-2505 B	2624	PV	ASTARNS	17192941	05/11/1905	13	0		V
V-2505 B	2625	PV	ASTARNS	17192941	05/11/1905	7	0		V
V-2505 B	2626	PV	JPRESTRID	20268	05/13/1905	50	0		V
V-2505 B	2626	PV	ASTARNS	17192941	05/11/1905	7400	0		V
V-2505 B	2628	PV	ASTARNS	17192941	05/11/1905	18	0		V
V-2505 B	2629	PV	ASTARNS	17192941	05/11/1905	580	0		V
V-2505 B	2635	PV	ASTARNS	17192941	05/11/1905	55	0		V
V-2505 B	2636	PV	ASTARNS	17192941	05/11/1905	86	0		V
V-2505 B	2639	PV	ASTARNS	17192941	05/11/1905	5	0		V
V-2505 B	2640	PV	ASTARNS	17192941	05/11/1905	72	0		V
V-2505 B	2643	PV	ASTARNS	17192941	05/11/1905	19	0		V
V-2505 B	2644	PV	ASTARNS	17192941	05/11/1905	15	0		V
V-2505 B	2645	PV	ASTARNS	17192941	05/11/1905	6	0		V
V-2505 B	2646	PV	ASTARNS	17192941	05/11/1905	12	0		V
V-2505 B	2648	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2505 B	2650	PV	ASTARNS	17192941	05/11/1905	2	0		V

Area D&E TRTR

ExxonMobil Chemical Co. BRPO
Recordkeeping Log
May 2005

Sub Area	Tag ID	Equip Type	Opr. ID	Inst. ID	Monitor Date	Monitor Results (ppm)	BKGD (ppm)	Process Stream	V/L/H
V-2505 B	2651	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2505 B	30747	PV	ASTARNS	17192941	05/11/1905	470	0		V
V-2505 B	30752	PV	ASTARNS	17192941	05/11/1905	10	0		V
V-2505 B	30753	PV	ASTARNS	17192941	05/11/1905	6	0		V
V-2505 B	32048	PV	ASTARNS	17192941	05/11/1905	13	0		V
V-2505 B	41110	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2505 B	41111	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2517 A	10478	PV	ASTARNS	17192941	05/11/1905	8	0		V
V-2517 A	10481	PV	ASTARNS	17192941	05/11/1905	6	0		V
V-2517 A	2596	PV	ASTARNS	17192941	05/11/1905	250	0		V
V-2517 A	2597	PV	ASTARNS	17192941	05/11/1905	45	0		V
V-2517 A	2599	PV	ASTARNS	17192941	05/11/1905	37	0		V
V-2517 A	2600	PV	ASTARNS	17192941	05/11/1905	540	0		V
V-2517 A	2602	PV	ASTARNS	17192941	05/11/1905	16	0		V
V-2517 A	2603	PV	ASTARNS	17192941	05/11/1905	124	0		V
V-2517 A	2604	PV	ASTARNS	17192941	05/11/1905	4	0		V
V-2517 A	33358	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2517 A	33359	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2517 A	33361	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2517 A	33362	PV	ASTARNS	17192941	05/11/1905	4	0		V
V-2517 A	34168	PV	ASTARNS	17192941	05/11/1905	8	0		V
V-2517 A	34169	PV	ASTARNS	17192941	05/11/1905	42	0		V
V-2517 A	34170	PV	ASTARNS	17192941	05/11/1905	40	0		V
V-2517 A	34171	PV	ASTARNS	17192941	05/11/1905	110	0		V
V-2517 A	34176	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2517 A	34177	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2517 A	34178	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2517 A	34184	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2517 A	34185	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2517 A	34186	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2517 A	34187	PV	ASTARNS	17192941	05/11/1905	15	0		V
V-2517 A	35282	PV	ASTARNS	17192941	05/11/1905	90	0		V
V-2517 A	35283	PV	ASTARNS	17192941	05/11/1905	114	0		V
V-2517 A	41798	PV	ASTARNS	17192941	05/11/1905	3663	0		V
V-2517 A	41798	PV	JPRESTRID	20268	05/13/1905	20	0		V
V-2517 B	10472	PV	ASTARNS	17192941	05/11/1905	11	0		V
V-2517 B	10475	PV	ASTARNS	17192941	05/11/1905	15	0		V
V-2517 B	20685	PV	ASTARNS	17192941	05/11/1905	3	0		V
V-2517 B	25102	PV	ASTARNS	17192941	05/11/1905	6	0		V
V-2517 B	2532	PV	ASTARNS	17192941	05/11/1905	220	0		V
V-2517 B	2535	PV	ASTARNS	17192941	05/11/1905	800	0		V

Area D&E TRTR

ExxonMobil Chemical Co. BRPO
Recordkeeping Log
May 2005

Sub Area	Tag ID	Equip Type	Opr. ID	Inst. ID	Monitor Date	Monitor Results (ppm)	BKGD (ppm)	Process Stream	V/L/H
V-2517 B	2562	PV	ASTARNS	17192941	05/11/1905	230	0		V
V-2517 B	2563	PV	ASTARNS	17192941	05/11/1905	159	0		V
V-2517 B	2564	PV	ASTARNS	17192941	05/11/1905	4	0		V
V-2517 B	2565	PV	ASTARNS	17192941	05/11/1905	6	0		V
V-2517 B	2572	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2517 B	2573	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2517 B	2575	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2517 B	33350	PV	ASTARNS	17192941	05/11/1905	25	0		V
V-2517 B	33351	PV	ASTARNS	17192941	05/11/1905	11	0		V
V-2517 B	33353	PV	ASTARNS	17192941	05/11/1905	104	0		V
V-2517 B	33354	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2517 B	34153	PV	ASTARNS	17192941	05/11/1905	730	0		V
V-2517 B	34155	PV	ASTARNS	17192941	05/11/1905	3	0		V
V-2517 B	34157	PV	ASTARNS	17192941	05/11/1905	2	0		V
V-2517 B	34161	PV	ASTARNS	17192941	05/11/1905	1	0		V
V-2517 B	34162	PV	ASTARNS	17192941	05/11/1905	120	0		V
V-2517 B	34165	PV	ASTARNS	17192941	05/11/1905	16	0		V
V-2517 B	34167	PV	ASTARNS	17192941	05/11/1905	30	0		V
V-2517 B	7755	PV	ASTARNS	17192941	05/11/1905	21	0		V

APPENDIX C

METHOD 21 STUDY

Special Fugitive Emission Survey

4/12/05

No.	Area	Tag No.	Description	Two Times Response time (Six Seconds)	60 Seconds	90 Seconds
1.	A/B	33225	Eth. Treater	20	35	35
2.	A/B	7030	"	30	100	200
3.	A/B	7019	"	60	100	100
4.	A/B	33222	"	20	20	25
5.	D/E	10472	"	200	500	600
6.	D/E	34153	"	200	300	500
7.	D/E	2552	"	500	*1,200*	*1,800*
8.	D/E	34167	"	30	50	50
9.	D/E	2563	"	20	50	80
10.	D/E	25102	"	50	500	*3,000*
11.	D/E	34177	"	50	70	100
12.	D/E	2599	"	30	50	150
13.	D/E	2600	"	500	500	*1,500*
14.	D/E	2604	"	50	70	100
15.	D/E	41798	"	300	500	*1,000*
16.	D/E	2629	Hex. Treater	50	80	150
17.	D/E	19105	"	100	200	400
18.	D/E	2338	Isob. Treater	100	300	700
19.	D/E	2344	"	50	70	200
20.	D/E	2346	"	150	150	300
21.	D/E	2347	"	150	500	*4,000*
22.	D/E	7114	"	50	150	300
23.	D/E	42064	"	30	40	60
24.	D/E	9391	"	50	300	500
25.	C	9391	Eth. Treater	40	40	50
26.	C	1118	"	ND	ND	ND
27.	C	1120	"	ND	ND	ND
28.	C	1110	"	ND	ND	ND
29.	C	1112	"	ND	ND	ND
30.	C	1114	"	ND	ND	ND
31.	C	24216	"	30	30	30
32.	C	1101	"	ND	ND	ND
33.	C	1100	"	ND	ND	ND
34.	C	20545	"	20	30	30
35.	C	1105	"	ND	ND	ND
36.	C	1104	"	ND	ND	ND
37.	C	9775	"	ND	ND	ND
38.	C	1098	"	20	20	20
39.	C	1083	"	ND	ND	ND

Special Fugitive Emission Survey

4/12/05

No.	Area	Tag No.	Description	Two Times Response time (Six Seconds)	60 Seconds	90 Seconds
40.	C	1085	Eth. Treater	ND	ND	ND
41.	C	1087	"	10	10	10
42.	C	1078	"	ND	ND	ND
43.	C	1079	"	ND	ND	ND
44.	C	1073	"	ND	ND	ND
45.	C	1074	"	10	10	10
46.	C	1081	"	ND	ND	ND
47.	C	1066	"	ND	ND	ND
48.	C	1068	"	20	20	50
49.	C	1070	"	ND	ND	ND
50.	C	1064	"	ND	ND	ND
51.	C	1063	"	20	20	20
52.	C	1052	"	ND	ND	ND
53.	C	1060	"	ND	ND	ND
54.	G	5145	"	30	50	60
55.	G	30871	"	100	100	100
56.	G	5140	"	ND	ND	ND
57.	G	30872	"	100	150	300
58.	G	5142	"	50	50	50
59.	G	11183	"	ND	ND	ND
60.	G	30873	"	10	10	10
61.	G	5177	"	10	10	10
62.	G	30874	"	15	15	15
63.	G	5133	"	100	300	300
64.	G	41729	"	15	15	15
65.	G	5190	"	10	10	10
66.	G	30887	"	ND	ND	ND
67.	G	11188	"	ND	ND	ND
68.	G	11186	"	10	10	10
69.	G	5355	Hex. Treater	60	100	250
70.	G	5356	"	10	10	10
71.	G	5175*	Eth. Treater	30	30	30
72.	G	5149*	"	200	1,500	1,500
73.	G	30903	Hex. Treater	ND	ND	ND
74.	G	5208	Isob. Treater	30	100	300
75.	G	30912	"	ND	ND	ND

Appendix A – Environmental Audits

ExxonMobil Refinery

BRRF

Shaw Project No. 115121-01
RTPLA Project No. 2005-007-001
June 2005

HRVOC Audit Report

ExxonMobil Refining and Supply Company Baton Rouge Refinery (BRRF)

Prepared for:

ExxonMobil Refining and Supply Company
Baton Rouge Refinery
4045 Scenic Highway
Baton Rouge, Louisiana

Prepared by:

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Baton Rouge, Louisiana 70809

RTP Environmental Associates, Inc.
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Kenner, Louisiana 70065

HRVOC AUDIT REPORT

ExxonMobil Refining and Supply Company
Baton Rouge Refinery (BRRF)

Shaw Project No. 115121-01
RTPLA Project No. 2005-007-001
June 2005

Prepared for:

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HRVOC AUDIT REPORT

Shaw Project No. 115121-01
RTPLA Project No. 2005-007-001

June 2005

Prepared for:

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Executive Summary

Pursuant to an Administrative Order issued by the Louisiana Department of Environmental Quality (LDEQ) on October 6, 2004, Exxon Mobil Corporation's (ExxonMobil) Baton Rouge Refinery (BRRF) was required to conduct a comprehensive environmental audit of the facility's operations for the purposes of documenting all potential sources of releases of highly reactive volatile organic compounds (HRVOC). To accomplish this objective, ExxonMobil commissioned a third-party systems audit by recognized environmental professionals. In selecting the audit team, ExxonMobil sought to identify recognized individual environmental professionals, rather than companies, and sought individuals who had no prior work experience related to BRRF. The audit team was charged to verify that all potential sources of emissions have been identified and accounted for, and to confirm that calculation techniques employed reflect the most appropriate and accurate methodologies for the respective emission sources. To this end, the audit team reviewed pertinent air permits, permit applications, process descriptions, process flow diagrams (PFDs), piping and instrumentation diagrams (P&IDs) and conducted interviews with BRRF environmental staff to gain an understanding of the processes and emission sources in place at the BRRF.

The audit team conducted site visits to BRRF several times during April 2005. An overview of the refinery processes was provided and discussions were held regarding the various emissions units, their potential to emit HRVOC, and the manner in which the emissions were calculated from both a permitting and an actual basis perspective. Representative samplings of calculations were checked to verify the calculation methodology.

The process utilized by BRRF to identify emission sources is very thorough. A comprehensive survey was conducted in the early 1990s as an outgrowth of SARA reporting requirements and the Louisiana Air Toxics regulations to ensure that all sources of air emissions had been identified. During the preparation of its initial Part 70 permit applications in the mid-1990s, these surveys were repeated and no major changes were noted. Many of the same personnel who were involved in these surveys were involved in additional surveys that were performed following the HRVOC rule to ensure that all sources of HRVOC emissions had been identified.

The audit team conducted a "systems audit", focusing on assuring that proper practices and procedures were in place to identify potential emission sources and accurately account for emissions from these sources. Therefore, while the audit did not confirm that all sources of

HRVOC have been identified by ExxonMobil and that all calculation techniques reflect the most appropriate and accurate methodologies, the audit did seek to ascertain if the practices and procedures employed by ExxonMobil were rigorous and appropriate. A qualitative assessment scale was used to judge each individual area as well as the system as a whole. The following is a table of classifications used.

Rating	Meaning
★★★★★	Meets industry standard , *no improvements identified*
★★★★	Meets industry standard, *only minor improvements needed*
★★★	Meets industry standard, *improvements needed*
★★	Improvements needed to meet industry standard
★	Below industry standard, major improvements needed

From the standpoint of the identification of sources of HRVOC emissions, the audit team concluded that it is highly probable that ExxonMobil has identified all such sources. From the standpoint of evaluating calculation methodologies and techniques, the audit team assessed an overall evaluation of ★★★★- Meets industry standard, *only minor improvements needed.* Information on the assessment of individual areas is provided in more detail in the body of the report.

1.0 Introduction

1.1 Objective and Purpose

Pursuant to an Administrative Order issued by the Louisiana Department of Environmental Quality (LDEQ) on October 6, 2004, ExxonMobil Corporation's (ExxonMobil) Baton Rouge Refinery (BRRF) was required to conduct a comprehensive environmental audit of the facility's operations for the purposes of documenting all potential sources of releases of highly reactive volatile organic compounds (HRVOC) and to perform testing of certain specified emissions sources. Since ExxonMobil believed that its in-house air permitting and emission reporting efforts were thorough and accurate, and they were required to comply with the Administrative Order, ExxonMobil commissioned a third-party systems audit by recognized environmental professionals. In selecting the audit team, ExxonMobil sought to identify recognized individual environmental professionals, rather than companies, and sought individuals who had no prior work experience related to the BRRF.

1.2 Audit Team Compostion

The audit team was composed of Mr. Gerald Brouillette, P.E. of Shaw Environmental & Infrastructure (Shaw) and Mr. William Palermo, P.E. of RTP Environmental Associates, Inc. (RTP). Mr. Brouillette is a Senior Project Manager with Shaw's Baton Rouge, Louisiana office and is a Louisiana Registered Professional Engineer. Mr. Brouillette has worked as an environmental engineer and manager in the petrochemical industry in Louisiana for over 14 years, and has worked as an environmental consultant for an additional three years. His industrial work background provides an excellent insight into plant operations, and he has extensive experience in developing and employing emission calculations for both permitting and reporting purposes. Mr. Palermo is a Principal of RTP and is Manager of RTP's Louisiana office. Mr. Palermo is a Louisiana Registered Professional Engineer and he has been employed in Louisiana as an environmental consultant in excess of 30 years. He has a comprehensive knowledge of Louisiana air permitting processes and requirements and with the procedures for identifying and quantifying sources of air emissions.

1.3 Methodology

The audit team reviewed pertinent air permits, permit applications, process descriptions, process flow diagrams (PFDs), and piping and instrumentation diagrams (P&IDs) to gain an understanding of the processes and emission sources in place at the various units within BRRF. Emphasis was placed on those sources that had the potential to emit any of the seven identified HRVOCs (ethylene, propylene, 1,3-butadiene, butenes and isomers, acetaldehyde, toluene, and xylene and isomers). Following this review, the team met with knowledgeable personnel from

the various BRRF units to review the processes that were in place for identifying emissions sources and emissions, including emergency releases, and the quantification of emissions from both a permitting basis and from the standpoint of reporting actual emissions on an annual and ongoing basis. Calculation procedures were evaluated with emphasis being placed on those emissions sources that had the greatest potential to emit HRVOC and those for which multiple possible quantification techniques were possible. A representative sampling of calculation methodologies was also performed.

1.4 Assessment

ExxonMobil requested a "systems audit" focused on assuring that proper practices and procedures were in place to identify potential emission sources and accurately account for emissions from these sources. Therefore, the audit itself did not include detailed plant walkthroughs, drawing review, and/or plant personnel interview to ensure all potential emission sources had been identified. Neither did the audit involve a thorough review of all emission calculations for each emission source. Thus, while the audit did not confirm that all sources of HRVOC have been identified by ExxonMobil and that all calculation techniques reflect the most appropriate and accurate methodologies, the audit did seek to ascertain if the practices and procedures employed by ExxonMobil were rigorous and appropriate. Accordingly, the audit team, with the agreement of ExxonMobil, embarked upon a subjective assessment of the extent to which ExxonMobil had identified and quantified all sources of HRVOC. Two different subjective methodologies were employed. A qualitative assessment scale was used to judge each individual area as well as the system as a whole. The following is a table of classifications used:

Rating	Meaning
★★★★★	Meets industry standard, *no improvements identified*
★★★★	Meets industry standard, *only minor improvements needed*
★★★	Meets industry standard, *improvements needed*
★★	Improvements needed to meet industry standard
★	Below industry standard, major improvements needed

2.0 Methodology

2.1 Approach

The audit team's task was to conduct a system's review of how ExxonMobil identifies and quantifies its emission sources of HRVOCs. ExxonMobil believes that its air permitting and emission reporting efforts are thorough and that it utilizes the most current information, emission factors, and other best practices in its permitting and compliance programs, consequently ExxonMobil sought the assistance of consultants to provide third party verification of the approaches that are currently in place at each facility. To this end, the audit team conducted a thorough review of ExxonMobil's approach in identifying and quantifying sources of HRVOC and representative spot checks of actual calculations and reports.

The audit team conducted a project kickoff meeting on March 9, 2005, at which representatives of each of the four ExxonMobil facilities were present and the manner in which the audit(s) would be conducted was defined and an audit schedule was developed. An initial needs list was provided to ExxonMobil identifying the types of information that would be reviewed prior to the respective site visit. The needs list information included items such as process descriptions, existing permits, permit applications, process flow diagrams, and supporting emission calculations methodology not included in the application(s).

The audit team conducted several site visits to BRRF during April, 2005. An overview of the processes was provided and discussions were held regarding the various emissions units, their potential to emit HRVOC, and the manner in which the emissions were calculated from both a permitting and an actual basis perspective.

2.2 Resources

Various resources were utilized to conduct the audit. Process flow diagrams for the different processes were reviewed to confirm the identification of potential sources of emissions. Facility permits and applications were reviewed to ensure proper assessment of all emission points including insignificant activities and "General Condition XVII" items. Emission calculation basis were discussed with knowledgeable plant personnel and spot checks were conducted to confirm the methodology employed was consistent with the generally accepted hierarchal approach for emission basis and regulatory requirements. The generally accepted hierarchy for calculating emissions is presented below:

Hierarchal Order	Calculation Basis	Examples
1	Direct Measurement	Emissions Monitoring, Stack Testing, Stream Sampling
2	Emission Factors/Studies	AP-42, Tanks 4.09, Water 9, ToxChem, API studies, etc.
3	Material Balances	Inlets minus Outlets, Materials Used, etc.
4	Manufacturers Specifications & Guarantees	
5	Engineering Judgment	

In assessing the calculation methodology employed by ExxonMobil, the calculation hierarchy was considered. Additionally, where vendor information for pollution control equipment (flares, thermal oxidizers) was part of the emission calculation basis, this information/documentation was reviewed and discussed.

2.3 Interviews

The audit team conducted interviews of the BRRF facility environmental staff personnel responsible for refinery operations. Mr. Robert Berg and Ms. Diane Leche were able to provide an in-depth review of the actions employed by BRRF to identify emission sources and quantify those sources. Detailed interviews were held with Mr. Tom Morrill (who is primarily responsible for calculating emissions from storage tanks and vessels) to review the processes employed in determining emissions from tanks, and with Ms. Meredith Moe to discuss secondary wastewater emission quantification. Additionally, Mr. Mark Hofmeyer and Ms. Angela Folse provided insight into how ExxonMobil quantifies emergency release volumes. Information on how changes to the process that may add or otherwise change an emission source was provided as well as how non-permitted activities (i.e. emergency releases) are addressed.

3.0 Findings

3.1 Background

BRRF is a fully integrated petroleum refinery processing both foreign and domestic crude into various petroleum products. The refinery has several operating areas, which include: Pipestills, Catalytic Crackers, Hydroprocessing, Reformer, Light Ends (including MTBE), Cokers, Alkylation, Sulfur Recovery, Specialties (Lube Extraction, Ketone Dewaxing, Wax Hydrofining, Lube Hydrofining, and the Specialties Tank Farm), Low Sulfur Mogas, Light Oils Finishing and Blending, Water Clarification and Docks.

Pipestills:

The Pipestills Complex consists of four distillation units (PSLA-7,8,9,10), which fractionate crude oil or rerun oil into various intermediate product streams. Each distillation unit has a preflash tower, an atmospheric tower and a vacuum tower. Feed to the unit is desalted, preheated, and split into various streams before routing to other units for further processing.

Catalytic Crackers:

The Catalytic Cracking Complex consists of two fluid catalytic cracking facilities that operate in parallel (PCLA-2, PCLA-3). The primary function of the complex is to crack feed stock into molecules suitable for use as motor gasoline and diesel blending components. The complex has two furnaces to heat feed prior to entering the reactor. During the cracking process carbon deposits build-up on the catalyst and are burned off in the regenerator. Each regenerator's flue-gas is combusted in its associated CO furnace. The off-gases from both CO furnaces are scrubbed by a wet gas scrubber to remove sulfur dioxide and solid particulates before release to the atmosphere.

Hydroprocessing:

The Hydroprocessing Complex consists of Hydrocracking (HCLA) and Hydrofining (HHLA-N, S and E). The Hydrocracker area cracks heavy petroleum stocks using catalyst and hydrogen. The Hydrofining area consists of multiple trains (HHLA-N, S, and E) which remove sulfur and nitrogen compounds from Jet and Diesel blend stocks by a hydrogenation process using catalyst and hydrogen.

Reformer:

The Reformer Complex consists of feed preparation (T-30 and T-31), feed hydrofining (RHLA-2), reforming (PHLA-2), and pentane splitting (T-210).

The naphtha fed to the reforming section is first processed through feed preparation section, which fractionates the naphtha into components. The lighter components are sent to lights ends to be further fractionated, and the heavier components are sent to the light oil finishing unit to produce jet fuel. The components between the light and heavy cuts are sent to a hydrofining section, which removes sulfur and nitrogen in the presence of a catalyst and hydrogen. The hydrofined stream then flows through a series of furnace/reactor sets where the reforming process occurs in the presence of a catalyst. The reformate leaving the reformer is stripped of its lighter molecules in a stabilizer tower. The lighter molecules from the stabilizer tower are sent to light ends and the remaining reformate is used as a motor gasoline blending component. The pentane splitting section separates a pentane stream into normal pentane and iso-pentane, and these two products are routed to the chemical plant.

Low Sulfur Mogas:

Low Sulfur Mogas is additional hydrotreating and caustic treating capacity to lower the sulfur content of mogas. Mogas primarily consists of naphthas with different boiling points. After production by upstream units, fractionators separate the blendstocks, which are then treated to reduce sulfur content. Treated streams are virgin naphtha, light-light cat naphtha (LLCN), intermediate cat naphtha (ICN), and heavy cat naphtha (HCN). The unit includes an LCN splitter, several hydrofiners for naphtha streams, a Selective Hydrogenation Unit, and a Caustic Treating and Regen Units. A flare is included to handle emergency relief.

Light Ends:

The Light Ends Complex consists of various facilities including Cat Light Ends, Virgin Light Ends, Refinery Gas Compression, Benzene and Sour Water Stripping, MEA Regeneration, Alkylation, and MTBE.

The Cat and Virgin Light Ends section handles distillate and gas streams from other refinery units. The Light Ends fractionation section consists of 1, 2,3,4,5 and 6 LEU. These units separate raw streams into narrow fractions such as fuel gas, mogas blending components, Alky feed, or use at the adjacent ExxonMobil Chemical Plant. Treating with MEA and caustic is performed on some streams to remove H2S and Mercaptans. The Monoethanolamine (MEA) Regeneration section rejuvenates an amine solution used throughout the refinery to treat various streams for H2S removal. The regenerated amine is recycled to various refinery treaters. H2S-laden gas from there juvenated solution is delivered to the Sulfur Complex for processing.

The MTBE unit serves two purposes: as feed preparation for the Alkylation unit and to create MTBE (Methyl Tertiary Butyl Ether). Methanol reacts with isobutylene to form MTBE which is directly blended into motor gasoline to enhance its oxygen content.

The Alkylation process combines butylenes and amylene with isobutane in the presence of sulfuric acid to produce alkylate, a high-octane motor gasoline blending component. The reaction is exothermic and requires the use of a refrigeration system to obtain the optimal low operating temperatures. The fractionation section consists of several distillation towers used to separate various components of the reactor product.

The Refinery Gas Compression (RGCU) section recovers light hydrocarbon gases from low pressure gas collection and yard gas. It compresses the gas and delivers the resulting gas and distillate streams to the Light Ends fractionation section for further processing.

The Benzene Stripping section removes benzene from various refinery wastewater streams with the use of refinery fuel gas. The product gas goes to the fuel system and the benzene-free water continues to waste water. The Sour Water Stripper strips ammonia and H2S from various refinery water streams. The overhead gas from this system is fed to the Sulfur Complex.

Cokers:

The Coker Complex consists of three interconnected facilities (West, East, and Far East) that use a delayed coking process to thermally crack feed stocks into coke, jet/diesel, and light ends. The Coker Plant processes heavy residual feed stocks from the Pipestills Complex and other sources. The process uses several furnaces, a fractionation tower, and several Coke Drums.

Specialties:

The Specialties Units consists of Lube Extraction (LELA), Ketone Dewaxing (KDLA), Wax Hydrofining (WHLA), Lube Hydrofining (LHLA) facilities and the Specialties Tank Farm. The Lube Extraction facility processes various feed stocks to produce a paraffinic raffinate product. The Ketone Dewaxing facility separates wax and oil from lube oil feed stocks. The Wax Hydrofining facility improves the color and removes sulfur from wax. The Lube Hydrofining facility improves the color, odor, sulfur content, or a combination of properties for certain products. The Specialties Tank Farm includes fixed roof tanks used in storing materials associated with lube manufacturing.

Light Oils Finishing and Blending:

The Light Oils Finishing Unit (LOFU) is a product finishing unit that treats motor gasoline components, kerosene, diesel, and other middle distillates. These products are treated to remove unwanted compounds, improve color, and remove entrained free water. A variety of processing steps are involved which include: caustic treating, acid treating, water washing, filtering, and drying.

Blending mixes various component streams to make on test finished products. The finished products include motor gasoline, aviation gasoline, jet fuel, diesel, and several other products.

Sulfur Recovery:

The acid gas (H2S laden) from the MEA regenerators and the ammonia acid gas from the sour water strippers are converted to elemental sulfur and an environmentally acceptable off gas at the Sulfur Plant (SRLA). H2S is converted to molten sulfur in three Claus process units (SRLA-100/200/400), employing reaction furnaces and a series of catalytic reactors. The SRLA Complex tail gas is then routed to the Tail Gas Clean-Up Unit (TGCU) for removal of additional sulfur compounds.

At the TGCU, two processing sections are used: the Hydrogenation section and the Amine sections. The Hydrogenation section (Beavon Unit) takes the SRLA tail gas and converts the remaining sulfur compounds (primarily SO2, CS2, and COS) to H2S and CO2. The tail gas then leaves the Hydrogenation section and enters the Amine section for H2S removal via a circulating amine solution (Flexsorb). The cleaned tail gas leaving the Amine section can be emitted directly to the atmosphere (at T-301 vent), or to the incinerators (F-101/F-201).

The amine solution containing the absorbed hydrogen sulfide from the tail gas stream is heated and sent to the Amine Regenerator tower. The amine solution is heated to remove the hydrogen sulfide, thus regenerating the amine solution for re-use.

Occasionally, the refinery diverts tail gas from the SRLA 100 and 200 units to the incinerators bypassing the TGCU. The refinery requests a variance from the DEQ when this need arises.

Water Clarification:

The WCLA unit treats wastewater from the refinery. The first stage of the WCLA unit is the oil/water separators (Tanks 21 and 22). Wastewater from these tanks, the central process sewers (CPS and 12-inch line), and the first rainwater surface impoundment flow through the pre-treatment section, including aggressive biological treatment (ABT). After secondary treatment in BIOX, the water is discharged. The solids from both ABT clarifiers and the BIOX clarifers are thickened and dewatered the ABT solids are sent to the coker while the BIOX solids are dried and sent for offsite disposal. Vapors are controlled via carbon canister, with negligible emissions to the atmosphere.

Docks

The Docks are used to load and unload a variety of products such as crude oil, middle distillates, motor gasoline, and jet fuel. In addition to refinery streams, the dock facility can also transfer

feed and products to/from ExxonMobil Chemicals located north of the refinery. The Docks are a steel and concrete pier-type structure consisting of berths which can accommodate ships or barges. All berths are equipped with both loading clusters for transfer through cargo hoses and marine loading arms. Marine Vapor Recovery (MVR) uses an enclosed air-assisted ground flare, which is backed up by an elevated air-assisted flare.

3.2 Emission Sources

The process utilized by BRRF to identify emission sources is very thorough. A comprehensive survey was conducted in the early 1990s as an outgrowth of SARA reporting requirements and the Louisiana Air Toxics regulations to ensure that all sources of air emissions had been identified. During the preparation of its initial Part 70 permit applications in the mid-1990s, these surveys were repeated and no major changes were noted. Many of the same personnel who were involved in these surveys were involved in additional surveys that were performed following the HRVOC rule to ensure that all sources of HRVOC emissions had been identified. Potential sources of emissions to the atmosphere are tightly controlled with most being vented to the Refinery Gas Compression Unit for recovery as product or routing to the fuel system. BRRF environmental personnel conducted interviews with operations and maintenance personnel to address potential Insignificant Activity items as well as GC-17 issues. Additionally, the management of change process is very strong. The Environmental Department reviews all capital projects and all maintenance except replacement in kind, not to include replacement of emissions units. Essentially, all expenditures in excess of $5,000 are reviewed.

The primary source of HRVOC emissions from BRRF from the units reviewed were emissions from accidental releases (36 tons of HRVOC reported from the selected units in 2004). The second highest source of HRVOC emissions are from cooling towers (9 tons of HRVOC), followed by fugitives (9 tons), and then combustion sources (6 tons).

The BRRF has a very comprehensive Environmental Reporting Guidelines and Procedures Manual, which outlines the roles and responsibilities pertaining to Environmental Spills and Releases. In general, the Refinery Superintendents are responsible for determining if a release has occurred, notifying the Environmental Section, and in some cases making the initial notifications to various agencies. Specifically, if the Refinery Superintendents are unable to inform a member of the Environmental Section of a release within the first 30 minutes after the release is discovered, the Refinery Superintendent must made the initial call to the State Police Hotline. He then contacts a member of the Environmental Section to relay the details of the release and to pass on the responsibility of all additional agency notifications. The Environmental Section is then responsible for making any other required notifications to the various agencies, as well as any follow-up calls to the State Police Hotline.

Detailed in the tables below is a listing of the different emission sources, a description of how the permitted and actual emissions are determined, comments and recommendations regarding the calculations, and a qualitative grade for the calculation methodology employed. The following types of emission points were identified associated with the BRRF processes:

Flares,
Fugitive Emissions,
Accidental Releases,
Cooling Towers,
Secondary Wastewater Emissions,
Process Vents,
General Condition-17/ Insignificant Activity,
Combustion Sources, and
Storage Tanks.

3.3 Emission Calculations

Source Description	Flares (11) (<1 tons of HRVOC in 2004)
Contributors	Dock Flare (enclosed air-assisted, ground flare) – Marine Loading vents. Dock Flare (air-assisted, elevated) – Marine Loading vents backup. RGCU (Refinery Gas Collection Unit) Flares – This flare system acts as a backup collection system when the RGCU is overloaded. There are eight flares associated with this system. Receives hydrocarbon vapors that flow through safety valves, flare release valves, or pulldowns during unit upsets or emergencies. What is not recovered in the RGCU system is vented to the flare for control. Additionally, process safety valves are tied to the header in some cases to protect equipment during periods of unexpected overpressure situations. North Tank Field Flare. There is one additional flare that serves to contain PRV releases from spheres storing isopentane. This flare is used to protect the spheres from overpressure.
Permit Methodology	The dock flares are capped together for permitting purposes and are permitted based on EPA AP-42 factors for projected maximum throughput for loading/unloading operations. The flares are assumed to be 99.5% efficient in controlling emissions. For the RGCU flares, the unit is permitted for pilot gas only as the flares do not receive any routine vents. The flares will receive material from safety valves and flare release valves when the RGCU cannot handle the entire flow. These events are accidental releases, and the emissions are accounted for in the discussion on accidental releases. The North Tank Field flare provides control for isopentane spheres. This flare is permitted for pilot gas only, as the flare only receives vents from the spheres during an accidental release from the sphere.
Actual Methodology	For the dock flares, actual loading quantities are used with the appropriate AP-42 factor for the subject chemical, and then 99.5% control efficiency is applied for the flare. For the RGCU flares and the North Tank Field flare, the pilot gas operating for the full year is reported for actual annual emissions. Any accidental releases that are routed to the flare system are addressed in the section on accidental releases.
Comments/ Recommendations	BRRF has 11 flares, where eight of the flares are tied to the RGCU recovery system. The recovery system compressor continually operates to recover hydrocarbons that are then reused or used as a fuel in the Refinery Mixing Manifold (RMM) system to feed fired equipment in the

	refinery process. Excluding the dock flares, the remaining flares are equipped with steam assist to aide in combustion. The flares are equipped with multiple redundant pilots and conventional high pressure steam control valves for steam injection. The pilots are monitored via multiple redundant thermocouples to ensure that pilots remain online and ready to ignite any hydrocarbons flowing up the flare stack. Any flaring that occurs is monitored via remote video/infrared cameras to monitor smoking flares (video) and to control steam addition (infrared) to the flares. For the dock flares, the primary dock flare is an enclosed ground flare that is air assisted to ensure proper combustion of the materials. With the unit being enclosed, it allows for a more controlled burn to achieve better efficiency with the assistance of a two stage air blower system. The backup dock flare is also air-assisted to optimize the combustion of materials. BRRF has undertaken a strong effort to fully define the flare system operations and to upgrade the systems to achieve optimal operation. BRRF has worked with flare manufactures to ensure the flares are operated correctly. BRRF has ensured that flare operations will consistently meet the NSPS requirements of 300 btu/scf. A 99.5% destruction efficiency has been applied by BRRF to the flare system based on the control systems in place and discussions with flare tip vendors. The 99.5% destruction efficiency for the flare is considered to be reasonably conservative for the following reasons: 1) the computer controlled system is an advanced system that ensures optimal steam addition to the flare tip – not too much that it dampens the efficiency of the flare and not too little so that proper mixing and turbulence is lacking; and 2) a review of EPA's Flare Efficiency Study, July 1983, confirms that with proper operation of a flare, destruction efficiencies in excess of 99.5% would be expected for a properly functioning flare gas system that is controlling HRVOCs.
Evaluation: ★★★★★ - Meets industry standard , *no Improvements identified*	BRRF utilizes EPA studies and factors (2) (Flare Efficiency study, AP-42 factor for loading/unloading operations), along with vendor supplied information (4) (Flare performance) to quantify these emissions. The methods employed are determined to meet industry standards.

Source Description	Fugitives (9 tons HRVOC in 2004)
Contributors	• Valves • Connectors • Compressors • Pumps • Process analyzers • Loading/ unloading operations
Permit Methodology	BRRF uses historical maximum measured leak rate information with the component count for the facility to define the potential to emit from fugitives. Stream speciation is based on process knowledge for the individual streams with component counts defined by stream type. BRRF uses the EPA correlation equations along with the historical data and component counts for permitting purposes.
Actual Methodology	To define actual emissions, BRRF takes the EPA correlation equations and applies the actual fugitive monitoring results from that year to the equations to determine the reported number. Speciation is based on design process stream composition.
Comments/ Recommendations	EPA identifies a hierarchy to estimate fugitive emissions. The method employed by BRRF is the most stringent method short of conducting bagging studies. For most conventional facilities, this is the recommended method to define fugitive emissions.
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRRF utilizes EPA correlation emission factors (2) and applies direct measurement data (1) to the factors. The manner to define actual emissions from this activity meets industry standards with no improvements identified.

Source Description	GC-17 / Insignificant Activities (<1 tons HRVOC in 2004)
Contributors	• Sampling • Tank Servicing • Opening of equipment • Equipment maintenance • Chemical Cleaning • Turnaround Activities • Catalyst dust from reactor preparation • Additive chemicals • P/V and Safety Valve Servicing • Tote Bins • Truck Unloading • Tankcar Cleaning • Startup Emissions • Tank Vapor Recovery System Maintenance
Permit Methodology	BRRF conservatively quantified the frequency for the various activities, and based on this quantification, determined the volume available for release from each activity after accounting for proper operation and clearing of equipment based on procedures and work practices used at the facility. In some instances, BRRF used API published data to define emissions from certain maintenance activities. Speciation for emissions is based on process knowledge.
Actual Methodology	BRRF identified potential emissions per activity and works closely with operations personnel to define the frequency of actual events during the calendar year. If there is any uncertainty as to the frequency of a specific activity, a conservative number is selected. Once the frequency is defined, BRRF then multiplies the number of times that activity was undertaken during the year to the developed factor.
Comments/ Recommendations	BRRF employs appropriate means to determine emissions from these sources. Judicious effort is undertaken to identify the actual frequency of events, and potential emissions per event are conservative.
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRRF uses industry published studies (2) and material balances (3) to determine these emissions. Appropriate conservativeness is applied to these calculations; therefore, the manner to define actual emissions from this activity meets industry standards with no identified improvements needed.

Source Description	Emergency Releases (36 tons HRVOC in 2004)
Contributors	BRRF calculates quantities emitted from all releases of any significance, whether "Reportable Quantity" level is attained or not.
Permit Methodology	Not a permitted source.
Actual Methodology	The procedures employed by BRRF for emergency releases are appropriate for this type industry. When an event if identified (typically by a unit operator), the refinery superintendent is informed. The BRRF superintendent is an individual with significant experience within BRRF who has a firm understanding of the various types of releases and the importance of accurately estimating the quantity released. The BRRF superintendent is responsible for investigating the release, logging it, and determining an initial estimate of quantity and speciation of the release. Based on the superintendent's comfort level, plant engineers and management may be enlisted to aid in defining the quantity and speciation. Most releases from safety valves are piped to the RGCU unit or directly to the flare system where the material is "controlled" through the flare. Flares are assumed to be 99.5% efficient in destroying the HRVOC. Once quantified and speciated, a form is filled out with details on the nature of the release, cause, actions to prevent recurrence, as well as quantity and speciation. This form is provided to BRRF environmental staff personnel for review and documentation. If there are any concerns or questions, the issue is resolved with the appropriate management and operations personnel. The typical approach is to be conservative in the estimates of potential quantities released.
Comments/ Recommendations	BRRF has a written, well documented, procedure that appears to be strictly followed when any release occurs. The procedure is complete in that it requires investigation and quantification for releases of any significance, regardless of whether they are thought to be of "Reportable Quantity" or not. Employing personnel with extensive experience and knowledge of the respective processes in calculating emissions from releases is the best manner to follow since these personnel have intimate knowledge of the operations and the systems employed by BRRF.
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRRF uses engineering calculation and process knowledge (3) to determine emissions from emergency releases. Appropriate engineering data and assumptions are utilized; consequently, the methods used in this area meet industry standards with no improvements identified. The efficiency applied to the flares during an accidental release (99.5%) is considered reasonable for most releases.

Source Description	Secondary Wastewater Emissions (3 ton HRVOC in 2004)
Contributors	Water Containment – Process Sewer Lines, Tanks, Oil/Solids Recovery, Pretreatment, and Bio-oxidation
Permit Methodology	The entire wastewater system (Water Containment) is mapped to identify all junction boxes, tanks, sumps, and treatment components. Design wastewater flowrates are then combined with historical samples taken throughout the refinery and are used with the ToxChem software model to develop the permitting number for the wastewater treatment plant.. Predicted emissions are based on the model results utilizing design flowrates. Emissions from components of the collection system are estimated using EPA factors.
Actual Methodology	Actual emissions are based on sample results (collected weekly throughout the system) with actual flowrates. ToxChem model runs are conducted monthly taking the average flow and composition for the month. Annual emissions are determined by totaling the twelve monthly emission numbers.
Comments/ Recommendations	BRRF accounts for emissions from conventional sources related to wastewater systems. Speciation for emissions is based on weekly sampling of the various streams. Actual emissions are then calculated by use of the ToxChem model. The mechanism employed by BRRF is considered appropriate to define emissions from these type activities.
Evaluation: ★★★★★ - Meets industry standard, *no improvements needed*	BRRF utilizes a combination of direct measurement (1) and EPA models (2) to quantify these emissions. The methods used in this area meet industry standards with no improvements identified.

Source Description	Process Vents (<1 tons HRVOC in 2004)
Contributors	Regeneration Tower, Flexsorb Tower, Coke Drum Vents
Permit Methodology	Emissions from process vents are permitted based on engineering correlation developed from stack tests, CEMS readings, and process knowledge. Most process vents are "captured" in either the RGCU or the "High Pressure Burner Line" (HPBL) where the material is either recovered or used as a fuel within the facility. These vents include the Pipe Stills (Atmospheric and Vacuum Towers), Vent Gas Absorber, Tail Gas Vent, among others. Pipe Still vents are routed directly to the RGCU for recovery of the hydrocarbons. The Tail Gas Vent is normally routed to the Tail Gas compressor for recovery, however when the compressor is off-line, the vent stream is routed to the RGCU. The Vent Gas Absorber is located in the Hydrofiner section of the refinery. In this absorber, lean oil is used to scrub the vent stream from the Light Cat Naphtha (LCN) Splitter Tower to recover hydrocarbons. The offgas from the absorber is collected in "fuel gas drums" where the material is then fed as a fuel to refinery furnaces. Process vents to the atmosphere include the Catalytic Reformer Regeneration Vent, Sulfur Plant Tail Gas and Flexsorb Absorber, and Coke Drum Vents.. The Catalytic Reformer periodically regenerates reactors to restore catalytic activity. The regeneration process involves depressuring the reactor to rid the reactor of hydrocarbon vapors. This is accomplished by venting the reactor first to the high pressure gas collecting system (the Refinery fuel system), then to the RGCU and finally after the regeneration system has stabilized to 5 psi or less, to the atmosphere through an elevated vent stack. After the reactor being regenerated has been depressured, the carbon build up on the catalyst is begun. During this process, the regeneration system is vented through the D-8 Adsorbent Bed where any HCL emissions from the reactor carbon burn are captured. The Flexsorb Absorber is part of the Sulfur Recovery process. In this process sulfur is recovered and converted to H2S. Vents from this system are routed to the Flexsorb Absorber, where residual H2S is absorbed and recovered. Emissions from the absorber are routed to the "Flexsorb Tower" (T-301) to the atmosphere.. Emissions from the Flexsorb Tower are based on engineering design and contain essentially no HRVOC. Permit basis is based on maximum expected flow rate, with the unit meeting NSPS J controls. Emissions are essentially only H_2S, COS, and CS_2 Coke Drum vents primarily contain H_2S. Emissions from this unit are based on historical process knowledge and contain essentially no HRVOC.

Actual Methodology	Actual emissions are determined by applying the stack test generated emission factors or continuous emissions analyzer readings to on-stream time or flow rates.
Comments/ Recommendations	Essentially all process vents that contain HRVOC are captured and recovered or used as fuel through the RGCU or HPBL. There are effectively no emissions of HRVOC from process vents that vent directly to the atmosphere.
Evaluation: ★★★★★ - Meets industry standard, *no improvements needed.*	The inherent design of the refinery is to recover as much HRVOC as possible. For the process vents that emit directly to the atmosphere, BRRF uses analyzer data, historical stack test data (1) and engineering design (3) to determine emission. This emission calculation methodology is considered to meet industry standards.

Source Description	Cooling Towers (9 ton HRVOC in 2004)
Contributors	Cooling Towers within the Refinery
Permit Methodology	Cooling towers are permitted based on maximum recirculation rate and AP-42 factor for "controlled" cooling tower emissions. The speciation for the emissions is based on historical sample results for the respective process area. A safety factor is included in the permitted emission rate to account for any potential anomalies. Maximum emissions are based on AP-42 factors for uncontrolled emissions.
Actual Methodology	Actual emissions are based on AP-42 factors at the maximum recirculation rate with speciation for HRVOCs based on the composition of process streams observed from the routine sampling. The safety factor included in developing the permitted number is not applied at this point.
Comments/ Recommendations	Cooling tower emission information is based on EPA emission factors with a speciation based on historical sampling data. Cooling tower units are sampled bi-weekly for conductivity and TOC. From this sample data BRRF identifies any potential leaks in the system and implements repairs. This data has not been used to quantify emissions from cooling towers.
Evaluation: ★★★★★ - Meets industry standard, *no improvements needed*	BRRF utilizes EPA factors (2) based on actual recirculation flow rates to define emission rates. Samples are collected routinely to define when potential leaks occur, so emissions from cooling tower operations are considered "controlled". The manner to define actual emissions from this activity meets industry standards with no improvements identified.

Source Description	Storage Tanks (5 tons HRVOC in 2004)
Contributors	• East Area Tank Field • South Tank Field • Knox Field • Bluff • Anchorage
Permit Methodology	RE/EIS software (EPA TANKS 4.09 equivalent) software based on facility capacity throughput for each respective tank.
Actual Methodology	RE/EIS software using actual monthly throughputs for the various chemicals as provided by operations personnel. When conducting the EIS model runs, actual monthly or ambient temperatures are used and speciation is based on the mix of each tank with composition determined from extensive in-house sampling, verified against the PERF database set. A study was conducted by the Petroleum Environmental Research Firm (PERF) to define typical speciation of various hydrocarbon mixtures (gasoline, etc.) per Reid Vapor Pressure (RVP). Extensive sampling from numerous petroleum companies was conducted to support this study. BRRF utilizes the dataset developed by ExxonMobil for this study to define the speciation for the various materials stored in tanks.
Comments/ Recommendations	The BRRF has numerous storage tanks and the materials contained within specific tanks are subject to change throughout the year. A database is used to track each tank's throughput as well as contents. EIS is used to determine emissions from storage tank operations. Unit personnel review the data (material stored, throughput, temperature, etc.) prior to submitting the information to the environmental department for calculation. Calculations are conducted on a monthly basis and reviewed for discrepancies. A large number of BRRF storage tanks are equipped with floating roofs. Inspectors conduct routine inspections of the EFR and IFR seals per the regulatory requirements to ensure the floating roofs are operating properly. If a deficiency is noted, operations personnel are notified so that repair can be initiated. If a seal failure is observed, emissions are calculated assuming that the failure occurred the day it was discovered until the time repairs are complete. Adjustments are made to the emissions calculation based on the failure type. If a gasket is torn, it is assumed that the entire gasket is missing. If a seal is missing, an approximation of the area of the seal that is compromised is made and the calculation adjusted taking the missing seal into account. For fixed roof tanks that have vapor recovery systems there are no emissions to the atmosphere. For the tanks that breathe to the atmosphere, EIS is used taking into account actual fluid temperatures, throughput, and composition.

	Speciation for the various tanks is based on process knowledge and Reid Vapor Pressure (RVP) using the data from the PERF study. BRRF utilizes sound methodology, based on widely accepted practices, to determine emissions from storage tanks. However, it is recommended that when a deficiency is noted in the floating roof mechanism, that instead of assuming the failure occurred the day it was discovered, it is recommended that if there is no mechanism by which to determine when the failure occurred that it is assumed to have occurred at the mid-point between the inspection that identified the failure and the previous inspection. These sources have a minimal impact on the total amount of HRVOC emissions from the facility (<1%).
Evaluation: ★★★★ - Meets industry standard, *minor improvements identified*	BRRF uses an EPA model (2) to define emissions from these tanks. Appropriate data and tools are utilized; however, it is recommended the method to account for emissions from tank seal failures be adjusted. Otherwise, the methods used in this area meet industry standards.

Source Description	Combustion Sources (6 tons HRVOC in 2004)
Contributors	Furnaces, Boilers
Permit Methodology	HRVOCs are not speciated for permitting of refinery combustion sources since refinery fuel gas is a virgin fossil fuel and is exempt from Chapter 51 requirements.
Actual Methodology	Emission factors used for permitting purposes are multiplied by actual firing rate to determine annual reported emissions. Also exempt from Chapter 51 TEDI requirements, speciated VOCs are reported for SARA, using the speciated developed from the WSPA (Western States Petroleum Association study, Development of Toxic Emissions Factors for Petroleum Industry Combustion Sources, September 1997.
Comments/ Recommendations	Speciation only identifies toluene and xylene as HRVOC emitted. .The other HRVOCs are not anticipated to be emitted in any quantity due to the nature of these compounds.
Evaluation: ★★★★★ - Meets industry standard , *no improvements identified*	BRRF uses an industry developed factor (2) to define emissions from these type sources. Appropriate data and methodology are utilized; consequently, the methods used in this area meet industry standards with no improvements identified.

ExxonMobil
Refining and Supply Company
HRVOC Reported Emissions
For calendar Year 2004
(Pounds)

Title
Pounds 2004

Source	Ethylene	Propylene	1,3-butadiene	Butene (+isomers)	acetaldehyde	toluene	Xylene (+ isomers)	Total
Accidental Releases	31134	32363	65	6385		1535	317	71799
Cooling Towers	229	3778	30			5812	9073	18922
Fugitive Emissions	178	1435	219			11813	3637	17282
Combustion Sources		5619				5619	936	12174
GC-17/ Insignificant Activities	110	308	2			794	910	2124
Flares	1	41	1	7		1		51
Wastewater Emissions	72	1136	9			1675	2183	5075
Process Vents			487			136	128	751
Storage Tanks			49			6624	3739	10412
Total	31724	44680	862	6392	0	34009	20923	138590

4.0 Assessment

Based on the information reviewed and considered while conducting this audit, the audit team has concluded that BRRF has a high probability of identifying all potential sources of emissions. Furthermore, the audit team finds that the calculation methodologies employed and the practices and procedures followed by BRRF meet or surpass that generally found in the petrochemical industry. Accordingly, an overall evaluation of ★★★★ Meets industry standard, *only minor improvements needed* was assessed.

Appendix A – Environmental Audits

Placid Refining Company, L.L.C

HRVOC AUDIT OF PROCESS STREAMS AND FUGITIVE EMISSIONS AT PLACID REFINING COMPANY, LLC

For
PLACID REFINING COMPANY, LLC
PORT ALLEN, LOUISIANA

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June 2005

PLACID REFINING COMPANY, LLC HRVOC AUDIT

1.0 INTRODUCTION

Placid Refining Company, LLC (PRC) has entered into an agreement with the Louisiana of Environmental Quality (LDEQ) to address the Baton Rouge five parish area ozone non-attainment administrative order. PRC requested Compliance Consultants Inc's (CCI) assistance in conducting an HRVOC (Highly Reactive Volatile Organic Compound) audit of its facility. CCI assisted in the identification and quantification of potential HRVOCs in process streams and investigation of PRC'S potential fugitive emission sources and Leak Detection and Repair (LDAR) program.

2.0 PROCESS STREAM SAMPLING

PRC and CCI personnel inventoried PRC's product lines and developed a listing of all product streams. These streams are identified in **Table 1**. Where applicable the process streams were further categorized into product grades. These product grades and process streams were sampled for HRVOC content. The storage facilities checked for sampling are identified in **Table 1** with **bold, underscore typeface**. Only those system components in operation at the time of sampling were included.

Table 1 PRC PRODUCT LINE SAMPLING LOCATIONS

Group	Product Stream	Tank Numbers: Contents **(Sampled Tanks)**	Total Tanks
1	Crude Different Blends in use	**13**, 14, 15, 17, 23, **24**, **25**, 65, 66, 940	10
2	Diesel + Jet Fuel High Sulphur Diesel Low Sulphur Diesel Jet Fuel	F1, F2 , 5, 61, 64 **2**, **28**, **3**,	8
3	Gasoline Super Unleaded Regular Unleaded	6, 20, 60, 62, 63, 67 **19**, **22**,	8
4	Naptha	4, **11**, 12, 26	4
5	Reformate	**9**, 10	2
6	Light Cycle/ Gas Oil	**7**, **8**, 18	3
7	Alkylate	**16**	1
8	Crude Condensate	**27**	1
9	Toluene	**58**	1
10	Sour Water Olefins	 **T112**	1
11	LPG Propylene Propane IsoButane 92-94% Butane 85-89% Butane	T100, T101, T102, T103, **T104**, T105, T106, T107, T107, **T108**, T109, T110, **T111**, T112, **T113**, T114, T115, **T116**, T117 **T116** **T108** **T111** **T104** **T113**	19
12	Wastewater	**941**	1
13	Fuel gas line	**Purchased**, **Mixed**	Before and after mix drum.

2.1 Methodology

Samples were collected from each product stream and analyzed by Method TO-15 with GC-MSD and FID for HRVOCs identified in LDEQ's Administrative Order methodology. Samples were delivered to Chemtex Environmental and Industrial Hygiene Services' (Chemtex) laboratory in Port Arthur, TX. Liquid product samples were provided to the laboratory with zero headspace; vapor product samples were provided in suma canisters.

2.2 Results

The results of the HRVOC sampling are expressed conventional compound terms in Table 2 for liquid samples ($ppm_{w/v}$) and Table 3 for the vapor products (ppm_v). .Tables 4 and 5 express the same results in terms of carbon (C) as requested by the LDEQ order/agreement. (Note: Tables 2-5 are presented in excel format as a separate electronic document). All process streams were found to contain HRVOCs; the low sulfur diesel, light cycle/gas oils and jet fuel were found to contain the least HRVOC content.

3.0. FUGITIVE EMISSION SOURCES

CCI personnel conducted an audit of the PRC LDAR program for components in VOC service that would likely contain high concentrations of HRVOCs. Essentially all components in the LDAR in VOC service contain HRVOC fractions. However, the majority of the HRVOCs are in the LPG service area, fuel gas service, reformate and gasoline product lines. CCI personnel performed the following activities in determining the potential for fugitive emissions contributions to potential HRVOC emissions:

- Reviewed P & ID drawings for fuel gas system line component locations
- Reviewed LDAR program leaker emission tabulations reported for the last two years from quarterly and monthly LDAR monitoring reports
- Reviewed and quantified components in process streams from master component list
- Reviewed facility process tagging thoroughness for inclusion of required components, and
- Made a walk-through of the facility, concentrated on the LPG area and fuel gas lines where the high HRVOC impacts were anticipated.

3.2 Fugitives Audit Findings

The following are the findings of the fugitives audit:

- The review of the fuel gas system P & IDs and the walk through indicate that all components have been included in the LDAR program.
- The LDAR program leaker emission for the last two years from quarterly and monthly LDAR monitoring reports indicates a leak rate of less than 0.5 %, which below the industry average
- The components identified in the master component list total 17093 components
- The facility process tagging is very thorough. Several process areas and tank have been retagged because of turn arounds and replacement of older and missing tags. Several recent LDEQ and EPA multimedia and LDAR inspections have served to function as a

regulatory impetus to keep the tagging and inclusion of components in the LDAR program thorough. No additional components were found that needed to be added.

- The walk-through of the facility, concentrated on the LPG area and fuel gas lines where the high HRVOC impacts were anticipated, No additional tagging was identified.

3.3 Pressure Relief Valves (PRV) in LPG Area

The pressure relief valves at PRC are monitored and a log is kept of their status and activity. According to the log review, the PRVs in LPG service have never been actuated.

4.0 CONCLUSIONS

The HRVOC audit indicates that the PRC facility is achieving and exceeding regulatory objectives for minimal emissions. Fugitive emissions are below industry average.

Process streams at PRC contain HRVOCs, in most cases these concentrations are minimal compared to the primary products, implying that the primary product would be present prior to or along with the HRVOCs, enabling fairly easy source identification.

Additional process venting occurs through Placid's flare system. Placid's flare system is predominantly for SSM service; however, Placid also uses the flare system more or less daily to control one diminutive LPG stream related to LPG truck loading. That stream is the residual line between the pressurized storage tank and the LPG truck,

and it is used approximately 6-7 times daily. The size of that line is such that the total controlled HRVOC emissions from Placid's flare is less that 0.1 tons annually. Placid's flare is steam assisted, and with steam to the flare being controlled manually based on main control room visual observations using a remote camera.

Similarly, emissions from all of Placid's fixed roof atmospheric tanks are controlled by an enclosed vapor combustor, which is part of Placid's MTR vapor control facility. Placid's external floating roof tanks include primary and secondary seals conformed to 40 CFR 60 standards as referenced by LAC 33:III.2103. Placid's wastewater treatment plant also includes storage and treatment tanks conformed to those same standards. Analysis of Placid's noncontact cooling water from that respective cooling tower revealed the absence of any volatile organic compounds (Placid's contact process wastewater is controlled through the wastewater treatment plant).

Emissions from Placid's truck transfer operations are also controlled using the MTR facility enclosed vapor combustor system.

Finally, Placid's fuel gas stream shows a small percentage of HRVOC (10-20%). The total amount, if any, emitted to atmosphere will be a function of combustion efficiency. Placid combusts refinery fuel gas to each of its process heaters and boilers.

Placid will submit a revised air permit application to include speciated HRVOC emissions by the date set forth in the Order, based on findings of this audit.

TABLE 2. PLACID REFINING CO., LLC PROCESS STREAM HRVOC ANALYSES

Compound	Formula	Wt	Compound Carbon Wt	Carbon Fraction	Tank 19 Gasoline Super	Tank 22 Gasoline Regular	Tank 2 High Sulphur Diesel	Tank 28 Low Sulphur Diesel	Tank 3 Jet Fuel	Tank 24 Crude	Tank 13 Crude	Tank 25 Crude
					ppm w/v							
Ethylene	C2H4	28	24	0.86	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200
Acetylene	C2H2	26	24	0.92	963	< 200	< 200	< 200	< 200	< 200	< 200	< 200
Ethane	C2H6	30	24	0.80	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200
Propylene	C3H6	42	36	0.86	1,270	< 200	< 200	< 200	< 200	< 200	< 200	< 200
Propane	C3H8	44	36	0.82	< 200	834	< 200	< 200	< 200	1,932	1,564	2,498
Isobutane	C4H10	58	48	0.83	1,417	3,493	< 200	< 200	< 200	2,541	1,969	2,839
1-Butene	C4H8	56	48	0.86	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200
n-Butane	C4H10	58	48	0.83	12,797	13,724	203	< 200	< 200	4,695	4,801	< 200
Trans-2-butene	C4H8	56	48	0.86	< 200	304	304	< 200	< 200	< 200	< 200	< 200
Cis-2-butene	C4H8	56	48	0.86	222	579	579	< 200	< 200	< 200	< 200	< 200
1,3-Butadiene	C4H6	54	48	0.89	< 200	2,444	2,444	< 200	< 200	< 200	< 200	< 200
Isopentane	C5H12	72	60	0.83	31,309	16,058	992	< 200	< 200	11,715	8,256	11,433
1-Pentene	C5H10	70	60	0.86	957	3,169	260	< 200	< 200	< 200	< 200	< 200
n-Pentane	C5H12	72	60	0.83	9,026	16,058	16,058	< 200	< 200	6,824	5,530	7,912
Isoprene	C5H8	68	60	0.88	< 200	326	326	< 200	< 200	< 200	< 200	< 200
Trans-2-Pentene	C5H10	70	60	0.86	2,531	6,433	< 200	< 200	< 200	< 200	202	289
Cis-2-Pentente	C5H10	70	60	0.86	3,333	8,471	< 200	< 200	< 200	< 200	< 200	< 200
2,2-Dimethylbutane	C6H14	86	72	0.84	555	1,850	< 200	< 200	< 200	672	362	448
Cyclopentane	C5H10	70	60	0.86	1,262	2,979	< 200	< 200	< 200	994	994	1,021
2-3-Dimethylbutane	C6H14	86	72	0.84	8,410	7,506	< 200	< 200	< 200	1,261	908	682
2-Methylpentane	C6H14	86	72	0.84	6,873	4,445	351	< 200	< 200	702	512	5,309
3-Methylpentane	C6H14	86	72	0.84	44,848	14,997	276	< 200	< 200	3,680	2,878	4,410
1-Hexene	C6H12	84	72	0.86	< 200	3,965	356	< 200	< 200	4,742	3,708	5,683
n-Hexane	C6H14	86	72	0.84	2,511	10,895	282	< 200	< 200	5,075	4,181	6,502
Methylcyclopentane	C6H12	84	72	0.86	3,144	1,081	254	< 200	< 200	3,144	3,177	2,891
2,4-Dimethylpentane	C7H16	100	84	0.84	< 200	4,516	< 200	< 200	< 200	592	< 200	576
Benzene	C6H6	78	72	0.92	2,275	9,780	229	< 200	202	1,953	1,086	1,091
Cyclohexane	C6H12	84	72	0.86	539	3,516	< 200	< 200	< 200	5,027	4,742	4,382
2-Methylhexane	C7H16	100	84	0.84	4,056	9,780	374	< 200	< 200	4,270	3,187	4,811
2,3-Dimethylpentane	C7H16	100	84	0.84	9,039	3,716	< 200	< 200	< 200	915	721	1,045
3-Methylhexane	C7H16	100	84	0.84	3,302	12,687	357	< 200	< 200	3,576	2,875	4,214
Isooctane	C8H18	114	96	0.84	24,194	20,662	514	< 200	<200	348	<200	<200
n-Heptane	C7H16	100	84	0.84	3,485	12,766	853	< 200	294	8,432	6,768	10,704
Methylcyclohexane	C7H14	98	84	0.86	1,288	5,659	462	< 200	1,052	3,923	8,041	7,351
2,3,4-Trimethylpentane	C8H18	114	96	0.84	1,660	9,533	< 200	< 200	<200	<200	<200	<200
Toluene	C7H8	92	84	0.91	29,053	26,407	16,915	705	790	4,675	2,955	3,240
2-Methylheptane	C8H18	114	96	0.84	2,246	5,709	532	< 200	506	3,270	2,523	3,834
3-Methylheptane	C8H18	114	96	0.84	3,987	9,950	709	< 200	574	3,769	2,774	4,430
n-Octane	C8H18	114	96	0.84	3,089	5,653	1,433	< 200	1,513	6,428	4,772	7,823
Ethylbenzene	C8H10	106	96	0.91	5,769	7,656	574	200	410	840	532	629
M/p-Xylene	C8H10	106	96	0.91	17,911	24,101	2,253	889	2,123	4,197	2,440	3,170
Styrene	C8H8	104	96	0.92	288	<200	<200	< 200	<200	<200	<200	<200
o-Xylene	C8H10	106	96	0.91	8,715	10,534	1,045	449	1,042	1,675	948	1,293

TABLE 2. PLACID R[illegible]NING CO., LLC PROCESS STREAM HRVOC ANALYSES

		ppm w/v								
Compound	Formula	Tank 16 Alkylate	Tank 11 Naptha	Tank 9 Reformate	Tank 7 Light Cycle/ Gas Oil	Tank 8 Light Cycle/ Gas Oil	Tank 18 Light Cycle/ Gas Oil	Tank 27 Crude Condensate	Tank 58 Toluene	Tank 941 Wastewater
Ethylene	C2H4	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	<200
Acetylene	C2H2	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	<200
Ethane	C2H6	< 200	< 200	< 200	< 200	< 200	< 200	260	< 200	<200
Propylene	C3H6	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	<200
Propane	C3H8	< 200	< 200	2,939	< 200	< 200	< 200	684	< 200	<200
Isobutane	C4H10	308	368	4,544	< 200	< 200	< 200	< 200	< 200	<200
1-Butene	C4H8	< 200	266	< 200	< 200	< 200	< 200	< 200	< 200	<200
n-Butane	C4H10	15,676	2,405	6,208	< 200	< 200	< 200	1,616	< 200	<200
Trans-2-butene	C4H8	384	750	< 200	< 200	< 200	< 200	< 200	< 200	<200
Cis-2-butene	C4H8	< 200	714	< 200	< 200	< 200	< 200	< 200	< 200	<200
1,3-Butadiene	C4H6	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	<200
Isopentane	C5H12	23,759	57,359	20,754	< 200	< 200	< 200	4,529	< 200	<200
1-Pentene	C5H10	< 200	6,464	< 200	< 200	< 200	< 200	< 200	< 200	<200
n-Pentane	C5H12	< 200	12,795	9,750	< 200	< 200	< 200	2,421	< 200	<200
Isoprene	C5H8	< 200	746	< 200	< 200	< 200	< 200	< 200	< 200	<200
Trans-2-Pentene	C5H10	< 200	11,722	< 200	< 200	< 200	< 200	< 200	< 200	<200
Cis-2-Pentente	C5H10	< 200	15,435	< 200	< 200	< 200	< 200	< 200	< 200	<200
2,2-Dimethylbutane	C6H14	< 200	809	2,362	< 200	< 200	< 200	523	< 200	<200
Cyclopentane	C5H10	287	2,485	2,092	< 200	< 200	< 200	562	< 200	<200
2-3-Dimethylbutane	C6H14	11,873	6,827	3,323	< 200	< 200	< 200	849	< 200	<200
2-Methylpentane	C6H14	6,859	3,922	1,919	< 200	< 200	< 200	2,380	< 200	<200
3-Methylpentane	C6H14	1,818	15,444	11,506	< 200	< 200	< 200	1,947	< 200	<200
1-Hexene	C6H12	2,342	8,326	14,827	< 200	< 200	< 200	< 200	< 200	<200
n-Hexane	C6H14	< 200	4,982	10,409	< 200	< 200	< 200	2,484	< 200	<200
Methylcyclopentane	C6H12	1,087	13,056	5,941	< 200	< 200	< 200	2,543	< 200	<200
2,4-Dimethylpentane	C7H16	13,100	1,939	2,191	< 200	< 200	< 200	453	< 200	<200
Benzene	C6H6	< 200	6,203	14,983	< 200	< 200	< 200	1,666	< 200	<200
Cyclohexane	C6H12	< 200	1,807	552	< 200	< 200	< 200	5,146	< 200	<200
2-Methylhexane	C7H16	1,168	14,158	18,796	< 200	< 200	< 200	2,526	< 200	<200
2,3-Dimethylpentane	C7H16	16,223	3,852	3,959	< 200	< 200	< 200	842	< 200	<200
3-Methylhexane	C7H16	307	10,154	16,561	<200	<200	<200	1,991	< 200	<200
Isooctane	C8H18	43,151	2,176	<200	<200	<200	<200	< 200	< 200	<200
n-Heptane	C7H16	<200	4,261	18,605	<200	<200	<200	4,713	< 200	<200
Methylcyclohexane	C7H14	<200	5,543	794	<200	<200	<200	9,518	< 200	<200
2,3,4-Trimethylpentane	C8H18	26,917	664	224	<200	<200	<200	< 200	< 200	<200
Toluene	C7H8	251	20,364	33,092	2,747	1,094	438	4,270	845,593	5,790
2-Methylheptane	C8H18	483	4,497	8,883	<200	<200	<200	1,947	< 200	<200
3-Methylheptane	C8H18	774	8,368	17,191	329	<200	<200	< 200	< 200	<200
n-Octane	C8H18	<200	2,324	11,467	<200	<200	<200	4,128	< 200	<200
Ethylbenzene	C8H10	212	5,642	10,789	1,137	335	<200	746	1,485	<200
M/p-Xylene	C8H10	310	19,761	28,046	5,287	1,512	298	4,173	< 200	<200
Styrene	C8H8	<200	<200	<200	<200	<200	<200	< 200	< 200	<200
o-Xylene	C8H10	<200	8,318	28,046	2,502	747	<200	1,636	< 200	<200

TABLE 3. PLACID REFINING C[illegible]LLC PROCESS STREAM HRVOC ANALYSES

		ppb$_v$							
		Tank T116	Tank T111	Tank T108	Tank T112	Tank T104	Tank T113	N/A	N/A
					Olefins	High Purity	Normal	Purchased	Mixed
Compound	Formula	Propylene	ISO Butane	Propane	"Slop"	Butane	Butane	Fuel Gas	Fuel Gas
Ethylene	C2H4	<400	<400	<1000	<1000	<1000	<400	21,940	34,460
Acetylene	C2H2	<400	<400	<1000	<1000	<1000	<400	<400	20,100
Ethane	C2H6	1,426,948	4,846,979	10,109,981	<1000	8,106,467	<400	67,327,342	86,916,708
Propylene	C3H6	308,360,000	<400	3,261,700	1,428,334	4,328,550	<400	8,780	2,987,560
Propane	C3H8	148,160,000	65,669,994	316,587,392	200,088,000	40,467,401	1,006,880	5,722,244	5,716,647
Isobutane	C4H10	6,662,955	288,859,454	43,084,225	200,202,390	68,568,954	210,911,458	144,200	2,962,160
1-Butene	C4H8	645,300	12,920	315,350	218,113,503	12,750	45,550	1,460	3,284,240
n-Butane	C4H10	28,960	14,783,001	27,024,198	19,309,850	704,837,114	677,028,708	937,700	1,234,360
Trans-2-butene	C4H8	525,940	<400	10,161,750	143,179,636	264,550	<400	2,120	1,706,280
Cis-2-butene	C4H8	18,420	<400	7,627,750	7,686,250	49,800	<400	720	1,298,060
1,3-Butadiene	C4H6	<400	<400	<1000	<1000	<1000	<400	<400	<400
Isopentane	C5H12	<400	<400	1,312,750	665,800	146,350	2,740,940	996,360	2,780,640
1-Pentene	C5H10	<400	<400	54,100	170,100	222,400	<400	<400	291,820
n-Pentane	C5H12	<400	35,840	21,850	127,900	262,850	27,340	403,300	415,660
Isoprene	C5H8	<400	<400	<1000	<1000	<1000	<400	<400	28,760
Trans-2-Pentene	C5H10	<400	<400	14,150	213,450	6,900	<400	15,440	486,560
Cis-2-Pentente	C5H10	<400	<400	20,100	54,150	<1000	<400	<400	368,920
2,2-Dimethylbutane	C6H14	<400	780	<1000	3,000	<1000	69,720	45,960	24,140
Cyclopentane	C5H10	<400	<400	<1000	<1000	<1000	12,960	59,160	61,500
2-3-Dimethylbutane	C6H14	<400	5,580	<1000	<1000	42,550	<400	268,220	442,840
2-Methylpentane	C6H14	<400	2,320	<1000	2,200	32,250	135,720	202,340	352,420
3-Methylpentane	C6H14	<400	2,400	<1000	<1000	7,450	25,600	133,600	227,860
1-Hexene	C6H12	<400	3,180	<1000	<1000	4,950	33,780	176,280	90,820
n-Hexane	C6H14	<400	2,080	<1000	<1000	<1000	<400	150,300	100,360
Methylcyclopentane	C6H12	<400	520	<1000	<1000	<1000	4,680	112,460	110,800
2,4-Dimethylpentane	C7H16	<400	<400	<1000	<1000	13,900	99,440	11,980	10,220
Benzene	C6H6	<400	5,580	<1000	<1000	1,500	<400	135,960	69,040
Cyclohexane	C6H12	<400	<400	<1000	<1000	<1000	<400	9,466,880	61,760
2-Methylhexane	C7H16	<400	<400	<1000	<1000	<1000	7,940	64,060	47,380
2,3-Dimethylpentane	C7H16	<400	<400	<1000	<1000	9,900	111,280	13,680	10,420
3-Methylhexane	C7H16	<400	<400	<1000	<1000	<1000	1,840	43,680	34,320
Isooctane	C8H18	<400	680	2,150	4,500	50,300	636,040	<400	<400
n-Heptane	C7H16	<400	<400	<1000	<1000	<1000	<400	84,160	44,100
Methylcyclohexane	C7H14	<400	<400	<1000	<1000	<1000	<400	104,440	55,380
2,3,4-Trimethylpentane	C8H18	<400	<400	<1000	<1000	12,200	286,580	1,600	<400
Toluene	C7H8	5,460	5,600	6,250	11,200	1,650	4,000	74,880	64,760
2-Methylheptane	C8H18	<400	<400	<1000	<1000	<1000	8,840	17,500	12,160
3-Methylheptane	C8H18	<400	<400	<1000	<1000	<1000	2,220	7,620	15,700
n-Octane	C8H18	<400	<400	<1000	<1000	<1000	<400	29,100	16,360
Ethylbenzene	C8H10	<400	<400	<1000	<1000	<1000	<400	3,940	6,220
M/p-Xylene	C8H10	<400	<400	<1000	<1000	<1000	<400	4,420	19,760
Styrene	C8H8	660	1,100	1,200	<1000	<1000	<400	1,140	1,740
o-Xylene	C8H10	<400	<400	<1000	<1000	<1000	<400	4,240	8,040

TABLE 4. PLACID REFINING CO., LLC PROCESS STREAM HRVOC ANALYSES (as C)

Compound	Formula	Wt	Compound Carbon Wt	Carbon Fraction	Tank 19 Gasoline Super	Tank 22 Gasoline Regular	Tank 2 High Sulphur Diesel	Tank 28 Low Sulphur Diesel	Tank 3 Jet Fuel	Tank 24 Crude	Tank 13 Crude	Tank 25 Crude
					ppm $C_{w/v}$							
Ethylene	C2H4	28	24	0.86	<171	<171	<171	<171	<171	<171	<171	<171
Acetylene	C2H2	26	24	0.92	889	<185	<185	<185	<185	<185	<185	<185
Ethane	C2H6	30	24	0.80	<160	<160	<160	<160	<160	<160	<160	<160
Propylene	C3H6	42	36	0.86	1,089	<171	<171	<171	<171	<171	<171	<171
Propane	C3H8	44	36	0.82	<164	682	<164	<164	<164	1,581	1,280	2,044
Isobutane	C4H10	58	48	0.83	1,173	2,890	<166	<166	<166	2,103	1,630	2,349
1-Butene	C4H8	56	48	0.86	<171	<171	<171	<171	<171	<171	<171	<171
n-Butane	C4H10	58	48	0.83	10,591	11,357	168	<166	<166	3,886	3,974	<166
Trans-2-butene	C4H8	56	48	0.86	<171	260	260	<171	<171	<171	<171	<171
Cis-2-butene	C4H8	56	48	0.86	190	497	497	<171	<171	<171	<171	<171
1,3-Butadiene	C4H6	54	48	0.89	<178	2,173	2,173	<178	<178	<178	<178	<178
Isopentane	C5H12	72	60	0.83	26,091	13,382	826	<167	<167	9,762	6,880	9,527
1-Pentene	C5H10	70	60	0.86	821	2,716	223	<171	<171	<171	<171	<171
n-Pentane	C5H12	72	60	0.83	7,522	13,382	13,382	<167	<167	5,687	4,609	6,593
Isoprene	C5H8	68	60	0.88	<176	288	288	<176	<176	<176	<176	<176
Trans-2-Pentene	C5H10	70	60	0.86	2,169	5,514	<171	<171	<171	<171	173	248
Cis-2-Pentente	C5H10	70	60	0.86	2,857	7,261	<171	<171	<171	<171	<171	<171
2,2-Dimethylbutane	C6H14	86	72	0.84	465	1,549	<167	<167	<167	563	303	375
Cyclopentane	C5H10	70	60	0.86	1,081	2,553	<171	<171	<171	852	852	875
2-3-Dimethylbutane	C6H14	86	72	0.84	7,041	6,284	<167	<167	<167	1,056	760	571
2-Methylpentane	C6H14	86	72	0.84	5,754	3,721	294	<167	<167	588	428	4,444
3-Methylpentane	C6H14	86	72	0.84	37,547	12,555	231	<167	<167	3,081	2,409	3,692
1-Hexene	C6H12	84	72	0.86	<171	3,398	305	<171	<171	4,064	3,179	4,871
n-Hexane	C6H14	86	72	0.84	2,103	9,122	236	<167	<167	4,249	3,500	5,443
Methylcyclopentane	C6H12	84	72	0.86	2,695	927	218	<171	<171	2,695	2,724	2,478
2,4-Dimethylpentane	C7H16	100	84	0.84	<168	3,794	<168	<168	<168	497	<168	484
Benzene	C6H6	78	72	0.92	2,100	9,028	212	<185	186	1,802	1,002	1,007
Cyclohexane	C6H12	84	72	0.86	462	3,014	<171	<171	<171	4,309	4,064	3,756
2-Methylhexane	C7H16	100	84	0.84	3,407	8,215	314	<168	<168	3,587	2,677	4,042
2,3-Dimethylpentane	C7H16	100	84	0.84	7,593	3,122	<168	<168	<168	769	605	877
3-Methylhexane	C7H16	100	84	0.84	2,773	10,657	299	<168	<168	3,004	2,415	3,540
Isooctane	C8H18	114	96	0.84	20,374	17,400	433	<168	<168	293	<168	<168
n-Heptane	C7H16	100	84	0.84	2,927	10,724	717	<168	247	7,083	5,685	8,991
Methylcyclohexane	C7H14	98	84	0.86	1,104	4,851	396	<171	902	3,362	6,892	6,301
2,3,4-Trimethylpentane	C8H18	114	96	0.84	1,398	8,027	<168	<168	<168	<168	<168	<168
Toluene	C7H8	92	84	0.91	26,527	24,111	15,444	643	721	4,268	2,698	2,958
2-Methylheptane	C8H18	114	96	0.84	1,892	4,808	448	<168	426	2,754	2,125	3,229
3-Methylheptane	C8H18	114	96	0.84	3,358	8,379	597	<168	484	3,174	2,336	3,731
n-Octane	C8H18	114	96	0.84	2,601	4,760	1,207	<168	1,274	5,413	4,019	6,588
Ethylbenzene	C8H10	106	96	0.91	5,225	6,933	520	181	372	761	482	570
M/p-Xylene	C8H10	106	96	0.91	16,221	21,827	2,040	805	1,923	3,801	2,209	2,871
Styrene	C8H8	104	96	0.92	266	<185	<185	<185	<185	<185	<185	<185
o-Xylene	C8H10	106	96	0.91	7,893	9,540	946	407	944	1,517	859	1,171

TABLE 4. PLACID R[illegible]NING CO., LLC PROCESS STREAM HRVOC ANALYSES (as C)

		ppm $C_{w/v}$								
Compound	Formula	Tank 16 Alkylate	Tank 11 Naptha	Tank 9 Reformate	Tank 7 Light Cycle/ Gas Oil	Tank 8 Light Cycle/ Gas Oil	Tank 18 Light Cycle/ Gas Oil	Tank 27 Crude Condensate	Tank 58 Toluene	Tank 941 Wastewater
Ethylene	C2H4	<171	<171	<171	<171	<171	<171	<171	<171	<171
Acetylene	C2H2	<185	<185	<185	<185	<185	<185	<185	<185	<185
Ethane	C2H6	<160	<160	<160	<160	<160	<160	208	<160	<160
Propylene	C3H6	<171	<171	<171	<171	<171	<171	<171	<171	<171
Propane	C3H8	<164	<164	2,404	<164	<164	<164	559	<164	<164
Isobutane	C4H10	255	304	3,761	<166	<166	<166	<166	<166	<166
1-Butene	C4H8	<171	228	<171	<171	<171	<171	<171	<171	<171
n-Butane	C4H10	12,973	1,990	5,138	<166	<166	<166	1,337	<166	<166
Trans-2-butene	C4H8	329	643	<171	<171	<171	<171	<171	<171	<171
Cis-2-butene	C4H8	<171	612	<171	<171	<171	<171	<171	<171	<171
1,3-Butadiene	C4H6	<178	<178	<178	<178	<178	<178	<178	<178	<178
Isopentane	C5H12	19,799	47,799	17,295	<167	<167	<167	<167	<167	<167
1-Pentene	C5H10	<171	5,540	<171	<171	<171	<171	<171	<171	<171
n-Pentane	C5H12	<167	10,663	8,125	<167	<167	<167	2,017	<167	<167
Isoprene	C5H8	<176	658	<176	<176	<176	<176	<176	<176	<176
Trans-2-Pentene	C5H10	<171	10,047	<171	<171	<171	<171	<171	<171	<171
Cis-2-Pentente	C5H10	<171	13,230	<171	<171	<171	<171	<171	<171	<171
2,2-Dimethylbutane	C6H14	<167	677	1,978	<167	<167	<167	438	<167	<167
Cyclopentane	C5H10	246	2,130	1,793	<171	<171	<171	482	<171	<171
2-3-Dimethylbutane	C6H14	9,940	5,716	2,782	<167	<167	<167	710	<167	<167
2-Methylpentane	C6H14	5,742	3,283	1,607	<167	<167	<167	1,992	<167	<167
3-Methylpentane	C6H14	1,522	12,930	9,633	<167	<167	<167	1,630	<167	<167
1-Hexene	C6H12	2,007	7,136	12,709	<171	<171	<171	<171	<171	<171
n-Hexane	C6H14	<167	4,171	8,714	<167	<167	<167	2,080	<167	<167
Methylcyclopentane	C6H12	931	11,191	5,092	<171	<171	<171	2,180	<171	<171
2,4-Dimethylpentane	C7H16	11,004	1,629	1,840	<168	<168	<168	380	<168	<168
Benzene	C6H6	<185	5,725	13,830	<185	<185	<185	1,538	<185	<185
Cyclohexane	C6H12	<171	1,549	473	<171	<171	<171	4,411	<171	<171
2-Methylhexane	C7H16	981	11,892	15,789	<168	<168	<168	2,122	<168	<168
2,3-Dimethylpentane	C7H16	13,627	3,236	3,325	<168	<168	<168	708	<168	<168
3-Methylhexane	C7H16	258	8,530	13,911	<168	<168	<168	1,672	<168	<168
Isooctane	C8H18	36,338	1,833	<168	<168	<168	<168	<168	<168	<168
n-Heptane	C7H16	<168	3,579	15,628	<168	<168	<168	3,959	<168	<168
Methylcyclohexane	C7H14	<171	4,751	680	<171	<171	<171	8,158	<171	<171
2,3,4-Trimethylpentane	C8H18	22,667	560	189	<168	<168	<168	<168	<168	<168
Toluene	C7H8	229	18,593	30,215	2,508	999	400	3,898	772,063	5,287
2-Methylheptane	C8H18	407	3,787	7,480	<168	<168	<168	1,640	<168	<168
3-Methylheptane	C8H18	651	7,047	14,476	277	<168	<168	<168	<168	<168
n-Octane	C8H18	<168	1,957	9,656	<168	<168	<168	3,476	<168	<168
Ethylbenzene	C8H10	192	5,109	9,771	1,030	303	<181	676	1,345	<181
M/p-Xylene	C8H10	281	17,897	25,401	4,788	1,369	270	3,779	<181	<181
Styrene	C8H8	<185	<185	<185	<185	<185	<185	<185	<185	<185
o-Xylene	C8H10	<181	7,533	25,401	2,266	677	<181	1,482	<181	<181

TABLE 5. PLACID REFINING C[illegible]LLC PROCESS STREAM HRVOC ANALYSES (as C)

Compound	Formula	Tank T116 Propylene	Tank T111 ISO Butane	Tank T108 Propane	Tank T112 Olefins "Slop"	Tank T104 High Purity Butane	Tank T113 Normal Butane	Line Purchased Fuel Gas	Line Mixed Fuel Gas
		ppb$_v$ C							
Ethylene	C2H4	<343	<343	<857	<857	<857	<343	18,806	29,537
Acetylene	C2H2	<343	<343	<857	<857	<857	<343	<343	18,554
Ethane	C2H6	1,141,558	3,877,583	8,087,985	<857	6,485,174	<343	53,861,874	69,533,366
Propylene	C3H6	264,308,571	<343	2,795,743	1,224,286	3,710,186	<343	7,526	2,560,766
Propane	C3H8	121,221,818	53,729,995	259,026,048	163,708,364	33,109,692	823,811	4,681,836	4,677,257
Isobutane	C4H10	5,514,170	239,056,100	35,655,910	165,684,737	56,746,721	174,547,414	119,338	2,451,443
1-Butene	C4H8	553,114	11,074	270,300	186,954,431	10,929	39,043	1,251	2,815,063
n-Butane	C4H10	23,967	12,234,208	22,364,854	15,980,566	583,313,474	560,299,620	776,028	1,021,539
Trans-2-butene	C4H8	450,806	<343	8,710,071	122,725,402	226,757	<343	1,817	1,462,526
Cis-2-butene	C4H8	15,789	<343	6,538,071	6,588,214	42,686	<343	617	1,112,623
1,3-Butadiene	C4H6	<343	<343	<857	<857	<857	<343	<343	<343
Isopentane	C5H12	<343	<343	1,093,958	554,833	121,958	2,284,117	830,300	2,317,200
1-Pentene	C5H10	<343	<343	46,371	145,800	190,629	<343	<343	250,131
n-Pentane	C5H12	<343	29,867	18,208	106,583	219,042	22,783	336,083	346,383
Isoprene	C5H8	<343	<343	<857	<857	<857	<343	<343	25,376
Trans-2-Pentene	C5H10	<343	<343	12,129	182,957	5,914	<343	13,234	417,051
Cis-2-Pentente	C5H10	<343	<343	17,229	46,414	<857	<343	<343	316,217
2,2-Dimethylbutane	C6H14	<343	653	<857	2,512	<857	58,370	38,478	20,210
Cyclopentane	C5H10	<343	<343	<857	<857	<857	11,109	50,709	52,714
2-3-Dimethylbutane	C6H14	<343	4,672	<857	<857	35,623	<343	224,556	370,750
2-Methylpentane	C6H14	<343	1,942	<857	1,842	27,000	113,626	169,401	295,049
3-Methylpentane	C6H14	<343	2,009	<857	<857	6,237	21,433	111,851	190,767
1-Hexene	C6H12	<343	2,726	<857	<857	4,243	28,954	151,097	77,846
n-Hexane	C6H14	<343	1,741	<857	<857	<857	<343	125,833	84,022
Methylcyclopentane	C6H12	<343	446	<857	<857	<857	4,011	96,394	94,971
2,4-Dimethylpentane	C7H16	<343	<343	<857	<857	11,676	83,530	10,063	8,585
Benzene	C6H6	<343	5,151	<857	<857	1,385	<343	125,502	63,729
Cyclohexane	C6H12	<343	<343	<857	<857	<857	<343	8,114,469	52,937
2-Methylhexane	C7H16	<343	<343	<857	<857	<857	6,670	53,810	39,799
2,3-Dimethylpentane	C7H16	<343	<343	<857	<857	8,316	93,475	11,491	8,753
3-Methylhexane	C7H16	<343	<343	<857	<857	<857	1,546	36,691	28,829
Isooctane	C8H18	<343	573	1,811	3,789	42,358	535,613	<343	<343
n-Heptane	C7H16	<343	<343	<857	<857	<857	<343	70,694	37,044
Methylcyclohexane	C7H14	<343	<343	<857	<857	<857	<343	89,520	47,469
2,3,4-Trimethylpentane	C8H18	<343	<343	<857	<857	10,274	241,331	1,347	<343
Toluene	C7H8	4,985	5,113	5,707	10,226	1,507	3,652	68,369	59,129
2-Methylheptane	C8H18	<343	<343	<857	<857	<857	7,444	14,737	10,240
3-Methylheptane	C8H18	<343	<343	<857	<857	<857	1,869	6,417	13,221
n-Octane	C8H18	<343	<343	<857	<857	<857	<343	24,505	13,777
Ethylbenzene	C8H10	<343	<343	<857	<857	<857	<343	3,568	5,633
M/p-Xylene	C8H10	<343	C	<857	<857	<857	<343	4,003	17,896
Styrene	C8H8	609	1,015	1,108	<857	<857	<343	1,052	1,606
o-Xylene	C8H10	<343	<343	<857	<857	<857	<343	3,840	7,282

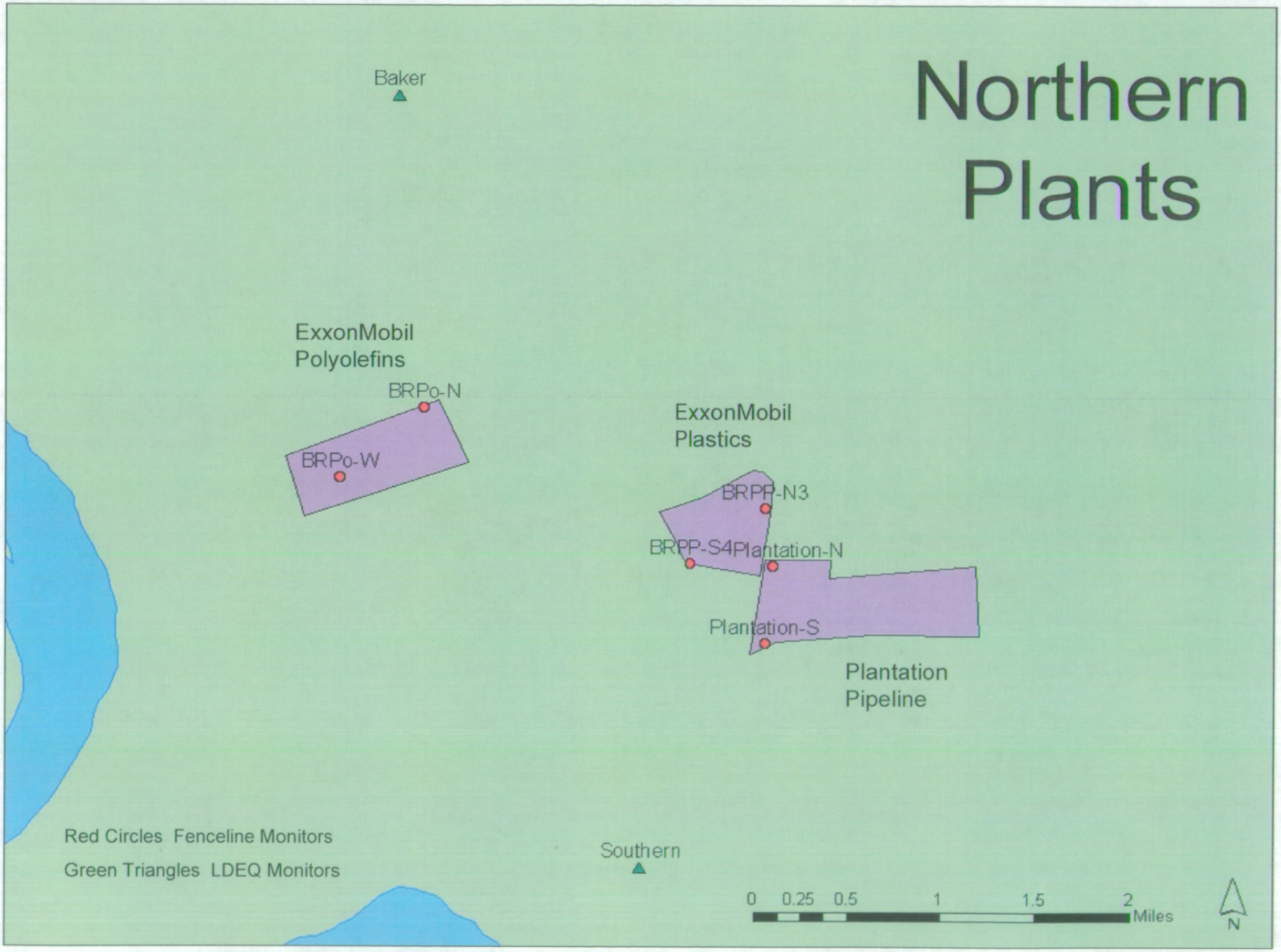
Appendix B - Ozone Precursor VOC List

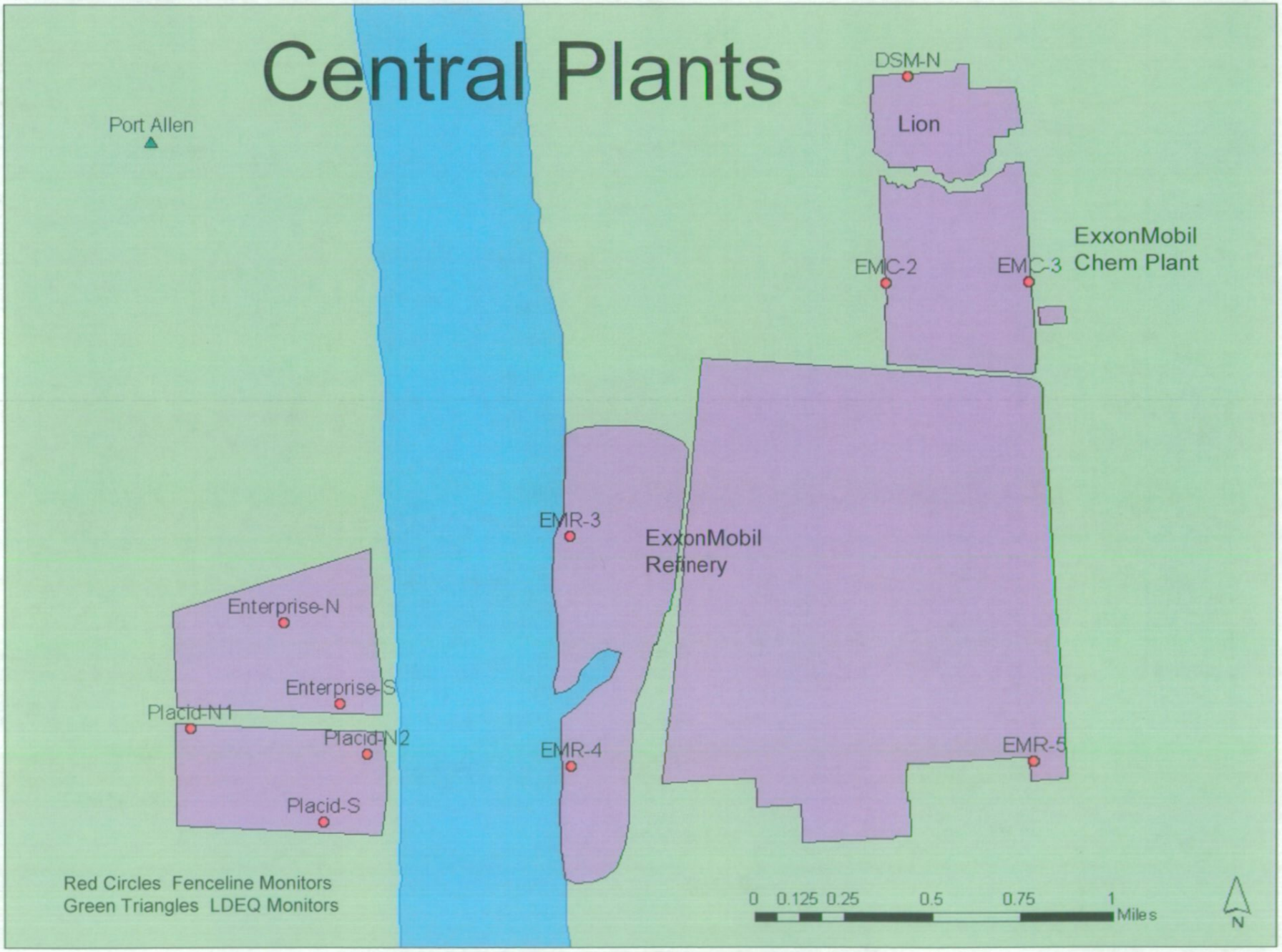
Ozone Precursor VOC for Fenceline Monitoring

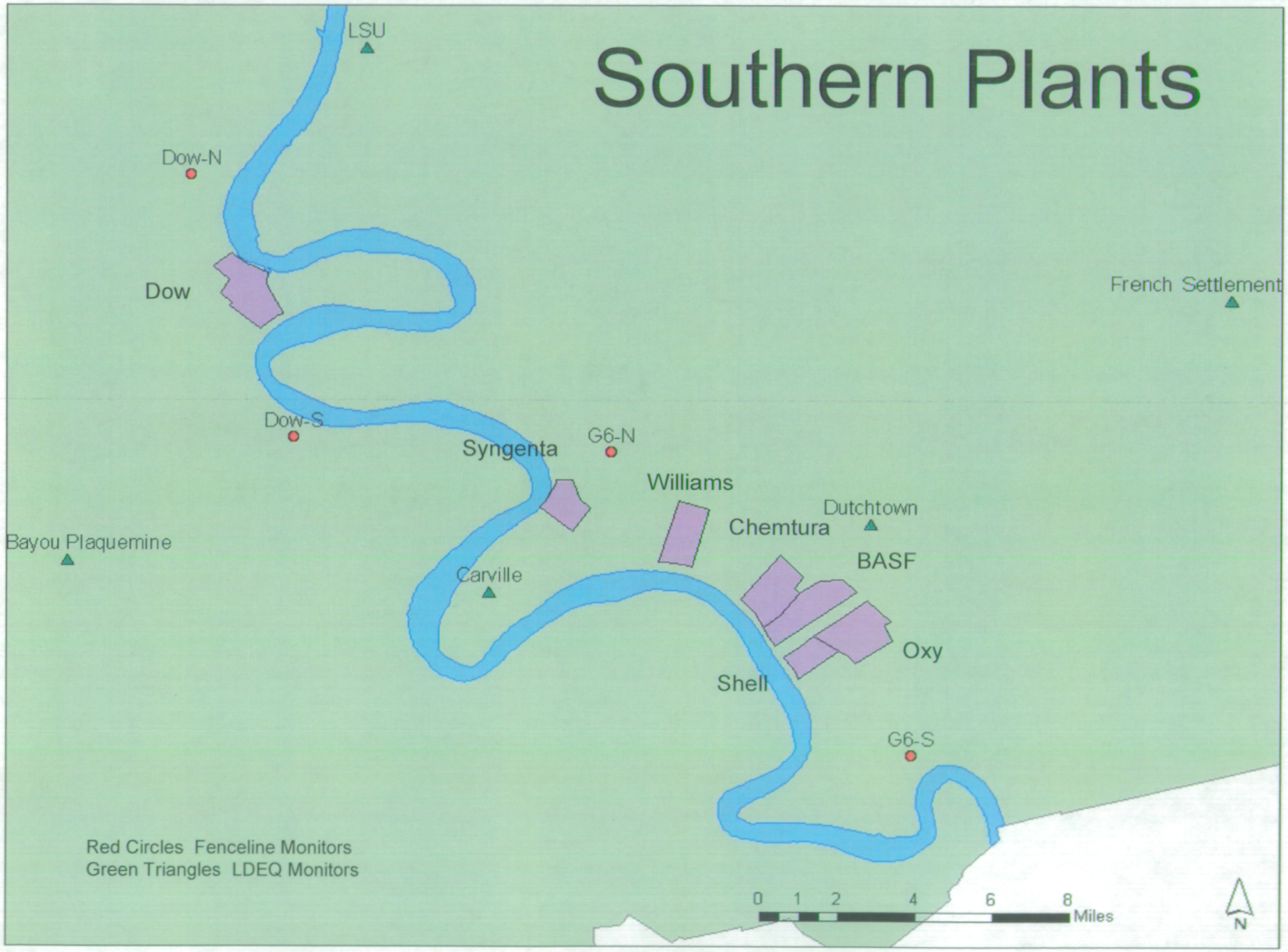
AIRS Code	Compound	AIRS Code	Compound
43202	Ethane, aka Methylmethane	43245	1-Hexene
43203	**Ethylene, aka Ethene**	43247	2,4-Dimethylpentane
43204	Propane, aka Dimethylmethane	43248	Cyclohexane, aka Hexamethylene
43205	**Propylene, aka Propene**	43249	3-Methylhexane
43206	Acetylene, aka Ethyene	43250	2,2,4-Trimethylpentane, aka Isooctane
43212	Butane	43252	2,3,4-Trimethylpentane
43214	Isobutane, aka 2-Methylpropane	43253	3-Methylheptane
43216	**Trans-2-Butene**	43261	Methylcyclohexane, aka Hexahydrotoluene
43217	**Cis-2-Butene**	43262	Methylcyclopentane
43218	**1,3-Butadiene**	43263	2-Methylhexane, aka Isoheptane
43220	Pentane, aka Amyl Hydride	**43280**	**1-Butene, aka Ethylethylene**
43221	Isopentane, aka 2-Methylbutane	43284	2,3-Dimethylbutane, aka Diisopropyl
43224	1-Pentene, aka Propylethylene	43285	2-Methylpentane,aka Isohexane
43226	Trans-2-Pentene	43291	2,3-Dimethylpentane
43226	Cis-2-Pentene, aka Cis-B-N-Amylene	43960	2-Methylheptane
43230	3-Methylpentane, aka Diethylmethylmet	**45109**	**M/P Xylene**
43231	Hexane	45201	Benxene
43232	Heptane, aka Dipropylmethane	**45202**	**Toluene, aka Methylbenzene**
43233	Octane	45203	Ethylbenzene, aka Phenylethane
43242	Cyclopentane, aka Pentamethylene	**45204**	**O-Xylene, aka 1,2-Dimethylbenzene**
43243	**Isoprene, aka 3-Methyl-1,3-Butadiene**	45220	Styrene, aka Ethenylbenzene
43244	2,2-Dimethylbutane, aka Neohexane		

Note: Highlighted compounds are HRVOC for purposes of this project.

Appendix C – Fenceline Monitor Location Maps


Northern Plants
Baker
ExxonMobil Polyolefins
BRPo-N
BRPo-W
ExxonMobil Plastics
BRPP-N3
BRPP-S4
Plantation-N
Plantation-S
Plantation Pipeline
Red Circles Fenceline Monitors
Green Triangles LDEQ Monitors
Southern
0 0.25 0.5 1 1.5 2 Miles
N


Central Plants
Port Allen
DSM-N
Lion
ExxonMobil
Chem Plant
EMC-2
EMC-3
EMR-3
ExxonMobil
Refinery
Enterprise-N
Enterprise-S
Placid-N1
Placid-N2
Placid-S
EMR-4
EMR-5
Red Circles Fenceline Monitors
Green Triangles LDEQ Monitors
0 0.125 0.25 0.5 0.75 1
Miles
N


Southern Plants
LSU
Dow-N
Dow
French Settlement
Dow-S
Syngenta
G6-N
Williams
Dutchtown
Chemtura
Bayou Plaquemine
BASF
Carville
Oxy
Shell
G6-S
Red Circles Fenceline Monitors
Green Triangles LDEQ Monitors
0 1 2 4 6 8
Miles
N

Appendix D – Facility Final Reports

The Dow Chemical Company

The Dow Chemical Company
P.O. Box 150
Plaquemine, Louisiana 70765-0150

February 15, 2007
Building 3502E

HAND DELIVERY

LDEQ RECEIPT
7 FEB 15 P3:55

Mr. Maurice Oubre
Louisiana Department of Environmental Quality
Office of Environmental Services
Post Office Box 4313
Baton Rouge, Louisiana 70821-4313

FINAL REPORT
OZONE PRECURSOR AIR MONITORING NETWORK FOR
THE DOW CHEMICAL COMPANY, LOUISIANA OPERATIONS
AGENCY INTEREST NUMBER 1409
ADMINISTRATIVE ORDER - AE-AO-04-0001

Dear Mr. Oubre:

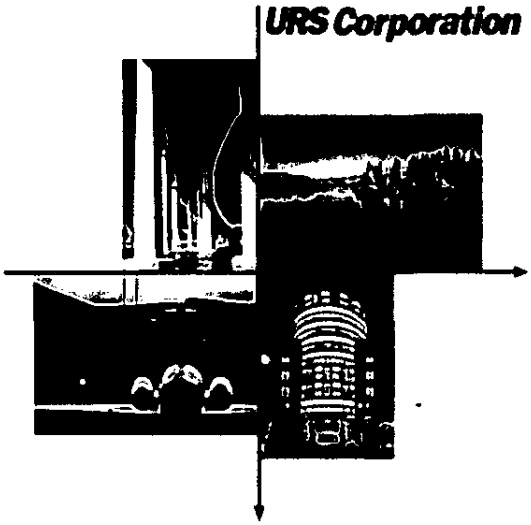
Enclosed please find three (3) copies of The Dow Chemical Company, Louisiana Operations' (Dow) Final Report - Ozone Precursor Air Monitoring Network. Dow requested and received approval for termination of the Ambient Air Fenceline Monitoring Administrative Order and Consent (AOC). A condition of the termination approval included submittal of a final report no later than February 15, 2007.

Should the Department have any questions or require additional information, please contact me at 225-353-8270.

Regards,

Bob Brady, Jr.
Senior Specialist
Environmental, Health, and Safety
The Dow Chemical Company

Enclosure



The Dow Chemical Company Louisiana Operations Plaquemine, Louisiana

Final Report for the Ozone Precursor Air Monitoring Network

February 2007

Prepared for:

The Dow Chemical Company,
Louisiana Operations
P. O. Box 150
Plaquemine, Louisiana

Prepared by:

URS Corporation
Baton Rouge, Louisiana

FINAL REPORT FOR THE OZONE PRECURSOR AIR MONITORING NETWORK

Prepared for:

The Dow Chemical Company
Louisiana Operations
Plaquemine, Louisiana

February 2007

URS
7389 Florida Boulevard
Suite 300
Baton Rouge, Louisiana 70806
(225) 922-5700

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Figure 4-2 TNMOC Pollution Roses – Non-Ozone Season
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Figure 4-3 NO_x Pollution Rose – Non-Ozone Season

The Dow Chemical Company, Louisiana Operations (Dow LAO) began operating and maintaining two (2) ambient air monitoring systems to measure ozone precursors and meteorological parameters near its facility in Plaquemine, Louisiana on May 1, 2005. The monitoring system included two monitoring stations, each equipped with state-of-the-art instruments for:

- Continuous monitoring of total nonmethane organic carbon (TNMOC);
- Continuous monitoring of oxides of nitrogen (NOx);
- Continuous monitoring of wind speed and wind direction;
- Measurements of 43 volatile organic compounds (VOC), which are common ozone precursors, at sampling times triggered by measurements of high levels of TNMOC, and during a grab sample collection between 6 AM and 9 AM every 6 days.

TNMOC levels were measured by a PerkinElmer Clarus 500 gas chromatograph (GC). This GC was electronically linked with another Clarus 500 GC that measured ozone precursors. This second GC was equipped with dual capillary columns, a Dean switch used as a heart cut accessory, dual flame ionization detectors; and a PerkinElmer Turbomatric Thermal Desorption (TD) System to concentrate and deliver the sample to the GC. The PerkinElmer TNMOC/Ozone Precursor Monitoring System was used to continuously monitor TNMOC levels and trigger sample collection over 20-minute periods and analysis for the target list of 43 ozone-forming VOC whenever the 10-minute average TNMOC level exceeded 1 part per million carbon (ppmc). The monitoring program also included automatic grab sample collection between 6 and 9 AM every 6 days to measure ozone precursors. Ten (10) minute average TNMOC data, and Ozone Precursor data was recorded and submitted to LDEQ in Microsoft Excel format.

Oxides of Nitrogen (NOx) were measured using a Thermo Environmental Instruments Inc. Model 42C Chemiluminescence NO- NO2- NOx analyzer. Oxides of nitrogen data was recorded on site using Campbell Scientific data loggers. The data loggers processed five-minute averages for each hour in Microsoft Excel format for submittal to LDEQ.

A 10-meter tower meteorological tower equipped with sensors to measure wind speed and direction. Wind speed was measured using the Met One, Inc. Model 010 wind speed sensor,

and wind direction was measured using the Met One, Inc. Model 020 wind direction sensor. Wind speed and wind direction data was recorded on site using Campbell Scientific data loggers. The instantaneous measurements were processed to five-minute averages for each hour.

Calibration procedures were performed on the monitoring equipment according to approved methods, and at the required frequency. Additionally, performance audits of continuous analyzers include the monitors for nitrogen oxides (NOx), and total nonmethane organic carbon (TNMOC) analyzers, and audits of the semi-continuous Ozone Precursor Auto GC systems. The field performance audits were conducted every quarter.

The monitoring stations were located within a distance approved by the LDEQ to the north and south of the Dow LAO facility. Table 2-1 shows the latitude and longitude of each station. Figure 2-1, 2-2, and 2-3 shows the location of Dow LAO facility, the Plaquemine Station, and the Addis Station.

Table 2-1
Monitoring Sites Latitude and Longitude Coordinates

Site Name	Latitude	Longitude
Addis	30° 22' 20.8"	91° 15' 45.9"
Plaquemine	30° 16' 08.7"	91° 13' 01.8"

TNMOC, Ozone Precursor, NOx and meteorological monitoring data were uploaded from personal computers within each station to an offsite database system. Data from the database was then posted in near real-time format to an internet site monitored 24 hours a day by Dow personnel. Whenever the 10-minute average TNMOC level exceeded 1 part per million carbon (ppmc) the website page would sound an alarm for Dow personnel to respond. Additional notification systems such as phone messages, text paging, and fax transmission were also employed when a trigger occurred. Dow personnel would then determine if the meteorological data indicated that the Dow LAO facility is within the prevailing wind pattern. Dow only investigated the source of trigger events when meteorological data indicated that the Dow LAO facility was within the prevailing wind pattern. Following the trigger event, and if the prevailing wind pattern according to meteorological data aligns with the Dow LAO facility; then, a survey of activities within the Dow LAO facility would be performed at potential sources of the trigger event. If the source is determined to be at the LAO facility, the source will be investigated and the findings of the investigation reported in the monthly report. When a trigger event occurs and meteorological data and HRVOC analysis results did not indicate a possible source at the Dow LAO facility, Dow did not conduct an investigation of the source of triggered event.

The major intent of the monitoring program was to continuously monitor TNMOC levels and trigger sample collection over 20-minute periods and analysis for the target list of 43 ozone-forming VOC whenever the 10-minute average TNMOC level exceeded 1 part per million carbon (ppmc). TNMOC levels exceeded 1 ppmc on the following occasions listed in Table 4-1.

Table 4-1
Table of TNMOC Triggers

Date	Station
June 2, 2005	Addis
November 2, 2005	Addis
December 13, 2005	Plaquemine
January 2, 2006	Addis
January 11, 2006	Addis
*June 3, 2006	Plaquemine
July 1, 2006	Addis

*Note: Only event with recorded TNMOC levels aligned with meteorological wind data relative to Dow.

However, all of the trigger events with the exception of the June 3, 2006 event at Plaquemine had recorded TNMOC levels that did not align with meteorological wind data relative to Dow. Dow only investigates the source of TNMOC trigger events whenever 10-minute average TNMOC levels exceed 1 ppm and meteorological data indicates that Dow is within the prevailing wind pattern. Whenever the 1 ppm TNMOC level was exceeded, the PerkinElmer Ozone Precursor GC began collecting a 20 minute ambient air sample for analysis of the target list of 43 ozone forming volatile organic compounds (VOC). The result of the analyses did not indicate a significant level of any particular ozone precursor chemical related to Dow.

On June 3, 2006 at the Plaquemine station, a TNMOC trigger event occurred from 00:20 to 00:30. During the event, meteorological equipment recorded that Dow was in the prevailing wind pattern. However, due to a procedural error, we did not initiate a response to investigate the source of the trigger event. On June 5, 2006 a look back at the operations within Dow at the time of the trigger event indicated that the source of the trigger was unlikely to have been from a source at Dow. Furthermore, the trigger event occurred when

the Ozone Precursor Gas Chromatograph was performing routine calibrations, and a 20-minute air sample (trigger sample) could not be collected.

Whenever the 1 ppm TNMOC level was exceeded, the PerkinElmer Ozone Precursor GC began collecting a 20 minute ambient air sample for analysis of the target list of 43 ozone forming volatile organic compounds (VOC). The result of the analyses did not indicate a significant level of any particular ozone precursor chemical.

TNMOC and NOx data are summarized in Figures 4-1, 4-2, 4-3 and 4-4. The data is presented in pollution roses for TNMOC and NOx data collected during ozone and non-ozone seasons during 2005 and 2006.

Dow LAO was required to operate the TNMOC analyzer year round with a data completeness of at least 85%. Table 4-2 contains data completeness for TNMOC captured in 2005 and 2006 at each station. The table shows that Dow exceeded the 85% data capture while operating the stations.

Table 4-2
2005-2006 TNMOC Data Capture

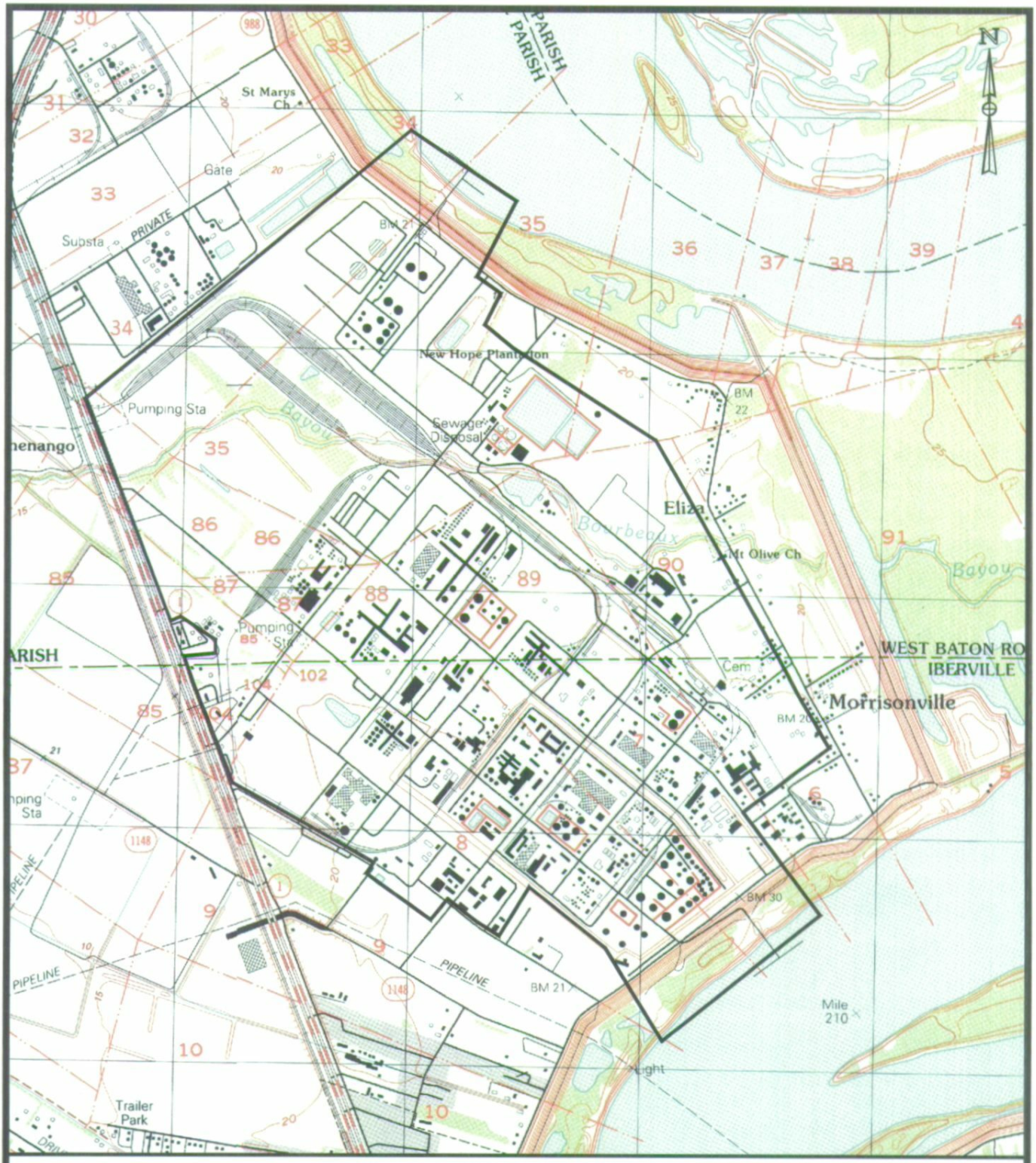
Site	Year	Possible Number of 10-Minute Averages	10-Minute Averages Flagged as Calibrations	Number of Possible 10-Minute Averages Minus Calibrations	Actual Number of Valid 10-Minute Averages	True Valid Data Capture (%)	True Valid Data Capture Adjusted for Calibrations (%)
Plaquemine	2005	35280	958	34322	31544	89%	92%
Plaquemine	2006	52560	1865	50695	46498	88%	92%
Addis	2005	35280	975	34305	31873	90%	93%
Addis	2006	52560	1823	50737	49694	95%	98%

Dow LAO operated the stations without significant modifications. Routine maintenance and timely repairs were performed at each station in order to maintain a high data capture rate.

The Dow Chemical Company, Louisiana Operations was pleased to assist the LDEQ in its efforts to research the impact of highly reactive volatile organic compound (HRVOC) emissions on ozone formation in the Baton Rouge Area. Although, Dow installed the monitoring equipment at two locations, the data from the monitoring program did not lead to Dow identifying any additional emission reduction opportunities. Dow maintains it chemical manufacturing operations within requirements contained in the air regulations and existing air permits issued by LDEQ.

Dow LAO believes that its air monitoring stations provided emissions data from within the vicinity of its operations to LDEQ that would not have been otherwise available. Dow hopes that the data assisted the LDEQ with identifying sources to reduce emissions area-wide in pursuit of meeting the National Ambient Air Quality Standard for ozone for the area.

FIGURES



Reference: U.S.G.S. 7.5 minute series quad maps, Addis, LA, Dated 1992 and Plaquemine, LA, Dated 1992. SCALE: 1"=2000'.

QUADRANGLE LOCATION

FIGURE 2-1

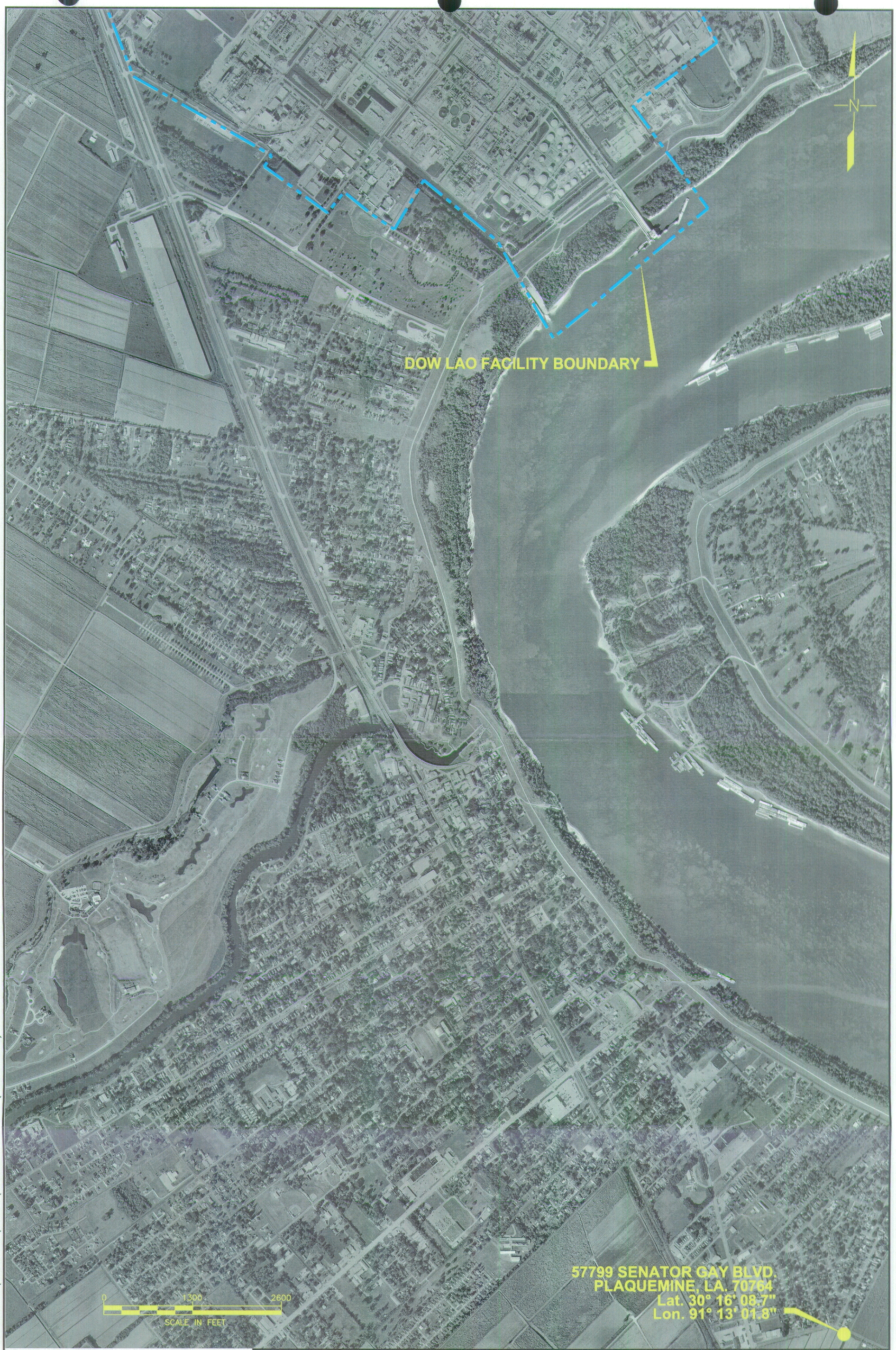
SITE LOCATION MAP

DOW

THE DOW CHEMICAL COMPANY
LOUISIANA OPERATIONS
PLAQUEMINE, LOUISIANA

URS

DOWA0019.CDR PLOT:1=1



I:\DOW LITIGATION\41566902-02\41567473\70000\41567473-04.DWG (SOUTH SITE)

DOW The Dow Chemical Company, Louisiana Operations Plaquemine, Louisiana	DATE 04/19/05 PREPARED WPS CHECKED TM	URS	FINAL REPORT FOR THE OZONE PRECURSOR AIR MONITORING NETWORK PLAQUEMINE MONITORING SITE LOCATION FIGURE 2-2

I:\DOW LITIGATION\41566902-02\41567473\70000\41567473-04.DWG (SOUTH SITE)

DOW The Dow Chemical Company, Louisiana Operations Plaquemine, Louisiana	DATE 04/19/05 PREPARED WPS CHECKED TM	URS	FINAL REPORT FOR THE OZONE PRECURSOR AIR MONITORING NETWORK ADDIS MONITORING SITE LOCATIONS FIGURE 2-3

Figure 4-1
TNMOC Pollution Roses – Ozone Season

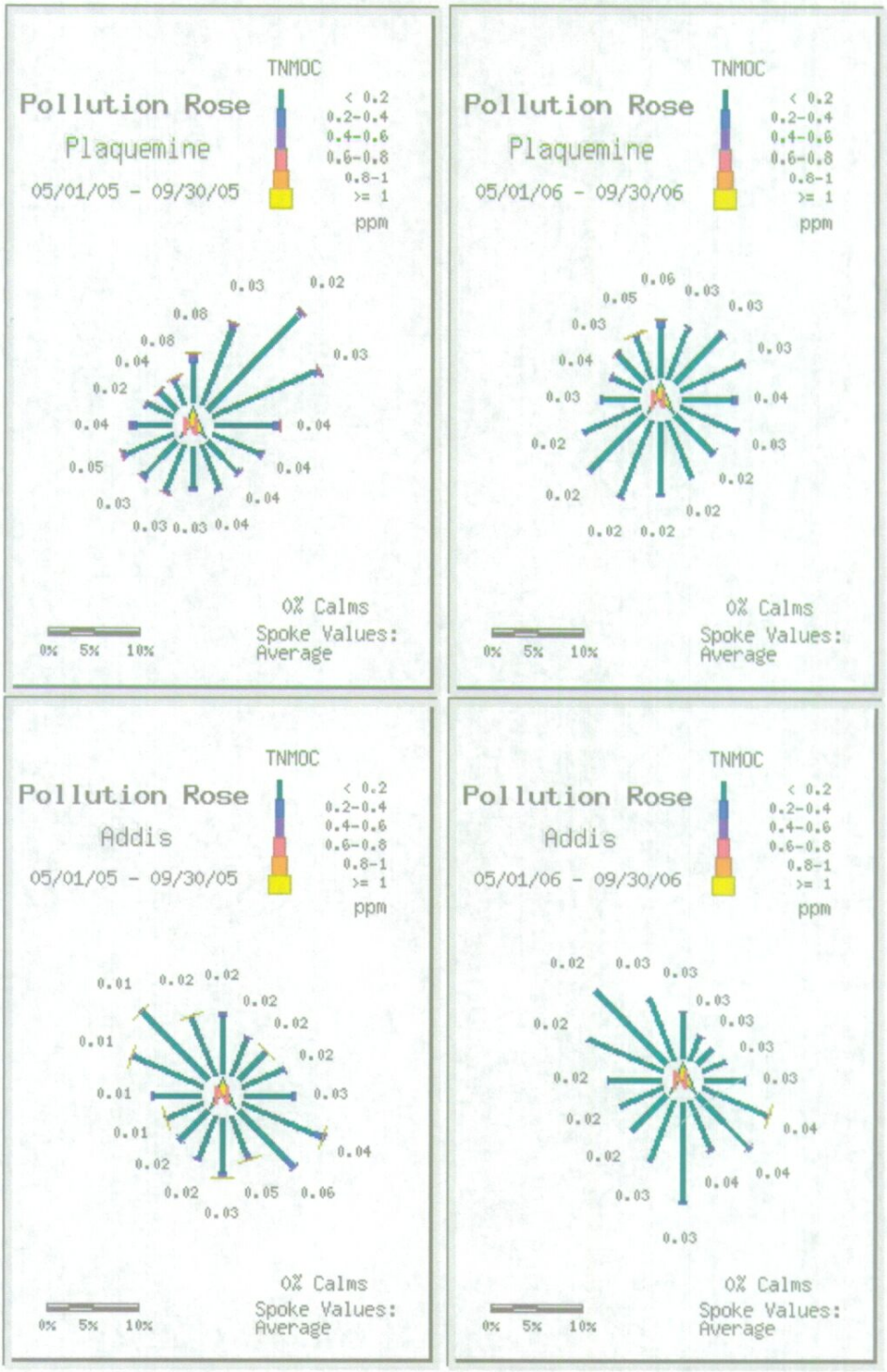


Figure 4-2
TNMOC Pollution Roses – Non-Ozone Season

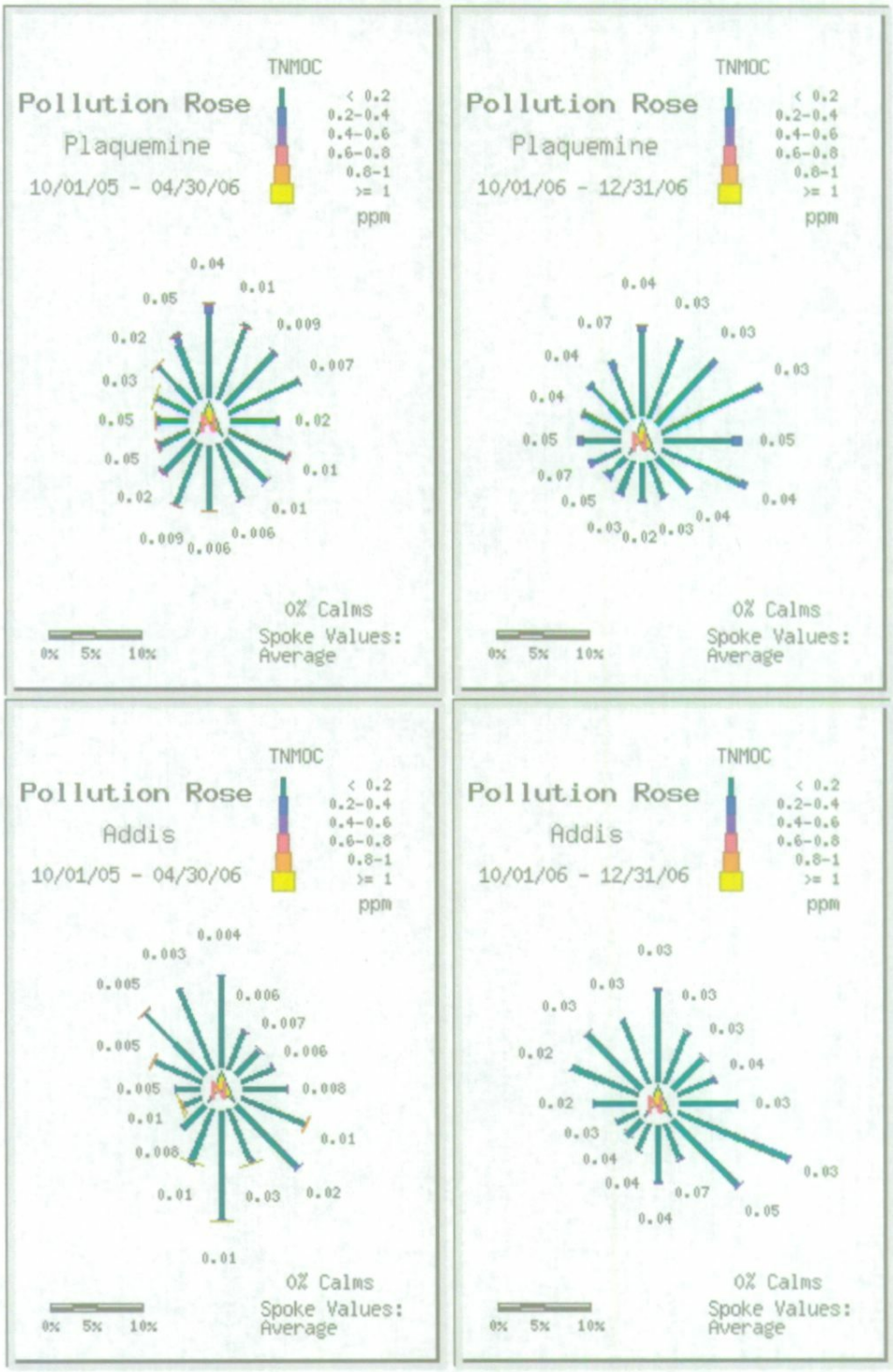


Figure 4-3
NOx Pollution Roses –Ozone Season

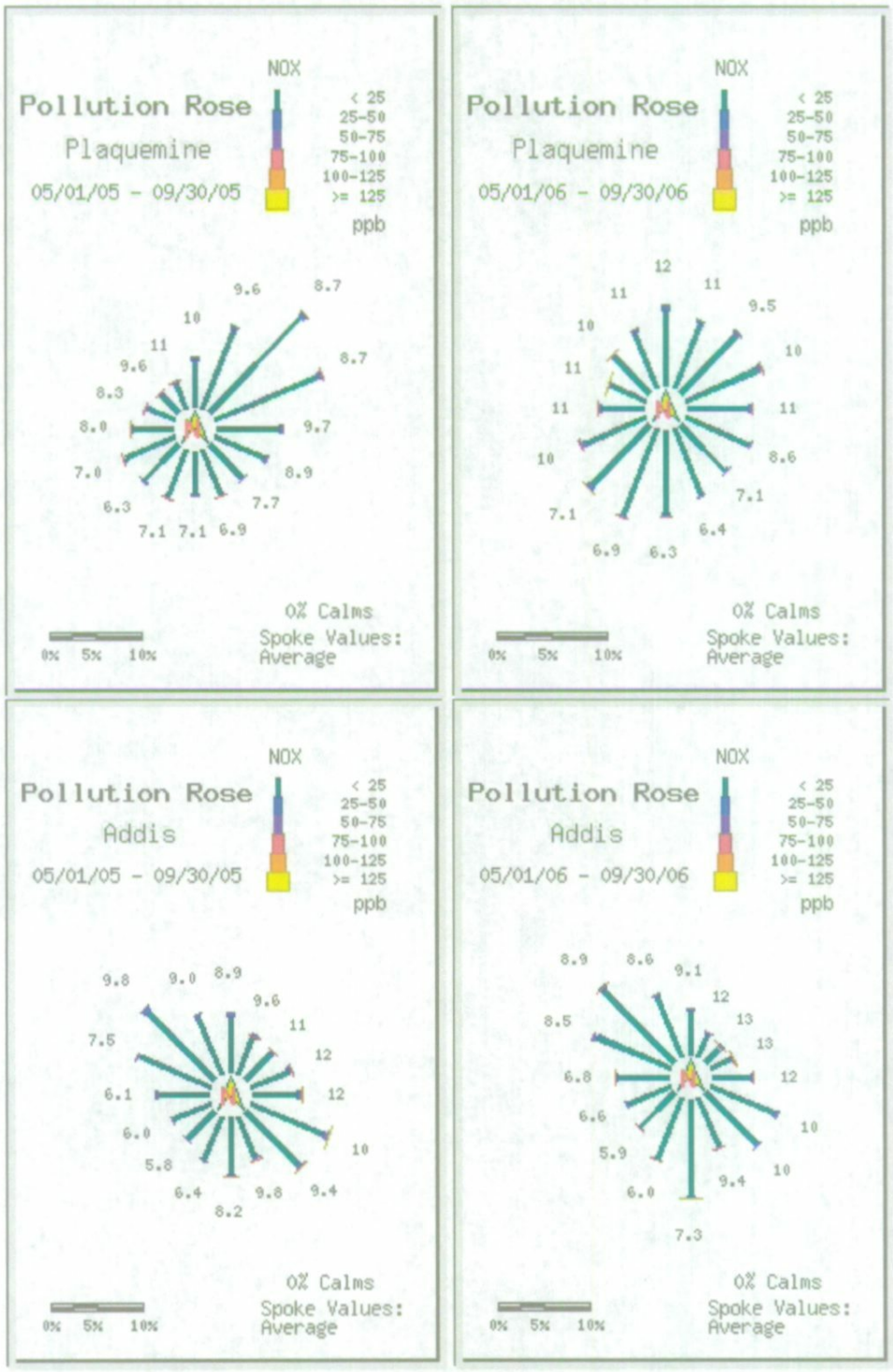
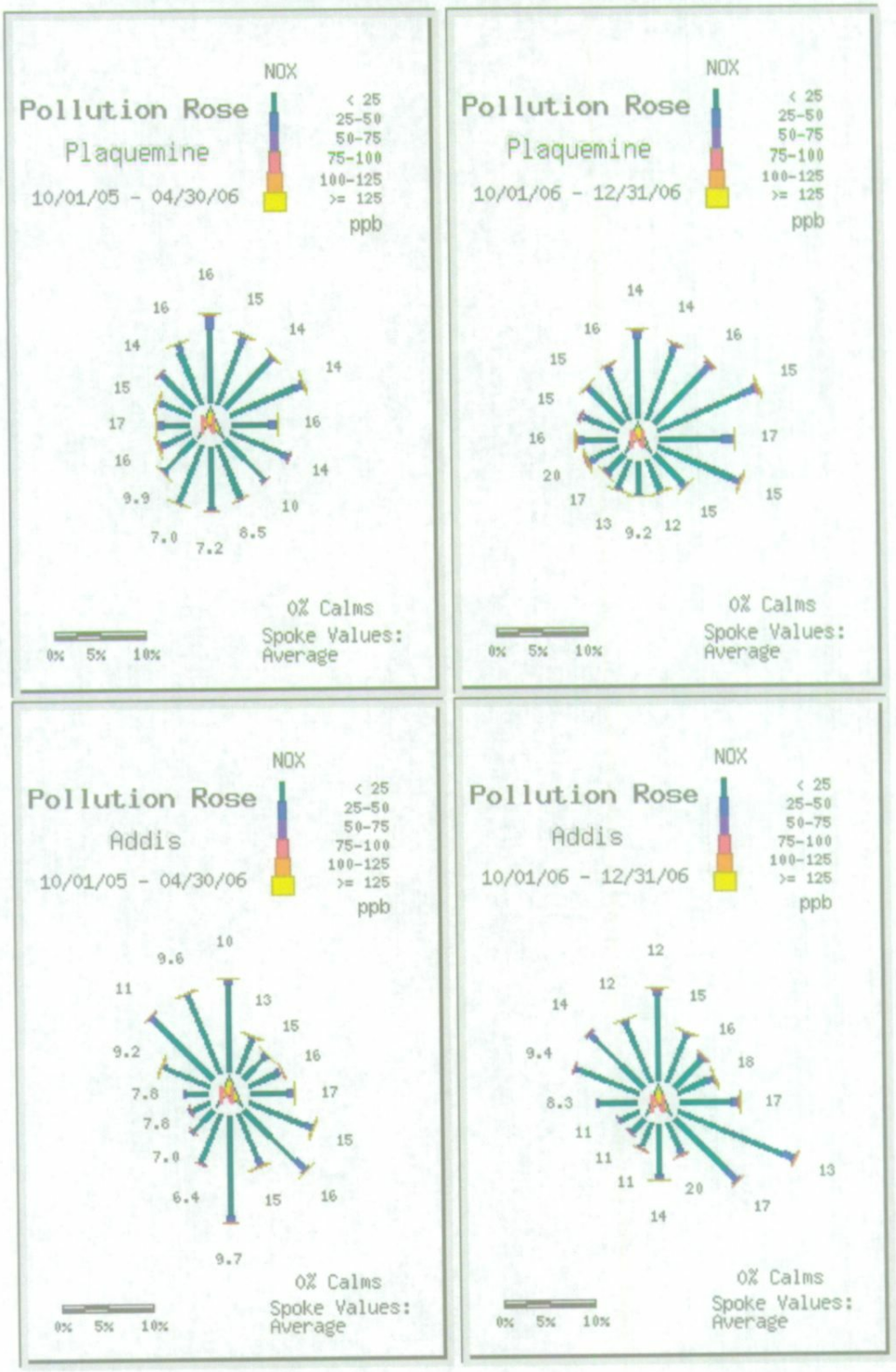


Figure 4- 4
NOx Pollution Roses –Non-Ozone Season



Appendix D – Facility Final Reports

Enterprise Products Operating, L.P

Enterprise Products

DEPARTMENT OF ENVIRONMENTAL QUALITY
MAR 0 2 2007
OFFICE OF THE SECRETARY

P.O. Box 4324 Houston, Texas 77210-4324 713.880.6500
2727 North Loop West Houston, Texas 77008-1044 www.epplp.com

February 27, 2007

7003 1680 0006 9185 1205
Return Receipt Requested

Mike McDaniel, Ph.D., Secretary
Office of the Secretary
LOUISIANA DEPARTMENT OF ENVIRONMENTAL QUALITY
P.O. Box 4301
Baton Rouge, La. 70821-4301

Subject: **Final Report**
Administrative Order on Consent AE-AOA-05-0009
Enterprise Products Operating, L.P.
Baton Rouge Fractionator & Splitter Units
Port Allen, West Baton Rouge Parish, Louisiana
Agency Interest No. 40198

Dear Dr. McDaniel:

The Louisiana Department of Environmental Quality (LDEQ) issued an Administrative Order on Consent (Order) to Enterprise Products Operating, L.P. (Enterprise) on January 27, 2005 for the facility located in West Baton Rouge Parish within the Baton Rouge Nonattainment Area. The Order required that Enterprise plan and implement a fenceline ambient monitoring program and conduct a comprehensive environmental audit of potential sources of Highly Reactive Volatile Organic Compounds (HRVOCs) at the facility.

Enterprise is submitting the attached Final Report summarizing the findings of the audit and sampling and the fenceline monitoring program. One leaking component was discovered prior to its next scheduled monitoring event. The procedure to transfer waste caustic was modified and the air blower arrangement was changed from variable pitch blades to a variable speed motor to ensure flare efficiency over a wider operating range. The fenceline monitoring program was very expensive for this very new, very small facility.

Should you have questions or require further information regarding this report, please do not hesitate to contact me at (713) 880-6518.

Yours truly,

Mary E. Hebert, P.E.
Environmental Director

/sjn
Attachment
copies: Maurice Oubre – LDEQ
Greg Johnson – Liskow and Lewis

ENTERPRISE

Administrative Order on Consent

AE-AOA-05-0009

Enterprise Products Operating LP

Baton Rouge Fractionator and Propylene Concentrator Unit

Port Allen, West Baton Rouge Parish, LA

Agency Interest No. 40198

Final Report

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Overview of Program

Timeline of the Program

The following represents a simple timeline of the Louisiana Department of Environmental Quality (LDEQ) Highly Reactive Volatile Organic Compound (HRVOC) Administrative Order on Consent (Order).

1. The LDEQ issued an administrative order on October 6, 2004 requiring fence line air monitoring, audit of fugitive emissions points, testing of cooling water and flare testing.
2. ENTERPRISE Products received the specific administrative order and fence line air monitoring plan dated January 14, 2005.
3. Flare testing was conducted by SETCO to reconfirm results of New Source Performance Standards under 40 CFR 60.18 and to determine the operating range of the new air blower variable speed motor.
4. Cooling water testing for Volatile Organic Compounds (VOCs) was conducted by EnRUD.
5. An audit was conducted to document all potential release sources of HRVOCs to include:
    a) Routine or continuous emission sources including an audit of the Leak Detection and Repair (LDAR) Program
    b) Non-routine sources such as equipment openings and clearings, startups, shutdowns, malfunctions, upsets, maintenance activities and leaks
    c) Emergency/safety emissions sources
6. The audit of the LDAR program resulted in a correction of the number of emission points.
7. A report summarizing the flare test and LDAR audit was submitted to the LDEQ on May 19, 2005, and was accepted on June 20, 2005.
8. Air monitoring and metrological equipment was installed, checked out and placed into service by May 2005.
9. An outside engineering firm qualified the analytical data for each month. Analytical data along with meteorological information for the month was reported to the DEQ by the 15th of each month for May 2005 through December 2006.
10. Request to terminate air monitoring was accepted by LDEQ on January 3, 2007.

Monitoring System Design

Enterprise Products installed two monitoring stations; one located at the northwest corner (91°12'21" W by 30°28'57" N) near the propylene splitter and one at the southeast corner (91°12'11" W by 30°28'45" N) near the fractionator. Each monitoring station is equipped with one total non-methane organic carbon (TNMOC) analyzer, one ozone precursor analyzer and a meteorological tower (wind speed and direction). A map of the facility follows in Figure 1.

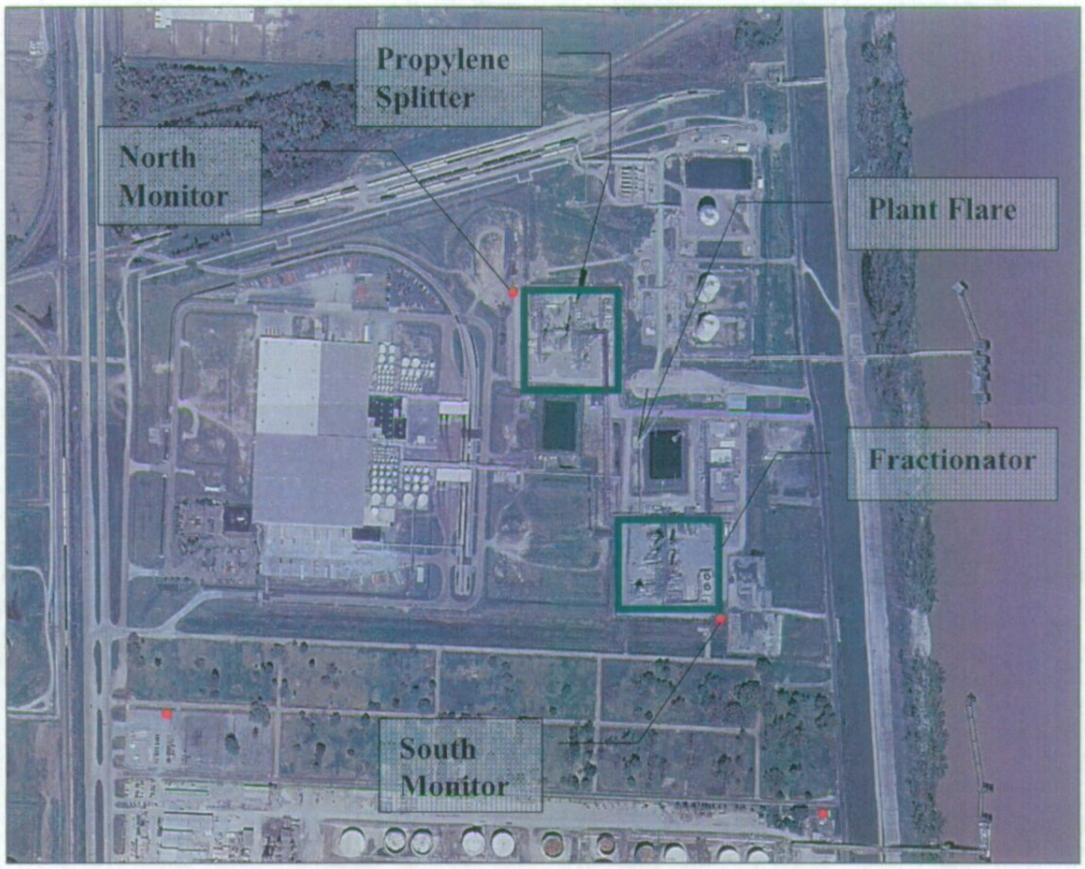


Figure 1: Overview of the Baton Rouge Complex

Total Non-Methane Organic Carbon (TNMOC) Analyzer:

This analyzer ran continuously in approximately three minute cycles. Methane and total non-methane values from each run were reported in ppmv. Data was averaged for each three-run cycle. Automated calibration was performed each evening from 8:00 – 9:00 pm.

Ozone Precursor Analyzer:

A preset trip value from the TNMOC analyzer triggered the Ozone Precursor Analyzer. The TNMOC trip value was 3 ppmv for most of the study period. The Ozone Precursor Analyzer pulled in and concentrated a 20-minute sample and then ran the extended 43-component analysis. These values are reported in ppbc. Automated calibration was performed each evening from 8:00 – 9:00 pm. A 15-component standard and a blank was used for calibration. A 43-component standard was used if a TNMOC trip occurred in the previous 24 hours prior to 8:00 pm.

Components analyzed by the Ozone Precursor Analyzer:

2-MethyIpentane	Ethylene	Styrene
3-Methylpentane	Propylene	n-Butane
2,3-DimethyIbutane	1-Butene	Isopentane
n-Heptane	cis-2-Butene	trans-2-Pentene
2Methylhexane	trans-2-butene	cis-2-Pentene

3-MethylHexane	1-Pentene	2,2-DimethyIbutane
2,4-Dimethylpentane	1,3-Butadiene	n-Pentane
Ethane	Isobutane	1-Hexene
n-Octane	Isoprene	2,3-Dimethylpentane
Isooctane	Acetylene	2,3,4-Trimethylpentane
Cyclopentane	Benzene	2-Methylheptane
Methylcyclopentane	Toluene	3-Methylheptane
Cyclohexane	Ethylbenzene	n-Hexane
Propane	o-Xylene	
Methylcyclohexane	m/p-Xylene	

Meteorological Tower:
Wind speed and directional data was collected continuously from the two stations. This data was reported in five-minute block averages.

Summary of Results

Significant Findings

Emission sources from the Baton Rouge complex were discovered including a leaking valve and the waste KOH transfer method. The flare was also modified in order to maximize its destruction efficiency over a larger range of feed flows.

Most of the elevated TNMOC and strike samples collected during this program, however, originated offsite. In particular, the following chart shows a strike fingerprint that is assumed to have traveled across the facility and was picked up by both monitors. On February 8, 2006 the south monitor picked up the emissions early in the morning causing the GC to collect samples at the south monitor around 2:30 am, 5:11 am and 8:11 am. By 10:00 am the wind had pushed the sample to the north monitor where a similar fingerprint was found. Figure 2 shows the VOC analysis by percent of each compound in each strike.

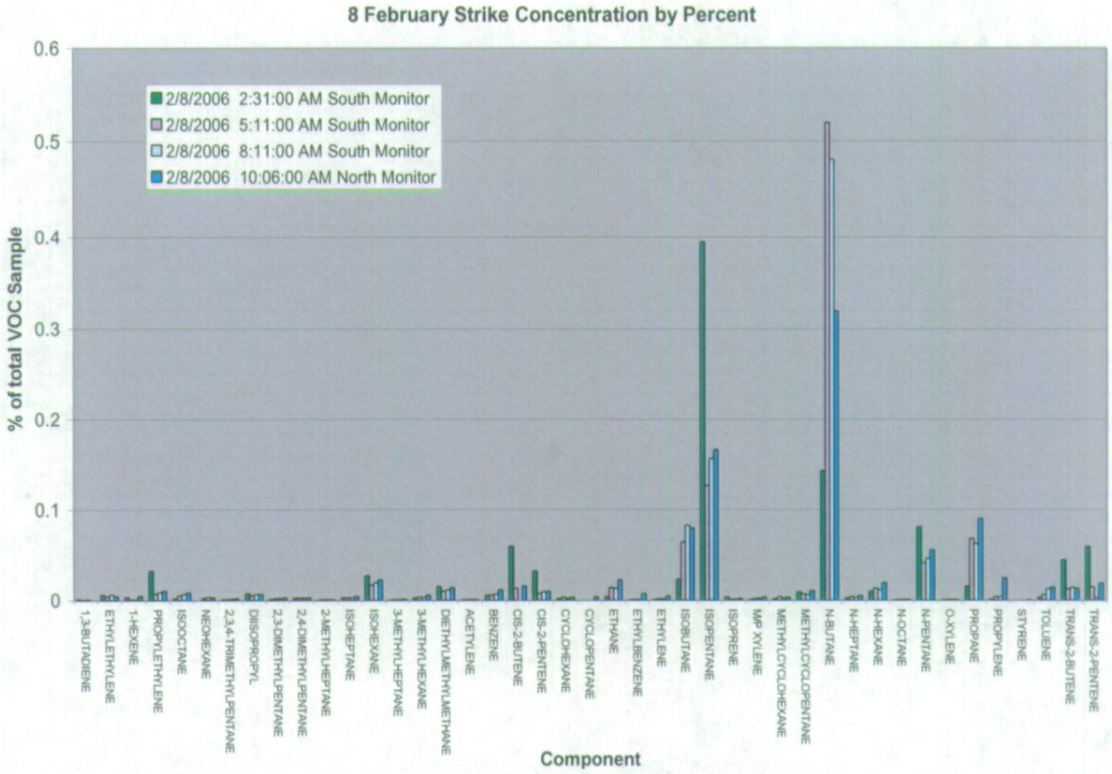


Figure 2: February 8, 2006 Sample Analysis for assumed emissions passing through facility

Particularly evident in an analysis of all TNMOC "strikes" taken at the monitors is the prevalence of offsite emissions detected as compared to emissions potentially from the units operated by Enterprise Products. Figure 3 shows the direction of the wind and the magnitude of the TNMOC concentration that caused each strike for 2006.

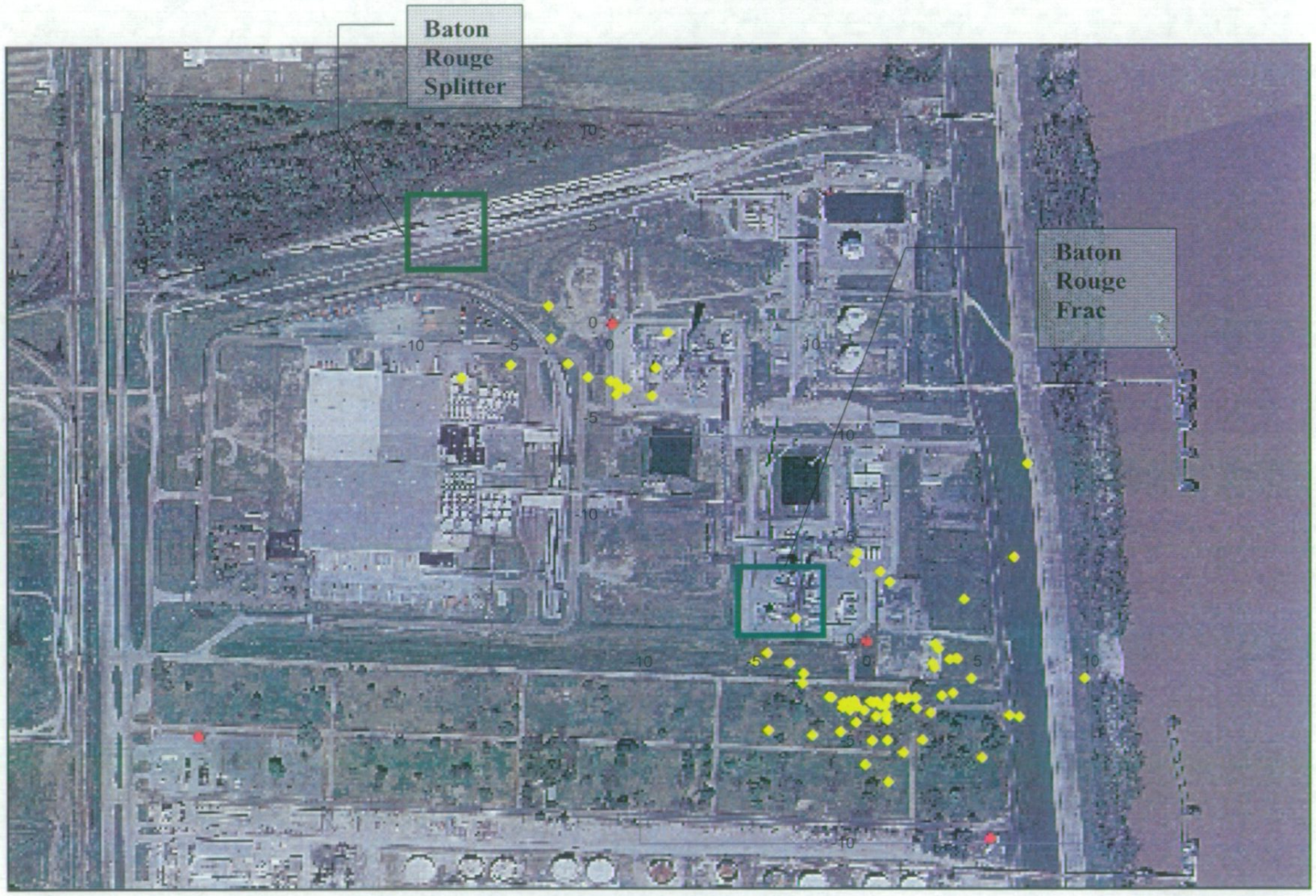


Figure 3: 2006 Strikes by Direction and Magnitude of TNMOC causing the Strike

Summary of Data Collected – Statistics, Graphs, Charts

2006 Annual summaries of TNMOC monitoring follow in Tables 1 and 2.

Table 1: 2006 Annual Summary of TNMOC Monitoring Results in ppmc

Station Identification	Minimum	Maximum	Average
Enterprise-N	0	7.98	0.62
Enterprise-S	0	34.58	0.42

Table 2: Available TNMOC Results

Station Identification	Total 10 Minute Periods in the Monitoring Period	Total of valid TNMOC data	Completeness
Enterprise-N	52,560	49,970	95%
Enterprise-S	52,560	49,144	94%

Along with Figure 3, the following figures (figure 4 and figure 5) show summaries of the Data collected in 2006.

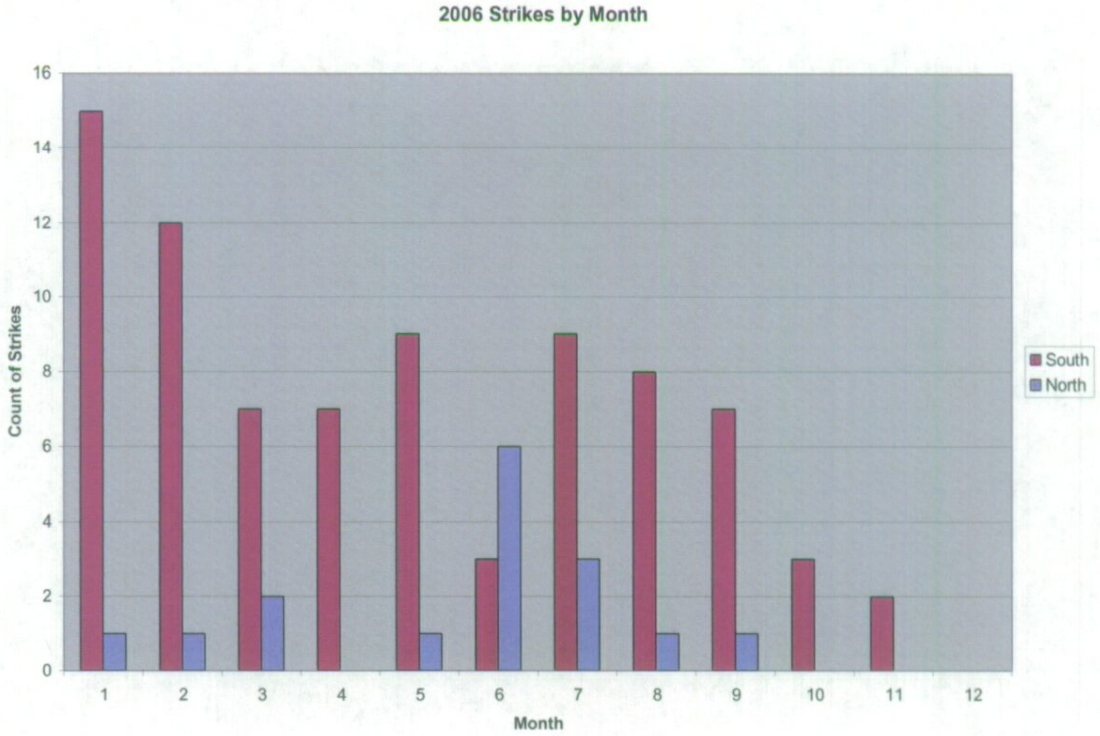


Figure 4: Strike Count by Month for 2006

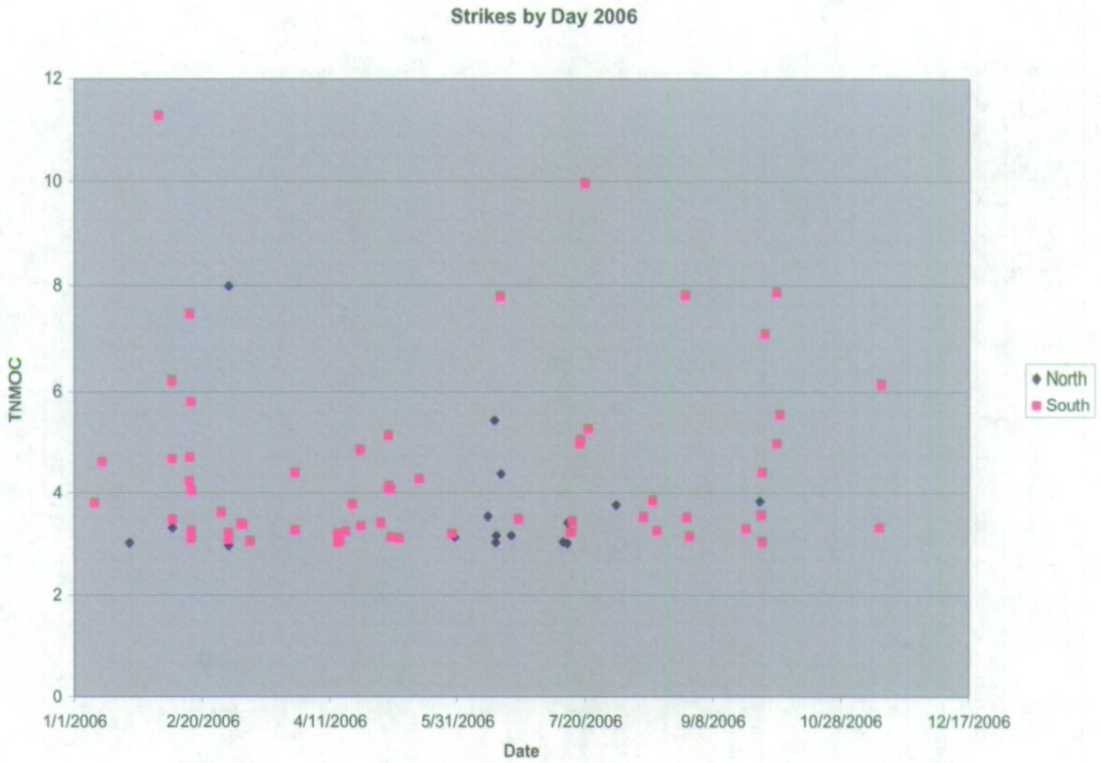


Figure 5: 2006 Strikes and the TNMOC Trigger Concentration

Overall program data runs 20 months from May 1, 2005 to December 31, 2006. Because of this fact, the above figures used calendar year 2006 data to summarize the results over one entire calendar year. The following figures and information incorporate data from the entire project or as noted.

As a result of issues with the TNMOC analyzer triggering the GC to take a strike sample, the GC was run continuously taking one sample per hour for the first two months of the program. This data is not summarized here in conjunction with the trigger summaries, but it was submitted to the LDEQ as part of this program in the normal monthly reports.

Table 3: Strike Summaries

2006 Strike Summary	
North Monitor	16
South Monitor	82
Total Strikes	98

Partial 2005 Strike Summary	
North Monitor	11
South Monitor	51
Total Strikes	62

Due to issues with the triggering mechanism toward the end of the program a more accurate 12 month depiction of monthly strike levels would be October 2005 through September 2006. This information follows in figure 6.

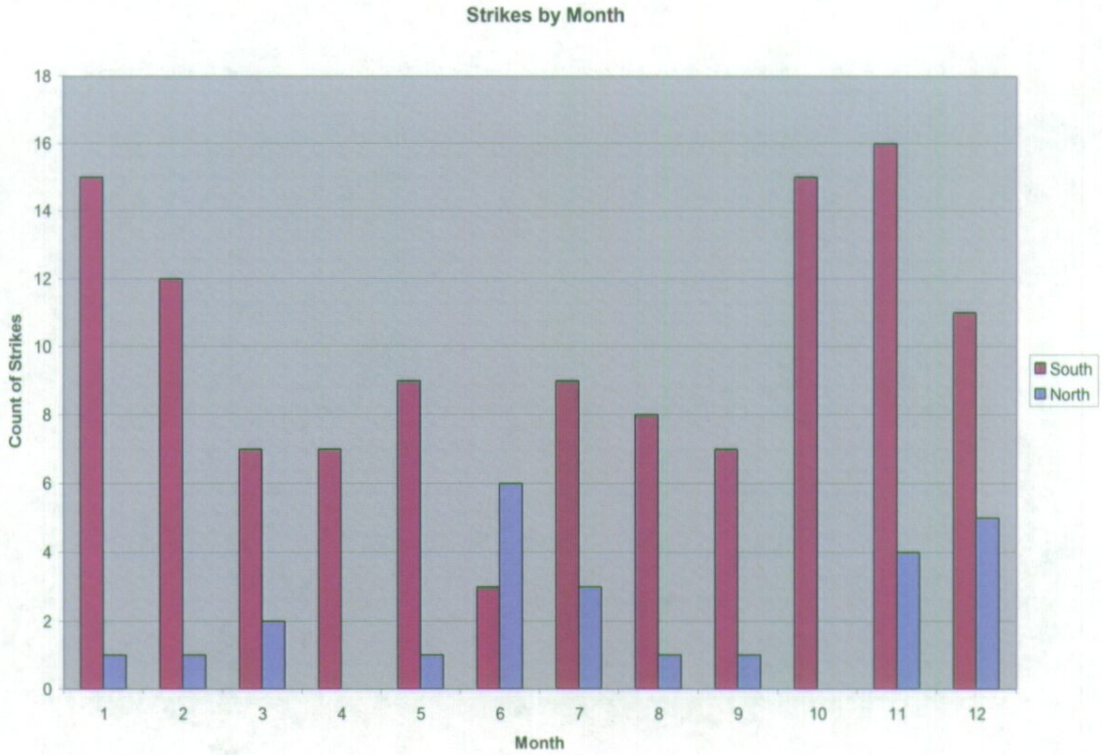


Figure 6: Count of Strikes by Month

Figure 7 represents the average TNMOC concentration recorded by the TNMOC analyzer broken down by wind direction. There are two lines on the figure's roses. One line (blue) shows the average for only 2006 data where the other line (pink) shows the average for all the data collected in conjunction with this program.

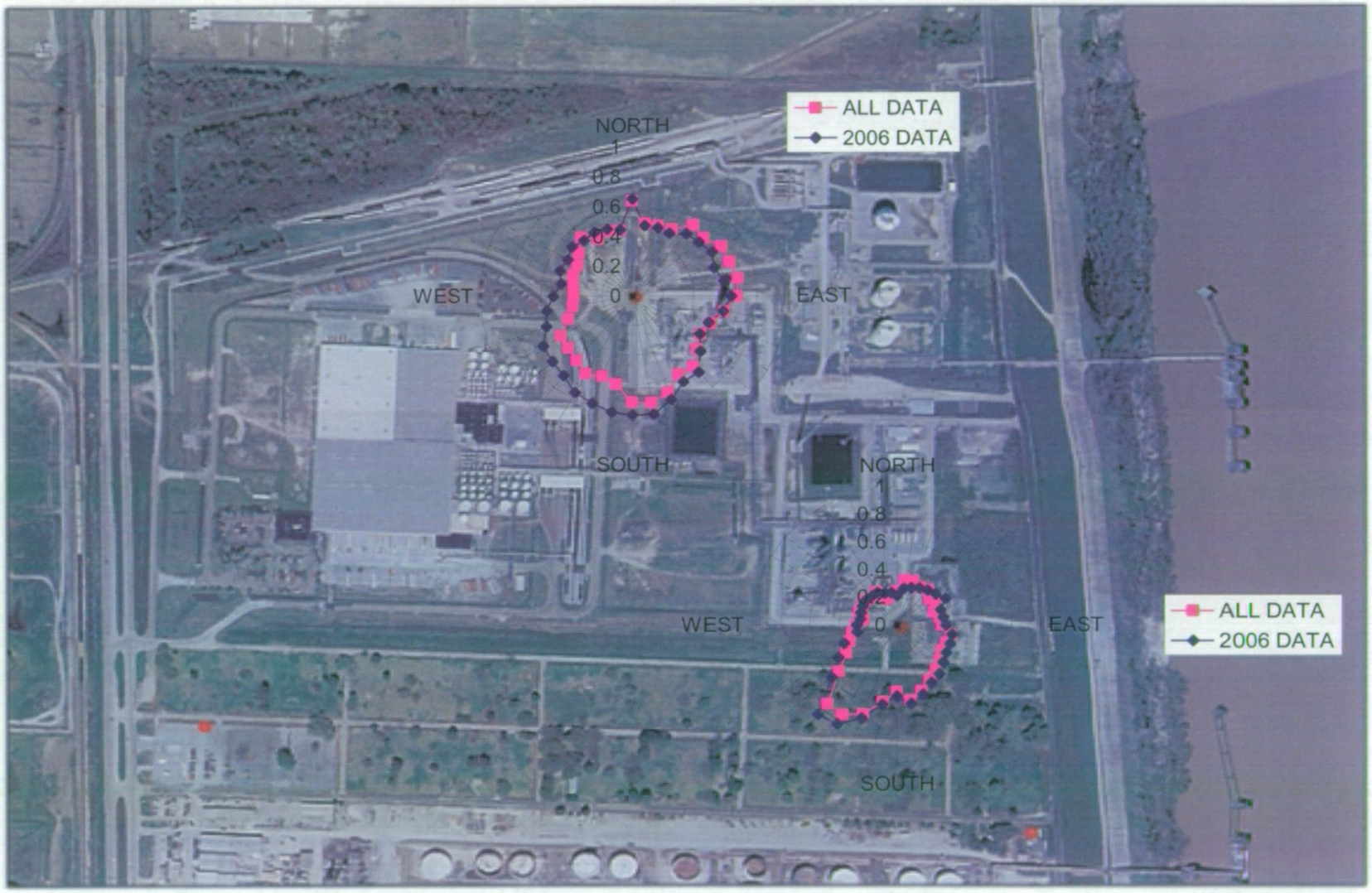


Figure 7: Average TNMOC Pollution Roses for the North and South Monitors

The pollution roses show a distinct bias in the southern direction. This would support a conclusion that much of the VOC registered by the monitors has a source outside the fence line.

Description of Modifications

KOH Treatment

The procedure for transferring the waste caustic from the KOH treater was modified to reduce the release of emissions. In the past, the KOH treater was cleared rapidly to the flare causing a surge of splitter feed (a mixture of propane and propylene) to go to the flare. This clearing process has been slowed down to dampen the surge but operationally takes longer.

Plant Flare

Historically throughout industry, blower controls focused on opacity rather than burn efficiency. The original blower control design used variable fan pitch to affect the amount of air to the burner tip. Using this method allowed about 30% control range of the top end of the air flow.

The flare blower was changed from a variable pitch fan to a fixed pitch with a variable speed motor drive, which allowed a much wider control range of the amount of air to the burner tip. The addition of a stand alone flare flow instrument coupled with controls to vary the blower speeds provided an air/fuel ratio much closer to optimum, thus greatly improving flare burn efficiency.

Conclusions

Summary of Emission Reductions Achieved

Emission reductions were realized based on results from the ambient air monitoring program by changing the waste caustic transfer procedure and by finding one leaking component prior to the next LDAR monitoring event. The modifications made to the plant flare blower and LDAR audit were from the other items listed in the Agreed Order.

Description of On-Going Programs to Prevent Back-Sliding

The Leak Detection and Repair program will continue and will be more accurate based on the audit. The flare blower modifications will continue to ensure a proper mix of fuel to oxygen over a wider flow rate range. A more heightened awareness of the HRVOC issue will continue at this facility and others that are operated by Enterprise.

Positives and Negatives of the Program.

The positives of the program include being able to respond quickly to a suspected leak based on TNMOC and wind direction. Reductions in emissions resulted from compliance with the order.

The negatives of the ambient air monitoring program include the very high expense, including substantial capital and operating costs. Maintenance costs were high along with the time operators spent responding. The overall cost per pound of emissions reductions for this very new, very well controlled facility was extremely high.

Appendix D – Facility Final Reports

ExxonMobil Chemical Plant/ ExxonMobil Refinery

BRCP/BRRF

Project Completion Report
Perimeter Monitoring Project
ExxonMobil Baton Rouge Refinery and Chemical Plant
February 28, 2007

ExxonMobil

LDEQ RECEIPT

7 FEB 28 P4:28

ExxonMobil

February 28, 2007

HAND DELIVERED

RECEIVED
FEB 28 2007
LDEQ

Mr. Maurice Oubre
Environmental Chemical Specialist III
Louisiana Department of Environmental Quality
P. O. Box 4314
Baton Rouge, LA 70821-4301

RE: Final Project Completion Report
HRVOC Administrative Order on Consent
ExxonMobil Baton Rouge Chemical Plant and Baton Rouge Refinery
Tracking Nos: AE-AOA-05-0029 & AE-AOA-05-0031
Agency Interest No. 286 & Agency Interest No. 2638

Dear Mr. Oubre:

Please find attached two (2) copies of the final report summarizing the monitoring activities performed under the above mentioned Administrative Order on Consent (AOC's) for the ExxonMobil Baton Rouge Chemical Plant (BRCP) and Baton Rouge Refinery. The LDAR and emission systems audits that were conducted during 2005 by third party experts were previously submitted under separate cover. Based on our telephone conversations with you, ExxonMobil is submitting one report covering both facilities, reflective of the monitoring efforts that were conducted.

We think that a review of this report will clearly demonstrate ExxonMobil's commitment of technical and financial resources to this project as another example of our interest in assisting the LDEQ in helping the Baton Rouge area achieve attainment with the EPA's ozone standard(s). In fact it is that commitment to this project that led to our being recognized by the LDEQ management as being the industry leaders among the group of companies participating in this AOC process. Our monitoring systems were truly the first of their kind, to our knowledge in the country, from a technical perspective, and the level of effort in pursuit of identifying sources of elevated levels detected during the monitoring is believed to have been unmatched throughout the 20 months of operation.

While considerable effort and resources went into the monitoring effort and investigation activities, it should be noted that there were several salient points. There were literally only a handful of the nearly 1000 triggers at our five monitors that ended up as reportable events. Many of the triggers were attributable to permitted emission points or activities, largely influenced by ExxonMobil's decision to place the monitors in close proximity to our operations. It was also interesting that our monitoring showed over one third of our triggers coming from off-site sources, and in many cases, showed a much higher concentration of organic compounds than those events that originated from the direction of our operations.

We also note that the original target of this monitoring effort, the highly reactive volatile organic compounds, were only present in a small percentage of the samples analyzed by gas chromatograph when elevated levels of total organic compounds triggered the speciated sampling and analysis. This is especially true of some of the compounds that garner a lot of attention, such as ethylene, propylene and butadiene. It was especially pleasing to ExxonMobil to see so few analyses turn up concentrations of these three chemicals above the 100 parts per billion level, especially given the large quantities of these chemicals that are produced and used in the complex.

If you would like to discuss any of the items in this report following your review, we would be glad to meet with the LDEQ at your convenience. If you have any questions, please do not hesitate to call Robert Berg at (225) 977-0193.

Very Truly Yours,

W.D. Fellows
Environmental Manager

Cc: Mr. Chris Roberie
Mr. Robert Berg
Mr. Andrew Fisher

Project Completion Report
Perimeter Monitoring Project
ExxonMobil Baton Rouge Refinery and Baton Rouge Chemical Plant
February 27, 2007

Robert Berg and Dave Fellows

Executive Summary

Solving the ozone non-attainment problem in the Baton Rouge, Louisiana airshed continues to be a technical challenge. Based on the Louisiana Department of Environmental Quality ambient monitoring activities in 2003-2004, and similar work in the Houston/Galveston Non-attainment area, the agency opted to pursue a strategy that would address Highly Reactive Volatile Organic Compounds (HRVOC). To assist in these efforts, 15 industrial facilities in the Baton Rouge area, in partnership with LDEQ, installed ambient monitors with plans to operate them for a period of 2 years, from May 1, 2005 –May 1, 2007. The monitors needed to be capable of measuring a list of 43 compounds judged to be potential contributors to elevated ozone based on photochemical reactivity. Ambient monitoring stations currently operated in the Baton Rouge area by the LDEQ use a Total Non-methane Organic Carbon (TNMOC) analyzer, which runs continuously, and in the event of elevated TNMOC readings, a sample is collected in an evacuated Summa canister. The Summa canister is then manually changed out and the collected sample taken to an analytical laboratory for analysis. In designing our system, ExxonMobil felt it was important to find a way to obtain more "near real-time" results. By decreasing the amount of time elapsed between an event and having access to analytical results, we could increase the ability of facility personnel to quickly investigate and better identify possible sources of the elevated TNMOC levels.

The project was implemented at the ExxonMobil Baton Rouge Refinery and Chemical Plant (the Complex) with field measurements and initial data gathering commencing May 1, 2005. There were a number of events that occurred during the 20 month duration of the project. A number were from permitted emission sources or activities, some led to finding sources in the plant, but very few were from reportable events (exceeded any reportable quantities, or were a result of a non-compliance with an emission standard or regulation). The monitoring also showed a number of events with high levels of TNMOC from off-site sources, some from areas that might not have been expected to contribute significantly. Relatively few of the samples collected by the gas chromatographs when triggered by elevated TNMOC readings showed the compounds that were the initial targets of the AOC, and the number of samples with higher readings (> 100 **ppb**) of ethylene, propylene or 1, 3 butadiene were fewer still. This is particularly significant considering that the complex produces and processes all of these chemicals in large quantities. Extensive data submittals of all the TNMOC, GC results, meteorological data on 5 minute intervals and results of investigations of trigger events were made to the LDEQ on a monthly basis via uploads to a secure server.

The project was deemed successful by the LDEQ, and the agency allowed early termination of the monitoring efforts December 31, 2006.

Introduction

ExxonMobil is an active participant in several joint industry/agency technical workgroups that are focused on improving air quality in the Baton Rouge area. One of the joint groups is specifically looking at ways to help the Baton Rouge non-attainment area come into compliance with the National Ambient Air Quality Standards (NAAQS) for ozone. While there have been significant reductions in industrial emissions of two important ozone precursors, oxides of nitrogen (NOx) and volatile organic compounds (VOC), the area was still unable to meet the 1 hour NAAQS for ozone until CY2006. In the 2003 and 2004 ozone seasons, it appeared that a potential contributor to sudden rises in ambient ozone concentrations might be elevated levels of highly reactive VOC (HRVOC), a group of compounds such as ethylene, propylene, 1,3-butadiene, butenes, and isoprene that have a very high photochemical reactivity. Around this same time, similar groups studying the causes of ozone non-attainment in the Houston/Galveston, Texas areas, had concluded that releases of HRVOC could be a significant contributor to their non-attainment situation. This information and the need to validate these theories led to an agreement between the Louisiana Department of Environmental Quality (LDEQ) and 15 Baton Rouge area industrial facilities to enhance the ambient monitoring capabilities in the non-attainment region.

ExxonMobil's Baton Rouge complex includes the Baton Rouge Refinery (BRRF) which is one of the largest refineries in the United States. Products produced at the refinery include motor gasoline, diesel, jet fuel, aviation fuel, lubricating oils, waxes, petroleum coke, liquefied petroleum gas and chemical feedstocks. The complex also includes the Baton Rouge Chemical Plant (BRCP) which is one of the largest chemical operations in the U.S., manufacturing a variety of petrochemicals and polymers.

The combined footprint of the two operations encompasses more than 2200 acres, so designing a perimeter air monitoring network that would provide good coverage at a reasonable cost was the initial challenge. There were several additional criteria that the monitoring network had to satisfy. The network had to have the ability to continuously collect and retain monitoring data, yet only communicate the data when something appeared out of the ordinary. This also meant that the network had to communicate with several user groups, all of whom had differing data needs. And the communication portion of the network was complicated by the fact that the desire to have the monitors near the perimeter (of this very large facility) meant access to hardwired communications equipment would not be available. The network also had to be fully automated, since staffing operators and maintenance support for the equipment continuously around the clock was not a viable option.

It was also important to ExxonMobil that the network had the ability to rapidly provide information to plant operations and environmental personnel to allow response efforts to quickly identify and mitigate potential sources that might have caused or contributed to elevated emission levels. It was this goal that led our team to select use of a triggered Gas Chromatograph (GC) rather than a triggered sample collection system (summa canister) that would not provide such near real-time results. As will be discussed in more detail below, this type of triggered GC system, is to the best of our knowledge, the first of its kind to be used in the United States. As such, it meant that our network and monitoring system literally had to be designed from scratch, making estimating costs and developing a reasonable schedule to project completion difficult. The schedule was ambitious to start with, given the desire to have the

monitoring start no later than the beginning of "ozone season", or May 1, 2005. This left a little more than 4 months from final design approval and contractor selection to have five fully functional units in the field collecting data. (It should also be noted that two other ExxonMobil facilities in the area participated in these efforts, and each had two additional monitoring stations, making a total of nine for the project team to build and have in operation in this 4 month window)

There were several implementation details that had to be managed in addition to the physical workings of the equipment. Most involved how to manage and present the tremendous amount of data that would be collected. Total Non-Methane Organic Compound (TNMOC) concentrations, and wind speed and direction were collected continuously, and reported on 10 and 5 minute intervals. In the event of a TNMOC concentration exceeding a trigger level, a GC analysis for the 43 VOC compounds of interest was generated. By the end of the project in December 2006, there were a total of 1567 triggers over the values selected to represent baseline concentrations resulting from 474 separate trigger events that occurred in the approximately 20 months of operation, with 626 valid GC samples collected and analyzed. All of this data had to be collated and provided in a user friendly format for communicating results within ExxonMobil and for use by the LDEQ. The tools developed for analyzing and presenting this data are discussed in more detail below.

Network Design

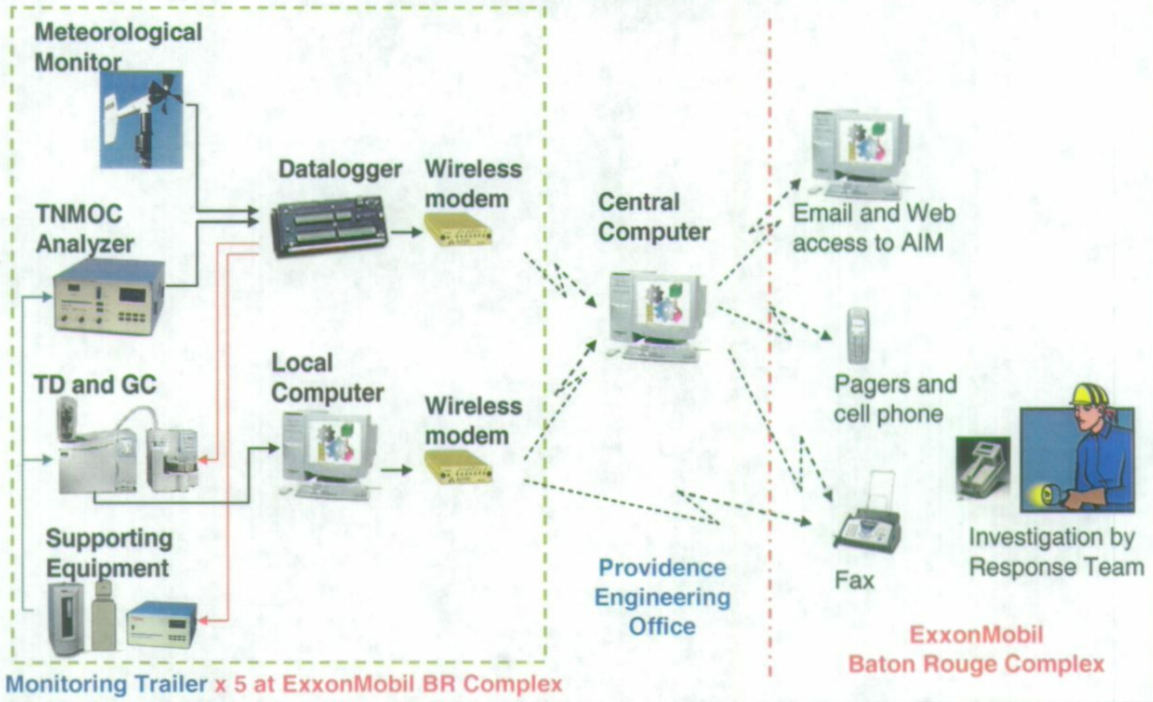
If stationary monitoring stations were installed, a large number of stations would be desired to provide a good coverage along the perimeter of the 2200 acre facility. To make the monitoring network cost effective, ExxonMobil designed a network using five mobile monitoring stations (five monitoring trailers). The trailers were placed generally upwind and downwind of the most likely emission sources, according to the prevailing wind directions during three periods occurring each year. The reason to divide a year into the three periods was that the patterns of monthly prevailing wind directions in the area tend to fall into three periods, based on a review of historical meteorological data. The three periods were from December through June, from July through August, and from September through November. The trailers were relocated at the beginning of each period to maximize the chances to capture samples of interest for the purpose of understanding releases, especially unexpected releases, of HRVOC, and the characteristics of these releases. The various locations are shown below. This approach satisfied the objective of the Baton Rouge area perimeter monitoring effort in a more cost effective manner than the initial suggestion from the LDEQ.

Location of Monitoring Sites-ExxonMobil Baton Rouge Complex

Monitoring System Design

Conventional ambient monitors generally collect data passively and do not require many decision making capabilities. The monitoring system for this project needed to be capable of automatically making some intelligent decisions and prompting facility personnel to take actions to investigate and mitigate possible unexpected releases. The system is referred to as "Active and Intelligent Monitoring" (AIM) and is illustrated in Figure 1.

Figure 1. Active and Intelligent Monitoring (AIM) System Used for the ExxonMobil Perimeter Monitoring Project



Each trailer is a self-contained mobile lab. Meteorological sensors are products of Y.M. Young Company and are installed on a 10-meter vehicle-mounted retractable tower. These sensors monitor wind direction, wind speed, temperature, and relative humidity continuously and the data is recorded on a five-minute average basis. Ambient TNMOC concentrations are continuously monitored by a Thermo Electron Model 55C direct methane, non-methane hydrocarbon analyzer with an analytical cycle time of approximately 70 seconds. The TNMOC data is averaged on a 10-minute basis. The meteorological data, methane data, and TNMOC data are captured by a Campbell Scientific, Inc. CR10X datalogger. A 16-channel multiplexer (Model AM16/32) and a 16-channel relay controller (Model SDM-CD16AC) are added to meet the project demand in data acquisition and control beyond the capability of CR10X. When a 10-minute average TNMOC concentration exceeds a predetermined threshold (trigger level), the datalogger initiates a GC analysis.

The GC analysis is performed by a PerkinElmer Ozone Precursor Analyzer, also referred to as Auto-GC in other air quality monitoring programs. The major components of the Ozone Precursor Analyzer are a Turbomatrix Thermal Desorber (TD) and a Clarus 500 GC. The Auto-

GC is designed to analyze more than 56 ozone precursors [1]. Based on the LDEQ's interest in the data, 43 chemicals were identified as target compounds for this project for all the facilities participating. The LDEQ dubbed this list of chemicals, "Target Ozone Precursor VOC or TOPVOC". In order to cover such a wide range of chemicals at very low concentrations, several analytical techniques are incorporated into the Auto-GC, such as an automated cold trap pre-concentrator and thermal desorption system, "2-D" GC using a Deans switch and two columns (a PLOT column for light compounds and a BP1 column for heavier compounds), etc.

Before this application, the Auto-GC was always used in a "continuous" operating mode for ozone precursor monitoring [1]. The system starts sampling typically at the beginning of an hour; collects an ambient air sample in the TD for 40 minutes; thermally desorbs the sample into the GC and performs GC analysis. It takes 47 minutes to elute all targeted ozone precursor compounds during the GC analysis. While the GC analysis is still in progress, the TD starts another sample. With this overlapped time between the TD and GC, the entire sampling/analysis cycle can fit into one hour, and the monitoring is running hour-by-hour continuously ("continuous" mode). As is the case with any modern GC, each individual analysis run is controlled by a "Method" in the GC's computer, and a series of runs are controlled by a "Sequence" stored in the GC's computer (a Sequence is made up by one or more Methods). When the Auto-GC is in the "continuous" mode, a Sequence can be programmed in advance to instruct the Auto-GC when to start a sample analysis, when to start a calibration check, etc. Such continuous Auto-GC systems for ambient monitoring have been used in Texas, Georgia, and other regions in the country for many years.

For this project, the goal of ExxonMobil and the LDEQ was to capture samples during high TNMOC episodes in the same manner as collecting triggered canister samples. ExxonMobil further desired to have the sample analyses completed immediately as opposed to the delayed analyses of the canisters. This desire lead to the application of Auto-GC operated in a "trigger" mode as opposed to "continuous" mode. The established GC control scheme for continuous operations through the sequence described above does not work because (1) the number and time of trigger events cannot be determined and programmed in a Sequence in advance, and, (2) blank and calibration check runs for quality control need to be scheduled at a fixed time of a day to make the GC available during the time ozone related information is important. After careful evaluation and experimentation, the team concluded that a solution relying on some kind of GC software control would be, if feasible at all, very complicated and unreliable in unmanned long-term operations. The team decided to use the datalogger to directly control the Auto-GC operations through the relays in the TD and the GC. The datalogger starts and stops triggered sample analyses based on the TNMOC concentrations in relation to the trigger levels. Considering that the triggered samples have higher concentrations, the sampling time is compressed to 10-20 minutes as compared to 40 minutes in current Auto-GC applications for a lower detection level. The datalogger also starts a single blank check run at 9 pm every day and a single calibration check run at 10 pm every day. The datalogger also controls the supply of blank samples or calibration samples to the Auto-GC in a synchronized fashion to facilitate the daily blank check and calibration check.

There are three types of calibration checks that shared the 10 pm time slot. A 15-component calibration verification standard (CVS) was normally used to verify that the system was working properly and that the response factors for quantitative analyses were in an acceptable range. At a two-week interval, a 44-component lab check standard (LCS) was used in place of CVS. The LCS check provided a quality check for all target compounds when compared to the expected

retention times and response factors. The third standard was a 44-component retention time standards (RTS). The RTS is the same as LCS but from an independent cylinder. The RTS was used in place of the CVS (or the LCS if it is the day scheduled for LCS) if one or more trigger samples had been analyzed for that day. The RTS was used primarily to confirm the retention times for each compound. Scheduling an RTS run on the same day as trigger event(s) provided additional confidence that the compounds were correctly identified. The three types of the calibration standards have been used in Texas ozone precursor monitoring program [2].

As illustrated in Figure 1, there is other supporting equipment that makes each trailer self-contained. The supporting equipment includes gas cylinders, gas generators, a dynamic multi-gas calibrator, a local computer interfacing with the Auto-GC, and wireless modems for data communication. The Central Computer located in Providence Engineering's Baton Rouge office pulls continuous monitoring data at an interval less than 10 minutes through the wireless modem connected to the datalogger in the trailer. The Central Computer houses programs that (1) parse the data and store the data in a database; (2) handle communication to the facility personnel (to be discussed in more detail later); (3) modify trigger levels and notification criteria; and (4) serve web applications allowing the facility personnel access to real-time data and other features as wind back trajectory plots and scatter plots (equivalent to pollution rose plots). When a trigger event occurs and it meets certain criteria for notifying facility personnel, the system will send a trigger notification to the facility response team along with detailed data to help the response team investigating potential causes of the elevated levels.

The other wireless modem connected to the local computer allows the team members to maintain the Auto-GC remotely. It is also used by the local computer to directly send the GC data to the response team after the local computer utilizes a specially designed program to determine if GC data need to be faxed, extract the GC data from the GC software, and convert the data into a faxable format suitable for sending via fax machine.

Triggering Method and Communication Process

In typical triggered canister systems for community air quality monitoring, a canister sample is triggered when the TNMOC concentration exceeds a trigger level somewhere in a range from 0.5 to 1.5 parts per million expressed as Carbon (ppmC). This range was not appropriate for perimeter monitoring because the monitors were much closer to sources, and the TNMOC was expected to be higher. Since data did not exist on what the baseline concentrations of TNMOC would be in the various locations along the perimeter of the facility where the trailers would be placed, ExxonMobil and LDEQ agreed that it was appropriate to set a 30 day shakedown period for each new location that a monitoring trailer was placed in, and use this time to ensure that all the equipment was operating properly, and to assess what the baseline concentrations were in the area. The trailers were placed in service May 1, 2005 and the data collection commenced. As expected, the background concentration of TNMOC was generally found to be highest in those monitoring locations closest to the process areas, but varied depending on proximity to the emission sources and what type of source was nearby.

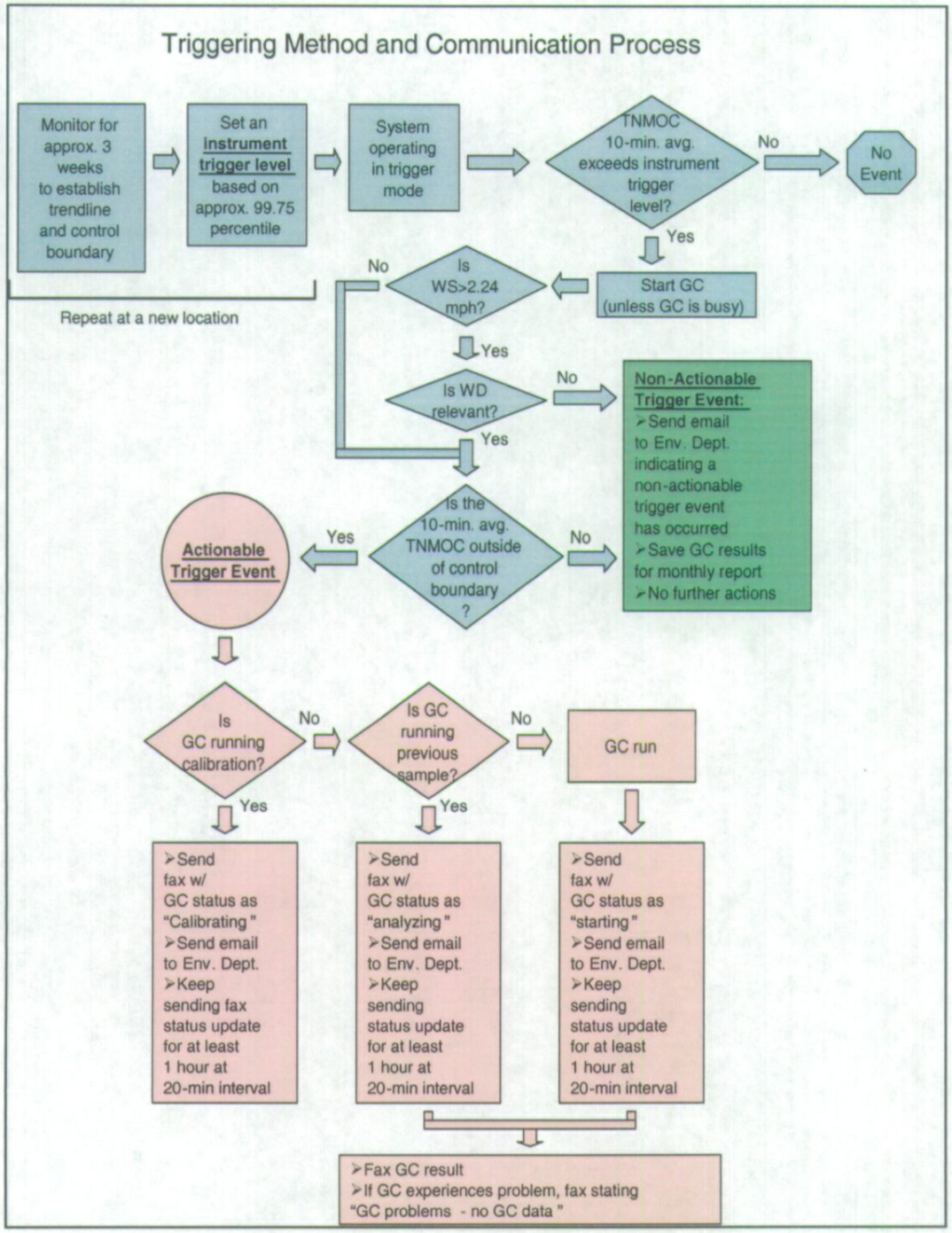
ExxonMobil used the system not only to collect monitoring data for the LDEQ, but also to help detect possible unexpected releases and take action to mitigate these units. If the trigger level was set too low, the system would produce excessive amounts of data, most of which would reflect routine (permitted) emissions. There was also a concern about alerting the facility

response team so frequently that the effectiveness of the system will be lost. Furthermore, it is unnecessary to notify the response team when a trigger event occurs, but the apparent source of the elevated concentration is unrelated to the ExxonMobil facility due to wind conditions. To differentiate between the two, trigger events were classified as "actionable" and "non-actionable" based on wind directions in relation to the monitor locations, as programmed into the system. Based on this distinction a triggering method and communication process was developed as illustrated in Figure 2.

For the initial placement of the trailers at each selected monitoring location, approximately 3 weeks worth of TNMOC monitoring data was collected to determine a reasonable baseline concentration for the location. Based on this data, an instrument trigger level (the trigger that will start the GC) was determined based on the 99.75 percentile. Because the TNMOC data is recorded on a 10-minute basis, about 11 trigger events per month could be statistically expected based on this 99.75 percentile. Considering multiple trigger events within the same hour will only actually produce one trigger event (because it will take the GC one hour to complete the analysis and subsequent events in that hour will be counted as the same event), this approach expected to meet or exceed the desired 5 trigger events per month desired by the LDEQ. As can be seen below, the number of triggers and samples exceeded the LDEQ expectations by a wide margin.

Once the instrument trigger level was established, the system continuously operated in the trigger mode. When a TNMOC concentration exceeded the instrument trigger level, the system initiated a GC analysis. At the same time, the system would determine whether the trigger was actionable or non-actionable based on the following criteria. If the wind speed is below 2.24 mph (1 m/sec, which is the threshold for calm wind condition in EPA dispersion modeling guidelines), the wind direction is considered unreliable. If above this wind speed, the wind direction is considered reliable. If the reliable and persistent wind direction suggests that this particular monitor was in an upwind position with respect to the ExxonMobil facility, the trigger event is considered non-actionable. Otherwise, it is considered actionable. Initially, another factor was considered in determination of non-actionable events – the natural fluctuation of the observed TNMOC data. For this consideration, a 3-day moving average and standard deviation were calculated. The 3-day moving average plus 6 standard deviations would form a control boundary. If the TNMOC concentration was within the control boundary, the event was considered to be caused by the permitted emissions under worst wind conditions and therefore no action is required. Although the control boundary approach was a sound one in principle, setting proper parameters (how many days used to calculate moving average and how many standard deviations) was arbitrary. In practice it was somewhat difficult to implement and caused some confusion. Therefore, this approach is no longer used. For future work, it is worth exploring some artificial intelligent system or pattern recognition methods with the same logic of consideration.

After a trigger event had been classified as actionable, the additional steps in the figure below were designed to best communicate with the facility response team regarding what types of data they could expect and when. These steps proved to be very critical in establishing clear communication and reducing confusion and frustration.


Triggering Method and Communication Process
Monitor for approx. 3 weeks to establish trendline and control boundary
Set an instrument trigger level based on approx. 99.75 percentile
System operating in trigger mode
TNMOC 10-min. avg. exceeds instrument trigger level?
No
No Event
Yes
Start GC (unless GC is busy)
Is WS>2.24 mph?
No
Yes
Repeat at a new location
Is WD relevant?
No
Non-Actionable Trigger Event:
➢Send email to Env. Dept. indicating a non-actionable trigger event has occurred
➢Save GC results for monthly report
➢No further actions
Yes
Is the 10-min. avg. TNMOC outside of control boundary ?
Yes
No
Actionable Trigger Event
Is GC running calibration?
No
Is GC running previous sample?
No
GC run
Yes
Yes
➢Send fax w/ GC status as "Calibrating"
➢Send email to Env. Dept.
➢Keep sending fax status update for at least 1 hour at 20-min interval
➢Send fax w/ GC status as "analyzing"
➢Send email to Env. Dept.
➢Keep sending status update for at least 1 hour at 20-min interval
➢Send fax w/ GC status as "starting"
➢Send email to Env. Dept.
➢Keep sending status update for at least 1 hour at 20-min interval
➢Fax GC result
➢If GC experiences problem, fax stating "GC problems - no GC data"

Use of the System by Facility Personnel

When the monitoring system was conceived and developed, a key driver was having a tool that would be useful for identifying sources of plant emissions that were out of the ordinary. The decision to utilize a triggered GC, in lieu of the suggested canister system was largely based on the desire to know the identity of the compounds as quickly as possible during an event, so the search for the potential source could be narrowed down quickly. Considering that the two facilities (BRRF and BRCP) have more than 1000 combined emission sources, and occupy over 2200 total acres, pinpointing a non-routine source of emissions can be a real challenge.

When one of the monitors exceeded a trigger value (as explained earlier in this Section), a fax was sent to the Operations Emergency Center (OEC) and to both the BRRF and BRCP operations superintendents. The superintendents would then lead the response efforts, which included mobilizing 3-6 trained operators who used handheld hydrocarbon gas detectors to help locate the source of the emissions. These handheld devices are actually Flame Ionization Detectors (FIDs) similar to those used for monitoring fugitive emission components and are capable of reading hydrocarbons in the low part per million range with a very fast response time. ExxonMobil purchased a total of six of these units for use by the response teams.

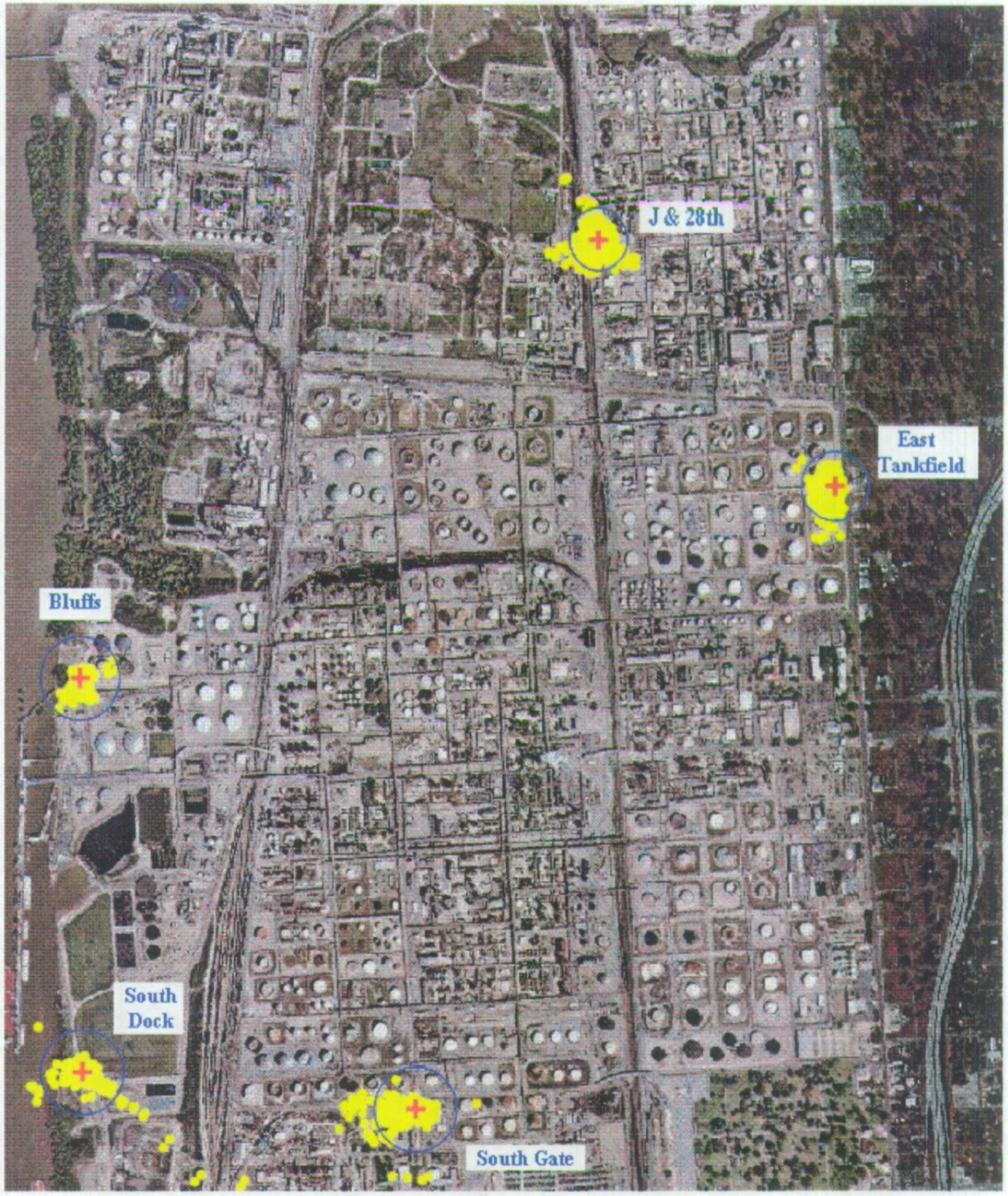
Even with the wind speed and direction and TNMOC concentrations provided on 5 minute intervals, and use of a team of trained responders with handheld detectors, it was still difficult to quickly isolate a source. In light of early experiences, several additional tools were developed to enhance response efforts.

Complex maps of the largest emissions sources of the TOPVOC being monitored were developed, based on the past 5 years actual emissions. The areas containing the top 5 emissions sources were shaded on a plant plot plan, so that when the GC results from an event came in, a high concentration of a particular constituent could be compared to the maps to identify likely areas to investigate.

Providence Engineering then developed and added to the website two very useful tools, a wind back trajectory tool and scatter plot capability. The back trajectory takes the wind speed and direction reading for up to three hours prior to the trigger event, and creates a series of vectors depicted as lines on a plant aerial photograph. This line is followed as a first path by the responders, and often identified the location of an emission source that was a potential contributor. An example of a back trajectory is shown below. Note in the example that the monitoring station is at the top of the plot, represented by a red cross, with each 5 minute segment of wind data "backtracked" away from the source, and bracketed by red dots. The length of each segment is based on the wind speed during this 5 minute period, so the longer the segment, the higher the wind speed. So, observing the representation of the time leading up to this event, it appears that the source of the trigger could have originated from the southwest of the monitor. As it turns out, this trigger was found to have been caused by emissions from a source in the refinery between the third and fourth dot back from the monitor. If the immediate observation of wind direction at the time of the trigger had been used for the investigation, it would have indicated a source almost due west of the monitor. Obviously, the backtrack tool is more difficult to rely on at longer elapsed times prior to the trigger.

Back Trajectory Mapping Tool

The scatter plots are another way of showing the TNMOC concentrations plotted against wind direction. The concentrations are plotted radially from the trailer, with the wind direction setting the angle from the trailer location, and the distance representing the magnitude of the TNMOC. This is especially useful for showing trends and focusing investigations in a particular area or at least a set direction. As the scatter plot includes data below the trigger level as well as above, this technique is useful for analyzing long term releases. An example scatter plot is shown below.



Example Scatter Plot October 2006

Several items to note from the example scatter plot. There were a number of trigger events that originated from off-site sources. At the South Dock location, there were TNMOC readings above the trigger level indicating a source from the west and several very high concentrations that originated from the southeast. The South Gate station shows off-site sources of elevated TNMOC from the southerly direction and elevated levels from due west of the station, which were found during follow-up investigations to be from a naphtha storage tank needing seal repairs. This tool was very useful to look at trends and graphically direct investigation teams. The scatter plot around the South Dock location clearly shows the sensitivity of this monitoring in relationship to wind direction, as a slight shift in direction is the difference between seeing a

really large concentration coming from off-site in the southeasterly direction versus very low concentrations with a change of a few degrees.

Another challenge when dealing with emissions from refinery processes is that process streams are rarely the pure substances that may be found in a chemical operation. Typical refinery streams contain varying concentrations of numerous hydrocarbons, which in turn can change as crude feed types change, making use of the GC data to trace back to a particular area difficult. To aid the response efforts, samples of 15 typical refinery streams (motor gasoline, diesel, alkylate, etc.) were collected in VOA vials and taken to the refinery laboratory. The vials, which were half full of the liquid from the streams noted, were heated to 80° F (to approximate storage in tanks at average ambient conditions) and a sample taken of the vapor space and analyzed on a laboratory GC. This allowed the development of a series of chromatograms that are statistically compared to the GC results from the ambient monitoring to identify the type of stream most likely contributing to the trigger event. By using these typical stream data, the wind back trajectory, and scatter plot tools collectively, the responders were able to narrow down the area to search.

Findings Resulting From Monitoring Activities and Investigations

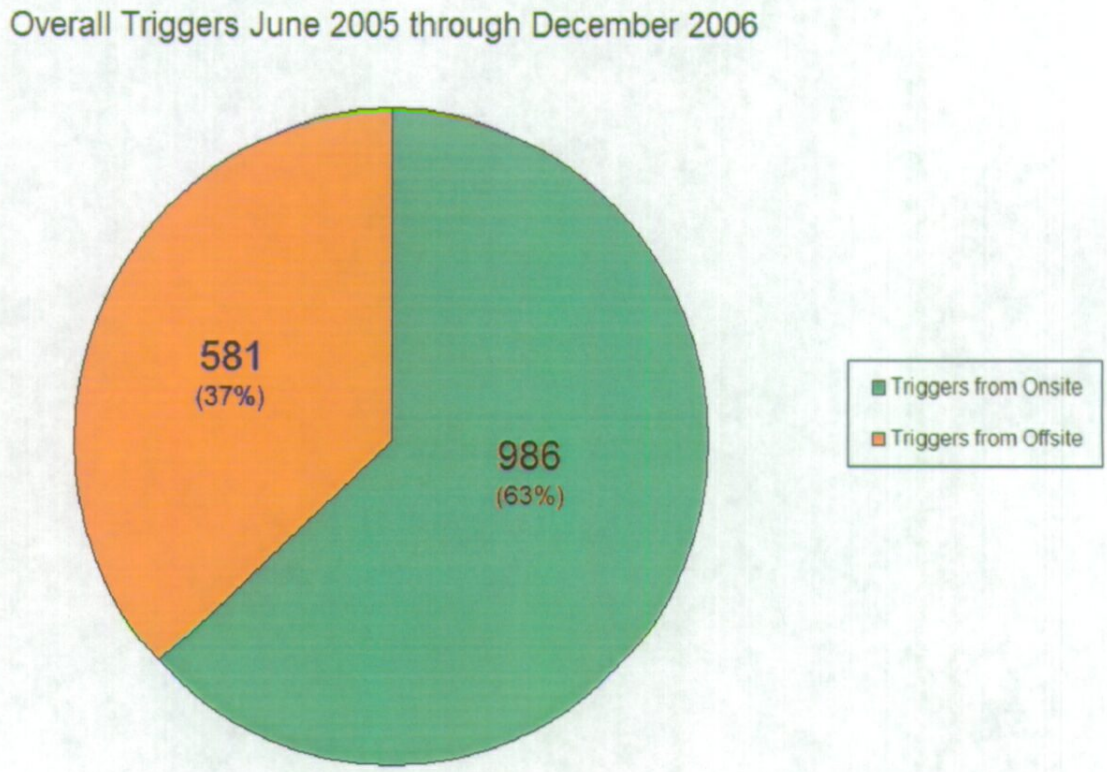
The monitoring network began operation on May 1, 2005 and shakedown was completed by July 1, 2005. There were initially some technical issues during system shakedown, mostly with the external communications features, but these issues were resolved in a timely fashion. The TNMOC monitoring results for July 2005 through December 2006 are summarized in the table below.

Station ID	Number of Triggers	TNMOC Range (ppmC)	TNMOC Average (ppmC)	Data Availability	Trigger Level Used
EMR-1 (South Gate)	213	0 - 27.68	0.52	92%	5.17, 6.36
EMR-2 (Knox Field)	143	0 – 27.57	0.71	96%	7.25
EMR-3 (Bluffs)	274	0 – 23.88	0.45	99%	3.51, 4.77
EMR-4 (South Dock)	378	0 – 29.63	0.51	99%	5.01, 8.98
EMR-5 (CAB)	46	0 - 5.90	0.18	94%	1.87
EMR-6 (East Tankfield)	44	0 – 13.33	0.39	90%	5.18, 8.84
EMC-1 (Monte Sano Bayou)	46	0 – 19.62	0.93	93%	9.12
EMC-2 (J & 28th)	352	0 – 17.38	0.71	99%	3.77, 6.85
EMC-3 (A & 28th)	66	0 – 15.28	0.32	92%	9.12

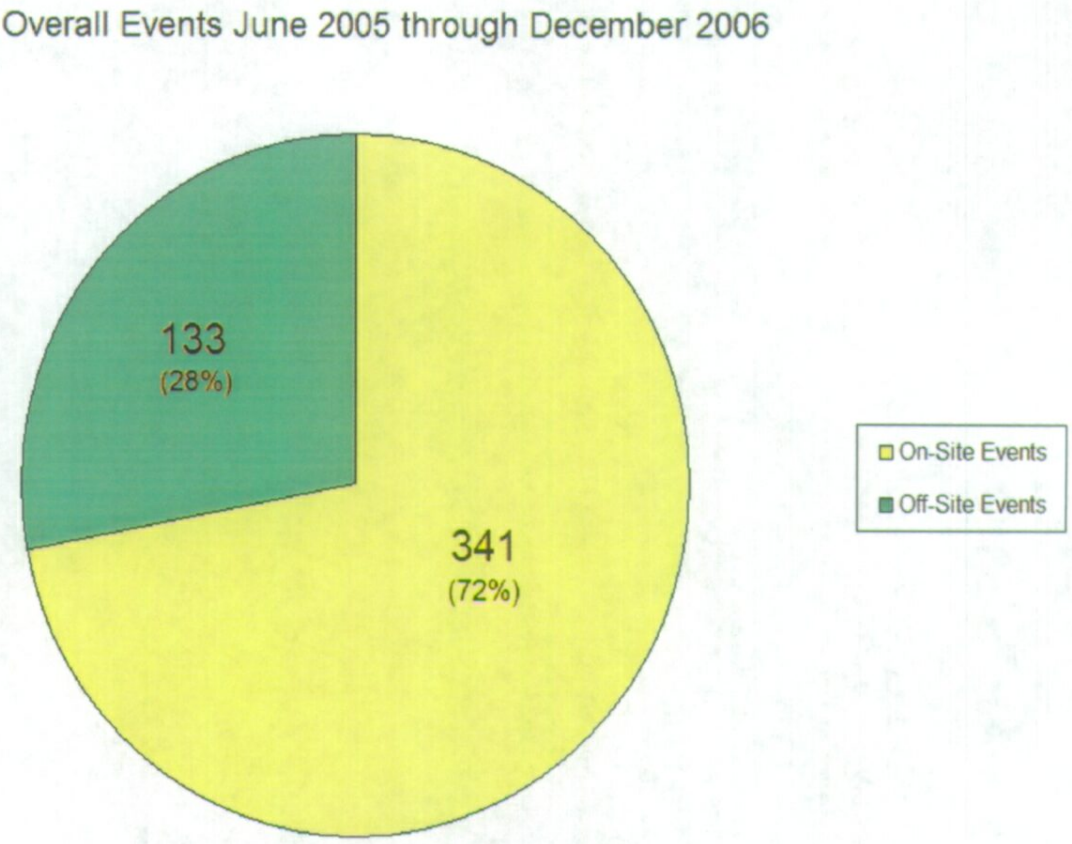
Monitoring Results

Maybe the most surprising finding was that there were numerous triggers, sometimes at a very high concentration (>20 ppmC), from off-site sources, many of which do not appear to originate in areas of industrial activity. In fact, based on data collected after approximately 20 months of operation, over one third of all triggers (38%) appear to have been caused by off-site sources, and generally at a higher concentration than those triggers that appear to be caused by on-site

sources. This is extremely interesting, given the location of these monitors in such close proximity to plant operations. This is something that bears further investigation as possible contributors to ozone formation in the area that have not been accounted for in any of the modeling analysis or control strategies. The monitoring results are shown in the graph below:

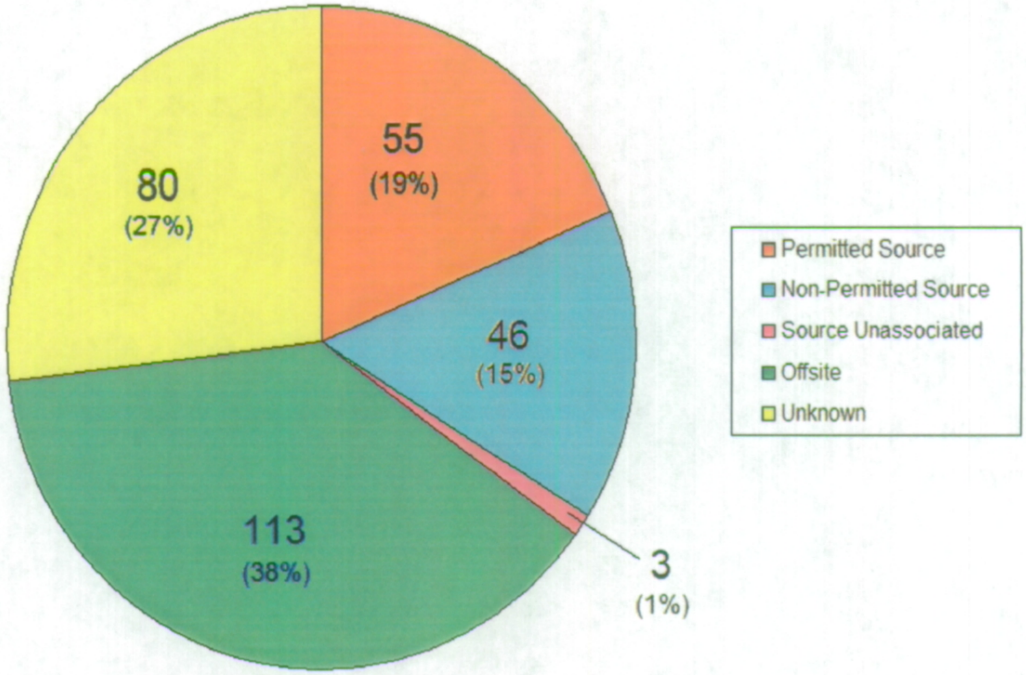


By counting multiple 10-minute periods when the value was above the trigger level as one ***event*** if they occurred during one GC run, each monitoring station typically experienced 8 trigger events per month. This included both actionable and non-actionable events. The field response team investigated only actionable events. The events for the 20 month period of operation are graphically displayed below. Note that the percentage of events from off-site sources is slightly lower than the percentage based on triggers. This might be attributed to the proximity of the stations to the process areas, as a source such as a tank seal leak would be less likely to be dispersed and less subject to variability due to shifts in wind speed and direction. The further away from the source, the more the plume would be subject to dispersion and sensitive to wind directions, as were seen in the earlier scatter plots. There were also a number of events where the GC chromatogram showed large peaks that were not identified, as they were not among the 43 compounds of interest.



As is discussed in the next section, the success rate of finding potential sources of emissions while investigating trigger events was much higher than expected than when the project was initiated. During the design discussions and training sessions, members of the technical team felt that it would be quite difficult to identify potential sources due to the size of the operations and the transient nature of air emissions. However, the response team had far better success than first thought, finding likely sources (or at least contributors) well over 50% of the time (approaching a 75% success rate some months) for the trigger events that originated from on-site, based on the wind direction. The classifications of the events are summarized graphically below. Note that the totals in the event classification graph do not match the total number of events. This is due to the fact that the more detailed classification scheme was not implemented until March 2006, as ExxonMobil gained more experience with the monitoring system and refined our investigation techniques. It can also be seen from this distribution that there were a fair number of events where a source was not found. The vast majority of these were events where there was a single spike in concentration above the trigger, and with the time lag in the sample collection by the GC system, the GC results would be based on a very low concentration in the TNMOC at the time of collection, and would not be considered representative of the peak event. The other situation was when the GC was already in use, either in the calibration cycle, or running a previous sample, which precluded obtaining GC results for some. The "source unassociated" category refers to events that were caused by an identified source off-site, such as due to marine activities or in a couple of instances, equipment emissions from pipeline stations that are not operated by the ExxonMobil Baton Rouge complex.

Event Classifications March 2006 through December 2006



Far and away the most common non-permitted sources causing events that were found during the investigations were related to storage tank operations. In some cases, inspection hatches on tanks with vapor recovery systems were found to have been either inadvertently left open, or not adequately tightened; allowing emissions out of what should be a sealed system. In other cases, there are tanks that are blanketed with either natural gas or nitrogen that have had malfunctioning regulators, causing the pressure relief vents (PV vents) to lift intermittently, allowing hydrocarbons to escape. In a couple of instances, the investigation of the trigger events identified seals on floating roof tanks that needed repair.

There were initially trigger events that were traced to marine activities, such as product barges. This led to discussions with barge fleet operators and third party sampling companies who implemented new procedures similar to those now used in the Houston area to minimize emissions related to those sources. This included use of closed hatch sampling and gauging devices designed to effectively reduce emissions that result from these same tasks done through an open hatch. This was an area where the LDEQ also participated with the barge companies, based on concerns noted during their flyovers with the HAWK Infrared Camera.

Another contributor to the events was heat exchange system leaks, either into the cooling water or into the plant steam system. While most cooling water returns are monitored regularly under a variety of regulatory requirements, steam blowdown and condensate systems are not routinely monitored for the presence of hydrocarbons. The monitoring and response in these cases has often meant that process leaks into the steam system causing hydrocarbon emissions have been identified more rapidly than through other existing means.

There were certain wind directions that caused permitted emission sources to trigger a station, but the levels were not all that high, especially considering the proximity of the monitors to the process. Several of the trigger events were traced back to permitted work activities, such as sampling, tank cleaning, and maintenance activities, and some to permitted loading into tanks or for transportation. There were only a few events that were reportable as releases or permit deviations, most notably the process leak into the steam system, and tank issues with seals or malfunctioning blanketing systems, which required timely repair upon discovery.

And the TNMOC levels from on-site sources were generally much lower than some of the peak TNMOC readings measured from off-site sources.

Lessons Learned and Possible Future Improvement

Certainly one of the lessons learned is that there are likely to be some complications that arise during startup of the monitoring system, just as there typically are when starting up a new process. The fact that a system of this type had never been utilized before made this startup even more difficult, as there were no instruction or troubleshooting manuals to refer to. With a number of months of operating experience, and with having experienced some of the technical problems and fixed them, it should be expected that future implementation of projects of this type would proceed very smoothly. It is highly recommended that an appropriate amount of time be allocated to the design and construction phases, and that the actual start of monitoring incorporate a reasonable shakedown period. It is not realistic to expect the system to be operating flawlessly from its first day in the field. We also underestimated the care which needed to be taken when moving equipment that was designed to remain parked on a laboratory bench. This was especially the case with moving the GCs over the roads between the construction location and the deployment site.

When problems do occur, it is very important that field personnel have ready access to the technical resources who can explain the failure or apparent failure of the system. This is critical to the acceptance of any new system by the field personnel. If the system acquires a poor reputation during initial shakedown, it can be very difficult to re-establish its credibility, internally or externally.

Frequent quality control checks of all the data are extremely important. While the system operated in automatic mode fairly effectively, human intervention is important, especially in QA/QC of GC data, and in making certain that calibrations of all instruments, even the simpler items like the wind direction indicator are performed on a regular basis, and particularly after a station is moved. If the wind direction is off, or the GC peaks are shifted, even slightly, then the response efforts can be misdirected and ineffective.

Discussions about data management and presentation should be conducted between all parties prior to startup of monitoring activities. With the tremendous amount of data being collected, it is important to preserve it and be able to present it in a useful fashion. Falling a few weeks behind in data entry can create a considerable challenge to getting caught up.

There are several areas for possible future improvement. The wind back trajectory has proven to be a very useful tool. However, the current algorithm to calculate the trajectory is based on a single wind monitor. The resulting trajectory is reasonably reliable near the monitor. As the

trajectory endpoints get further away from the monitor, it becomes less and less reliable. This problem can be significantly minimized by using a more advanced algorithm to calculate a wind field using multiple wind monitors in the area, and then calculate the trajectory based on the more representative wind field.

Although the simplistic approach of control boundary did not work well as discussed earlier, a better method to identify a true "out of ordinary" event is still desirable. In most cases such an event can be recognized by a trained person, but it is more difficult for the computer to recognize it. Some artificial intelligent approach such as a neural network may work better.

Another tool is worthy of consideration for addition to future designs. ExxonMobil has analyzed vapor compositions of more than dozen of process streams. These compositions are effectively the profiles (or near fingerprints) of these streams. The profile data can be stored in the system. When a trigger event occurs and the ambient GC data is acquired, the system can calculate the correlation coefficients or other measures of similarity between the ambient GC data and each of the profiles; rank them; and include the ranking in the same fax as the GC data to provide the facility response team the first guess of where the source may be based on its chemical composition. For this project this step was done manually by one of the engineers in ExxonMobil's air quality group, but automating this should be possible and would assist greatly in response. The main difficulty in not having the human intervention is in when there are large unknown peaks that clearly mark the sample as not being likely to be the stream identified based strictly off of the correlation.

The other lesson learned is that use of the handheld FID instruments in the response efforts showed some limitations. Since the sample is drawn in through a probe on the instrument, the sample collected is limited to putting the instrument, and the person using it, in close proximity to the source. This does not allow the responders to readily investigate sources above ground level and other difficult to reach places. Towards the end of the project, ExxonMobil brought in an IR camera and operator from our Baytown, Texas facility and he was able to identify several sources of elevated TNMOC that had eluded the response teams armed with FIDs. This technology shows great promise and the ExxonMobil Baton Rouge complex has purchased our own camera, and is in the process of training personnel and incorporating it as a tool in identifying emissions from non-traditional and traditional sources of leaks and emissions.

Conclusion

This project was successful in several aspects. The technology selected worked almost flawlessly once the initial startup period had passed. The monitoring results and investigations showed more elevated concentrations resulting from permitted activities than from releases, and nearly a third of the total events were apparently caused by off-site sources, which was surprising given the close proximity of the monitors to ExxonMobil's operations. It is apparent that that an infrared gas finder camera is a much more powerful tool than the handheld FID devices, due to their ability to quickly scan multiple potential sources of emissions, as well as "see" emissions from a much greater distance from the user.

The perimeter ambient air monitoring system described in this paper represents several new approaches and concepts. The methodology of setting trigger levels based on certain percentile for desired trigger events (99.75 percentile in this case) provides an analytic approach to similar

applications. Classifying trigger events into actionable and non-actionable made the response effort more effective and efficient and reduced personnel fatigue. Use of wind back trajectory and scatter plots as tools increases the effectiveness and speed of locating unexpected releases. Nearly two years of operating this equipment demonstrated that these approaches are both practical and valuable. The system has proven to be a useful tool in prompt detection of unexpected VOC releases, locating the release, and therefore mitigating and minimizing the air quality impact, especially in the context of ozone formation affected by the presence of HRVOC.

This system represents one of the first applications of Auto-GC operating in trigger mode. It combines two commonly used speciated VOC sampling approaches – the triggered canister sampling method and Auto-GC operating in continuous mode. Compared to the triggered canister sample method, this system provides near real time speciated VOC data, which is much more useful for release identification and mitigation. Although the canister system generally cost less, its cost advantage may diminish if trigger events are frequent and monitoring duration is long.

Compared to continuous Auto-GC, triggered GC has a distinct advantage – it is better in capturing transient plumes with a small foot print. The foot print of a plume is smaller when it is not far away from its source. The farther away from the source, the larger the foot print becomes (and more dilute it will be) due to dispersion. As mentioned in the "Monitoring System Design" section, the continuous Auto-GC operates on a one-hour cycle. Within the hour, the samples are collected in the first 40 minutes. If a transient plume with a small foot print equivalent to about 20 minutes passes through the monitor during the last 20 minutes of the cycle (from 40 minutes after the hour to the end of the hour), the continuous Auto-GC will miss the plume entirely. If the plume passes through the monitor earlier during the hour, the sample will be diluted into the 40-minute sample. Through this project, it is common to observe plumes with small foot prints. Based on this discussion, it is concluded that continuous Auto-GC is more suitable for community or larger scale monitoring whereas triggered Auto-GC is more suitable for near source monitoring.

References

1. U.S. Environmental Protection Agency, *Technical Assistance Document for Sampling and Analysis of Ozone Precursors*; EPA/600-R-98/161; September 1998.
2. Texas Commission on Environmental Quality, *PAMS Network Quality Assurance Project Plan for Monitoring in Texas*; Version 13, May 2004.

Key Words

Perimeter ambient air monitoring, HRVOC, Auto-GC, Triggered GC, wind back trajectory, VOC release investigation.

Appendix D – Facility Final Reports

ExxonMobil Plastics Plant

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RECEIVED
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Engineering Support

ExxonMobil
Chemical

January 12, 2007

Ms. Jane LaCour
Louisiana Department of Environmental Quality
Office of Environmental Compliance
P.O. Box 4312
Baton Rouge, LA 70821-4312

RE: In the matter of ExxonMobil Corporation Enforcement Tracking No. AE-AOA-05-0003 - Ambient Air Fenceline Monitoring Final Report

Dear Jane:

Please find enclosed ExxonMobil Chemical Baton Rouge Plastics Plant's Ambient Air Fenceline Monitoring Final Report. This report was developed in accordance with the outline provided by the LDEQ in correspondence dated December 18, 2006.

We appreciate all the support provided by the Offices of Environmental Assessment and Compliance in what has been a challenging and educational project.

Sincerely,

Pat Carrasco

c: Mr. Maurice Oubre
Louisiana Department of Environmental Quality
LDEQ Office of Environmental Assessment
P.O. Box 4314
Baton Rouge, LA 70821-4314

Baton Rouge Plastics Plant

Ambient Air Fenceline Monitoring Final Report

JANUARY 2007

PROTECT TOMORROW. TODAY.

ExxonMobil Chemical

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INTRODUCTION

On October 6, 2004 the Louisiana Department of Environmental Quality issued an Administrative Order (AE-AO-04-02955) to ExxonMobil Chemical's Baton Rouge Plastics Plant (BRPP) as well as 15 other industrial facilities in the area. The Order required affected facilities to implement a fenceline ambient air monitoring program and to conduct comprehensive audits of emission sources emitting Highly Reactive Volatile Organic Compounds (HRVOC).

The fenceline monitoring program was to contain the following elements.

- At least one monitoring station at each of the four main compass points.
- At least two of the stations were to be equipped with a 10-meter meteorological tower with sensors to continuously measure wind speed and direction. Additionally, one tower was to be in the prominent up and downwind directions from the center of the facility.
- Meteorological data was to be recorded and submitted in 10-minute averages.
- Each monitoring station was to be equipped with a continuous total non-methane organic carbon (TNMOC) analyzer of detecting VOC concentrations of 0.1 ppm or less for each 10-minute period. This analyzer was to be operated continuously with at least 85% data completeness.
- The TNMOC analyzer was to be integrated with a summa-canister sampling system to be triggered at a predetermined concentration threshold which would automatically collect a 20-minute air sample.
- The trigger threshold was to be such that a minimum of five samples per month were to be collected.
- Each summa-canister was to be analyzed for a compound target list supplied by the LDEQ and analyzed per established EPA test methods with a detection limit of 0.5 ppbv or better.
- A 24-hr composite sample was also to be taken every six days.
- All data was to be reported to the LDEQ beginning on April 15, 2005 with subsequent submissions on the 15th of each month thereafter.

A plan detailing both the audit and fenceline monitoring efforts was due to the LDEQ within 45 days of receipt of the Administrative Order. The LDEQ welcomed suggestions to the stated protocol to improve the efficiency and effectiveness, which will be discussed in subsequent sections of this document.

The scope of this report was derived from an outline provided by the LDEQ in its response to BRPP's request for early termination of the fenceline monitoring project dated December 18, 2006. As such, topics outside the of the outline (e.g., monitoring QA/QC plan details, LDAR and Air System audits) are not addressed.

PROGRAM OVERVIEW

Upon receipt of the Administrative Order, affected ExxonMobil facilities formed a team to study the requirements and respond accordingly. As such, the following changes to the stipulated requirements were suggested by BRPP and accepted by the LDEQ as documented in a consolidated response (i.e., for all ExxonMobil facilities) dated February 28, 2005.

- Rather than four fixed stations at the main compass points, two mobile monitoring units were to be moved with seasonal changes in the prevailing wind direction. Both mobile monitoring stations were to be equipped with integral meteorological towers that could be lowered for transport.
- Rather than summa-canisters, on-line Gas Chromatographs (GC) were to be employed for immediate identification of target compounds.
- Initiation of the monitoring effort was moved to May 1, 2005.

In general, all other elements of the program were maintained as per the original order except changes that occurred after project initiation. These changes are noted in subsequent sections where appropriate. Response procedures specific to ExxonMobil (some specific to BRPP) were developed and approved by the LDEQ, which are described in greater detail in subsequent sections of this document.

MONITORING SYSTEM DESIGN

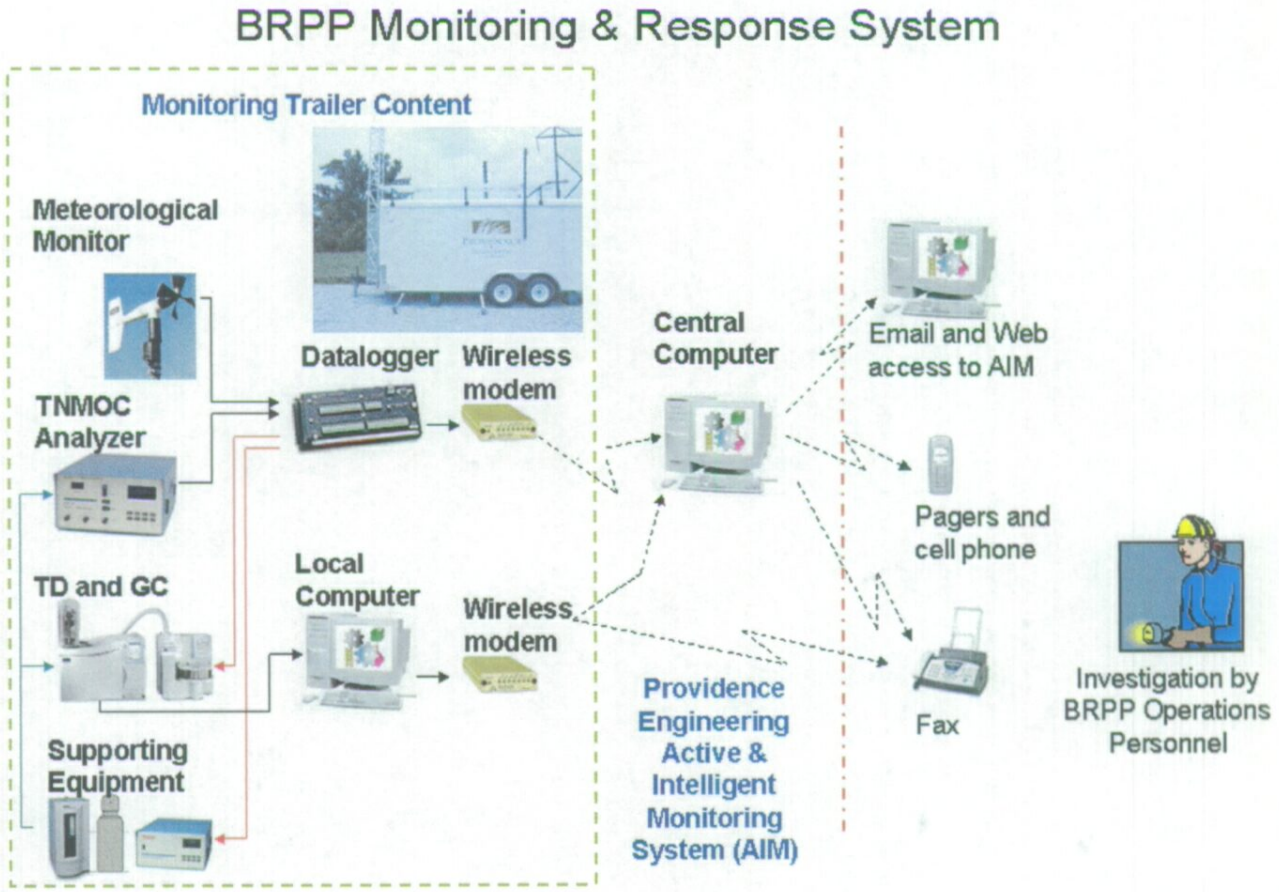
The monitoring system was designed to provide timely and accurate analysis of ambient air samples coupled with meteorological data that would together, all contribute to rapid identification of any potential release location. As previously stated, BRPP chose to use two mobile monitoring units equipped with GCs rather than four fixed stations using summa-canisters. BRPP retained Providence Engineering to construct the monitoring units and develop a system for data management. The graphic below is a simplified diagram of the monitoring trailer content and functionality.

Major equipment included:

- Thermo Environmental Instruments Model 55C
- Perkin Elmer Clarus 500 GC with TurboMatrix ATD for Ozone Precursor Analysis
- Met One 50.5 C Meteorological Station

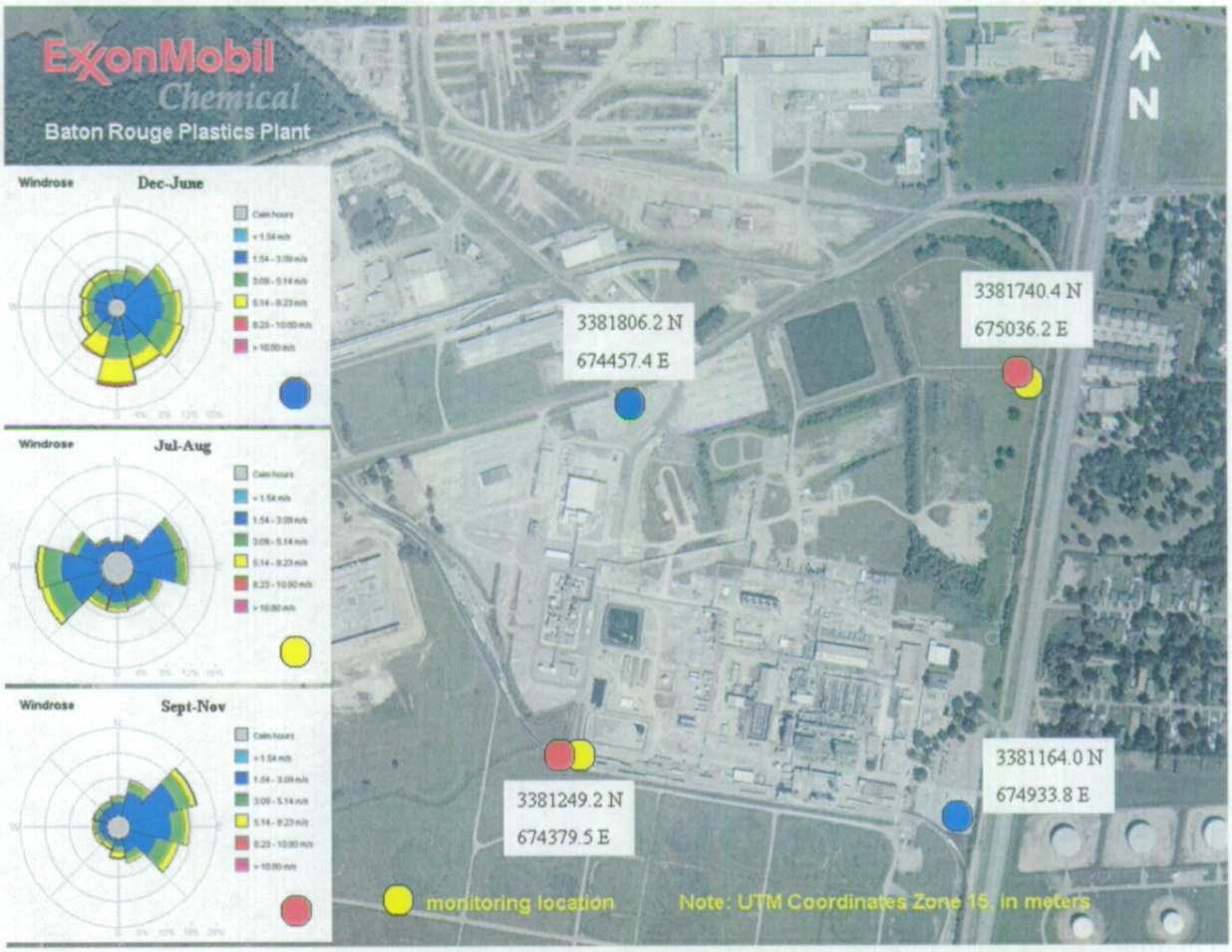
Other supporting equipment included calibration and carrier gas cylinders, nitrogen generator, oxygen monitors, computer, and other general equipment to ensure a safe and continuous operation of the monitoring trailer.

Each location chosen for monitoring was fitted with the appropriate power supply. In general, the monitoring locations were ready for use except one, where a special parking area with access had to be constructed. Each trailer was leveled and secured for the duration of the monitoring period.



MONITOR LOCATIONS

Since two mobile stations were chosen over four fixed locations, a careful study of predominant winds in the area was warranted. As a result, monthly windroses were analyzed from 1996 through 2002 for the purpose of identifying repeating seasonal patterns. The seasonal patterns and resulting monitoring trailer locations are shown in the graphic below. The seasonal pattern of December through June resulted in two distinct monitoring locations. The pattern for July through August included east and west components, while the pattern for September through November was predominantly east. Due to BRPP's orientation, the locations for July through November overlap; therefore, only two other locations were chosen. In summary, four locations (shown below) were monitored for the duration of the project with the monitoring trailers being moved every December and July to their respective alternate location.



TRIGGER RESPONSE PROCEDURES

In developing trigger response procedures, three distinct areas emerged: 1) at what level(s) of TNMOC would a trigger occur; 2) at what wind directions and wind speeds would a response be required; and 3) what would the response entail. These three aspects are further detailed below.

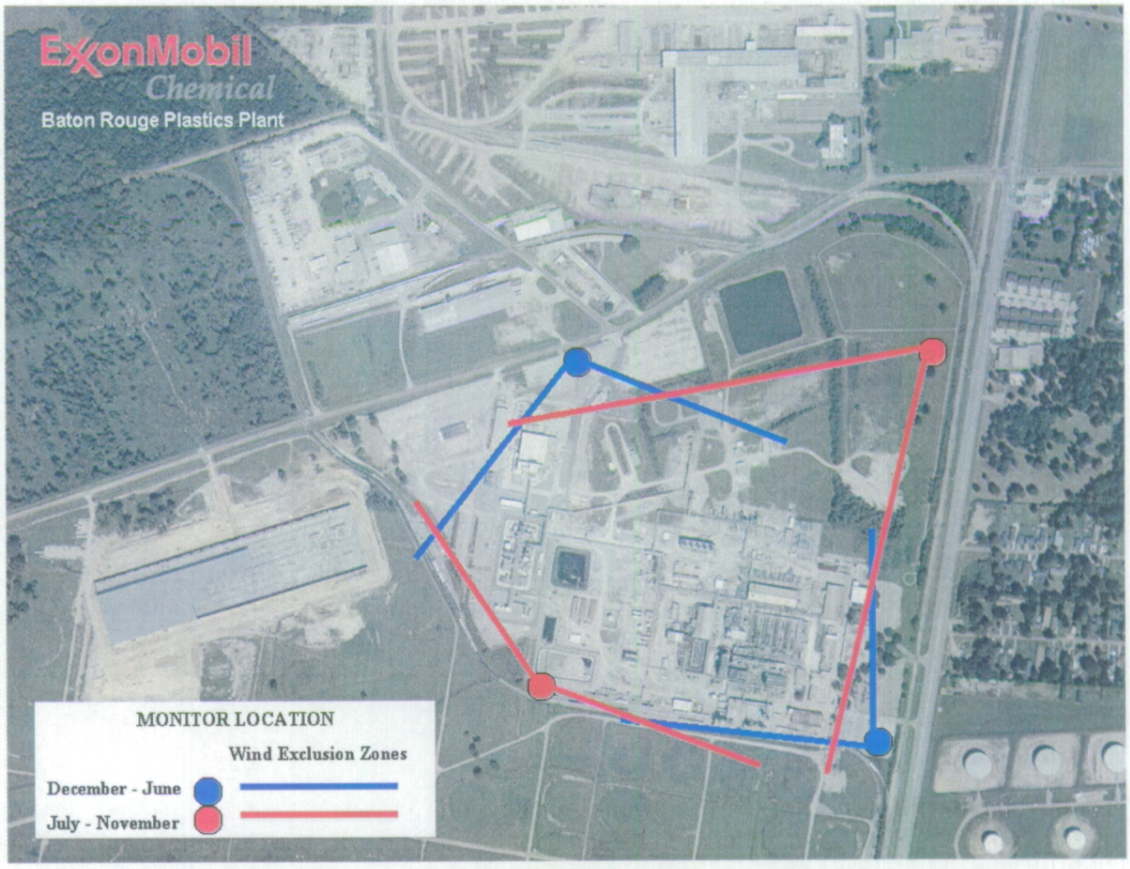
TNMOC Trigger Levels

An "instrument" trigger level was statistically derived such that approximately five samples per month would be achieved. This was obtained by operating the monitoring trailers in their first location for approximately three weeks and utilizing the 99.75 percentile of the readings seen during this timeframe. During the initial evaluation, it was determined that significant variation existed such that much more than five samples would be obtained unless another mechanism was established. In response to this issue, a "3-day moving average" was proposed and accepted by

the LDEQ. The moving average allowed for at least five samples per month without excessive triggers resulting from normal variations due to changing wind directions, process variations, etc.

Wind Direction & Wind Speed

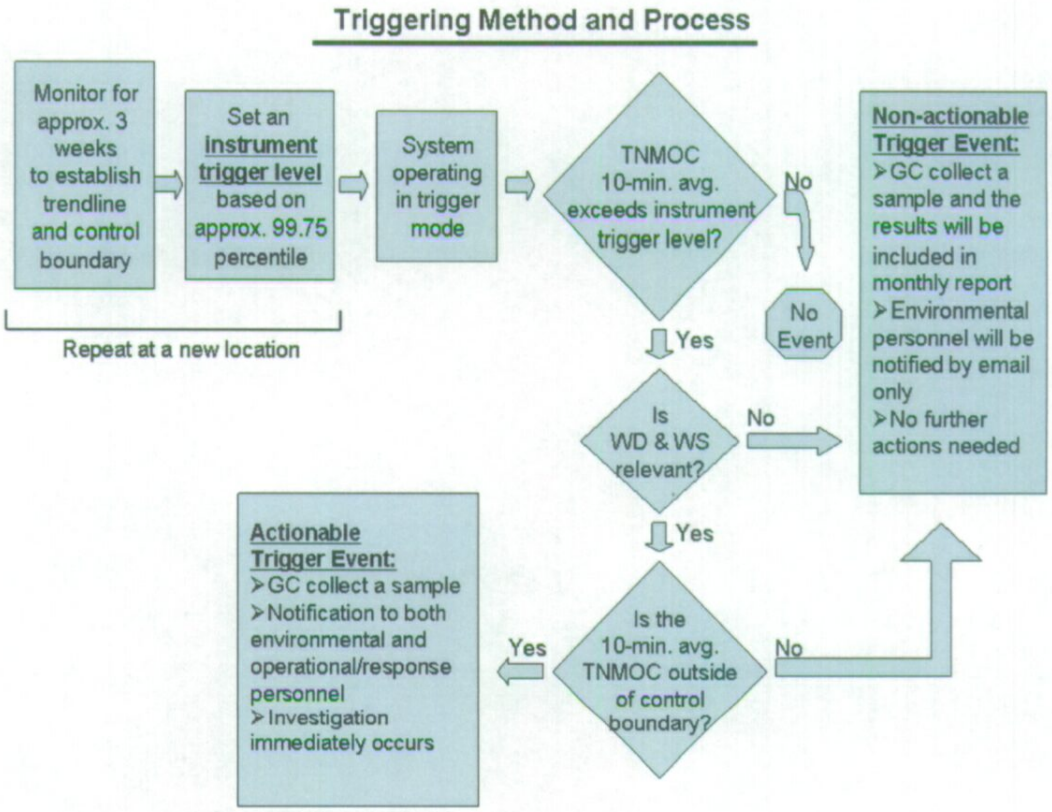
In order to maximize the quality of investigations by operations personnel and to avoid "nuisance" triggers, it was agreed that BRPP would only respond to triggers where the wind direction was relevant to its operations. With this in mind, wind exclusion zones were established based on the location of on-site operations and are shown below. Triggers with wind direction outside the exclusion zones were reported in the upload of monthly data, but were not investigated. Initially, events with windspeeds below two miles per hour were to be investigated because of the potential for the wind to be erratic under such conditions. However, after several months of operation, it was evident that numerous triggers occurring at less than two miles per hour were the result of a source southeast of BRPP and quickly becoming a nuisance. As a result, BRPP proposed and the LDEQ accepted, to not notify under such trigger conditions, but investigate the event afterwards and include the investigation in monthly reports. The exclusion zones shown below were transformed into specific coordinates that were integrated into the overall computer logic associated with this effort.



Trigger Response

Upon notification of an actionable (wind within action zones) trigger, BRPP personnel were to respond with a review of unit operations, notation of special operations / activities, and a unit walkthrough where warranted. Higher levels of investigations (e.g., use of handheld leak detectors) were not deemed necessary because: 1) BRPP operates at very high pressures making any leaks immediately noticeable; and 2) BRPP has over 220 gas detectors with alarming capability located throughout the plant. In a very few specific cases, special sampling (e.g., cooling tower water return) or instruments (i.e., LDAR instrument) were used to investigate specific pieces of equipment.

The overall triggering method and process is shown below.



SIGNIFICANT FINDINGS / MITGATION

Below is an overall summary of project findings and associated mitigation initiatives.

- There were very few discrete findings linked to equipment (e.g., leaks) or specific activities and none that would suggest a systemic issue.
- There was significant impact on our monitors throughout the project from a source east-southeast of BRPP.
- There were low-level triggers caused when the wind passed directly over permitted sources (e.g., operating units, flares), which confirmed that BRPP has been addressing the proper strategic environmental focus areas including:
    - **Control of product emissions**: BRPP has now routed all vents from A-D-Line production units to a thermal oxidizer reducing overall site VOC (primarily HRVOCs and HAPs) emissions by approximately 350 tons/year. This reduction was initiated well in advance (A&D-Lines in 2003, B&C-Lines in 2006) of the May 10, 2008 deadline imposed by the Miscellaneous Organic NESHAP rule. Also, several vents were controlled voluntarily (all D-Line sources and some vents from downstream storage silos) as they did not emit HAPs or were below control thresholds. Other production lines (E/F/G-Lines) not connected to the thermal oxidizer utilize vacuum extrusion that sufficiently reduces residual VOC below MACT and NSPS Subpart DDD control thresholds.
    - **Flaring**: Flaring is minimal when all units are operating, but is needed during start-up and shutdowns despite the maximum use of the site's Purge Gas Purification Unit to recycle off gases. With this in mind, unit reliability is the key to minimizing flaring and is recognized as the foundation for all other business performance results. Future plans include the

implementation of ExxonMobil's Global Reliability System which is a comprehensive management system that encompasses maintenance, technical aspects, operations, projects and more.

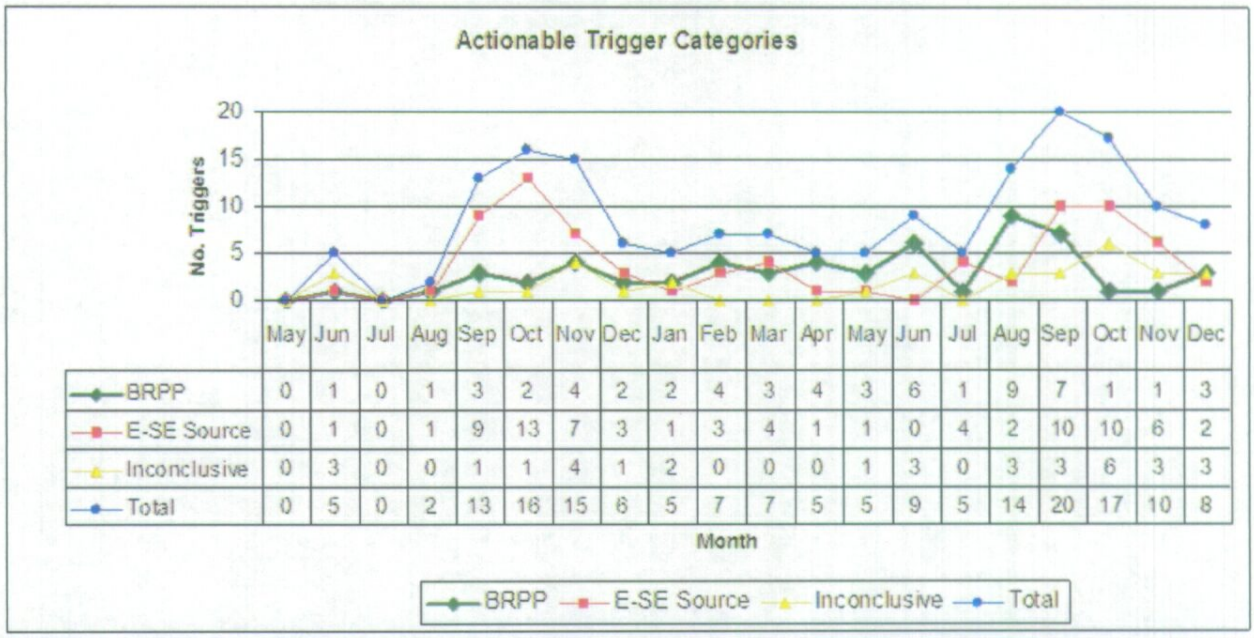
Typical profiles (GC data, wind direction, TNMOC data) of the findings discussed above can be found in Attachment 1.

SUMMARY OF DATA COLLECTED

Actionable Triggers

Below is a graph of actionable triggers obtained since the inception of the project (May 1, 2005 - December 31, 2006). The separation of categories was based on wind direction and GC data. Triggers that occurred while the GC was unavailable (e.g., busy from previous trigger, daily calibration, downtime) were deemed "inconclusive." A review of inconclusive triggers suggests that, based on wind data only, they follow the approximate parity attributed to BRPP and the east-southeast source. Triggers that occurred during periods of wind speed less than two miles per hour were not included and were typically less than five per month.

Actionable Trigger Summary



	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BRPP	0	1	0	1	3	2	4	2	2	4	3	4	3	6	1	9	7	1	1	3
E-SE Source	0	1	0	1	9	13	7	3	1	3	4	1	1	0	4	2	10	10	6	2
Inconclusive	0	3	0	0	1	1	4	1	2	0	0	0	1	3	0	3	3	6	3	3
Total	0	5	0	2	13	16	15	6	5	7	7	5	5	9	5	14	20	17	10	8

Actionable Trigger Breakdown

- 169 Total (Avg 9/month)
- 57 BRPP (34%)
- 78 E-SE Source (46%)
- 34 Inconclusive (20%)

NOTES:

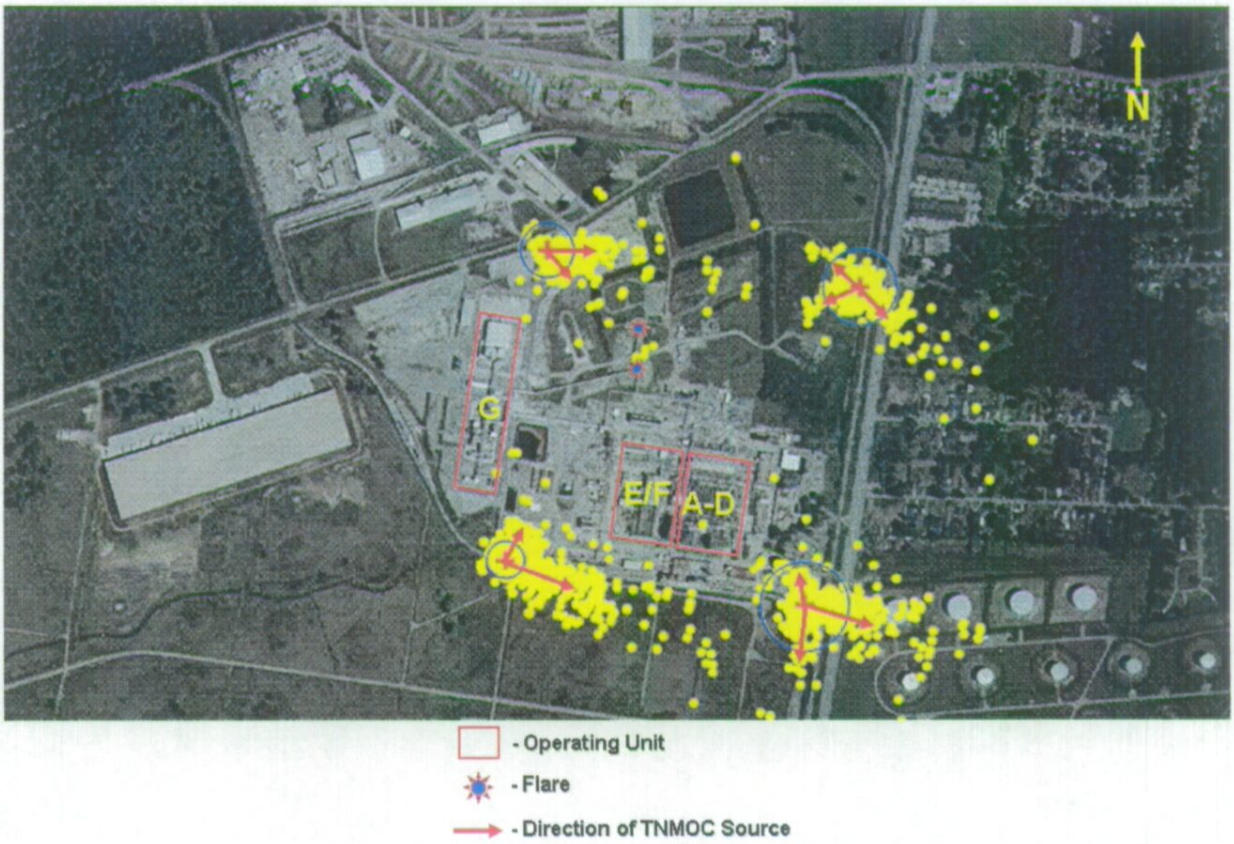
- Separation between categories based on GC data and wind direction
- Excludes triggers < 2 mph
- "Inconclusive" means that the GC was unavailable at the time of the trigger
- No triggers in May & July of 2005 as these were threshold setting months

TNMOC PLOTTING

The following graphic is a scatter-plot of all TNMOC data obtained since the inception of the project (May 1, 2005 - December 31, 2006). Discrete TNMOC data points combined with their respective wind direction form basis for the plot. The further the TNMOC data point is from the

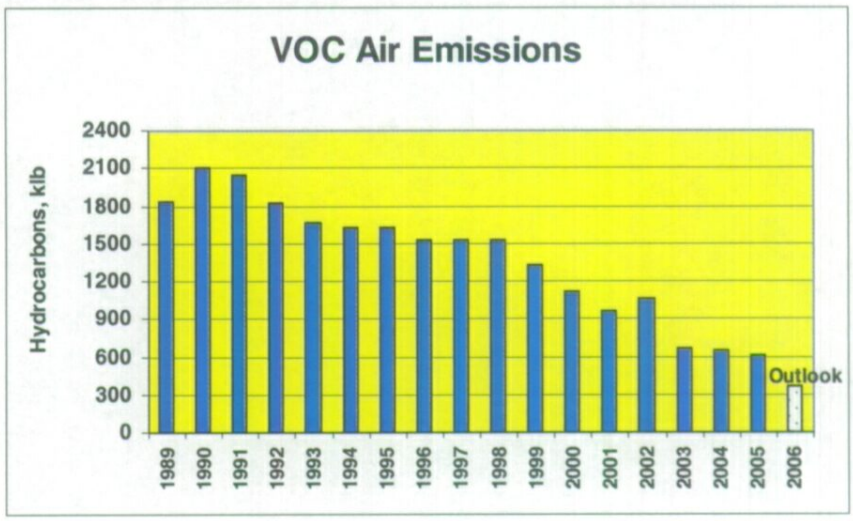
monitor location, the higher the TNMOC concentration. Clusters of TNMOC points protruding from the monitor location indicate the relative direction of the source, which has been highlighted with arrows. As previously stated and illustrated in the graphic, there was significant influence on all four monitoring locations from a source east-southeast of BRPP. As anticipated, there is also impact noted from BRPP's permitted emission sources.

TNMOC PLOT 5/1/05-12/31/06



SUMMARY OF EMISSION REDUCTIONS ACHIEVED OR TO BE ACHIEVED

As noted in the adjacent graph, BRPP has made significant reduction in VOC air emissions, with approximately an 83% reduction anticipated (i.e., 2006 outlook) from peak levels (1990). This reduction was achieved despite the addition of substantial production capacity from two new production lines and various debottleneck projects. Significant improvements leading to this success are outlined in the following section by source category.



Process Vents

- F-Line was constructed (1991) to New Source Performance Standards (NSPS - Subpart DDD) for a "new facility," employing degassing extrusion technology to reduce product emissions below control thresholds.
- Conversion of E-Line's extruder (1999) from conventional to degassing as part of overall debottleneck project.
- Regenerative Thermal Oxidizer (RTO) added (2003) to control A&D-Line product emission sources five years ahead of MON regulation (compliance deadline May 2008). The control of D-Line sources was voluntary since its HAP use is insufficient to trigger MON process vent control threshold.
- G-Line built to Maximum Achievable Control Technology regulations (Subpart U) for a "new facility."
- B&C-Line product emission sources were connected to the RTO in 2006 in preparation for compliance with the Miscellaneous Organic NESHAP (MON) rule.

Process Vent Summary

All BRPP process vents meet either NSPS or MACT standards. Many vents were controlled voluntarily (i.e., no HAP emissions) and years in advance of the regulatory deadline. BRPP spent over $6 million dollars on the RTO and ancillary equipment (e.g., ductwork) yielding greater than 350 tons in actual emissions reductions (combination of HAPs and Highly Reactive Volatile Organic Compounds (HRVOC)). Due to the high level of emissions control already in place, there are no other process vent controls planned in the future.

Equipment Leaks

- BRPP has consistently operated with <0.5% leaking valves, well below the "good performance" criteria.
- Over $1.0 million dollars has been spent over time on leak-capture retrofits and/or enhancements for high-pressure pumps and compressors.
- The LDAR audit (performed by URS Corporation) mandated by said Administrative Order found BRPP's program to be in excellent health:
  - Grade of "A" was given in the areas of component identification, monitoring, repairs, and condition issues.
  - U.S. benchmarking placed BRPP's program elements in the top 25%: open-ended line control; component identification; comparative monitoring; and delay of repair.

Equipment Leak Summary

BRPP has consistently operated with a very low percentage of leaking valves and similar to process vents, has employed state-of-the-art emission control technologies (i.e., pumps / compressors) extensively across the site. As part of MON compliance efforts, BRPP plans to replace a small amount of pumps in HAP service due to their leak history.

Wastewater

- BRPP processes are inherently hydrophobic; therefore, water is only used in the final formation of product (underwater pellet cutting). As such, there is no wastewater treatment at BRPP other than stormwater retention and gravity separation of oil (machinery lubrication) and polymer from water.
- BRPP replaced (2004) its flare water seal with a dry velocity-seal eliminating one of BRPP's only direct contact (with hydrocarbons) wastewater streams.
- BRPP will be subject to the MON requirements for heat exchange systems (May 2008) and currently employs a voluntary cooling tower monitoring program.

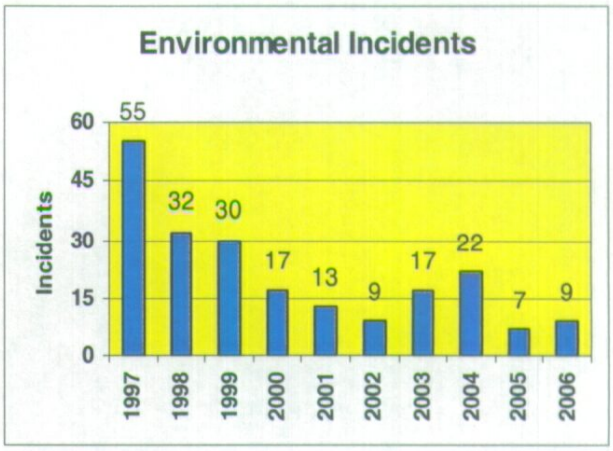
Wastewater Summary

Due to the nature of BRPP's processes, VOC emissions from wastewater are not an issue. Future efforts will involve the implementation of MON requirements applicable to heat exchange systems.

Accidental Releases

- Numerous efforts have been employed over many years including:
  - Root cause investigation / mitigation.

- Interlock schedule (a matrix of process conditions that determines when immediate venting is necessary to ensure personnel safety and to prevent equipment damage) overhaul.
- Implementation of the ExxonMobil's High Pressure Polyethylene Network's Best Practices.
- Implementation of the 2003 Vent Reduction Team (VRT) recommendations.



Accidental Release Summary

As noted in the adjacent graph, the efforts described above have significantly reduced accidental releases at BRPP. Many performance records were set in 2005: 1) fewest incidents; 2) longest incident-free streak at 173 days; and 3) lowest emissions for the accidental release category. Future plans include implementation of the final VRT recommendations (F-Line) and reliability efforts that will be discussed in subsequent sections of this document.

Storage Tanks

- Several raw materials are received by pipeline and many are stored in pressure vessels.
- Internal floating roofs already in use for: vinyl acetate (2 tanks), 1-octene, n-hexane, recycle octene.
- Some pressure vessels and internal floating roofs were voluntary installations (e.g., odor control).
- The MON rule will require that two tanks TK-260 (n-hexane) and TK-280 (isooctane) either be upgraded with internal floating roofs or remove them from HAP service. At this time, BRPP has elected to remove the two tanks from HAP service and replace them with non-HAP substitutes. To the extent possible, lower vapor pressure substitutes will be sought.

Storage Tanks Summary

BRPP currently utilizes pressure vessels and internal floating roofs extensively, many voluntarily. Future plans include replacing existing HAPs in TK-260 (n-hexane) and TK-280 (isooctane) with non-HAP solvents.

Combustion

- BRPP operates four small package boilers and two flares.
- New boiler added in 2004 fitted with low-NOx burners and B-Boilers had its control system and other ancillary equipment modernized.
- As part of an energy savings project, computer control systems and other ancillary equipment (e.g., fan motors) are being modernized on the three older boilers (expected completion year-end 2007).
- Second flare was added in 2004, which allows for either maintenance without atmospheric venting.
- Older flare tip and ignition system replaced in 2004.
- Both flares utilize:
  - Callidus'$_{TM}$ latest technology in tip design, dry-seals, and ancillary equipment;
  - Panametrics$_{TM}$ flowmeters;
  - Powertrol$_{TM}$ flame monitors for steam control; and
  - BTU analyzers with natural gas supplementation capability.
- There are essentially three sources of flaring at BRPP: 1) emission control; 2) emergency events; and 3) unit start-up and shutdowns.
- BRPP already employs both equipment and procedures to minimize flaring. Specifically, BRPP utilizes its Purge Gas Purification Unit (ethylene distillation) to recover ethylene from unit off-gases. Distillation overheads and bottoms are both used as boiler fuels. Flowmeters are strategically placed in major legs of the flare header and operator rounds target tell-tale signs of ethylene loss (e.g., icing on piping), both for the purpose of detecting and mitigating unnecessary raw material loss.

- Flaring is minimal when all units are operating; therefore, flaring reduction efforts surround improving equipment reliability through event root-cause analysis / mitigation and implementation of ExxonMobil's Global Reliability System (GRS). GRS is a common global system which consolidates existing reliability practices / procedures from various Exxon Mobil Corporation businesses (e.g., Refining, Chemical's, Production). The system structure is similar to ExxonMobil's Operations Integrity Management Practices. GRS is fully supported by senior management and its progress will be closely stewarded.

  Combustion Summary

  BRPP has installed (or is in the process of installing) state-of-the-art control systems on both boilers and flares. Future improvements surround the minimization of flaring through event root-cause analysis / mitigation and implementation of ExxonMobil's Global Reliability System.

CONTINUOUS IMPROVEMENT INITIATIVES

Below is a summary of focus areas and respective action plans designed to deliver continuous improvement in environmental performance.

FOCUS AREA	ACTION PLAN
Emissions - Normal Operations	Implement remaining items needed to comply with MON • HAP substitutions • Pump replacements
Flaring	• Continue root-cause investigation / mitigation of unit shutdowns. • Continue existing reliability efforts while transitioning to the Global Reliability System.
Accidental Releases	• Implement remaining VRT recommendations – Remaining Base Plant items, F-Line in 2007 • Continue root-cause investigation / mitigation of accidental releases. • Continue existing reliability efforts while transitioning to the Global Reliability System.
HAWK / Smart LDAR	• Short-term: consider targeted use within BRPP as part of broader use among BR ExxonMobil sites. • Long-term: transition to Smart LDAR in lieu of traditional method (Method 21) upon maturation of technology / regulatory framework.

POSITIVES AND NEGATIVES OF THE PROGRAM

Negative aspects of the program included.

- The project was expensive with over $500,000 spent that would have otherwise been dedicated toward unit reliability improvements.
- The project required significant staff involvement from approximately October 2004 (order issuance) through September 2005 (monitoring effort reached steady-state), which delayed other continuous improvement efforts.
- The high volume of triggers resulting from a source east-southeast of BRPP quickly became a nuisance to operations personnel, particularly during periods of sustained east-southeast wind.

Positive aspects of the program included.

- Operation of the monitoring trailers through two "ozone seasons" confirmed that there is no direct correlation between specific BRPP operations/activities and high ozone readings or HRVOC strikes at LDEQ monitors.

- The project confirmed that BRPP has been addressing the proper strategic environmental focus areas including control of product emissions and the reduction of flaring for the purpose of reducing HRVOC emissions.
- The project raised awareness among operations personnel that their actions as well as normal plant operations can be detected at the fenceline depending on weather conditions.

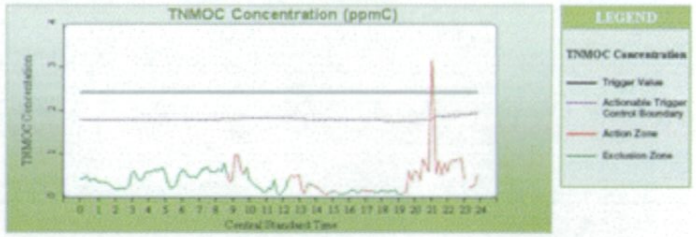
ATTACHMENT 1

TYPICAL TRIGGER PROFILES ASSOCIATED WITH OBSERVED TRENDS

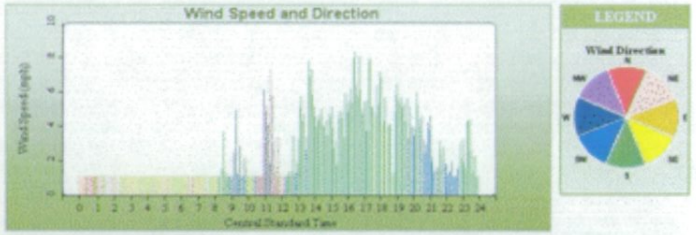
Findings: Typical Trigger Profile BRPP General Operations

Compound	ppbC	Compound	ppbC
Ethane	3.674	n-Hexane	46.511
Ethylene	451.510	Methylcyclopentane	
Propane	2.665	2,4-Dimethylpentane	
Propylene	22.445	Benzene	10.255
Isobutane	3.393	Cyclohexane	
n-Butane	60.362	2-Methylhexane	
Acetylene	1.456	2,3-Dimethylpentane	
t-2-Butene	1.414	3-Methylhexane	
1-Butene	3.232	2,2,4-Trimethylpentane	10.812
c-2-Butene	1.705	n-Heptane	
Cyclopentane		Methylcyclohexane	
Isopentane	0.562	2,3,4-Trimethylpentane	
n-Pentane	0.879	Toluene	7.259
1,3-Butadiene	17.944	2-Methylheptane	
t-2-Pentene		3-Methylheptane	
1-Pentene		n-Octane	
c-2-Pentene		Ethylbenzene	
2,2-Dimethylbutane		m/p-Xylene	1.146
2,3-Dimethylbutane		Styrene	1.159
2-Methylpentane	2.953	o-Xylene	0.779
3-Methylpentane		Total GC	974.393
Isoprene			
1-Hexene	318.878		

- **Trigger Details**
  - ➥ TNMOC 3.152 ppmC
  - ➥ Set point 2.41 ppmC
  - ➥ Mov. Avg. 1.798 ppmC
  - ➥ All lines running
  - ➥ No significant flaring
  - ➥ No findings



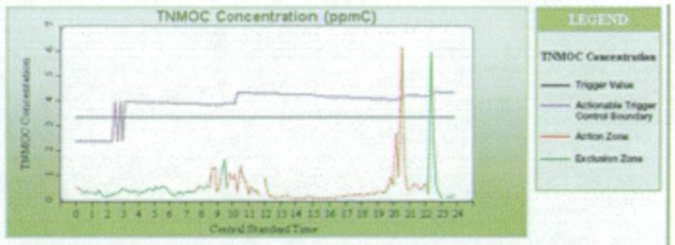
The TNMOC data displayed has been validated.



Findings: Typical Trigger Profile BRPP General Operations + Flaring

Compound	ppbC	Compound	ppbC
Ethane	20.94	n-Hexane	4.405
Ethylene	217.116	Methylcyclopentane	
Propane	10.362	2,4-Dimethylpentane	
Propylene	14.563	Benzene	
Isobutane	4.656	Cyclohexane	
n-Butane	15.406	2-Methylhexane	
Acetylene		2,3-Dimethylpentane	
t-2-Butene	3.010	3-Methylhexane	
1-Butene	2.081	2,2,4-Trimethylpentane	
c-2-Butene	6.132	n-Heptane	
Cyclopentane		Methylcyclohexane	
Isopentane	2.843	2,3,4-Trimethylpentane	22.091
n-Pentane		Toluene	5.905
1,3-Butadiene		2-Methylheptane	
t-2-Pentene		3-Methylheptane	
1-Pentene		n-Octane	
c-2-Pentene		Ethylbenzene	
2,2-Dimethylbutane	2.405	m/p-Xylene	2.513
2,3-Dimethylbutane		Styrene	
2-Methylpentane		o-Xylene	
3-Methylpentane		Total GC	351.113
Isoprene			
1-Hexene	16.688		

- **Trigger Details**
  - ➥ TNMOC 6.125 ppmC
  - ➥ Set point 3.32 ppmC
  - ➥ Mov. Avg. 4.080 ppmC
  - ➥ D-Line shutdown
  - ➥ Flaring ≈ 5.5 klb/hr



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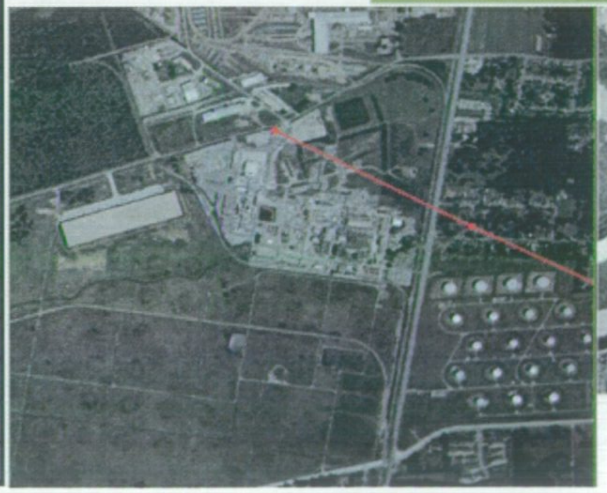
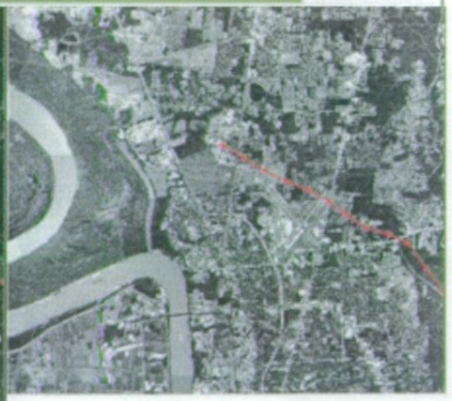
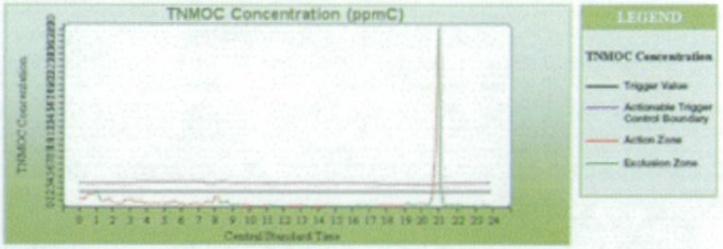




Findings: Typical Trigger Profile E-SE Source

Compound	ppbC	Compound	ppbC
Ethane	40.036	n-Hexane	258.721
Ethylene	9.339	Methylcyclopentane	146.485
Propane	107.216	2,4-Dimethylpentane	267.824
Propylene	7.824	Benzene	121.368
Isobutane	669.691	Cyclohexane	22.511
n-Butane	9999.000	2-Methylhexane	78.562
Acetylene	47.46	2,3-Dimethylpentane	113.186
t-2-Butene	314.702	3-Methylhexane	90.798
1-Butene	73.114	2,2,4-Trimethylpentane	184.536
c-2-Butene	269.416	n-Heptane	62.580
Cyclopentane	37.561	Methylcyclohexane	32.369
Isopentane	11671.431	2,3,4-Trimethylpentane	1001.034
n-Pentane	1840.925	Toluene	1101.008
1,3-Butadiene	14.329	2-Methylheptane	20.881
t-2-Pentene	811.936	3-Methylheptane	27.274
1-Pentene	588.398	n-Octane	11.524
c-2-Pentene	364.487	Ethylbenzene	39.487
2,2-Dimethylbutane	193.331	m/p-Xylene	111.223
2,3-Dimethylbutane	864.733	Styrene	
2-Methylpentane	821.386	o-Xylene	34.495
3-Methylpentane	456.715	Total GC	33025.963
Isoprene	44.366		
1-Hexene	47.243		

- **Trigger Details**
  - ➥ TNMOC 29.25 ppmC
  - ➥ Set point 2.41 ppmC
  - ➥ Mov. Avg. 3.938 ppmC



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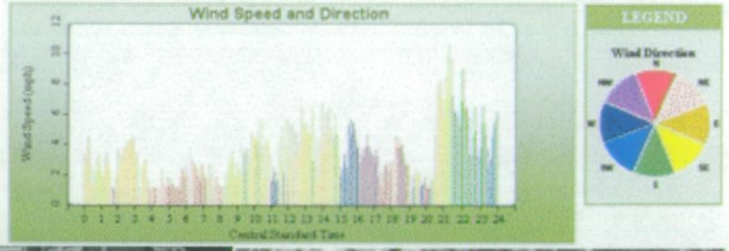
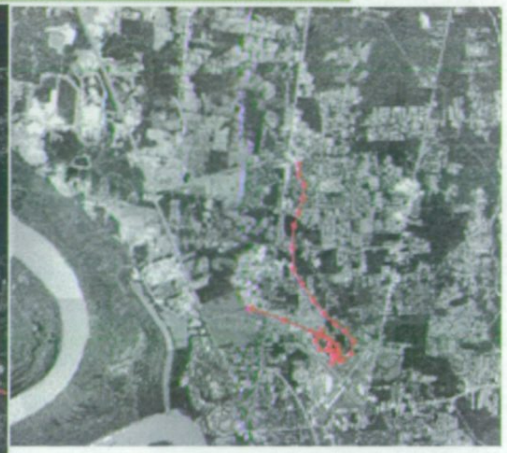




Appendix D – Facility Final Reports

ExxonMobil Polyolefins Plant

BRPO

Baton Rouge Polyolefins Plant
12875 Scenic Highway (70807)
P. O. Box 53006
Baton Rouge, LA 70892-3006

ExxonMobil
Chemical

February 13, 2007

Dr. Harold. Leggett
Louisiana Department of Environmental Quality
Office of Environmental Compliance
Enforcement Division
Post Office Box 4312
Baton Rouge, Louisiana 70821-4312

Ref: Administrative Order Final Report
ExxonMobil Baton Rouge Polyolefins Plant
AI No. 3519

Dear Dr. Leggett:

ExxonMobil Chemical Company, Baton Rouge Polyolefins Plant (BRPO) is submitting this Final Report as required by the Administrative Order AE-AOA-05-0030 Early Termination Agreement issued December 20, 2006. Please find attached a report containing an Overview of the Program, Summary of Findings, and data collected.

BRPO has operated two monitoring trailers with Gas Chromatography (GC) analyzers since May 2005. During this monitoring period the site had very few discreet findings and no unidentified sources or unauthorized releases were discovered.

In October 2005 BRPO voluntarily installed a regenerative thermal oxidizer to reduce emissions for the process vent area. This RTO has reduced actual emission from the site approximately 30%. BRPO will continue existing efforts to address emissions reductions where feasible.

If you have any questions or require additional information, please contact me at (225) 977-9795.

Sincerely,

George W. Jones
Safety, Health & Environmental Coordinator

Cc: Maurice Oubre
LDEQ

Ambient Air Fenceline Monitoring Project
Final Report

ExxonMobil
Chemical

Introduction

- **Site Background**
  - ➥ BRPO operates seven polyethylene reactors (A-G) and one polypropylene reactor.
  - ➥ Polypropylene unit was constructed in 2000.
- **Project Background and System Design**
  - ➥ In 2004 prior to A.O. BRPO site initiated a fenceline monitoring program during ozone season.
  - ➥ ExxonMobil (EM) has applied innovative techniques to answer the challenge imposed by the LDEQ order
    - – GC vs. canisters, mobile trailers, wireless communications, data analysis tools
  - ➥ EM developed and applied aggressive notification, investigation, and reporting systems in response to "triggers"
  - ➥ Monitoring trailers have operated at steady state conditions at all sites capturing seasonal wind shifts
  - ➥ Monitoring trailers were placed at BRPO's fenceline to facilitate rapid and accurate depiction of triggers
  - ➥ BRPO operated two Monitoring trailers (Lat – Long N 30°33"30.24" W 91°12"50.58" and N 30°33"50.52" W 91°12"22.44) a site map with the locations of the stations is included on page 4 of this document.
- **Overview and Details of ExxonMobil / BRPO Program**
  - ➥ Trigger "set-point" established at each monitoring site targeted at delivering ≈ 5 triggers / month
  - ➥ BRPO established a 4 ppm Trigger "set-point for actionable response. (2.14 non-actionable)
  - ➥ Protocol adjusted to include inclusion / exclusion zones for actionable triggers, except when wind is < 2 mph
  - ➥ Protocol adjusted to NOT *immediately investigate* triggers when wind < 2 mph

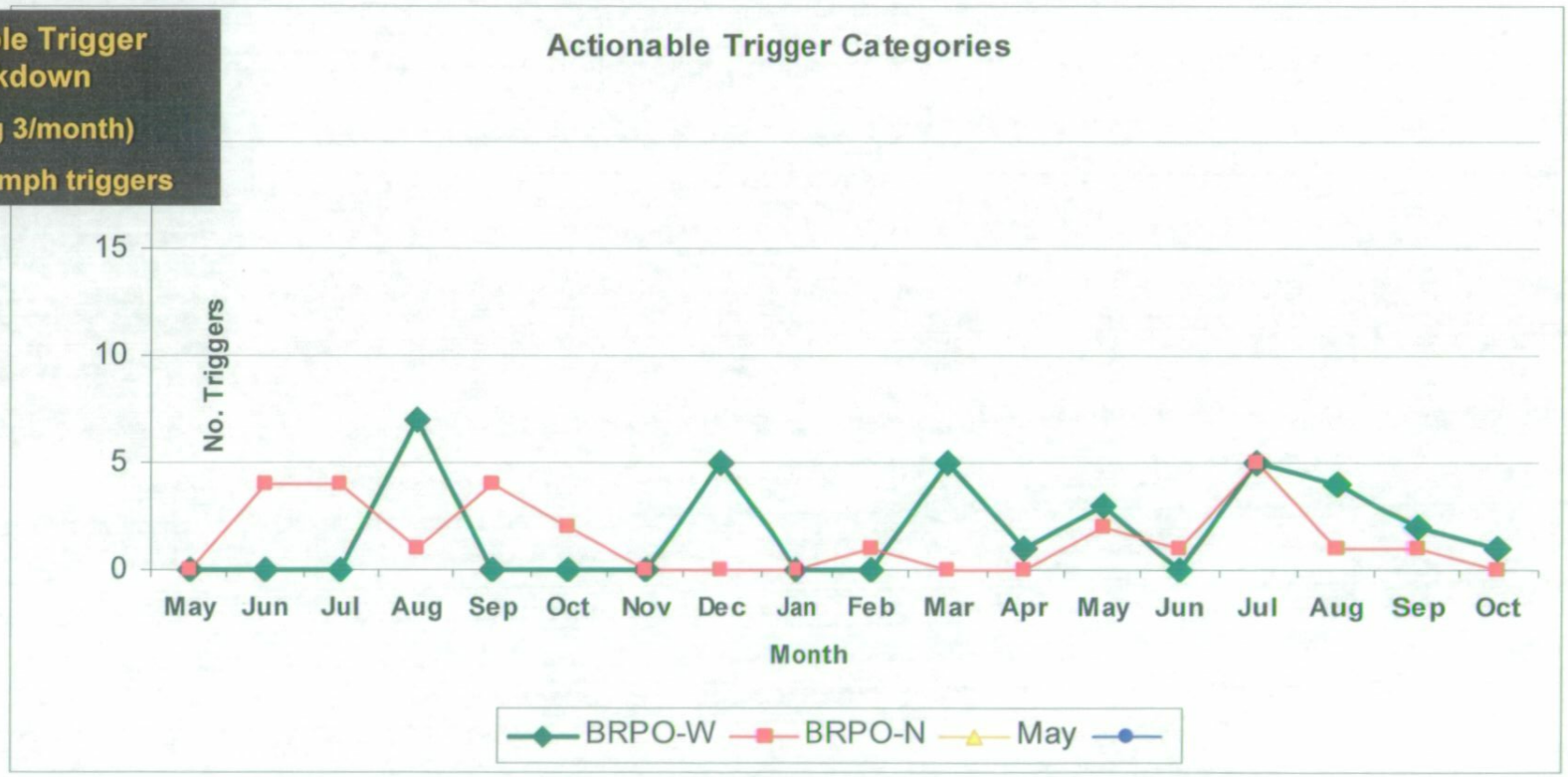
Findings

- Very few discreet findings: unauthorized discharge
- Trends: low-level triggers caused by routine permitted operations / sources

Actionable Trigger Breakdown

•59 Total (Avg 3/month)

Excludes < 2 mph triggers



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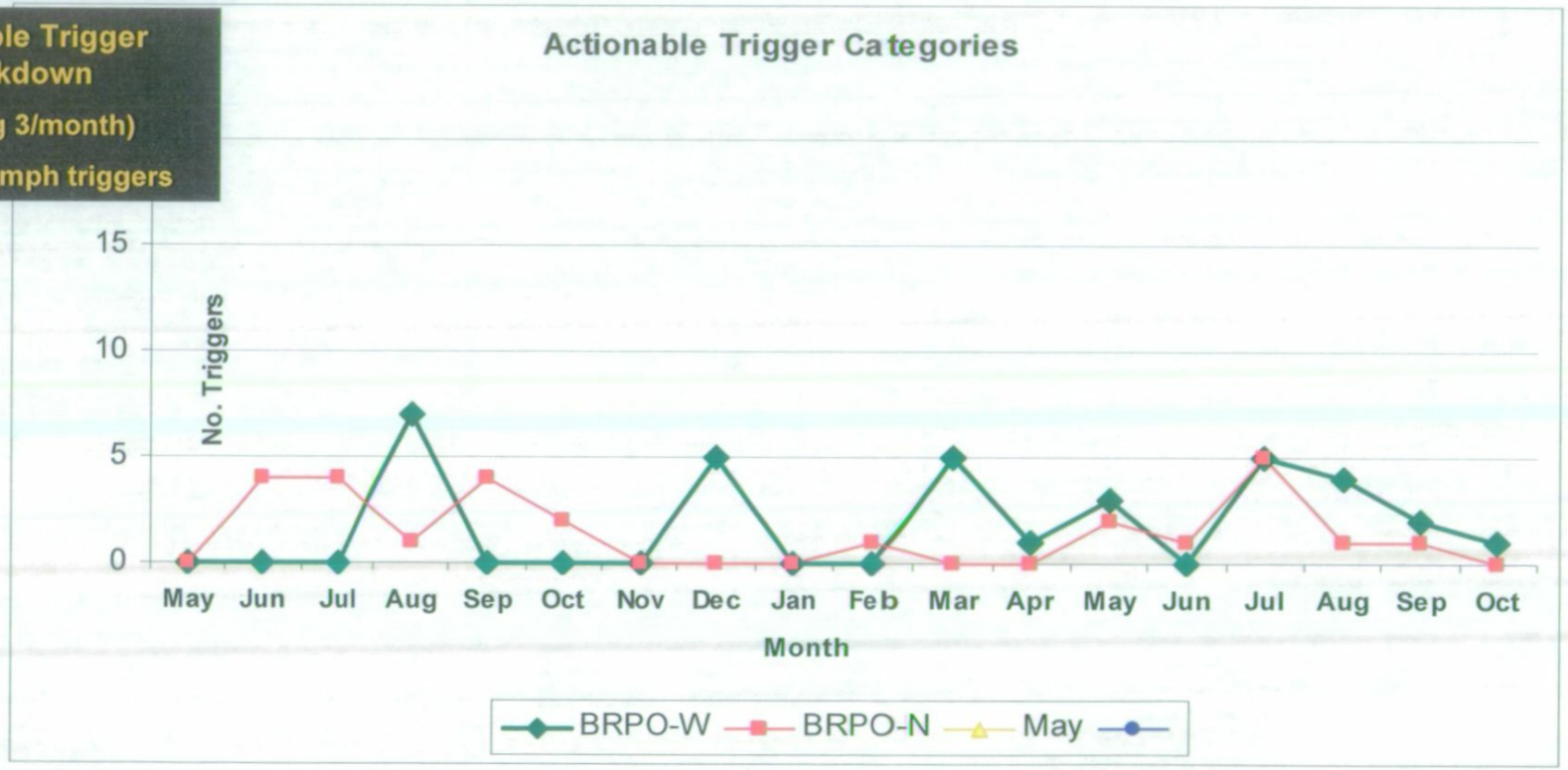
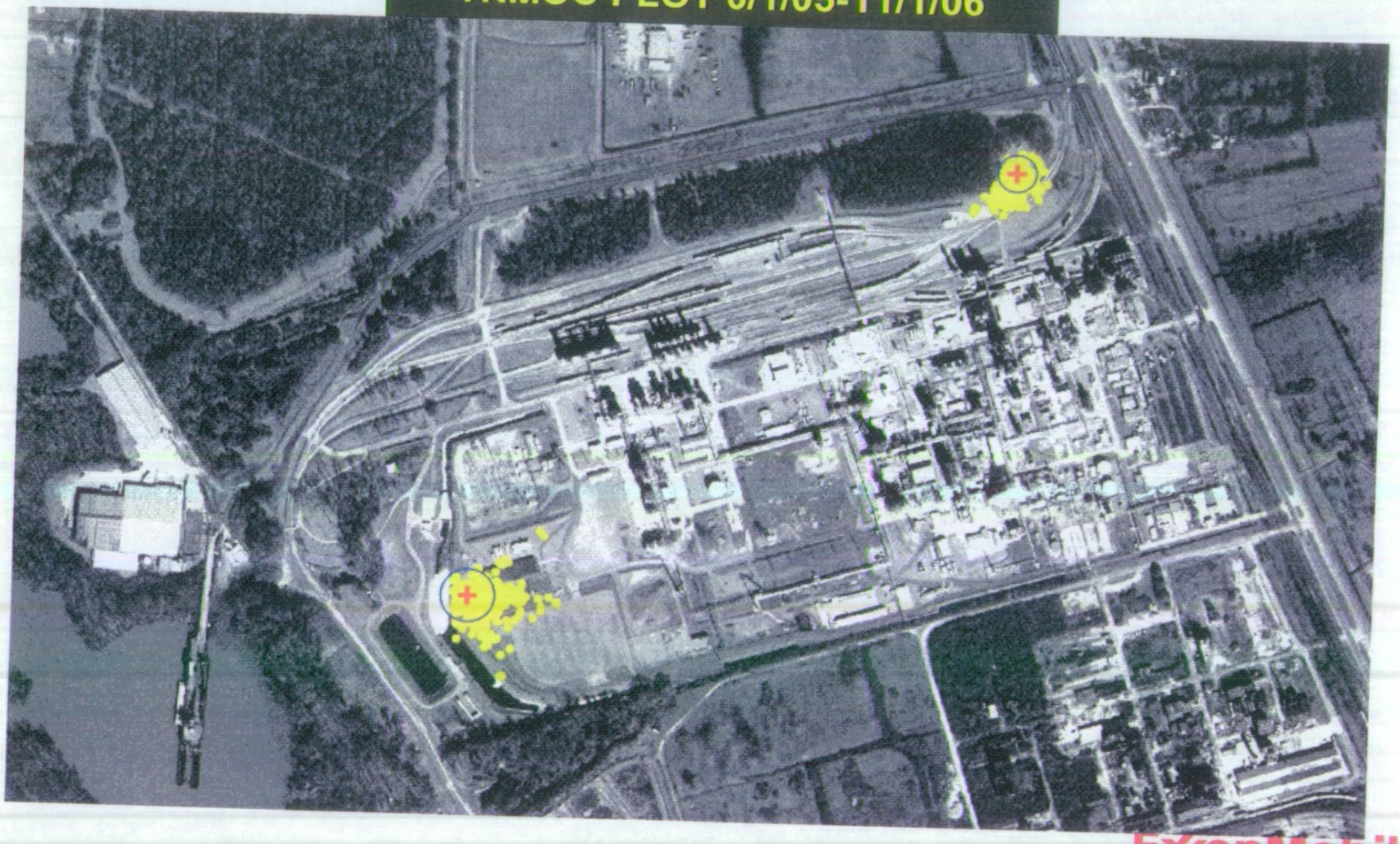


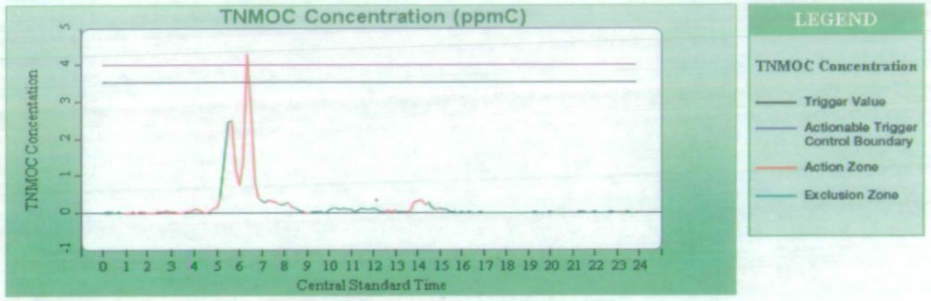
TNMOC PLOT 6/1/05-11/1/06



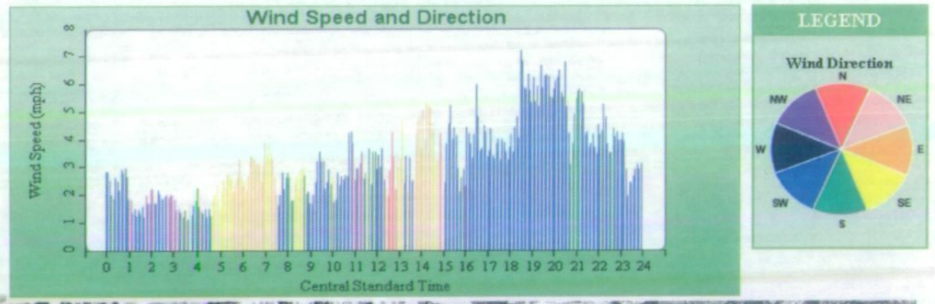
BEST COPY

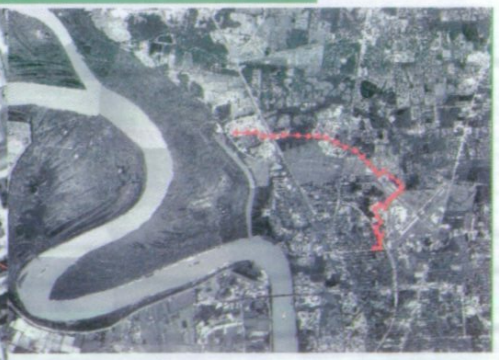
Findings: Typical Trigger Profile BRPO General Operations

Compound	ppbC	Compound	ppbC
Ethane	17.45	n-Hexane	094
Ethylene	263.86	Methylcyclopentane	
Propane	343.94	2,4-Dimethylpentane	
Propylene	516.37	Benzene	1.56
Isobutane	950.44	Cyclohexane	1.85
n-Butane	27.84	2-Methylhexane	
Acetylene	11.46	2,3-Dimethylpentane	
t-2-Butene	2.74	3-Methylhexane	
1-Butene	2.98	2,2,4-Trimethylpentane	0.71
c-2-Butene		n-Heptane	1.08
Cyclopentane		Methylcyclohexane	
Isopentane	2.29	2,3,4-Trimethylpentane	0.002
n-Pentane	1.41	Toluene	3.23
1,3-Butadiene		2-Methylheptane	
t-2-Pentene	077	3-Methylheptane	
1-Pentene		n-Octane	
c-2-Pentene		Ethylbenzene	
2,2-Dimethylbutane		m/p-Xylene	1.99
2,3-Dimethylbutane	1.13	Styrene	0.58
2-Methylpentane	4.23	o-Xylene	1.38
3-Methylpentane	.88	Total GC	2235.6
Isoprene	20.034		
1-Hexene	54.50		

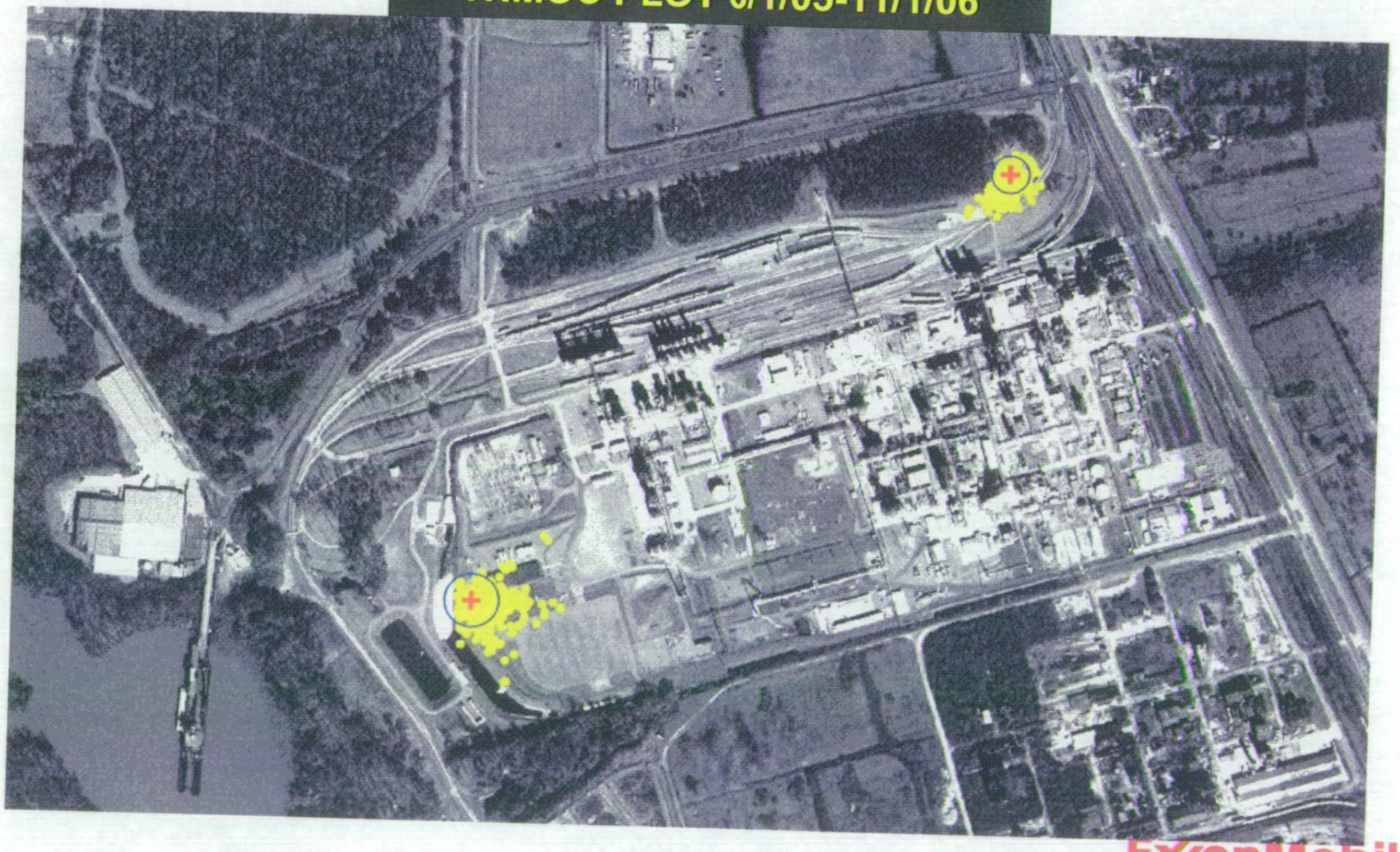


The TNMOC data displayed has been validated.





TNMOC PLOT 6/1/05-11/1/06



Status Air Emission Source Control

- ***Process Vents Reductions***
  - ➥ Regenerative Thermal Oxidizer installed voluntarily
  - ➥ Oxidizer controlling inert gas vent 207 started up in October 2005.
  - ➥ RTO sized to include attritional vents in future.
  - ➥ ≈$4M spent RTO / generating ≈50% actual emissions reduction from Inert Gas Vents
  - ➥ BRPO is a minor source for HAPs

- **Equipment Leaks**
  - ➥ BRP0 has consistently operated with ≤0.5% leaking valves, well below the "good performance" criteria
  - ➥ URS LDAR audit found BRPO's program in excellent health:

    U.S. benchmarking placed BRPO program elements in top 25%: open-ended line control, component identification, comparative monitoring, and delay of repair

- **Accidental Releases**
  - ➥ No discovered accidental releases or unauthorized discharges

Summary / Action Plans

- **Very few discreet findings; however, routine operations / flaring caused low-level triggers**

PROJECT FINDINGS	ACTION PLAN
Emissions - Normal Operations	• Emissions reduced from Thermal Oxidizer
Flaring	• Continue existing reliability efforts
FUTURE INITIATIVES	**ACTION PLAN**
Accidental Releases	• Continue existing reliability efforts
Flare	• Evaluate feasibility of routing streams to oxidizer

Appendix D – Facility Final Reports

Geismar 6

BASF, Chemtura, Shell, Syngenta, Occidental, Williams

E·A·G·L·E
ENVIRONMENTAL SERVICES, INC.
18369 Petroleum Drive • Baton Rouge, Louisiana • 70809
Ph. (225) 757-0870 • Fax (225) 757-8855

RECEIVED
FEB 21 2007
Office of
Environmental Compliance

February 13, 2007

Ms. Jane Lacour
Louisiana Department of Environmental Quality
Office of Environmental Compliance - Enforcement Division
Post Office Box 4312
Baton Rouge, Louisiana 70821-4312

Re: Geismar 6 Air Monitoring Program Final Report

Dear Ms. Lacour:

On behalf of our client, the Geismar 6 whose members include: BASF Corporation, Chemtura Corporation, Occidental Chemical Corporation, Shell Chemical Company, Syngenta Crop Protection, Inc., and Williams Olefins, L.L.C., we respectfully submit to the Louisiana Department of Environmental Quality (LDEQ) Office of Environmental Compliance – Enforcement Division three copies of the "Final Report for the Geismar 6 Air Monitoring Program" for your review. This report includes the monitoring program specifics, results and findings, and project conclusions.

Should you have any questions or require further information, please do not hesitate to contact me at (225) 757-0870.

Sincerely,

Jennifer Herrick

Jennifer Herrick
Eagle Environmental Services, Inc.

RECEIVED
FEB 15 2007
LDEQ
7 FEB 15 P1 7
LDEQ RECEIPT

Enc: As stated

FINAL REPORT FOR THE GEISMAR 6 AIR MONITORING PROGRAM

Prepared for:
The Geismar 6

BASF Corporation, Chemtura Corporation,
Occidental Chemical Corporation, Shell Chemical Company,
Syngenta Crop Protection, Inc., & Williams Olefins, L.L.C.

Submitted to:
State of Louisiana Department of Environmental Quality

February 2007

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EXECUTIVE SUMMARY

On January 25, 2005, the Louisiana Department of Environmental Quality (LDEQ) issued an Administrative Order on Consent (Order), in which the members of the Geismar 6 companies (Geismar 6) agreed to join together to proactively assist the LDEQ in its efforts to research the impact of highly reactive volatile organic compounds (HRVOC) emissions on ozone formation in the 5-parish Baton Rouge Area and to assist with efforts to prevent and/or reduce ozone formation.

These efforts included the installation, operation, and maintenance of two new ambient air monitoring stations and the monitoring of two existing LDEQ ambient air monitoring stations. These area monitors provided continuous measurement of total non-methane organic carbon (TNMOC) and nitrogen oxides (NO_x) with trigger sampling capability for episodic measurement of target ozone precursor volatile organic compounds (TOPVOC), which included HRVOC. Another requirement of the order was to respond to predetermined TNMOC alarms. This would assist the facilities in identifying any site HRVOC releases which were previously not recognized.

The ambient air monitoring stations, meteorological towers, and communication systems were installed and operational on May 1, 2005. They operated continuously through December 31, 2006.

While no direct correlation between the HRVOC activities of the facilities and impacts on the air monitoring stations was demonstrated, the Geismar 6 air monitoring program did illustrate that industry and the agency can successfully work together to study and address environmental issues that impact the surrounding communities.

1.0 INTRODUCTION AND PROGRAM SPECIFICS

On January 25, 2005, the LDEQ issued an Administrative Order on Consent (Order) to the Geismar 6 Companies (Geismar 6). The Geismar 6 agreed to join together to proactively assist LDEQ in its efforts to research the impact of highly reactive volatile organic compound (HRVOC) emissions on ozone formation in the 5-parish Baton Rouge Area, and to assist with efforts to prevent and/or reduce ozone formation. These efforts included the installation, operation, and maintenance of two new ambient air monitoring stations in Ascension and Iberville Parish and the monitoring of two existing LDEQ ambient air monitoring stations.

1.1 The Geismar 6 Companies

BASF Corporation, Chemtura Corporation (formerly Crompton Manufacturing Company, Inc.), Occidental Chemical Corporation (formerly Vulcan Chemicals, Inc.), Shell Chemical Company, Syngenta Crop Protection, Inc., & Williams Olefins, L.L.C. operate facilities within close proximity to each other along the Mississippi River in southeastern Louisiana. Collectively, they are referred to as the "Geismar 6".

BASF Corporation's (BASF) facility is located at 8404 Highway 75, Ascension Parish, Louisiana. This facility produces isocyanates, hydrochloric acid, 1,4-butanediol and downstream derivatives, as well as a range of specialty chemicals including numerous amines.

Chemtura Corporation (Chemtura) is located at 36191 Highway 30, Ascension Parish, Louisiana. This facility is a major producer of synthetic rubber primarily used in automobiles, hoses, roofing, wire and cable. The company also produces agricultural chemicals and a variety of specialty rubber chemicals used as processing aids and antioxidants for the rubber and plastics processing industry.

Occidental Chemical Corporation (Oxy) is located at 8318 Ashland Road, Ascension Parish, Louisiana. This facility converts brine into chlorine and other products with chlorine bases. Among the products produced are methyl chloride,

methylene chloride, chloroform, carbon tetrachloride, ethylene dichloride, perchloroethylene, pentachloropropane, hydrochloric acid, and caustic soda.

Shell Chemical Company (Shell) is located at 7594 Highway 75, Ascension Parish, Louisiana. This facility produces ethylene oxide, ethylene glycols, detergent alcohols, and olefins in commercial quantities.

Syngenta Crop Protection, Inc. (Syngenta) is located at 3905 Highway 75, Iberville Parish, Louisiana. This facility manufacturers and formulates pesticides, chemical intermediates, and specialty chemicals.

Williams Olefins, L.L.C. (Williams) is located at 5205 Highway 3115, Ascension Parish, Louisiana. This facility produces polymer grade ethylene and propylene, crude butadiene, and debutanized organic concentrate (DAC), which is also referred to as pyrolysis gasoline.

A topographic map showing the location of each facility and monitoring station is presented in **Appendix A, Figure 1**. An aerial photograph of the monitoring stations and facilities is presented in **Appendix A, Figure 2**.

1.2 Monitoring Site Descriptions

The Geismar 6 air monitoring program consisted of four strategically located air monitoring sites surrounding the facilities. Monitoring sites were chosen based on their distance from obstructions and the objective of recording data at both upwind and downwind locations. Two existing LDEQ monitoring sites, Dutchtown and Carville, and two new monitoring sites were used.

Dutchtown Air Monitoring Station

The Dutchtown air monitoring station is an existing LDEQ area monitoring station located in Dutchtown, Louisiana. This monitoring site included a TNMOC analyzer, NO_x analyzer, canister sampler, ozone analyzer, and wind speed/wind direction monitor. The monitoring station is located on the north side of Kling Road. The UTM coordinates of the site are East 695815, North 3345739 in Zone 15.

Carville Air Monitoring Station

The Carville air monitoring station is an existing LDEQ area monitoring station located in Carville, Louisiana. This monitoring site included a TNMOC analyzer, NO_x analyzer, canister sampler, ozone analyzer, and wind speed/wind direction monitor. The original location of the station was within the Gillis W. Long Center (GWL Center) owned by the State of Louisiana Military Department. However, during the week of May 8, 2006, the Geismar 6 funded the relocation of the Carville site to an open field just east of the GWL Center due to local sources influencing the TNMOC values. When the Geismar 6 monitoring program began, the site was located at UTM coordinates East 680184, North 3341928 in Zone 15. The site is now located at UTM coordinates East 681231, North 3342862 in Zone 15.

Hunt Air Monitoring Station

The Hunt air monitoring station was a new site installed by the Geismar 6. This monitoring site included a TNMOC analyzer, NO_x analyzer, canister sampler, and wind speed/wind direction monitor. It was located within the Hunt Correctional Facility in St. Gabriel, Louisiana. The UTM coordinates of the site were East 684838, North 3349161 in Zone 15.

Darrow Air Monitoring Station

The Darrow air monitoring station was a new site installed by the Geismar 6. This monitoring site included a TNMOC analyzer, NO_x analyzer, canister sampler, and wind speed/wind direction monitor. It was located behind the 5th Ward Volunteer Fire Department in Darrow, Louisiana. The UTM coordinates of the site were East 697293, North 3336055 in Zone 15.

1.3 Monitoring Program Specifics

The purpose of the G6 air monitoring program was to research the impact of HRVOC emissions on ozone formation and to assist with efforts to prevent rapid ozone formation. To accomplish this, each station was equipped with the same type of monitors and sampling equipment capable of year-round monitoring.

Each monitoring station continuously monitored TNMOC using the Thermo Environmental Instruments (TECO) Model 55C, Direct Methane, Non-Methane Analyzer. The analyzer was operated year round and reported the measurement of TNMOC in 10-minute block averages of methane and total non-methane in parts-per-million carbon (ppmC).

Each monitoring station continuously measured NO_x using the TECO Model 42C, NO-NO_2-NO_x Analyzer. The analyzer was operated year round and reported the NO_x concentration in 5-minute block averages in parts-per-billion (ppb).

Each station was equipped with an integrated 6-liter Summa-passivated canister sampler capable of automatically collecting a 20-minute air sample when triggered. A signal was sent to an RM Environmental Systems, Inc. (RMESI) Model 911A Canister Sampler when the continuously measured TNMOC concentration exceeded a predetermined threshold value. The air sample passed through the sampler and into an RMESI Model 912 Multi-Canister Sampling Adapter that directed the air sample to a Summa canister. The canister sample was analyzed for the 43 TOPVOC, which included HRVOC. A table listing the 43 TOPVOC can be found in **Appendix B**. Analysis of these compounds was performed in accordance with EPA/600-R98/161 Technical Assistance Document for Sampling and Analysis of Ozone Precursors (Section 2.5 – Manual Method for Collecting and Analyzing Volatile Organic Compounds). Minimum detection limits (MDLs) for each target compound was 10 parts-per-billion carbon (ppbC) or less.

The stations were also equipped with sensors to continuously measure and record both the wind speed and wind direction in a 5-minute block average. The wind

speed was measured and recorded to the nearest tenth of a mile per hour (mph) and the wind direction was measured and recorded to the nearest degree of azimuth.

The air monitoring program was operational from May 1, 2005 through December 31, 2006.

1.4 Trigger Response Procedures

As part of the Order, the Geismar 6 responded to predetermined TNMOC alarms. The Geismar 6 were notified via automatic call-out when a TNMOC alarm was detected. For this project, three TNMOC alarm levels were configured. A "Level 1" alarm was the result of the TNMOC concentration exceeding a pre-determined level during a 10-minute average. A "Level 2" alarm was triggered whenever the concentration exceeded two (2) times the predetermined concentration. A "Level 3" alarm interval was triggered if the concentration increased by more than 1 ppmC over a 20-minute period.

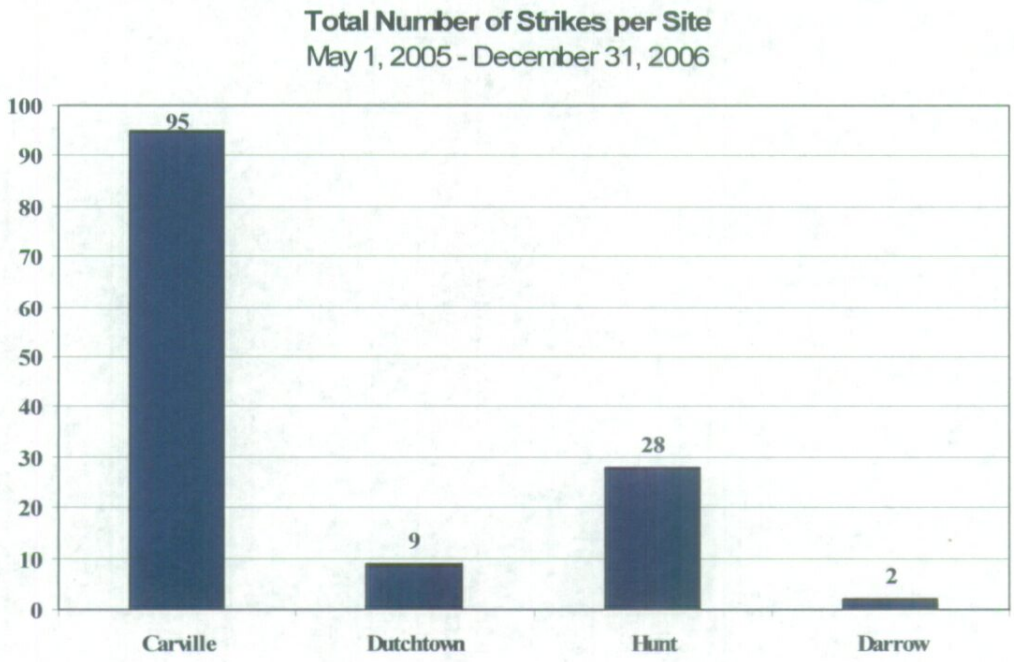
Upon notification of a Level 2 or Level 3 trigger event, each facility followed internal response plans approved by the LDEQ. While the response plans were tailored to the individual plants, they contained similar elements including: review of meteorological conditions during and immediately prior to the trigger event, review and recording of plant activities that could impact TNMOC levels, and perimeter air monitoring. By responding to the trigger events, the Geismar 6 could identify any HRVOC releases which were previously not recognized. Records of the responses were reported to the LDEQ in a monthly report submitted by the Geismar 6 Technical Review Team (TRT).

2.0 RESULTS AND FINDINGS

As a requirement of the air monitoring program, data outputs from each analyzer was continuously scanned and recorded as auxiliary and hourly averages by the on-site data logger. The data was reviewed by the data manager on a daily basis to ensure that the stations were responding as expected and that the data was reasonable. Daily calibration checks and quarterly performance audits were performed to ensure that the analyzers were operating within specified guidelines. On a monthly basis, the data was compiled and submitted to the Geismar 6 TRT for review. During the review, findings from the plants' individual investigations were discussed to determine if a source of strikes could be identified. A summary of the results and findings are discussed below.

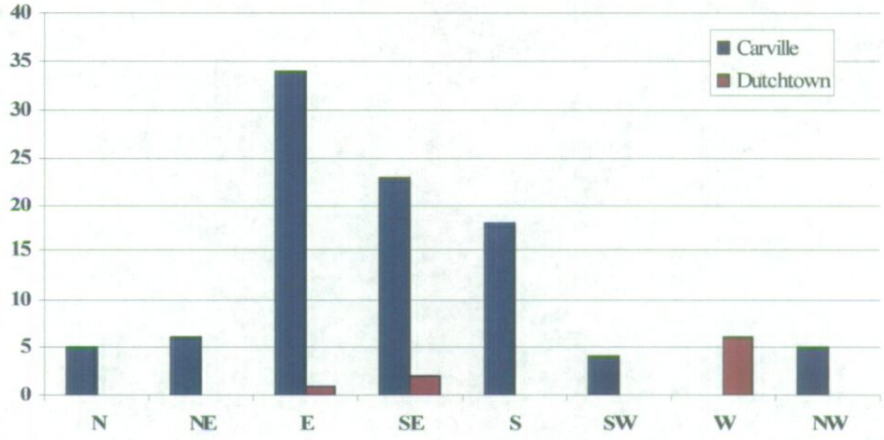
2.1 Summary of Results

The analyzers operated continuously from May 1, 2005 through December 31, 2006 and during that time a total of 134 canisters samples were analyzed for the 43 TOPVOC. The majority of the samples, 92%, were taken at the Carville and Hunt sites. Over the course of the twenty-month program, Carville averaged five strikes a month, Hunt averaged one strike a month, and both Dutchtown and Darrow averaged less than one strike a month.

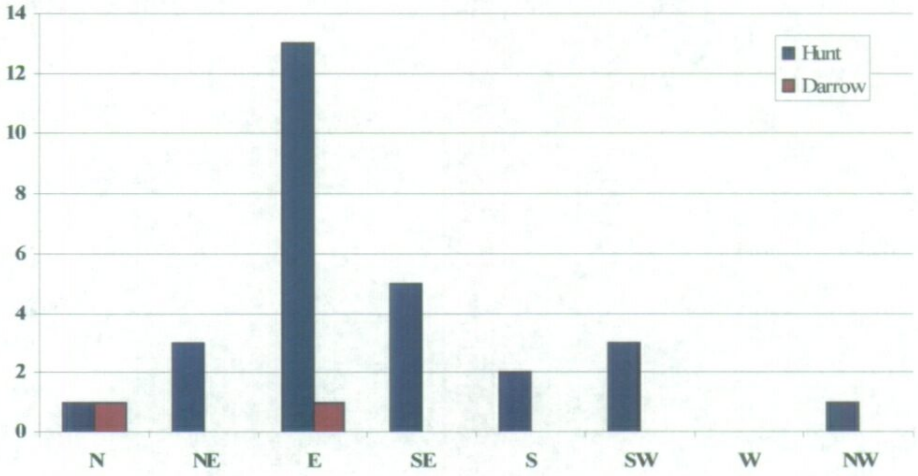


Wind direction is an important factor when determining a source for a strike. The wind direction preceding a strike event was analyzed by the plants as a part of the individual response plans. The wind direction at the time of the strike was recorded and submitted to the LDEQ. The majority of strikes at both the Carville and Hunt sites were out of the east and southeast while the majority of strikes at Dutchtown were out of the west. A map showing the location of the monitoring site in relation to the location of the plants and the number of strikes based on wind direction can be found in **Appendix A, Figures 3 – 7**.

Total Number of Strikes per Site Based on Wind Direction - Carville & Dutchtown
May 1, 2005 - December 31, 2006



Total Number of Strikes per Site Based on Wind Direction - Hunt & Darrow
May 1, 2005 - December 31, 2006



2.2 Significant Findings

On a monthly basis, members of the Geismar 6 TRT would meet and discuss the previous month's strikes and activities. The purpose of the meetings was to share information gathered by the individual plants and work together to identify a source of the strikes. A report summarizing the TRT review and conclusions was sent to the LDEQ at the end of each month.

The most significant finding was the lack of Geismar 6 strike sources. It was found that very few incidents occurring at any Geismar 6 facilities could have contributed to the strikes; and localized and non-Geismar 6 activities had the greatest influence on TNMOC values.

The site that was most influenced by local sources was Carville. The Carville site was originally located in close proximity to a fueling station used on a daily basis in the upkeep of the GWL Center. Due to the frequency of strikes occurring at Carville as a result of the fueling station activities, the Carville site was moved into an agricultural field immediately east of the GWL Center. However, following the move it was determined that activities pertaining to the agricultural field may have impacted the site. The Hunt site was also found to be influenced by local, non-Geismar 6 influences.

3.0 CONCLUSION

The collaborative effort put forth among the six companies comprising the Geismar 6 and the LDEQ was very successful. This effort demonstrates the desire for all parties to work together to study and address environmental issues which impact our communities. As a direct result of the air monitoring program, several of the companies reported TNMOC emission reductions, and on-going programs were initiated to monitor and further reduce emissions.

3.1 Emission Reductions

Through the course of the program, the Geismar 6 facilities evaluated their equipment and operations to proactively identify ways in which they could reduce emissions. Chemtura, Oxy, and Syngenta were able to identify specific sources and took actions to reduce emissions.

Chemtura monitored emissions from non-routine activities such as loading, unloading, and startup/shutdown activities. They found some minor leaks on railcars that were repaired. In addition, Chemtura found one leak from a compressor using the HAWK camera. The leak was repaired and reported as required under appropriate regulations.

Oxy installed a vent containment project to eliminate the ethylene releases associated with the emergency shutdown of their EDC MCI process.

Syngenta discovered weighted relief devices on two toluene storage tanks which occasionally leaked after reseating. The facility replaced these devices with a different technology that properly reseats.

3.2 On-Going Programs

The knowledge level with regard to potential negative environmental impacts increased throughout the facilities. This increased knowledge will assist the facilities in identifying and eliminating potential emission sources in a timely fashion. As a result of the air monitoring program, several facilities initiated on-

going programs to further identify and reduce emissions including BASF, Chemtura, Shell, Syngenta, and Williams.

BASF is participating in a voluntary fugitive emissions study. The program involves the coordinated application of gas imaging technology and traditional LDAR methods to improve leak detection of VOCs. The SMART LDAR pilot project will initially involve 1-2 units at BASF Geismar. In addition, BASF is involved in the Baton Rouge Ozone Task Force both in the oversight committee and technical committee.

As a result of the program, Chemtura has equipment available and an experienced team capable of monitoring their facility and onsite activities to identify and address releases as necessary. In addition, Chemtura continues to maintain a comprehensive LDAR program to identify and minimize hydrocarbon emissions.

Shell has an aggressive fugitive emissions program to identify any leaks. They also employ a local Ethylene Oxide monitoring network to identify any internal leaks. Shell will continue to support the HRVOC efforts by actively participating in the Baton Rouge Ozone Task Force Committee. Additionally, Shell has joined an industry subgroup that will study and gain an understanding of emissions that are associated with port activities.
Syngenta's on-going programs include monitoring of cooling towers, monitoring of tank roof tops, and LDAR activities. Syngenta has developed a site monitoring team capable of monitoring ambient air for potential releases from on-site or off-site releases.

Williams' on-going programs include replacing "A" body control valves with Enviro-Seal control valves, upgraded LDAR monitoring to include a full-time on-site dedicated LDAR technician, conducting a post-turnaround HAWK survey of the facility, and revised engineering specifications to reduce leaks where possible. Williams also moved their plant outage, which results in shutdown and startup emissions, from during the ozone season to outside of the ozone season. In addition, Williams is involved in the Baton Rouge Ozone Task Force both in the oversight committee and technical committee.

3.3 Overall Program Effectiveness

The purpose of the Geismar 6 air monitoring program was to research the impact of the facilities HRVOC emissions on ozone formation, assist with efforts to prevent ozone formation, and identify any site HRVOC releases which were previously not recognized. While the program was effective in bringing the facilities and the LDEQ together, few correlations could be found between the HRVOC activities of the facilities and the monitoring station results. However, the Geismar 6 appreciates the opportunity to participate in this program which will allow us to continue to improve the air quality in the surrounding communities.

APPENDIX A

FIGURES

Note:

Carville #1 refers to the original location of the Carville air monitoring station.

Carville #2 refers to the location of the Carville air monitoring station following its relocation during the week of May 8, 2006.

Geismar 6

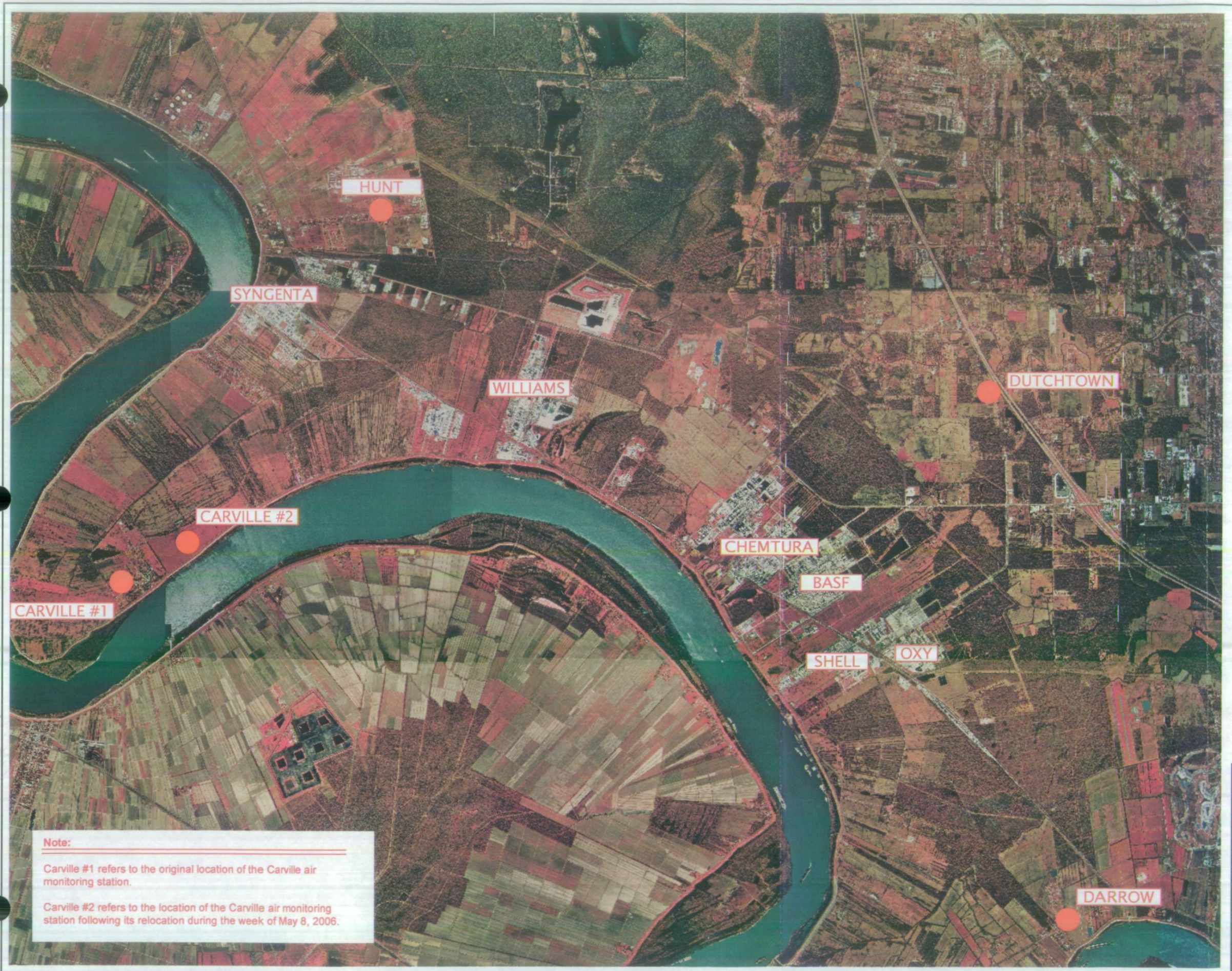
Geismar, Louisiana

Site Location Map

E·A·G·L·E ENVIRONMENTAL SERVICES, INC.

Drawn:	jbh
Checked:	JS
Approved:	JS
Date:	01/18/05
Dwg. No.:	108-0001-A1

Figure 1



Note:

Carville #1 refers to the original location of the Carville air monitoring station.

Carville #2 refers to the location of the Carville air monitoring station following its relocation during the week of May 8, 2006.

N

6000 0 6000

Scale: 1" = 6000'

Geismar 6
Geismar, Louisiana

Aerial Photograph

E·A·G·L·E ENVIRONMENTAL SERVICES, INC.

Drawn:	jbh
Checked:	JS
Approved:	JS
Date:	01/18/05
Dwg. No.:	108-0001-A2

Figure 2

Geismar 6
Geismar, Louisiana

Summary of Darrow Strikes Based on Wind Direction

E·A·G·L·E ENVIRONMENTAL SERVICES, INC.

Drawn:	jbh
Checked:	JS
Approved:	JS
Date:	02/07/07
Dwg. No.:	108-0001-A7

Figure 7

Note:

Carville #1 refers to the original location of the Carville air monitoring station.

Carville #2 refers to the location of the Carville air monitoring station following its relocation during the week of May 8, 2006.

Geismar 6
Geismar, Louisiana

Summary of Hunt Strikes Based on Wind Direction

E·A·G·L·E ENVIRONMENTAL SERVICES, INC.

Drawn:	jbh
Checked:	JS
Approved:	JS
Date:	02/07/07
Dwg. No.:	108-0001-A6

Figure 6

Note:

Carville #1 refers to the original location of the Carville air monitoring station.

Carville #2 refers to the location of the Carville air monitoring station following its relocation during the week of May 8, 2006.

Geismar 6

Geismar, Louisiana

Summary of Dutchtown Strikes Based on Wind Direction

E·A·G·L·E ENVIRONMENTAL SERVICES, INC.

Drawn:	jbh
Checked:	JS
Approved:	JS
Date:	02/07/07
Dwg. No.:	108-0001-A5

Figure 5

Note:

Carville #1 refers to the original location of the Carville air monitoring station.

Carville #2 refers to the location of the Carville air monitoring station following its relocation during the week of May 8, 2006.

Geismar 6
Geismar, Louisiana

Summary of Carville Strikes Based on Wind Direction (May 2006 - December 2006)

E·A·G·L·E ENVIRONMENTAL SERVICES, INC.

Drawn:	jbh
Checked:	JS
Approved:	JS
Date:	02/07/07
Dwg. No.:	108-0001-A4

Figure 4

Note:

Carville #1 refers to the original location of the Carville air monitoring station.

Carville #2 refers to the location of the Carville air monitoring station following its relocation during the week of May 8, 2006.

Geismar 6
Geismar, Louisiana

Summary of Carville Strikes Based on Wind Direction (May 2005 - April 2006)

E·A·G·L·E ENVIRONMENTAL SERVICES, INC.

Drawn:	jbh
Checked:	JS
Approved:	JS
Date:	02/07/07
Dwg. No.:	108-0001-A3

Figure 3

APPENDIX B

SUMMARY OF TARGET OZONE PRECURSOR VOLATILE ORGANIC COMPOUNDS

Appendix B

Summary of Target Ozone Precursor Volatile Organic Compounds			
Compound	AIRS Code	Compound	AIRS Code
Ethylene	43202	1-Hexene	43245
Acetylene	43206	n-Hexane	43231
Ethane	43202	Methylcyclopentane	43262
Propylene	43205	2,4-Dimethylpentane	43247
Propane	43204	Benzene	45201
Isobutane	43214	Cyclohexane	43248
1-Butene	43280	2-Methylhexane	43263
n-Butane	43212	2,3-Dimethylpentane	43291
Trans-2-Butene	43216	3-Methylhexane	43249
Cis-2-Butene	43217	2,2,4-Trimethylpentane	43250
1,3-Butadiene	43218	n-Heptane	43232
Isopentane	43221	Methylcyclohexane	43261
1-Pentene	43224	2,3,4-Trimethylpentane	43252
n-Pentane	43220	Toulene	45202
Isoprene	43243	2-Methylheptane	43960
Trans-2-Pentene	43226	3-Methylheptane	43253
Cis-2-Pentene	43227	n-Octane	43233
2,2-Dimethylbutane	43244	Ethylbenzene	45203
Cyclopentane	43242	m/p-Xylene	45109
2,3-Dimethylbutane	43284	Styrene	45220
2-Methylpentane	43285	o-Xylene	45204
3-Methylpentane	43230		

Appendix D – Facility Final Reports

Lion Copolymer, LLC

COPOLYMER

LION COPOLYMER, LLC

5955 Scenic Highway • Baton Rouge, LA 70805-2044
225-267-3400

February 15, 2007

CERTIFIED MAIL – RETURN RECEIPT REQUESTED
RETURN RECEIPT # 7002 0460 0002 6128 0291

Ms. Jane LaCour
Louisiana Department of Environmental Quality
Office of Environmental Compliance
Post Office Box 4312
Baton Rouge, Louisiana 70821-4312

REF: FINAL AMBIENT AIR MONITORING PROGRAM REPORT
AIR PERMIT NO. 0840-00008-V0, AI #1395
DOCUMENT TRACKING NO.: AE-AOA-05-0002

Dear Ms. LaCour,

Enclosed please find the final report for the Ambient Air Fenceline Monitoring Program at the Lion Copolymer's Baton Rouge facility. As previously stated in your letter granting approval for early termination, this report will be in lieu of the Annual Report required by the Administrative Order on Consent (AOC).

If you have any questions regarding this report, please contact Mr. Chad Orillion at (225) 267-3514.

Sincerely,

Herbert Lance, Jr.
Director, EHS

ENCLOSURES: AS STATED

CC: **CERTIFIED NUMBER: 7002-0460-0002-6128-0307**
Mr. Maurice Oubre
LA DEQ, Office of Air Quality Assessment
P.O. Box 4314
Baton Rouge, LA 70821-4314

LION COPOLYMER

AMBIENT AIR MONITORING PROGRAM

FINAL REPORT

Prepared For:

The Louisiana Department of Environmental Quality (LDEQ)
602 North 5th Street
Baton Rouge, Louisiana 70802

Prepared By:

Enviroplan Consulting
81 Two Bridges Road
Fairfield, NJ 07004

February 14, 2007

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1. MONITORING PROGRAM OVERVIEW

Lion Copolymer ("Lion") operates a production facility located in Baton Rouge, Louisiana. The Lion plant (formerly owned and operated by DSM Copolymer) primarily produces copolymers for wholesale distribution.

The Louisiana Department of Environmental Quality (LDEQ) and Lion entered into an agreement under which Lion voluntarily conducted a 20-month air monitoring program for highly reactive volatile organic compounds (HRVOC) as measured at Lion's Baton Rouge plant. Monitoring for this program commenced on May 1, 2005 and concluded January 1, 2007. The purpose of the Lion air monitoring program was to provide additional information concerning emissions of HRVOC in order to assist LDEQ with efforts to better assess and understand the potential contributory role of HRVOC with respect to the formation of ozone. This effort was prompted by the goal of achieving attainment with the 8-hour National Ambient Air Quality Standard (NAAQS) for ozone within the 5-parish Baton Rouge Ozone Non-Attainment Area.

The Lion Air Monitoring Program employed methods consistent with relevant sections of the EPA Technical Assistance Document For Sampling and Analysis of Ozone Precursors, EPA/600-R98/161 (Revised 1998). An Air Monitoring Plan (AMP) and Quality Assurance Project Plan (QAPP) were developed in accordance with EPA guidelines and approved by the LDEQ prior to commencing the field campaign. Implementation of the monitoring program was fully consistent with the approved AMP and QAPP.

The Lion Air Monitoring Program consisted of two major monitoring systems. The "Plant GC" (or "South") monitoring system provided semi-continuous (sequential) measurement of 1, 3 Butadiene, Styrene and Acetonytril at up to 14 sampling locations within the Lion plant facility. These chemicals are emitted at the Lion Copolymer facility at a threshold exceeding 1,000 pounds per year. Consequently, monitoring of these chemicals was incorporated in the Lion Copolymer Air Monitoring Project. Based upon process knowledge, 1, 3 Butadiene and Styrene were the only HRVOC compounds for which the Lion plant facility could be considered a potential source. Acetonytril measurement data were consequently not reported for this project.

The "North" monitoring station, located at the northern perimeter fenceline of the plant, collected continuous and episodic measurement of HRVOC, as well as meteorological observables (i.e., horizontal wind speed, wind direction and sigma theta).

Continuously-measured HRVOC and meteorological data and associated monitor operating status information were distributed in real time through a secure, in-plant data network accessible for review by designated personnel. An alarm system communicating with the plant control room provided immediate notification whenever HRVOC concentrations reported from any of the sampling locations exceeded pre-determined threshold values. In the event of an HRVOC alarm, reported data were evaluated with respect to the location of the reported exceedance, the operating status of the associated monitoring system, and current meteorological conditions.

When monitoring data for an alarm event met established criteria, plant operating personnel were dispatched to investigate to determine if the elevated HRVOC emissions were attributable to a source within the plant. If a source was identified, corrective actions were taken to mitigate the emissions. Throughout the monitoring program, Lion maintained a log to document the occurrence of each alarm event, associated monitoring data, and the results of any investigative and corrective actions taken.

To assist in meeting the monitoring requirement, Lion retained the services of Enviroplan Consulting (EC), an environmental consulting company specializing in the study and measurement of air pollution. EC designed and supplied the North monitoring station for this project and provided support services associated with operation of the North air monitoring station for the duration of the project (i.e., field operation and maintenance, quality assurance (QA), quality control (QC), data analysis, data validation and data reporting activities). Lion Copolymer retained similar responsibilities for operation of the Plant GC HRVOC measurement system and complete responsibility for responding to and management of HRVOC alarm events.

2. MONITORING SYSTEM DESIGN

As stated above, the Lion Copolymer Air Monitoring Program consisted of two major monitoring systems. Table 1 in this section summarizes the monitoring parameters, locations and measurement frequency for these systems. The following sections describe the design of each monitoring system.

2.1 MONITOR SITING

Monitoring site locations were determined in conjunction with discussions between DSM Copolymer (now Lion Copolymer) and the LDEQ, taking into account the geography of the plant facility, associated potential sources of HRVOC emissions, other nearby industrial potential sources of HRVOC emissions and associated HRVOC monitoring stations, and the predominately Southeasterly and Northerly prevailing winds for the Baton Rouge area.

The existing 14 sampling locations of the Plant GC monitoring system described in Table 3 and depicted in Figure 1 below, provided comprehensive real-time monitoring of potential HRVOC emission points within the plant. This system facilitated rapid identification and mitigation of excessive HRVOC emissions within the plant. In July 2006, the number of sampling locations were revised from 14 to 7 provide a more accurate monitoring and investigation procedure.

A new monitoring station for HRVOC was located near the Northwestern perimeter of the plant, as depicted in Figure 1. This location was well suited for detecting and quantifying HRVOC plant borne on prevailing winds from the North and Southeast. The "North" monitoring station therefore provided both upwind and downwind HRVOC measurement data, depending on prevailing meteorological conditions. Meteorological measurements were collected from an open field located approximately 50m (meters) northwest of the North site HRVOC monitor.

2.2 NORTH MONITORING STATION DESIGN

All monitoring equipment (except wind monitors and their support tower) was installed and operated inside an EKTO Model 888 temperature-controlled (20-30 °C) equipment shelter. The shelter was supplied with conventional electric utility service and featured interior electrical distribution circuits, lighting, workbench, a built-in equipment rack and sufficient space for housing, operating and maintaining the monitoring instruments.
The shelter was securely anchored to a concrete pad for safety. Compressed support gases required for the continuous TNMOC analyzer (i.e., hydrogen, nitrogen and calibration gas mixtures) were housed in a locked exterior compartment attached to the rear wall of the shelter.

2.2.1 Meteorological Measurement System

Horizontal wind speed and wind direction were continuously measured at the North monitoring station using Climatronics Model F-460 wind monitors interfaced with a meteorological signal processor module installed in an on-site Environmental Systems Corp. (ESC) Model 8832 data logger. The data logger scanned the meteorological measurement signals at a rate of once per second, converted the signals to scaled digital values, and compiled and stored the measurement data in the form of 5-minute, vector-averaged values. The data logger also calculated and recorded the standard deviation of the wind direction (sigma theta) in accordance with a US EPA-approved convention.

2.2.2 HRVOC Measurement Systems

2.2.2.1 Sample Intake Probe and Delivery System

The design and operation of the North site HRVOC sample air probe and delivery system for sample collection conformed to the guidance contained in Section 9 of 40 C.F.R. Part 58, Appendix E. Total sample residence time within the sample intake and distribution system was substantially less than 10 seconds. All surfaces in contact with the ambient sample air stream prior to analysis for HRVOC were comprised of either borosilicate glass or chromatographic grade stainless steel. O-rings or seals were Viton.

The sample probe elevation was 1.8m above the equipment shelter roofline and 4.3 m above ground level. The probe inlet had a 360° unobstructed arc for sample air intake and was located approximately 30m north of the nearest obstruction, an unused brick building approximately 15m in height. The ratio of the distance from the building to the sample inlet probe in comparison to the difference in building height minus probe height was equal to 2.8. A stainless steel rain hat with an integral, small mesh, stainless steel screen surmounted the inlet, preventing precipitation and large particles (e.g., insects) from entering the transport tube.

The HRVOC sample inlet was at the top of a 10-foot long, one-inch diameter glass transport tube that extended vertically from the shelter interior through a perforation in the roof to the exterior ambient environment. The exterior segment of the transport tube was encased in closed cell foam within a rigidly braced PVC pipe for protection. Inside the shelter, the lower end of the transport tube connected to a 1-inch diameter glass manifold equipped with six threaded side ports. The

bottom of the manifold connected to the inlet of a blower motor. In order to provide for proper operation of this system, the sample flow rate through the main sample probe and down tube was maintained at approximately 18 cubic feet per minute (cfm). The static pressure within the sample air transport tube and manifold was maintained at ≤0.5 inches of water. A differential pressure gauge connected to one of the manifold ports was installed to routinely verify proper operation of the sample air intake system. The outlet of the blower was directed through flexible, 2-inch internal diameter tubing to a PVC exhaust manifold. The excess sample air stream was exhausted through the exhaust manifold to the exterior of the shelter.

The entire interior segment of the transport tube and manifold were heat traced and insulated. A temperature probe inserted into a port on the manifold allowed the heat trace temperature controller to maintain the sample air stream temperature at 35°C, thereby preventing condensation from occurring within the air transport system.

Individual sample air streams for the continuous TNMOC monitor and episodic canister sampling system operated at the site were drawn from two separate, dedicated ports on the manifold through ¼" and $^1/_8$" O.D. chromatographic-grade stainless steel tubing, respectively. Unused sample ports on the manifold were capped by means of Teflon plug fittings with Viton O-rings.

2.2.2.2 Continuous (Non-Speciating) HRVOC Measurement System

Continuous measurement methane, total non-methane hydrocarbon (NMHC) and the sum of these parameters (total HC) were continuously monitored at the North monitoring station using a Thermo Electron Corp. (TECO) Model 55C, an automated, non-speciating GC/FID monitor.

The Model 55C utilizes a fully automated, microprocessor-based gas chromatograph employing a Flame Ionization Detector (FID) for superior sensitivity and long-term stability of response. The Model 55C is specifically intended for long-term, unattended ambient air monitoring applications. It completes a sample/analysis cycle approximately every 70 seconds and provides separate output signals for methane, total non-methane and total hydrocarbon measurements.

Features of the TECO 55C include:

- Detection Levels of 20 ppb (parts-per-billion) for CH_4 (methane) and 50 ppb for NMHC (as propane).
- Complete separation of CH_4 (methane) from all C_2 and higher compounds.
- Measurement of hydrocarbons from C_1 through C_{12} (minimum).
- Fully automatic, microprocessor-controlled operation for stable, reliable measurement.
- 24-hour span drift (*without* auto-calibration) = 3% of span range.
- Accuracy = ±2% of measured value.
- Precision = ±2% of measured value.
- Status information displays and digital status signal outputs linked to integral fault-sensing and operating status monitoring circuitry.
- Flame-out sensor and automatic re-ignition for the hydrogen-fueled detector.
- Automatic correction for zero prior to every sample analysis cycle.

- Automatic span calibration capability (this feature was disabled for this project).

The TECO 55C analyzer was operated in the continuous analysis mode. The full-scale measurement ranges were 0 to 15ppm for Methane and 0 to 45ppmC for total NMHC (referenced to propane). The analyzer monitors four different internal operating status conditions. The associated status output signal was routed to the on-site data logger, which in turn automatically flagged the data if the analyzer detected a malfunction in its operation.

NMHC concentration alarm functions were enabled in the on-site data logger and set to the pre-determined concentration for triggering a canister sample event.

Support gases maintained at the site for operation of the TNMOC analyzer included research-grade compressed hydrogen for the FID fuel; ultra-high purity (UHP) compressed nitrogen for the carrier gas; and a certified (±2%) compressed calibration gas mixture consisting of approximately 4ppm Methane and 2ppm Propane in UHP/HC-free air. Combustion air and actuator air were supplied via a Teledyne/Advanced Pollution Instruments (API) Model 701 continuous zero air generator installed at the station.

2.2.3 Data Logging

An Environmental Systems Corp. (ESC) Model 8832 Data Logger was the primary recording device for data collection for all continuously-monitored parameters. The Model 8832 was operated in an automatic mode at the site, scanning all analog input voltages and associated status inputs produced by the monitoring instruments at a once-per second rate, converting the instantaneous voltages to scaled digital values, calculating and storing average values (and appending status flags, as appropriate) in accordance with user-defined configuration instructions.

The data logger was also programmed to automatically initiate, control and report the results of 2-point (span/zero), daily calibration checks on the TNMOC monitor. Automatic calibration checks were made by substituting certified calibration gases in lieu of ambient sample air in the sample delivery line to the TNMOC monitor. This was accomplished via solenoid valves under the control of the data logger. The monitor's responses were evaluated with respect to the known test gas concentrations. No adjustment was made to the analyzer during automatic calibration checks; rather, these checks provided support for data validation and decision-making with respect to any need for manual calibration of the analyzer.

Stored data values, status conditions and results of programmed automatic calibration checks were routinely downloaded to central data computers via an on-site modem and a dedicated Ethernet port. The computers automatically retrieved the previous day's data summary report from the station data logger on a daily basis.

The Model 8832 was initialized to collect 10-minute block-averaged data reported in parts-per-million carbon (ppmC) for continuously-monitored hydrocarbon parameters and 5-minute, vector block-averaged meteorological data. A minimum of 7.5 minutes of valid data per 10-minute

block was required to report a valid 10-minute average. A minimum of 3.75 minutes (225 seconds) of valid data per 5-minute block was required to report a valid 5-minute average.

The Model 8832 was additionally programmed to activate and control collection of episodic, 20-minute HRVOC canister samples, as discussed below.

2.2.4 Episodic (Time-Integrated) HRVOC Measurement System

HRVOC whole air samples were collected at the DSM North air monitoring site in accordance with the Administrative Order promulgated by the LDEQ and the methodology described in Section 2.5 in EPA Technical Assistance Document For Sampling and Analysis of Ozone Precursors, EPA/600-R98/161 (Revised 1998). HRVOC are defined here as organic compound having a vapor pressure greater than 10^{-1} Torr at 25°C and 760 mm Hg. This method applies to ambient concentrations of HRVOC above 10 ppbC.

The 43 target compounds of interest for this monitoring program have been identified by the U.S. EPA as ozone precursors. Minimum detection limits (MDLs) for each compound were ≤10 parts-per-billion by volume (ppbV). Speciated analysis results were reported in equivalent carbon (ppbC). The target compounds and their associated data reporting limits are listed in Table 2 below.

20-minute, integrated, sub-atmospheric (non-pressurized) HRVOC samples were collected into 6–liter, passivated canisters on an episodic basis using an EC Model 103 multi-canister sampler. The HRVOC samples were collected at the site from a dedicated port on the glass sample intake manifold through sample delivery lines constructed of 1/8" OD chromatographic grade stainless steel tubing equipped with a low-temperature sample control valve.

The on-site data logger was programmed to initiate a canister sampling event by energizing the appropriate valve in the canister sampler when the continuously-measured ambient NMHC concentration exceeded a defined threshold value (nominally 1ppm). The monitoring station's sample intake probe and distribution manifold system served as the common source of ambient sample air delivered to both the canister sampler and the continuous TNMOC monitor. A capillary tube controlled sample air flow rate into the canister at approximately 250 cubic centimeters per minute (ccm) ±5% throughout the twenty-minute sampling event period. At the end of a sample event, each canister's "end" pressure was in the range of -6 to -7 inches of mercury. Features of the Model 103 canister sampler included sequential sample collection for up to three separate canisters. This allowed several sample events to occur before the sampler required servicing in the field.

The HRVOC canister sample collection regime was consistent with obtaining statistically meaningful data to gain a better understanding of the relationship between HRVOC and local formation of tropospheric ozone. The following criteria were used for HRVOC canister sample collection at the North monitoring station:

- A single HRVOC canister sample was collected immediately following the first 10-minute-averaged non-methane hydrocarbon (NMHC) concentration reported at the North

site on any given day provided the averaged concentration exceeded a pre-defined threshold value (nominally = 1ppmC).

- A maximum of one HRVOC canister sample would be collected at the monitoring site on any given day (as measured midnight-to-midnight).

- In the first four months of data collection, the operating group adjusted the NMHC threshold concentration triggering a HRVOC canister sample event as-needed (from 5.5ppmC to 0.1ppmC) to obtain approximately 5 canister sample events each month at the monitoring site. Beginning August 23, 2005, a threshold value of 1.5ppmC was selected for the remainder of the monitoring project.

2.3 "PLANT GC" HRVOC MEASUREMENT SYSTEM DESIGN

1, 3 Butadiene ("BD") and Styrene ("Sty") were continuously monitored at different locations within the Lion plant using an Optichrom Advanced Gas Chromatograph (GC) analyzer system located in the plant computer room. (Note: Acrylonitrile, also measured by the GC, is not an ozone precursor compound and so these data were not reported for this monitoring project.) The GC was located inside the plant Process Control Computer Room. Sample air for the GC was continuously drawn through 14 stainless steel sample lines with a total of 31 inlets located at potential emission points throughout the plant. The GC analyzed each air stream sequentially. Figure 1 shows the locations of the 31 sample inlets within the plant. Table 3 describes each sample stream location in the order of GC analysis sequence.

The gathering point for the 14 sample lines was a sample control panel located outside the plant Process Control Computer Room. Sample air was drawn through each of the lines via a regulated vacuum. Sample flow rates were controlled via a system of variable valves, back pressure and vacuum regulators. Rotameters and vacuum gauges provided visual indication of the sampling system status. Sample stream-switching was accomplished via solenoid valve actuation integrated with the GC software. The GC system completed an analysis cycle and reported the associated measurement data for a given sample stream location every 6.23 minutes, completing analysis of all 14 sampling streams every 87.3 minutes. In late July 2006 the number of sampling locations was reduced to 7, halving the total sequential measurement cycle time. This change improved the performance of the plant GC system and associated data quality.

2.4 HRVOC THRESHOLD EXCEEDANCE ALARM SYSTEMS

Data produced by the plant GC, continuous TNMOC monitor and meteorological system were distributed in real time and available to designated plant personnel via a secure plant data network. The plant GC system featured an alarm system to alert designated plant personnel of any major emissions of BD, Styrene or ACN. Data that exceeded 5ppmV were flagged with an "*h*" (high) and data exceeding 100ppmV were flagged with an "*H*" (high-high). The North station was equipped with a radio alarm linked to the Continuous Control Room.

During the monitoring program, when the current threshold concentration for NMHC measurements was exceeded by the continuous TNMOC monitor (a condition that, for the first

occurrence on any given day, would trigger a canister sample collection event at the North monitoring station), the Continuous Control Room received an alarm transmission from the monitoring station indicating the occurrence. Similar notification was provided to the Continuous Control Room when the plant GC data registered a high or high-high alarm.

In the event of an alarm transmission, the Continuous Leaderman would review associated meteorological data to determine if the elevated HRVOC could be from a source within the plant or if it was from an off-plant source. The following criteria were used to make this determination:

- For HRVOC alarms registered by the plant GC, if associated wind direction data were between 90° and 270°, the emission source was considered potentially within the plant.

- For HRVOC alarms registered by the TNMOC monitor at the North monitoring station, if associated wind direction data were between 270° and 90°, the emission source was considered potentially within the plant.

If the alarm criteria above were met, the Continuous Leaderman would notify relevant plant operating personnel to investigate the cause of the elevated HRVOC. The monitoring data would continue to be reviewed to determine if the data appear to be valid (e.g., no maintenance, calibration or bad status flags in the data from the monitor that registered the alarm).

Plant operating personnel were equipped with a Leakator Model 10, a portable, qualitative, non-speciating hydrocarbon (HC) monitor, to attempt to locate any emission source within the plant that might be responsible for triggering the NMHC exceedance event. The plant personnel would attempt to stop any emissions found. Lion then produced a report detailing relevant facts and findings associated with each exceedance event. These reports were included in the monthly data reports submitted to the LDEQ.

TABLE 1: MONITORING SITES AND PARAMETERS FOR THE LION COPOLYMER AIR MONITORING PROGRAM				
Site Designation and Location	**Monitored Parameter**	**Measurement Frequency and Range**	**Probe Height (meters)**	**Instrument / Method**
North Site (New Station) Longitude: 91° 10' 31.836" W Latitude 30° 30' 19.260" N UTM Coordinates: 3376199.74 (Northing) 675083.89 (Easting)	Methane	Continuous: 0.00-15.00 ppmC	4.3	TEI Model 55C (GC/FID)
	Total Non-Methane (NMHC)	Continuous: 0.00-45.00 ppmC		
	Total Hydrocarbon (THC)	Continuous: 0.00-60.00 ppmC		
	HRVOC	Episodic (20-Minute, Time-Integrated Samples)	4.3	EPA/600-R98/161 (See Table 2 for a list of Target Compounds)
	Horizontal Wind Speed (Vector Averaging)	Continuous: 0.5- 100.0 mph	10	Cup Anemometer (Climatronics F-460)
	Horizontal Wind Direction (Vector Averaging)	Continuous: 0-360°	10	Vane (Climatronics F-460)
	Sigma Theta	Continuous: 0-100°	10	Calculated by Data Logger
South Site (Plant GC System) Longitude: 91° 10' 25.320" W Latitude: 30° 30' 8.568" N UTM Coordinates: 3375873.34(Northing) 675262.94(Easting	1,3-Butadiene (BD)	Semi-Continuous: 6.23 Minutes for analysis of each sample stream. 87.3 minutes for a complete measurement cycle of all 14 sample streams. 44 minutes for a complete measurement cycle of 7 sample streams.	14 distributed sample streams (See Table 3 for inlet locations)	Optichrom Advanced Gas Chromatograph (GC/FID) Analyzer
	Styrene (STY)			

TABLE 2: TARGET HRVOC COMPOUNDS AND MINIMUM DETECTION LIMITS FOR CANISTER SAMPLE ANALYSIS

Target Compound	Minimum Detection Limit			Target Compound	Minimum Detection Limit		
	ppbC	ppbv	ug/m^3		ppbC	ppbv	ug/m^3
Ethylene	0.07	0.04	0.04	1-Hexene	0.26	0.04	0.11
Acetylene	0.06	0.03	0.03	n-Hexane	0.09	0.02	0.11
Ethane	0.20	0.10	0.04	Methylcyclopentane	0.12	0.02	0.10
Propylene	0.12	0.04	0.05	2,4-Dimethylpentane	0.28	0.04	0.11
Propane	0.18	0.06	0.05	Benzene	0.26	0.04	0.10
Isobutane	0.07	0.02	0.07	Cyclohexane	0.29	0.05	0.10
Isobutene/1-Butene	0.30	0.08	0.07	2-Methylhexane	0.18	0.03	0.12
1,3-Butadiene	0.52	0.13	0.07	2,3-Dimethylpentane	0.43	0.06	0.25
n-Butane	0.52	0.13	0.07	3-Methylhexane	0.23	0.03	0.14
trans-2-Butene	0.08	0.02	0.07	2,2,4-Trimethylpentane	0.43	0.05	0.15
cis-2-Butene	0.13	0.03	0.07	n-Heptane	0.26	0.04	0.14
Isopentane	0.32	0.06	0.09	Methylcyclohexane	0.13	0.02	0.13
1-Pentene	0.21	0.04	0.09	2,3,4-Trimethylpentane	0.36	0.05	0.15
n-Pentane	0.09	0.02	0.09	Toluene	0.35	0.05	0.12
Isoprene	0.17	0.03	0.08	2-Methylheptane	0.39	0.05	0.15
trans-2-Pentene	0.20	0.04	0.09	3-Methylheptane	0.28	0.04	0.15
cis-2-Pentene	0.12	0.02	0.09	n-Octane	0.25	0.03	0.15
2,2-Dimethylbutane	0.29	0.05	0.11	Ethylbenzene	0.19	0.02	0.16
Cyclopentane	0.12	0.02	0.09	m/p-Xylene	0.22	0.03	0.14
2,3,-Dimethylbutane	0.27	0.05	0.11	Styrene	0.81	0.10	0.14
2-Methylpentane	0.28	0.05	0.11	o-Xylene	0.19	0.02	0.14
3-Methylpentane	0.23	0.04	0.11				

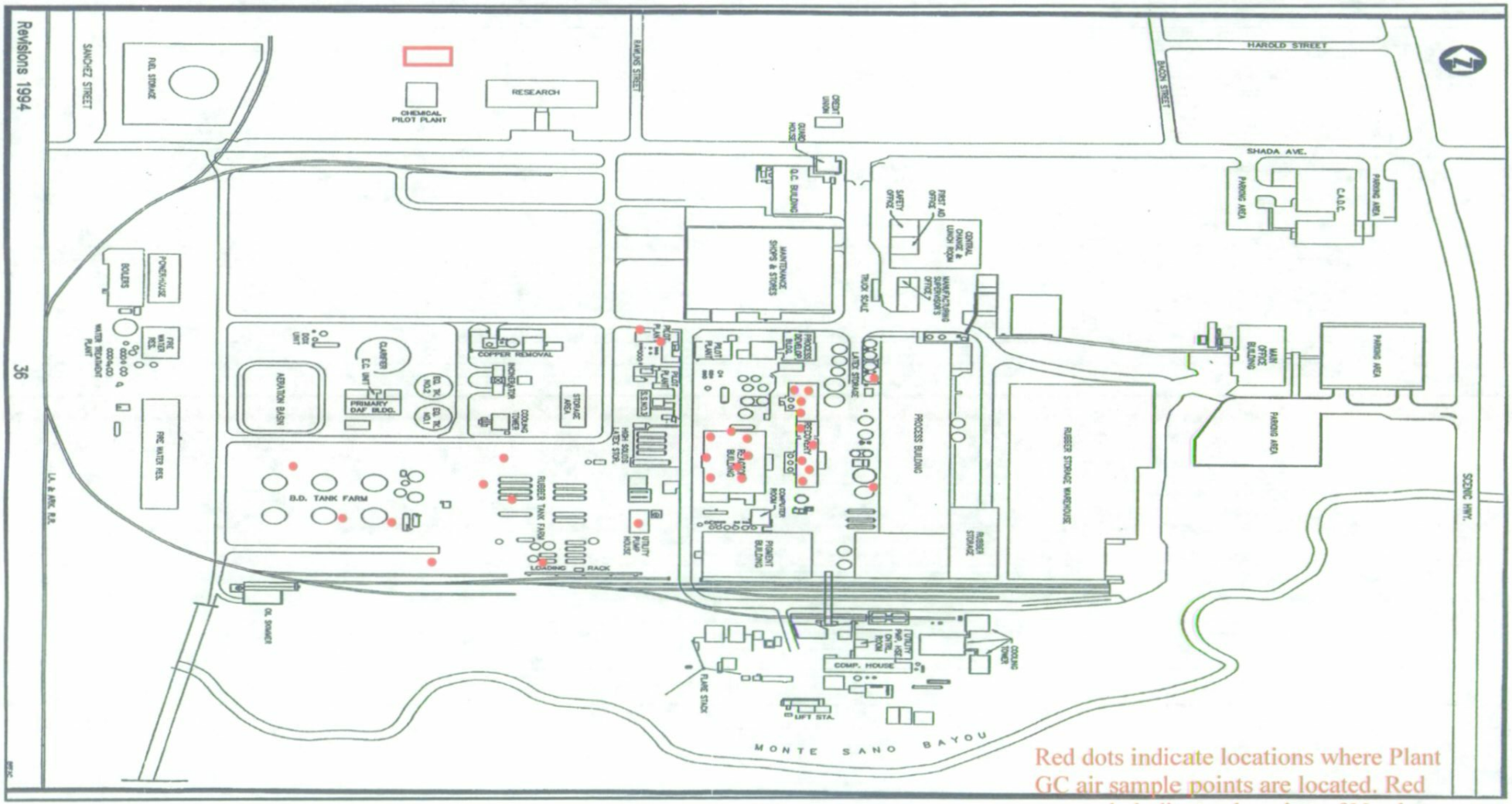
Table 3: Sample Sequence and Sample Inlet Locations for Plant GC Measurement System	
Sampling Sequence	**GC Sample Inlet Locations**
1. [1]	West side of Finishing Building, (between outside 3 & 4 Line Dryer Vents)
2.	Finishing (on Northwest wall, between vertical storage tanks & by 5 & 6 Line Dryer Vents)
3.	Recovery Ground Floor North (inside open process building with solid floor above)
4.	Recovery Ground Floor South (inside open process building with solid floor above)
5. [1]	Recovery Second Floor (on second floor of open process structure with solid floor below and above)
6. [1]	North Reactor Chain (above reactors in open process building, ground floor)
7.	South Reactor Chain (above reactors in open process building with solid floor below and roof above)
8.	Reactor Charge Pumps (in open process structure with solid roof above)
9.	Pilot Plant Second Floor (inside partially closed building)
10. [1]	Pilot Plant Sump (outside east wall of building at ground level across street from 3-story building)
11. [1]	North Rubber Tank Farm (around horizontal storage tanks)
12. [1]	BD Tank Farm (outside perimeter of BD tank farm in open area)
13. [1]	Tank Farm Loading Rack (below loading rack platform in open area)
14.	Styrene Storage Tanks (top of horizontal storage tanks and in open building)

NOTES:

1. Beginning on or about August 1, 2006 and continuing through December 31, 2006, the number of GC sample streams and inlet locations was reduced to seven (sample line Nos. 1, 5, 6, 10, 11 12 and 13 in Table 3 above).

2. Figure 1 in this section depicts the location of the 31 sample inlets relative to the Lion Copolymer plant facility.

FIGURE 1: NORTH MONITORING STATION AND PLANT GC SAMPLE INLET LOCATIONS



Red dots indicate locations where Plant GC air sample points are located. Red rectangle indicates location of North Monitoring Station.

3. SUMMARY OF RESULTS

This section presents and discusses significant findings and results for the Lion Copolymer HRVOC Air Monitoring Program. Analysis of the data collected over the course of the 20-month monitoring period is presented in the sections below. The unique attributes of the HRVOC monitoring systems operated at the two monitoring sites warrant separate discussion of the monitoring data and findings produced from these systems; i.e., the "South" Plant GC site, which measured BD and STY exclusively, and the continuous TNMOC and canister sample data collected at the "North" monitoring site. All data referenced or incorporated in this report meet the data quality objectives established for each measurement system.

3.1 RESULTS OF PLANT GC MONITORING EFFORT

From May 1, 2005 through December 31, 2006, a total of 576 exceedances of the threshold concentration (≥5ppmV) established for the Plant GC measurement system were recorded; 304 for BD and 282 for STY. It should be noted that this number of recorded exceedances is based on *each individual 6.23-minute measurement* performed by the GC. Consecutive measurements, regardless of whether the exceedances were measured in different or identical sample streams, are counted here as separate exceedances events.

Table 4 below summarizes the total number and type of exceedances recorded by the Plant GC during each month in the air monitoring alarm log maintained by Lion Copolymer, as well as associated investigative actions taken and subsequent results of those actions. False or invalid alarms due to calibration, maintenance or malfunction of the GC were noted in the alarm log and these events are excluded in Table 4. Additionally, any alarms recorded exclusively for Acetonitrile measurements are also excluded from this report.

As stated in Section 2.4 above, plant operators were dispatched to attempt to identify and fix any in-plant source contributing to an HRVOC exceedance recorded by the Plant GC if corresponding wind direction measurements were between 90° and 270°. The operators were guided in their investigations by information regarding the location of the sample stream registering the exceedance measurement or through communications regarding current plant process or equipment maintenance activities.

As Table 4 shows, a total of 378 investigations were performed in response to BD or STY alarm events meeting this criterion. Of the investigations performed, 226 (60%) found no identifiable source or cause within the plant responsible for the exceedance. In 67 instances (18% of the total) routine maintenance activities being performed on plant process equipment were found to be the cause of the exceedance(s). In these cases, actions were taken to mitigate the emissions where possible (e.g., closing any unnecessarily open valves, covering or containing open sources, etc.). In 27 instances (7% of the total), investigators established that the cause was attributable to process upset or equipment malfunction (e.g., leaky valve). In each of these cases, corrective actions were taken as quickly as possible to correct the problem. If the fault could not be corrected immediately, an action plan was formulated by the Continuous Leaderman and approved by plant managers to ensure the fault condition was corrected as quickly as practicable. Log entries were not available for 58 of the recorded GC alarm events that met criteria for investigative activity.

TABLE 4: SUMMARY OF HRVOC (BD & STY) EXCEEDANCE EVENTS MEASURED BY THE PLANT GC																						
Month and Year		5/05	6/05	7/05	8/05	9/05	10/05	11/05	12/05	1/06	2/06	3/06	4/06	5/06	6/06	7/06	8/06	9/06	10/06	11/06	12/06	TOTALS
Number of HRVOC Alarms		35	13	21	151	14	24	7	31	8	7	21	16	97	87	8	21	4	7	2	2	**576**
Compound	BD	16	10	18	25	10	13	1	26	4	3	11	8	48	77	4	17	3	7	2	1	**304**
	STY	19	3	3	126	5	22	6	5	4	2	10	8	49	10	4	4	1	0	0	1	**282**
Alarm Category	h (≥5ppm)	34	13	21	149	14	35	7	31	8	6	20	16	87	85	8	20	3	7	2	2	**568**
	H (≥100ppm)	1	0	0	2	0	0	0	0	0	1	1	0	10	2	0	1	1	0	0	0	**19**
Investigative Actions and Results	Number of Investigations	23	8	9	128	12	32	3	14	2	4	3	1	32	78	5	11	3	6	2	2	**378**
	No Source Found	2	4	7	109	2	27	3	6	2	3	2		10	35	1	3	1	5	2	2	**226**
	Source Was Maintenance Activity	7	3	1	19	9	2		1		1	1	1	5	9	1	3	3	1			**67**
	Process Upset Or Equipment Malfunction	6		1		1	3							8	6	1	1					**27**

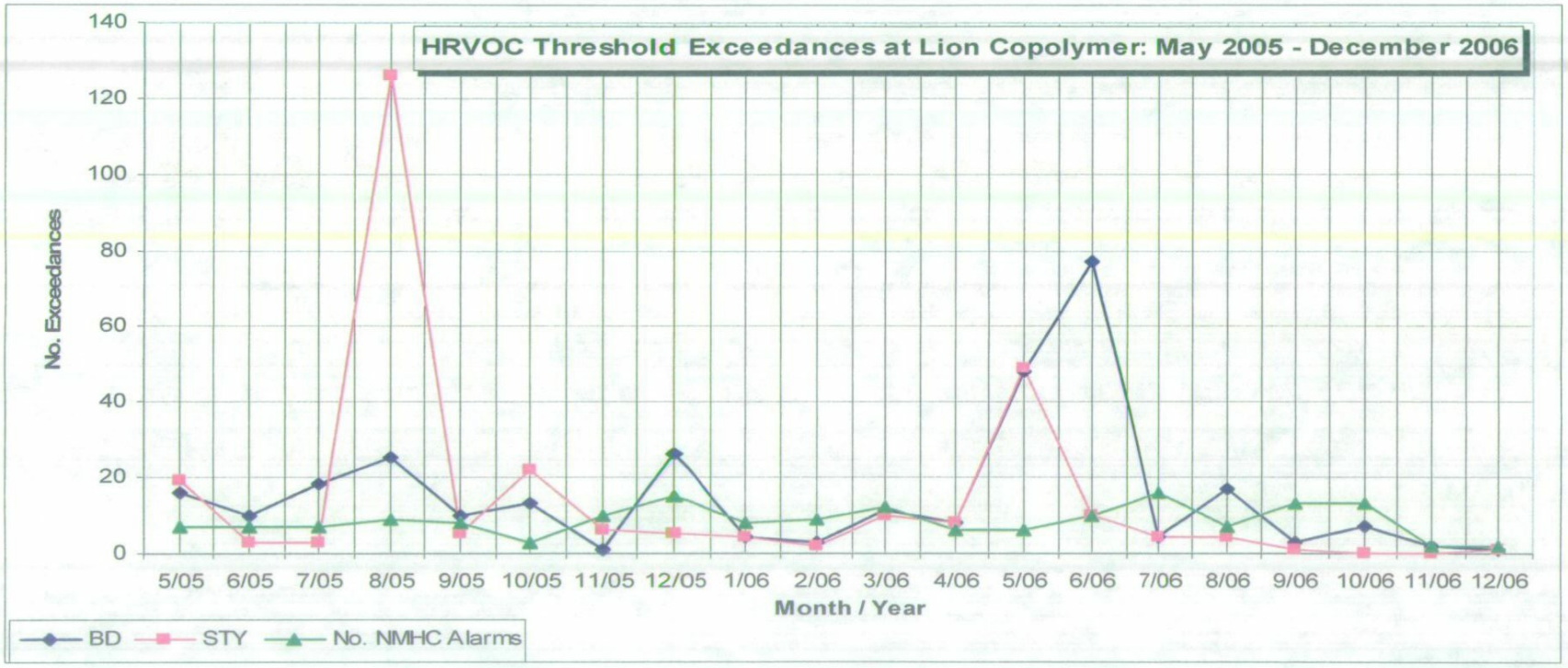


FIGURE 2: TRENDLINES OF HRVOC EXCEEDANCE EVENTS AT LION COPOLYMER

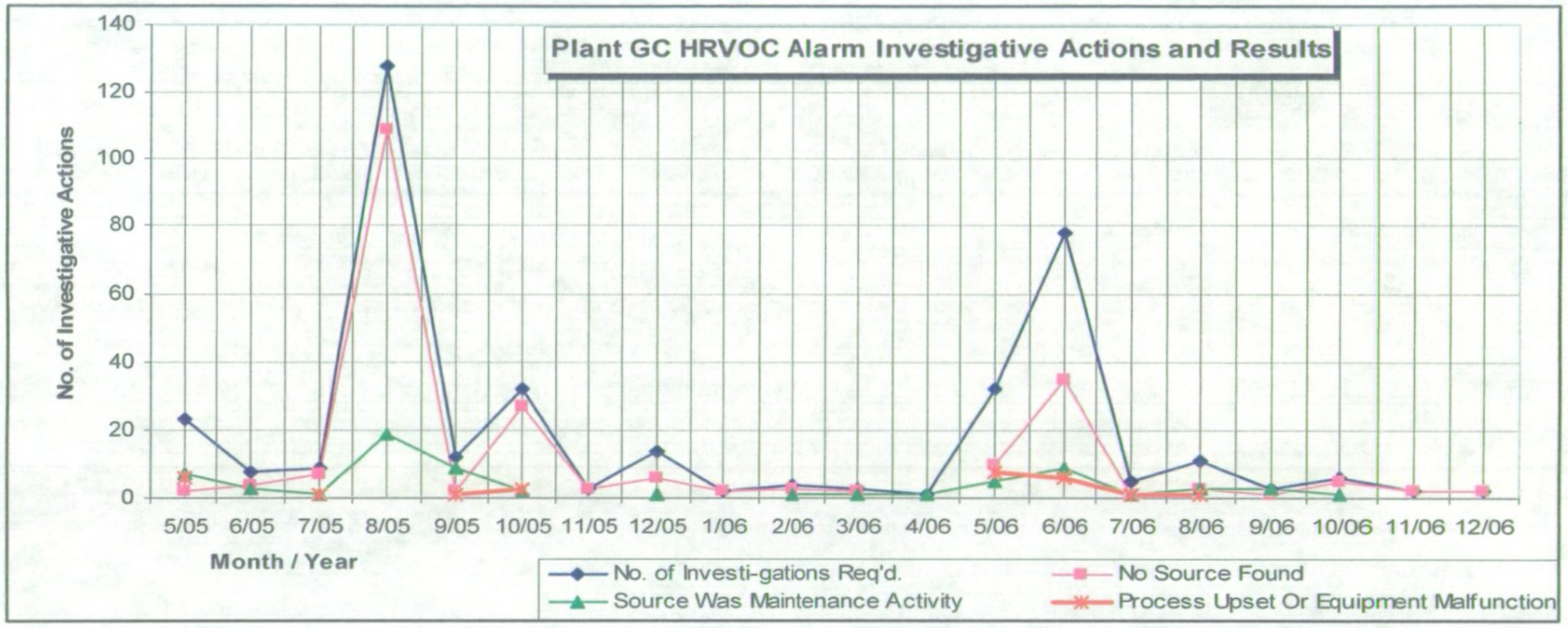


FIGURE 3: TRENDLINE OF PLANT GC INVESTIGATIVE EVENTS AND FINDINGS

Figure 2 above depicts trend line data presented in Table 4 for HRVOC exceedances measured at both the North and South (Plant GC) monitoring stations. With the exception of May and June, 2006, the frequency of BD and STY exceedance events clearly decreases with time, approaching zero as the monitoring program concluded in the final months of 2006. The spike in HRVOC exceedance events in May and June 2006 is attributed to temporary transition effects on operations and personnel as plant ownership transitioned from DSM to Lion.

Finally, Figure 3 above depicts corresponding trend line data of the investigative activity for BD and STY alarm events presented in tabular format in Table 4. Again, with the exception of the May-June 2006 spike noted above, the frequency of investigations decreases in tandem with the decrease in BD and STY exceedance events. In particular, the frequency of exceedances attributable to plant maintenance activities, process upsets or equipment failures is seen to decrease over time.

3.2 RESULTS OF CONTINUOUS TNMOC AND CANISTER MONITORING EFFORT

From May 1, 2005 through December 31, 2006, a total of 170 exceedances of the threshold concentration established for the continuous TNMOC measurement system were recorded. It should be noted that, unlike the assessment used for the Plant GC exceedance events, the number of NMOC exceedances recorded for this monitor is based on any single occurrence in which the monitor's 10-minute, block-averaged measurement of NMOC exceeded and *remained elevated above the threshold concentration, regardless of the number of consecutive measurements* recorded over time. For example, if NMOC measurements exceeded the threshold concentration at 10:20 and all subsequent measurements remained elevated above the threshold until 14:50, that event is treated here for statistical purposes as a single exceedance for the monitor.

Table 5 below summarizes the total number of exceedances recorded by the TNMOC monitor during each month in the air monitoring alarm log maintained by Lion Copolymer, as well as associated HRVOC canister samples collected, investigative actions taken in response to the exceedance events and subsequent results of those actions. False or invalid alarms due to calibration, maintenance or malfunction of the TNMOC monitor were noted in the alarm log and these events are excluded from Table 5. Additionally, any invalidated canister samples are excluded from this report.

As stated in Section 2.4 above, plant operators were dispatched to attempt to identify and repair any in-plant source contributing to an HRVOC exceedance recorded by the TNMOC monitor if corresponding wind direction measurements were between 270° and 90° (the opposite geographic sector as that defined for exceedance investigations for the Plant GC). The operators were guided in their investigations by information regarding current plant process or equipment maintenance activities.

As Table 5 shows, a total of 67 investigations were performed in response to HRVOC alarm events meeting the criterion above. Of the investigations performed, 49 (73%) found no identifiable source or cause within the plant responsible for the exceedance. In 5 instances (7.5% of the total) routine maintenance activities being performed on plant process equipment were

found to be the cause of the exceedance(s). In these cases, actions were taken to mitigate the emissions where possible (e.g., closing any open valves unnecessary to the maintenance task, covering or containing open sources, etc.). In one instance (1.5% of the total), investigators established that the cause was attributable to process upset or equipment malfunction (e.g., a leaking valve). In this instance, corrective actions were taken as quickly as possible to correct the problem. Log entries were not available for 12 of the recorded HRVOC alarm events that met criteria for investigative activity.

Figure 2 above graphically depicts trend line data (presented in Table 5 below) for the frequency of HRVOC exceedance events measured by the TNMOC monitor at the North monitoring station over the course of the monitoring effort. The frequency of TNMOC exceedance events does not exhibit any particular trend over time. This pattern contrasts with the overall decline noted for BD and STY exceedance events over time, and suggests that the frequency of TNMOC exceedance events does not necessarily correlate strongly with BD and STY exceedance events.

Figure 4 below depicts trend line data of the investigative activity in response to exceedance events recorded by the TNMOC monitor over time (also presented in tabular format in Table 5). The frequency of investigations in HRVOC in response to exceedance events recorded by the TNMOC monitor closely tracks the frequency of the TNMOC exceedance events, exhibiting no particular trend except for an inconclusive diminishment of occurrences in the last two months of 2006.

Figure 5 below presents a graphic profile of the 10 HRVOC compounds (Ethene, Propane, Propylene, Isobutane, Butane, Isopentane, Pentane, 1,3-Butadiene, Styrene and 1,2,4-Trimethylbenzene) found to predominate in canister samples collected in conjunction with TNMOC exceedance events at the North station. Each of these 10 compounds constitutes, on average, 2% or more of the total carbon present in the average of all 98 HRVOC samples collected at the North site over the course of the monitoring project. Analysis results for the remaining 43 HRVOC canister sample target compounds comprised, on an averaged basis, less than 1% of TNMOC in the samples. Consequently, the analysis presented in this report for canister sample data focuses on this group of 10 predominant compounds.

Figures 6 through 11 below graphically present the concentrations (in ppbC) of the 10 predominant compounds found in canister samples collected at the North site over the course of the monitoring period. Figures 12 through 29 below present joint frequency distribution plots (i.e., pollutant roses) for average and maximum concentrations of TNMOC and the 10 predominate compounds referenced above.

Pollutant roses for average and maximum TNMOC (refer to Figures 12 and 13) are consistent with seasonally prevailing wind directions established for the Baton Rouge area.

Figures 14 through 17, pollutant roses for average and maximum 1,3-Butadiene (BD) and Styrene (STY), are consistent with the location of the Lion Copolymer plant relative to the North monitoring station (i.e., South-Southeast). These patterns indicate the Lion plant as a likely source for these measurement data.

Although BD and STY concentrations measured at the North site were sometimes significant, measured concentrations for Butane (Figures 18-19), Propylene (Figures 22-23), Ethene (Figures 24-25) and Isopentane (Figures 27-27) exceeded BD and STY measurements as averaged over the course of the monitoring campaign despite the probable greater distance in transport (and attendant diffusion) of these compounds from likely emission sources and the monitoring site. The pollutant rose analyses suggest that HRVOC compounds not associated with the Lion Copolymer plant were commonly significant contributors to TNMOC exceedance events as measured at the North monitoring station.

4. CONCLUSIONS

Lion Copolymer continues to operate the Plant GC system as an effective means of monitoring ambient concentrations of BD and STY, the two HRVOC compounds for which the plant is identified as a potential source. The data analyses presented in this report demonstrate that emissions of BD and STY have declined over the course of the air monitoring project. This has been accomplished through heightened awareness and prompt investigative and corrective actions taken to correct identified, in-plant emission sources.

Lion Copolymer plans to continue the practice of using the Plant GC measurement data to rapidly identify and correct excess emissions of these compounds as they may occur within the plant. Lion Copolymer management emphasizes adherence to good engineering practice, standard operating procedures, implementation of preventive maintenance schedules and maintaining high-quality process control systems. These practices, together with conformance to applicable guidelines and requirements established for the industry, will help ensure minimal emission rates of HRVOC due to equipment malfunction or process upset.

Results of the Lion Copolymer Air Monitoring Program have served to characterize concentrations of a variety of HRVOC compounds emitted from area sources. It is believed that the measurement data collected over the course of the air monitoring program will assist the LDEQ in determining an appropriate strategy for achieving attainment status for the ozone NAAQS in the Baton Rouge area.

TABLE 5: SUMMARY OF HRVOC EXCEEDANCE EVENTS MEASURED BY THE NORTH SITE TNMOC MONITOR																						
Month and Year		**5/05**	**6/05**	**7/05**	**8/05**	**9/05**	**10/05**	**11/05**	**12/05**	**1/06**	**2/06**	**3/06**	**4/06**	**5/06**	**6/06**	**7/06**	**8/06**	**9/06**	**10/06**	**11/06**	**12/06**	**TOTALS**
Number of NMHC Alarms		7	7	7	9	8	3	10	15	8	9	12	6	6	10	16	7	13	13	2	2	**170**
No. of Can Samples	Valid Can Sample	3	5	6	6	5	1	5	8	4	4	6	5	5	5	8	4	7	7	2	2	**98**
Investigative Actions and Results	No. of Investigations	7	6	6	3	2	0	3	6	3	3	12	2	3	1	15	2	2	12	0	1	**67**
	No Source Found	4	4	3	3	2		3	6	3	2	12	2			5	1	1	12			**49**
	Source Was Maintenance Activity		1	2											1	4						**5**
	Process Upset Or Equipment Malfunction			1							1											**1**

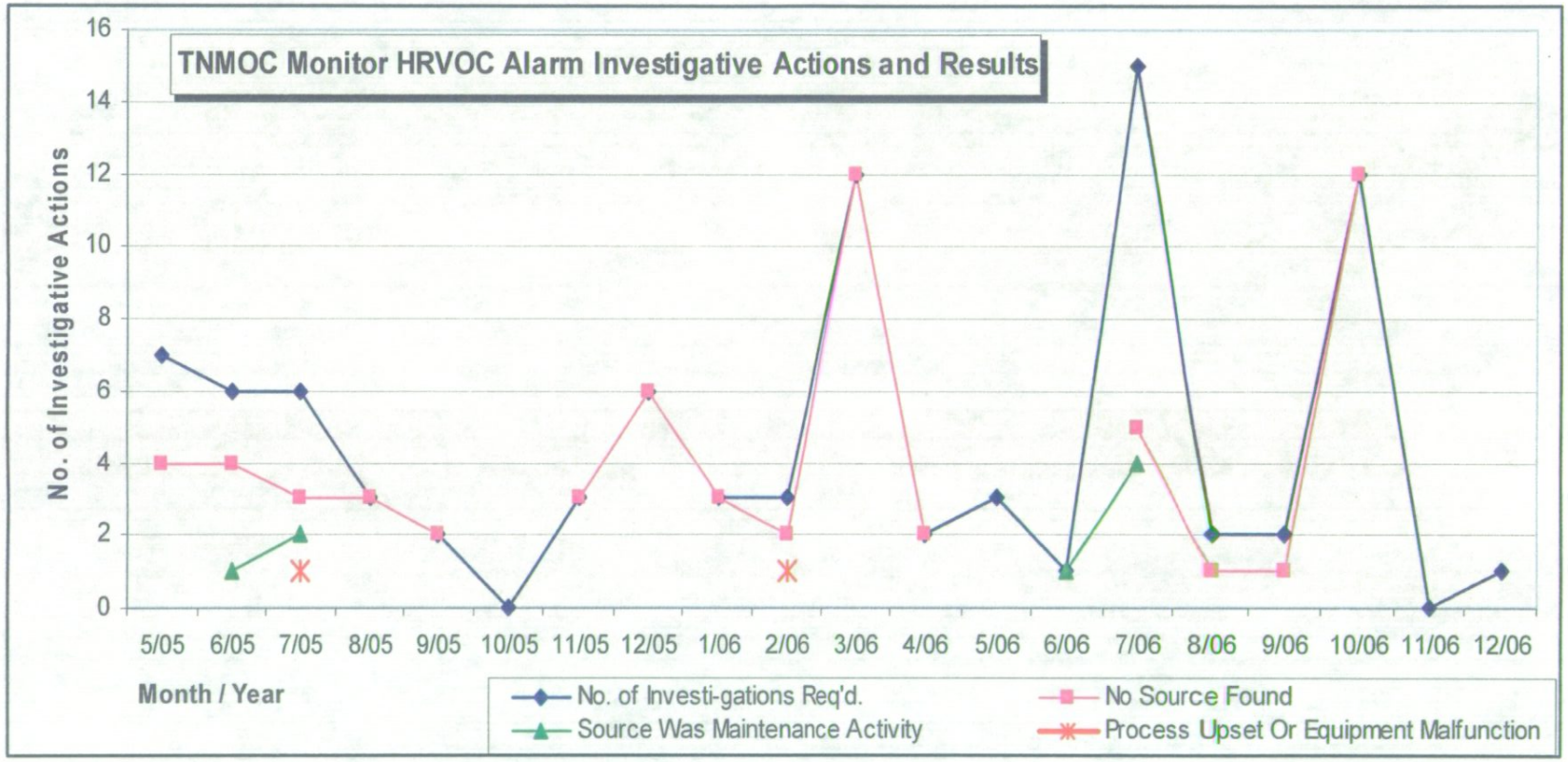


FIGURE 4: TRENDLINE OF TNMOC MONITOR INVESTIGATIVE EVENTS AND FINDINGS

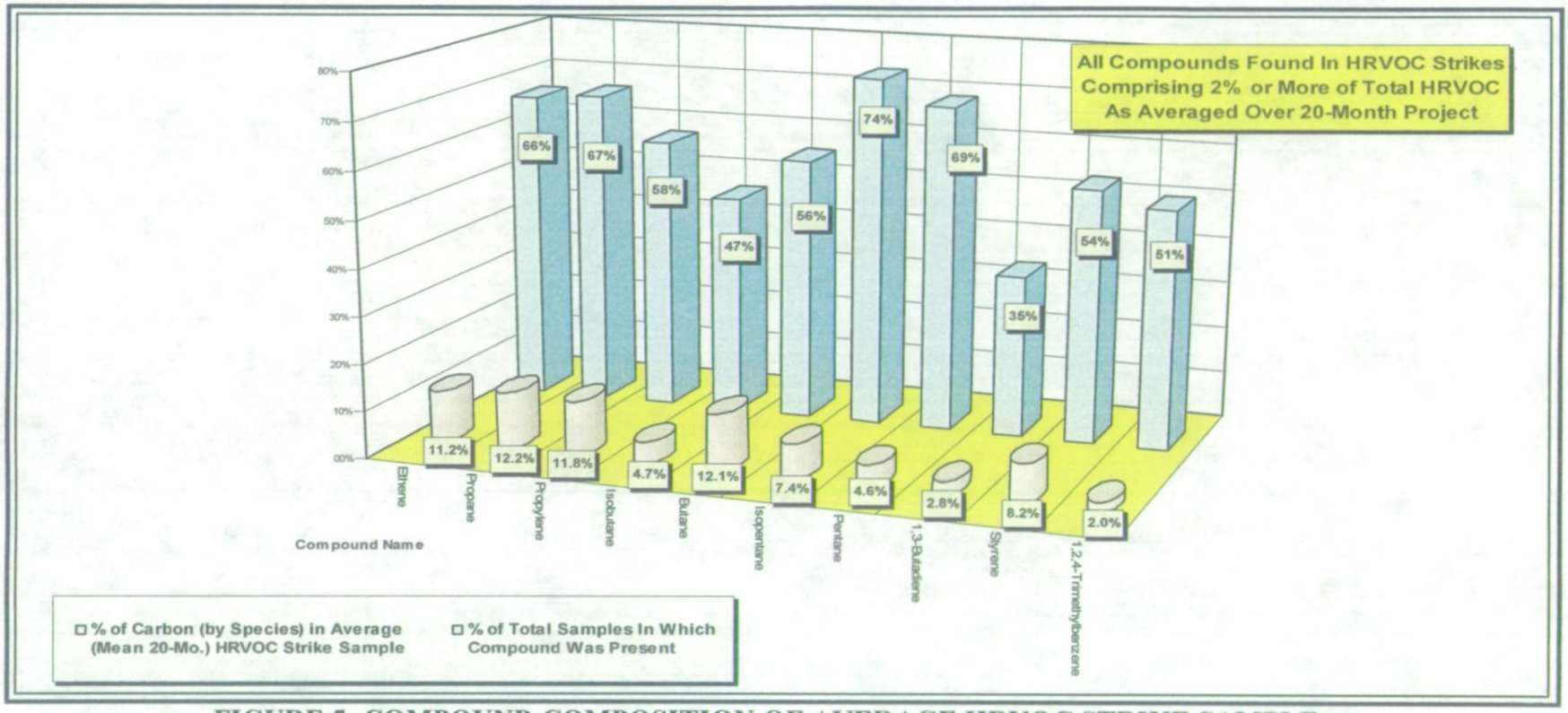


FIGURE 5: COMPOUND COMPOSITION OF AVERAGE HRVOC STRIKE SAMPLE

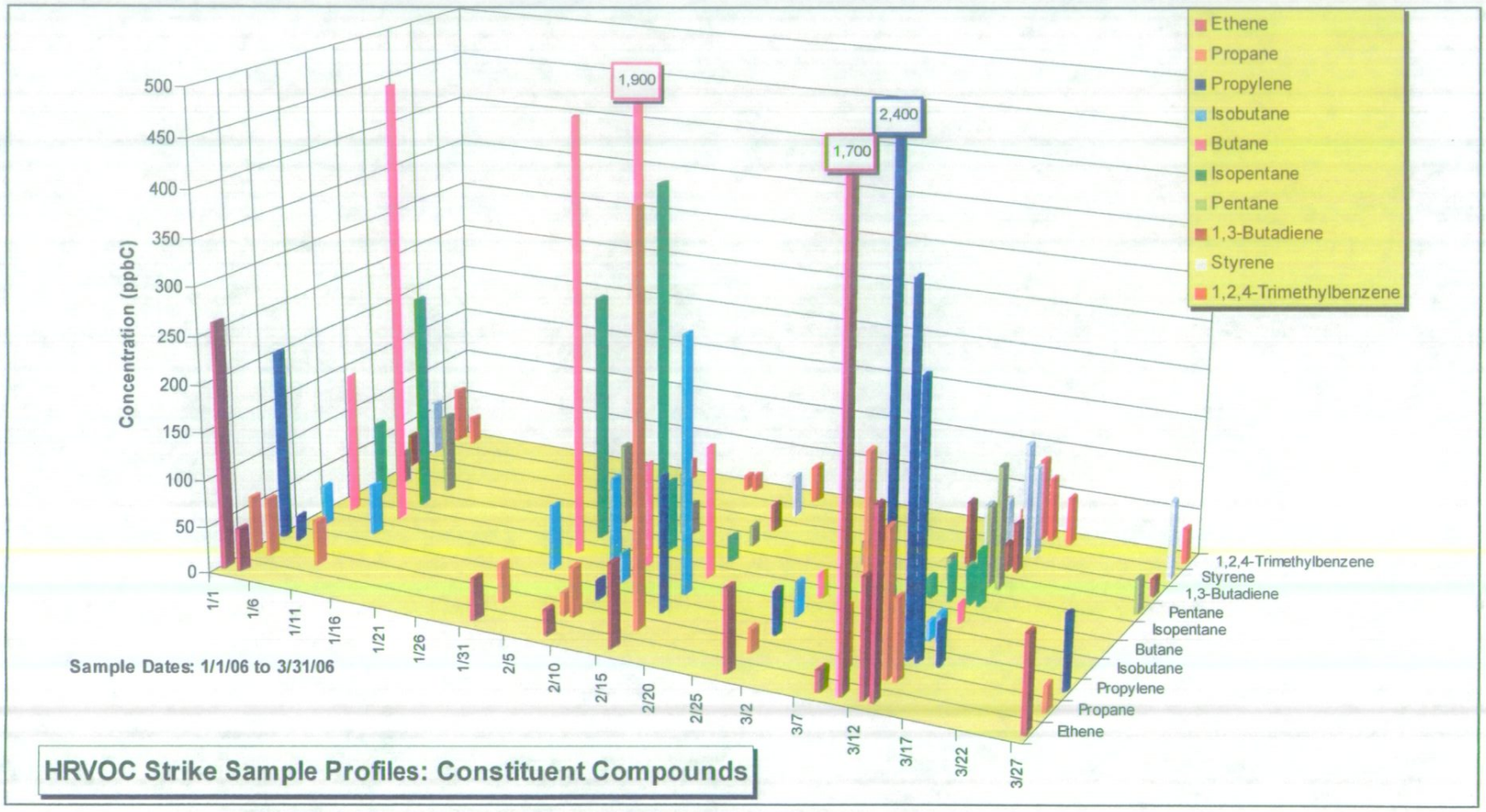


FIGURE 8: COMPOSITION OF HRVOC STRIKE SAMPLES: QUARTER 1, 2006

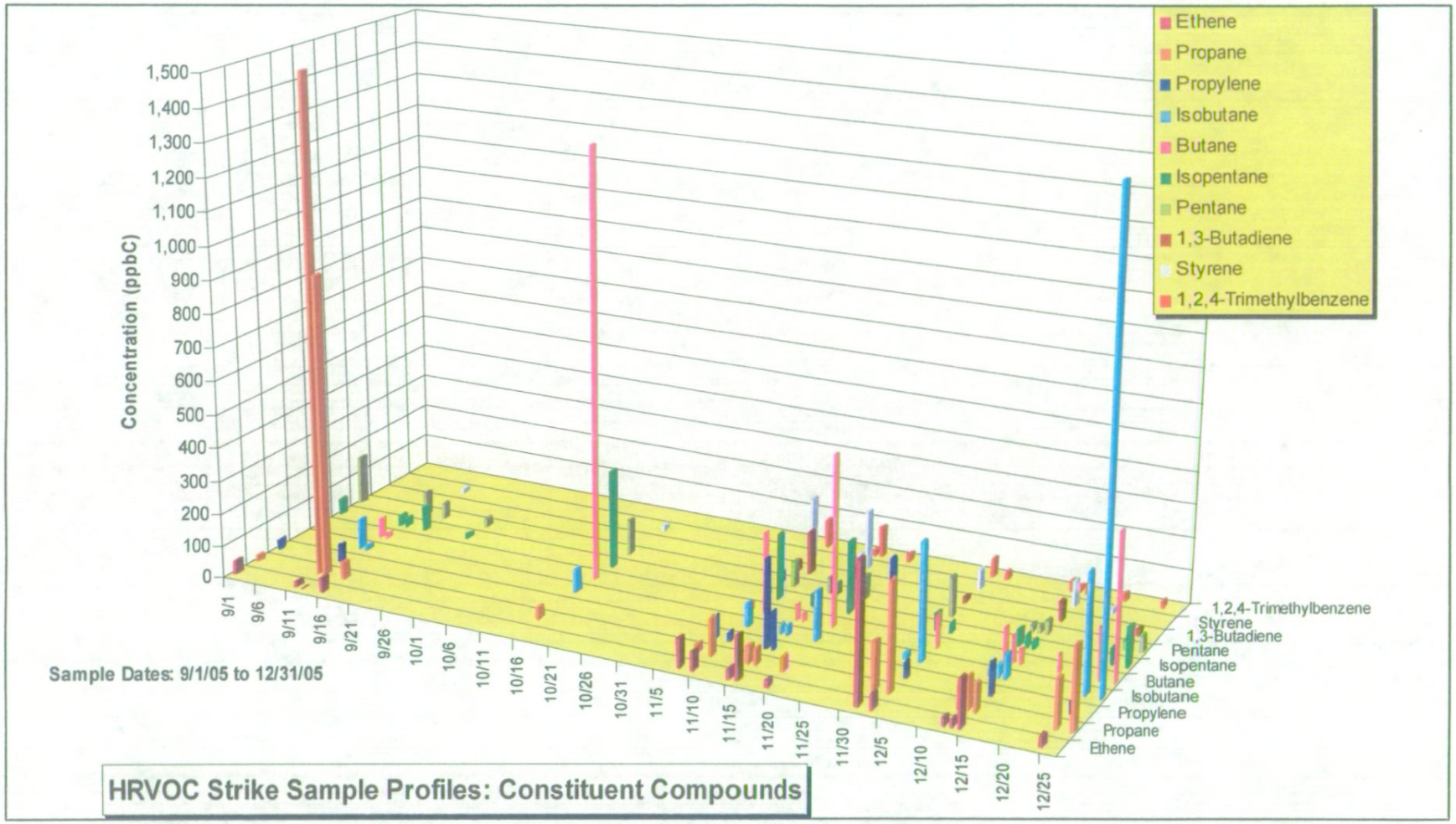


FIGURE 7: COMPOSITION OF HRVOC STRIKE SAMPLES: SEPTEMBER-DECEMBER 2005

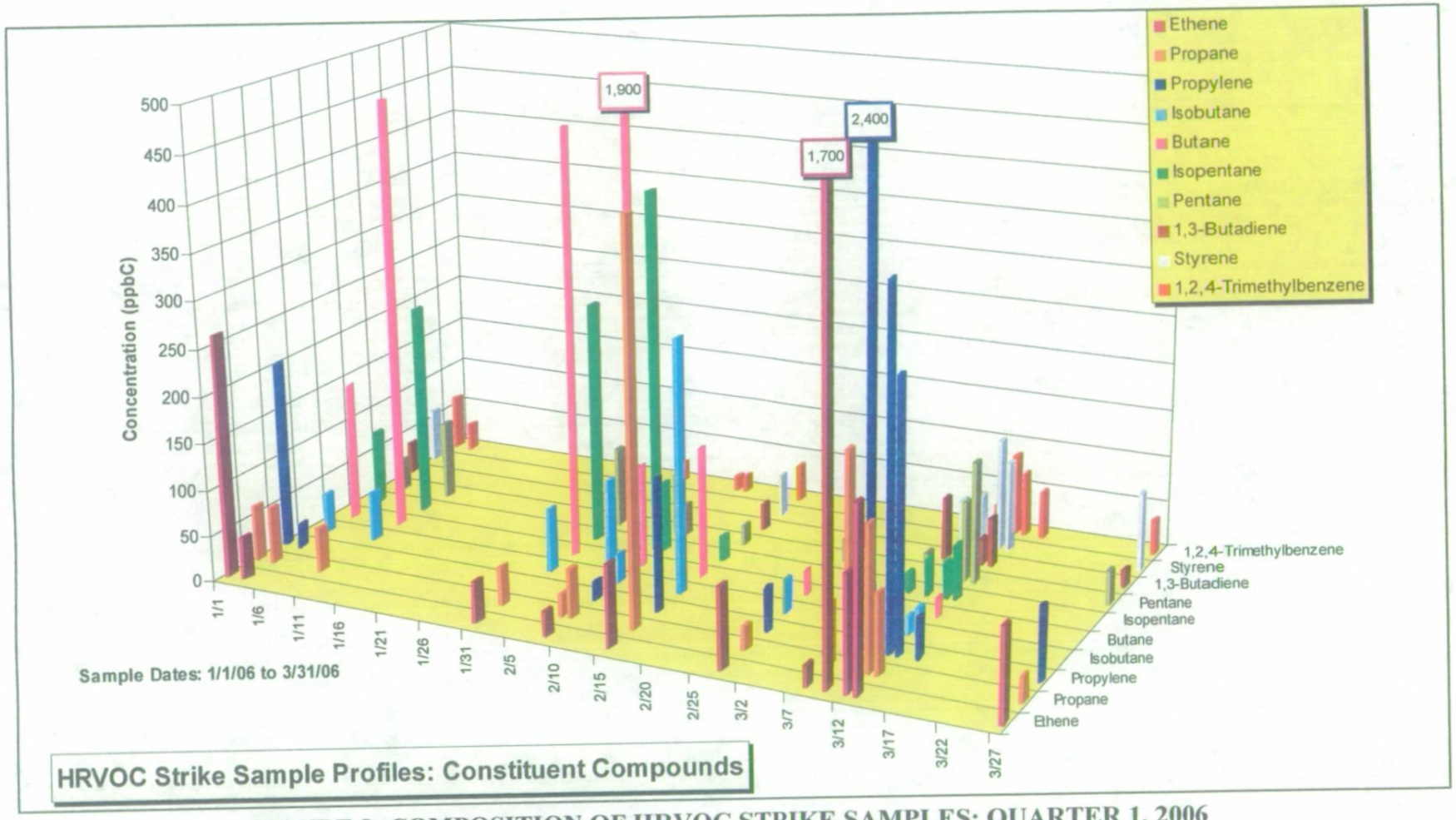


FIGURE 8: COMPOSITION OF HRVOC STRIKE SAMPLES: QUARTER 1, 2006

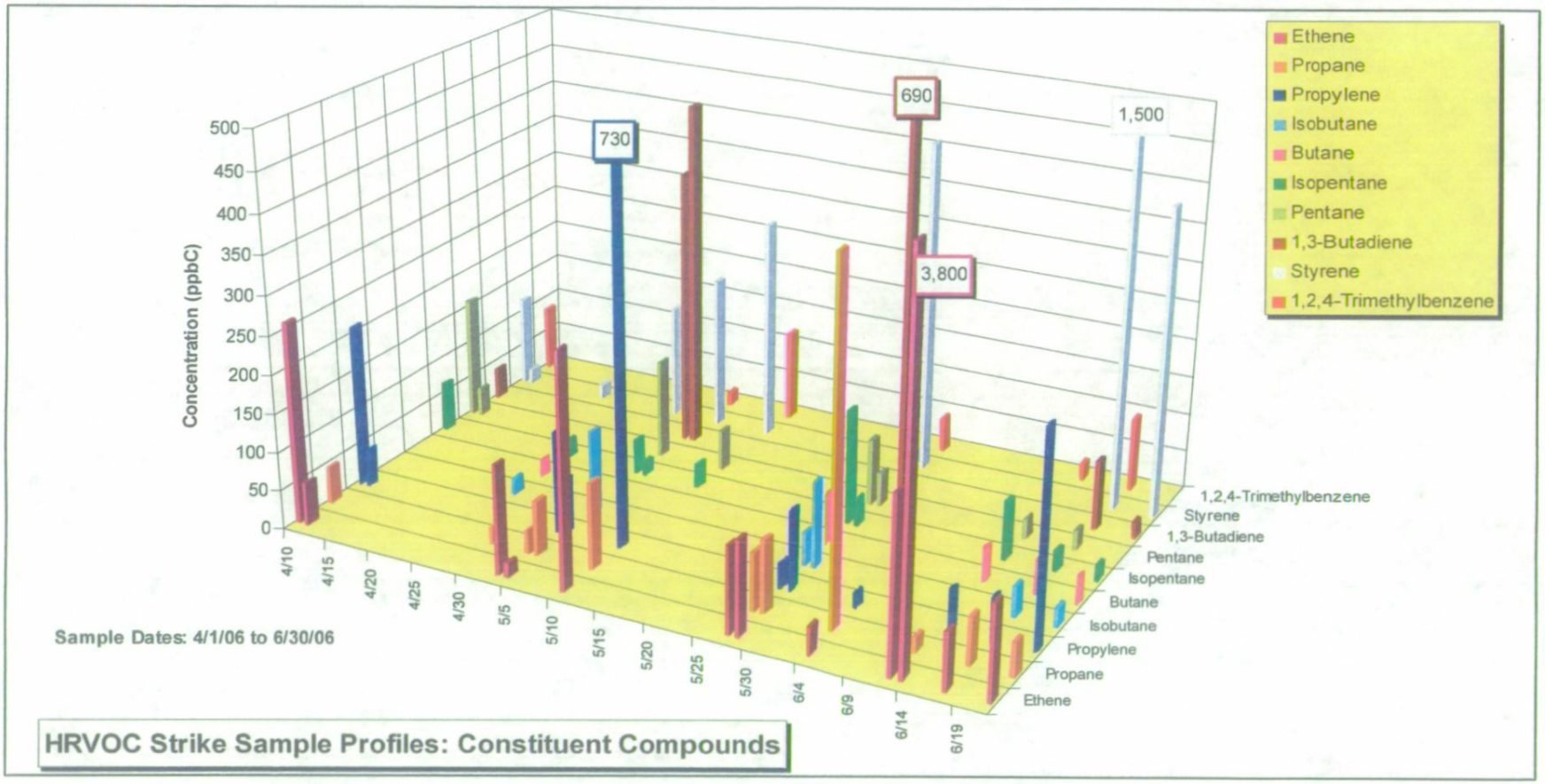


FIGURE 9: COMPOSITION OF HRVOC STRIKE SAMPLES: QUARTER 2, 2006

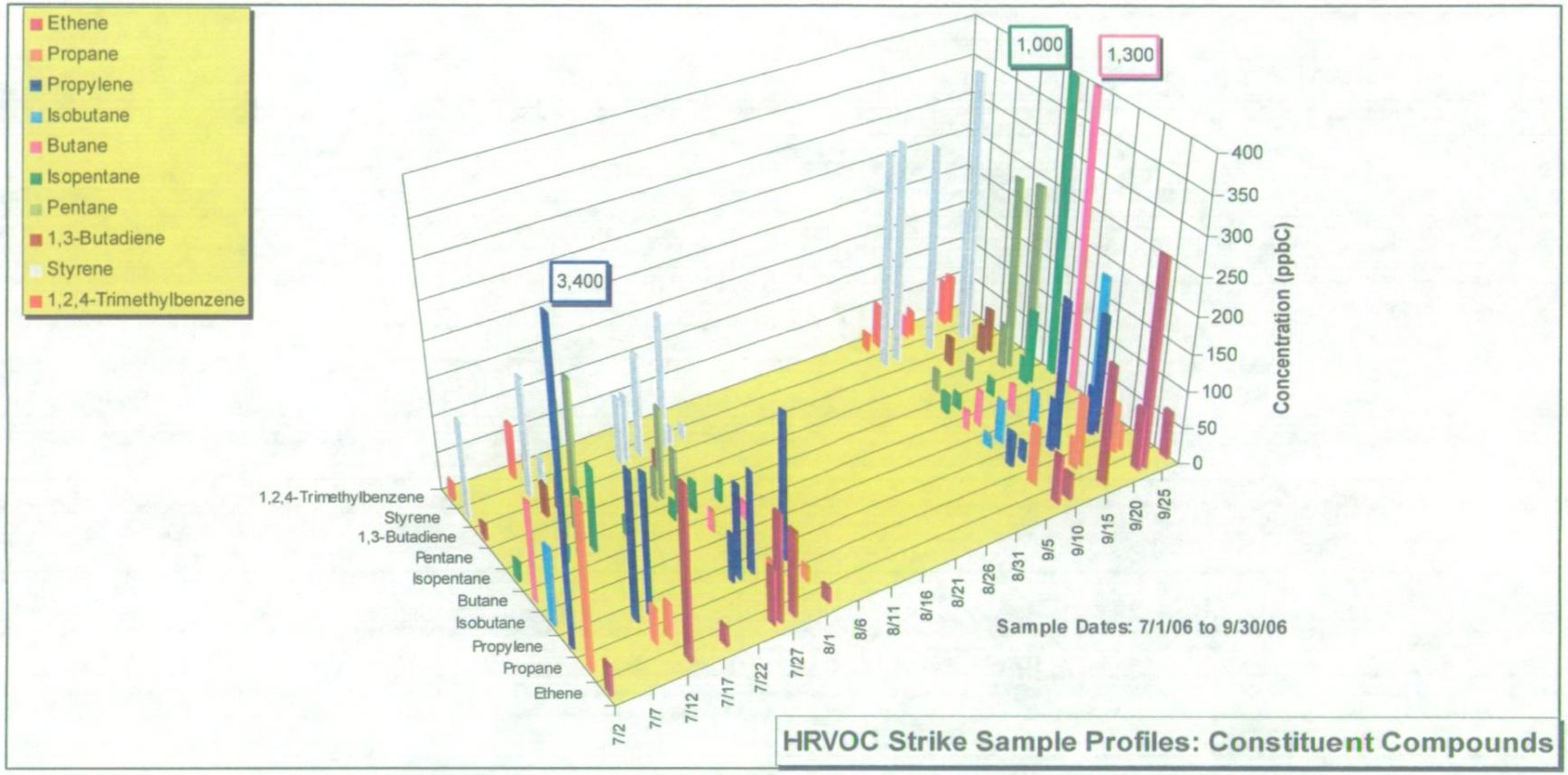


FIGURE 10: COMPOSITION OF HRVOC STRIKE SAMPLES: QUARTER 3, 2006

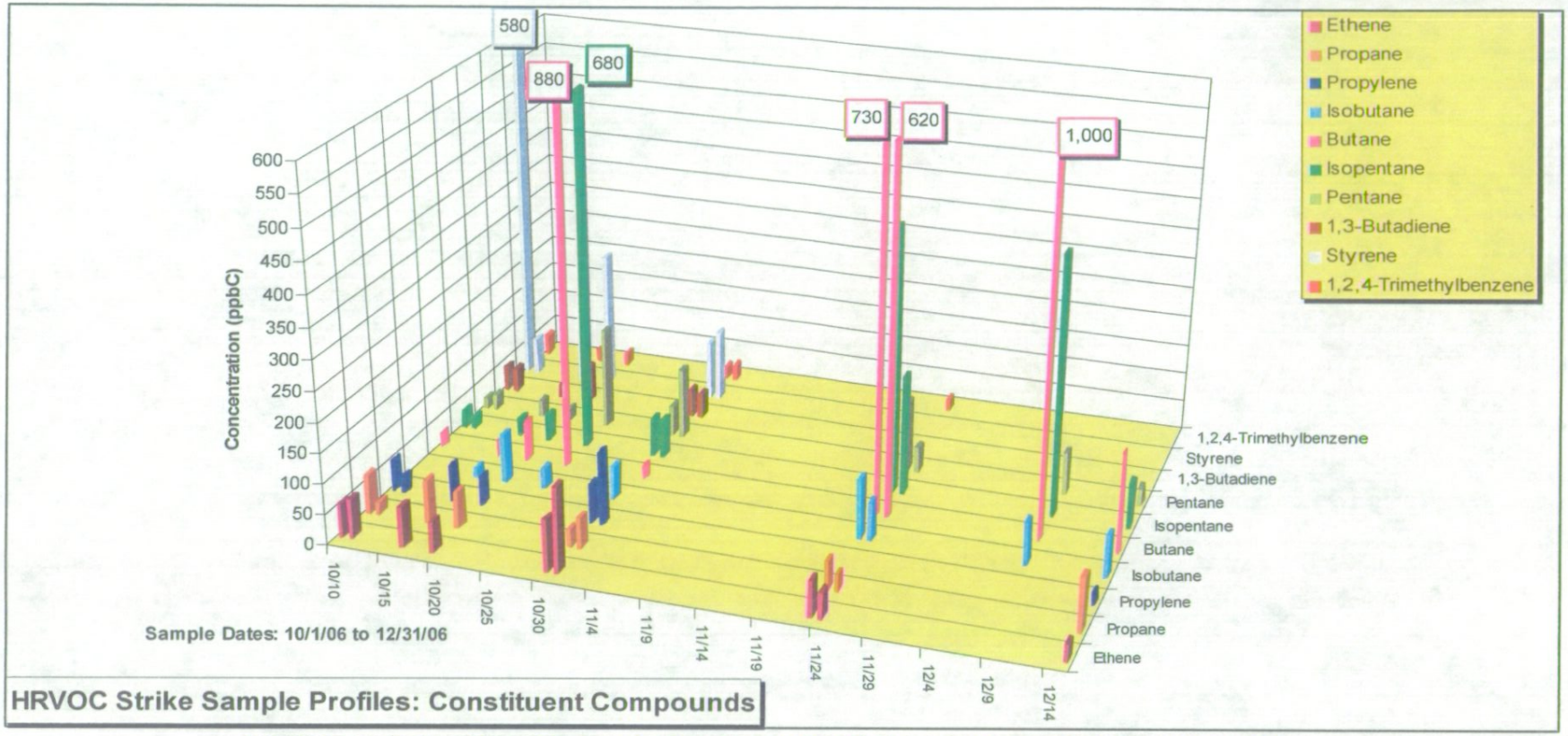
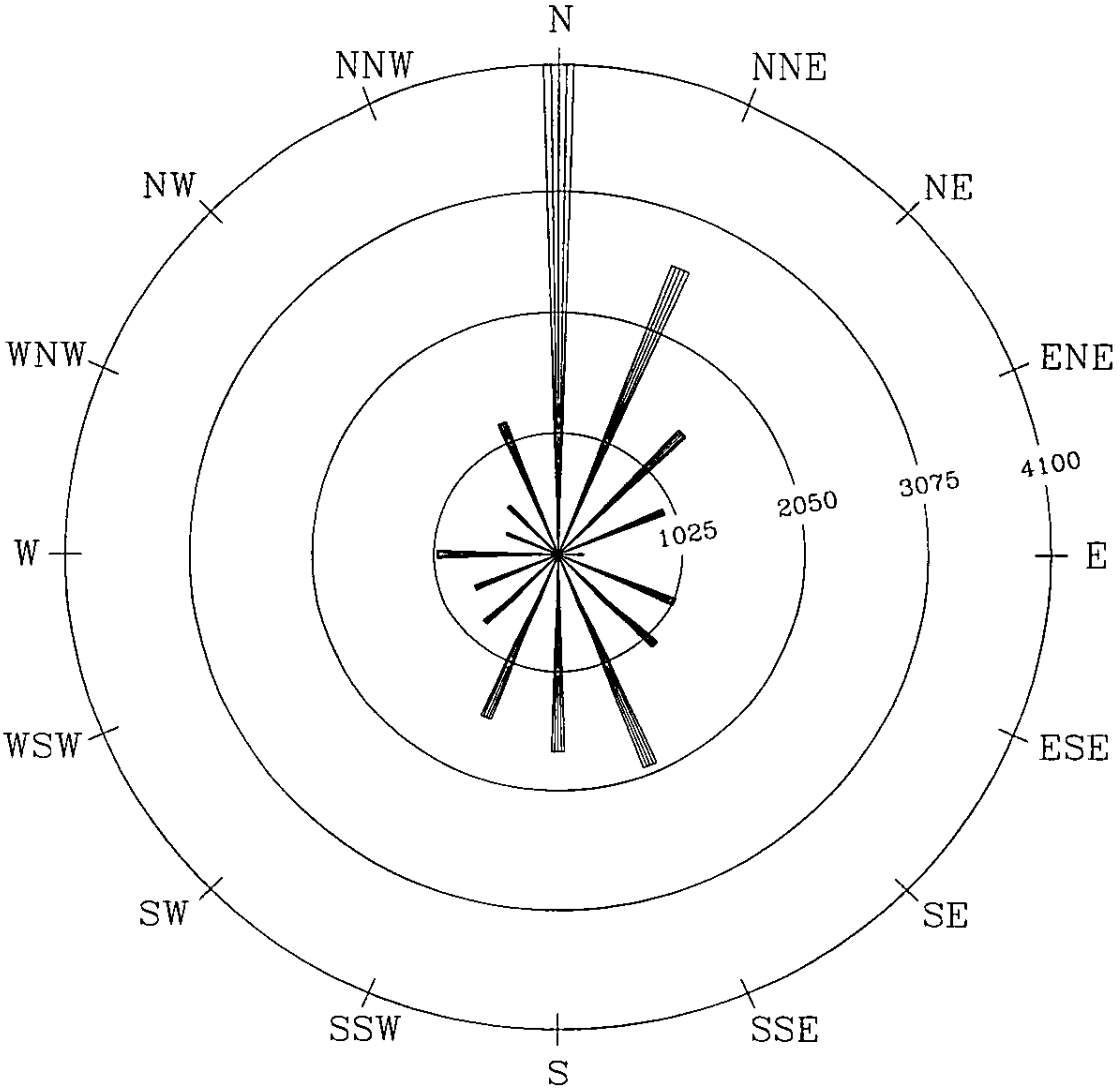


FIGURE 11: COMPOSITION OF HRVOC STRIKE SAMPLES: QUARTER 4, 2006

FIGURE 12: POLLUTANT ROSE OF AVERAGED TNMOC MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

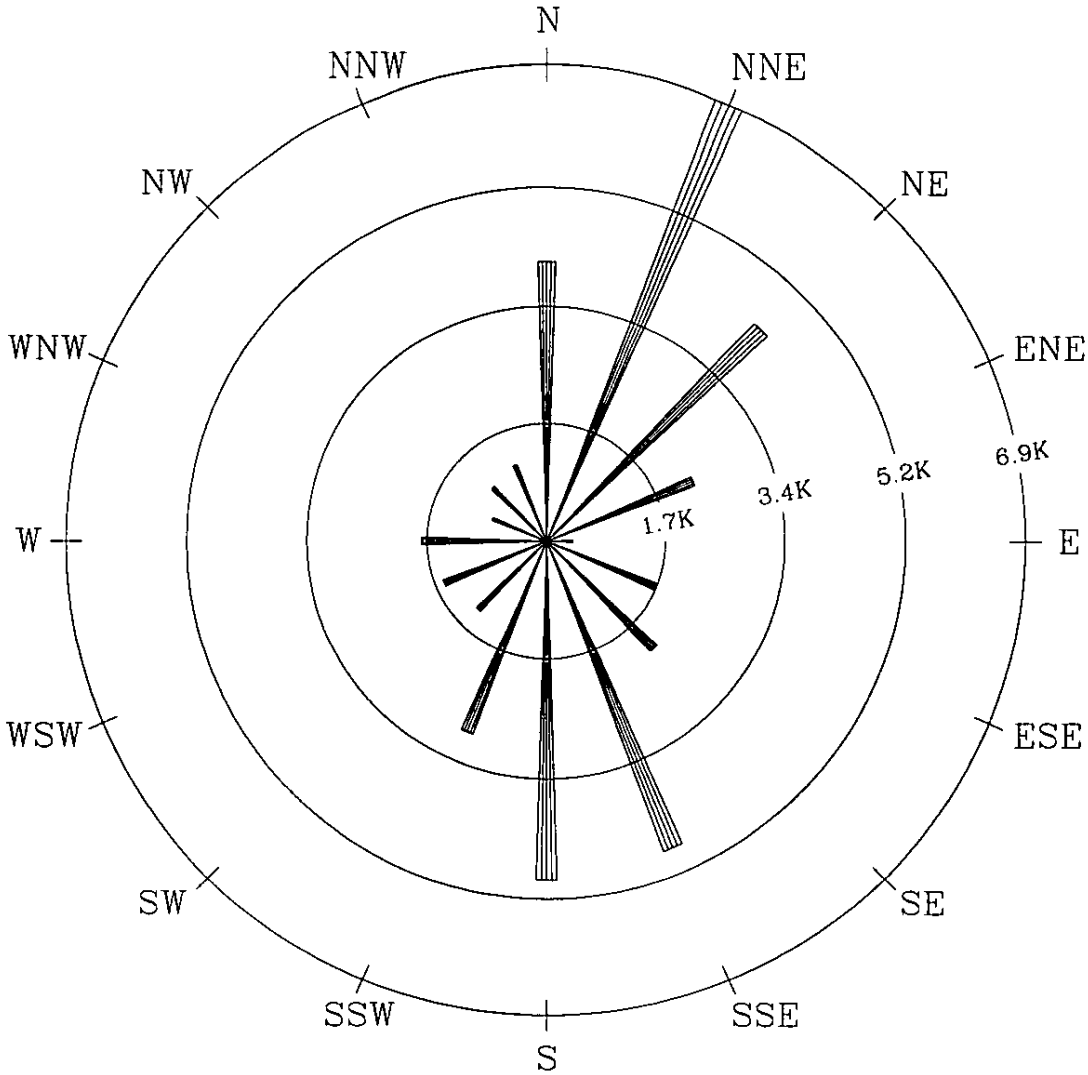


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: TNMOC Average Plot
Time Period Depicted: 5/ 1/05 - 12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of averaged TNMOC concentrations (C2-C12) as measured by the continuous monitor at North site indicates the majority of HRVOC is transported to the site from the north. (The monitoring site is located northwest of the Lion Copolymer plant.)

FIGURE 13:. POLLUTANT ROSE OF MAXIMUM TNMOC MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

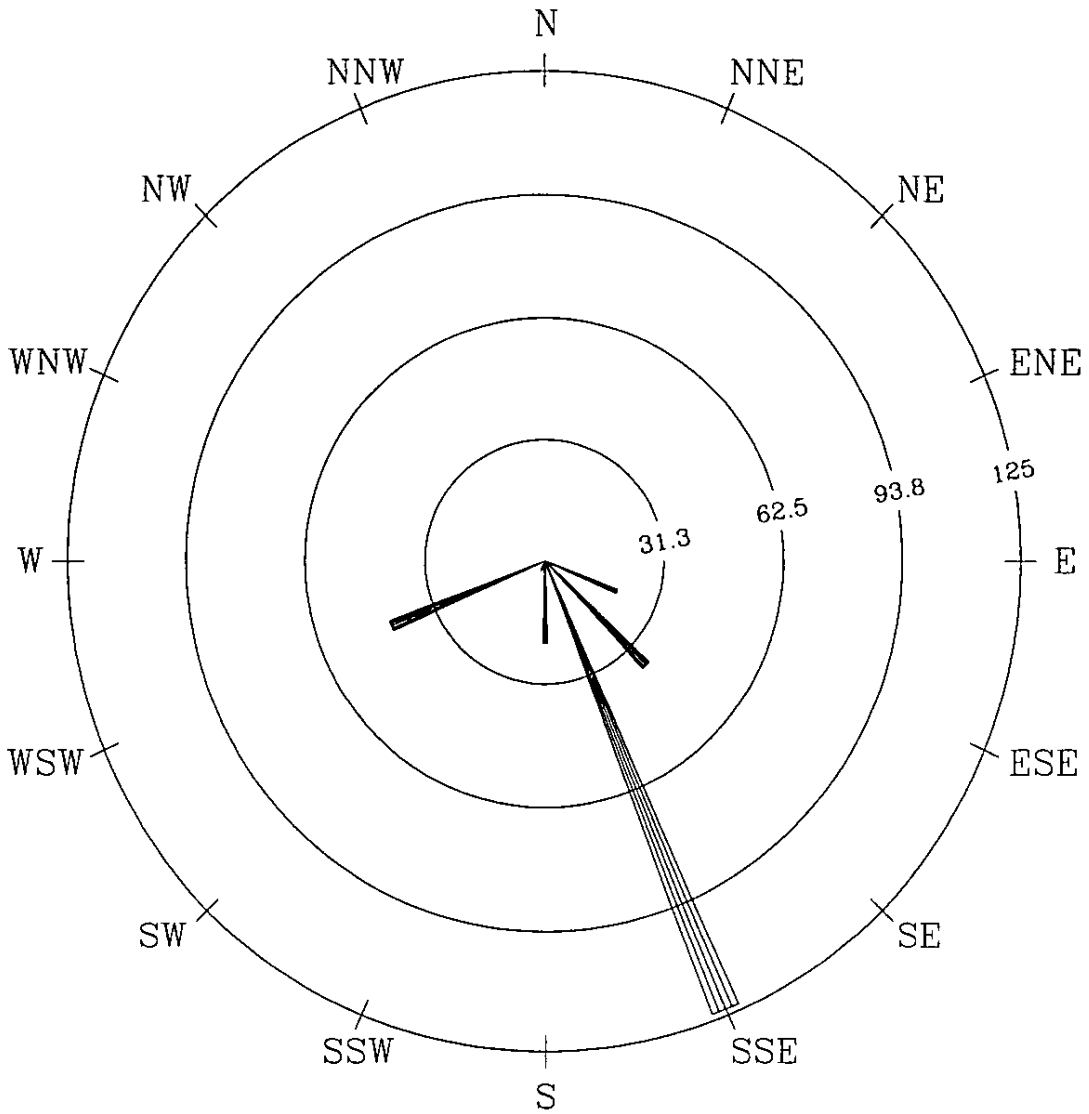


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: TNMOC Maximum Plot
Time Period Depicted: 5/ 1/05 - 12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum TNMOC concentrations (C2–C12) as measured by the continuous monitor at North site indicates the majority of HRVOC is transported to the site from the north–northeast. (The monitoring site is located northwest of the Lion Copolymer plant.) HRVOC maximums measured from points south are also significant

FIGURE 14: POLLUTANT ROSE OF AVERAGE 1,3-BUTADIENE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

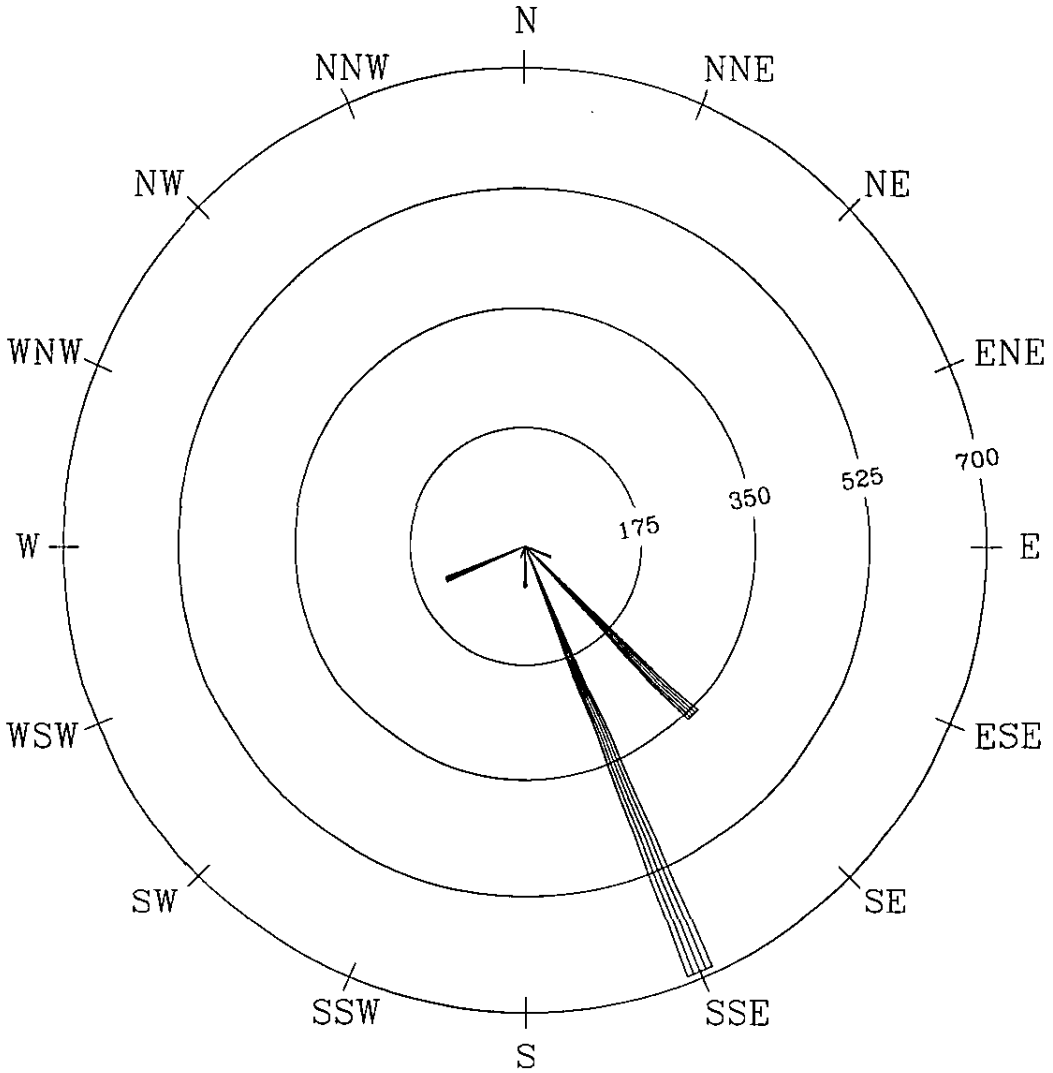


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: 1,3-Butadiene Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged 1,3-Butadiene concentrations as measured from HRVOC canister samples collected at the North site. 1-3, Butadiene was detected in 35 percent of the 98 canister samples collected over the 20-month project, averaging 2.8 percent of the total carbon in these samples. The Lion Copolymer plant is a significant source for 1,3-Butadiene emissions.

FIGURE 15: POLLUTANT ROSE OF MAXIMUM 1,3-BUTADIENE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

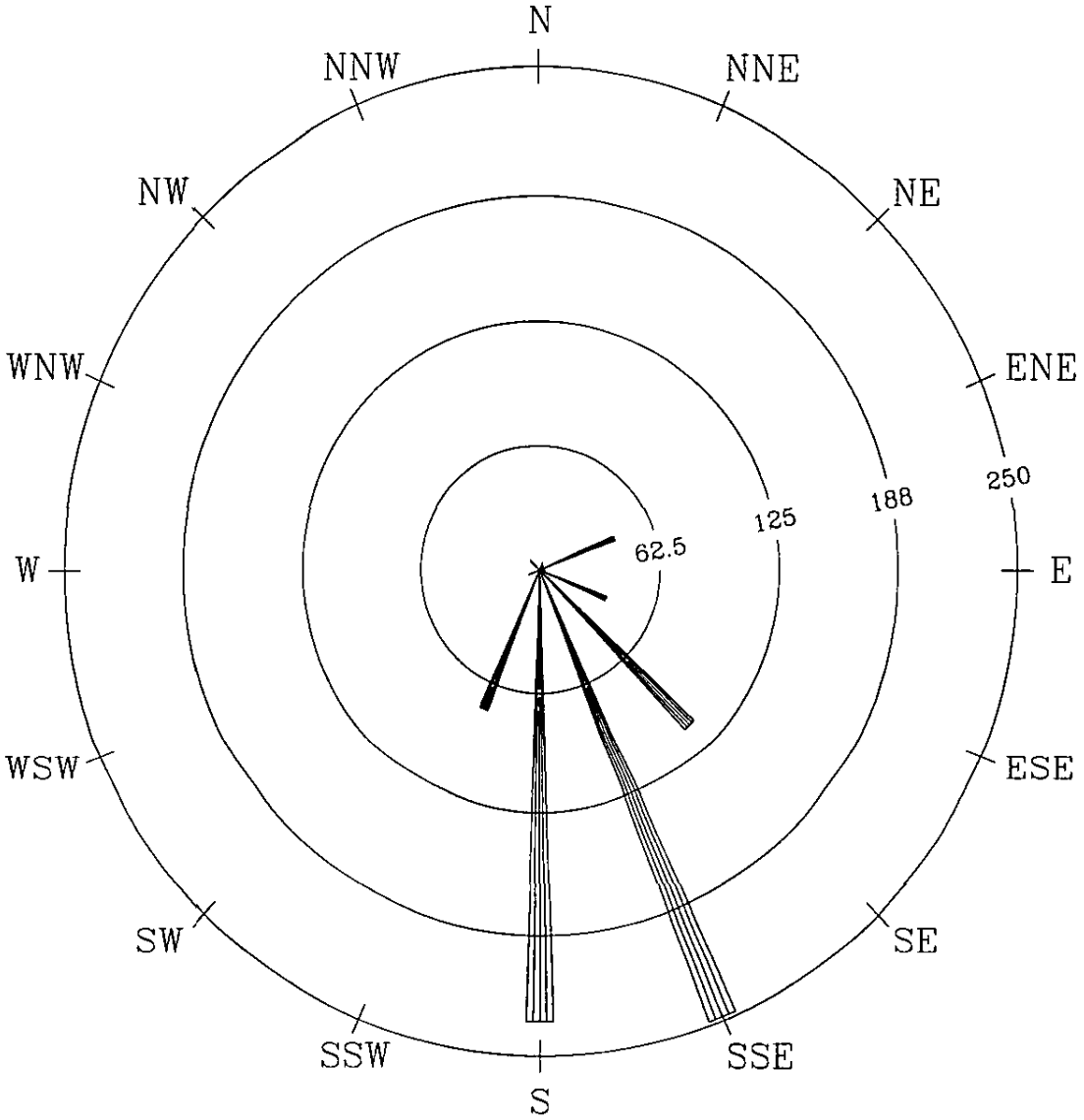


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: 1,3-Butadiene Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum 1,3-Butadiene concentrations as measured from HRVOC canister samples collected at the North site. 1-3, Butadiene was detected in 35 percent of the 98 canister samples collected over the 20-month project, averaging 2.8 percent of the total carbon in these samples. The Lion Copolymer plant is a significant source for 1,3-Butadiene emissions.

FIGURE 16: POLLUTANT ROSE OF AVERAGE STYRENE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

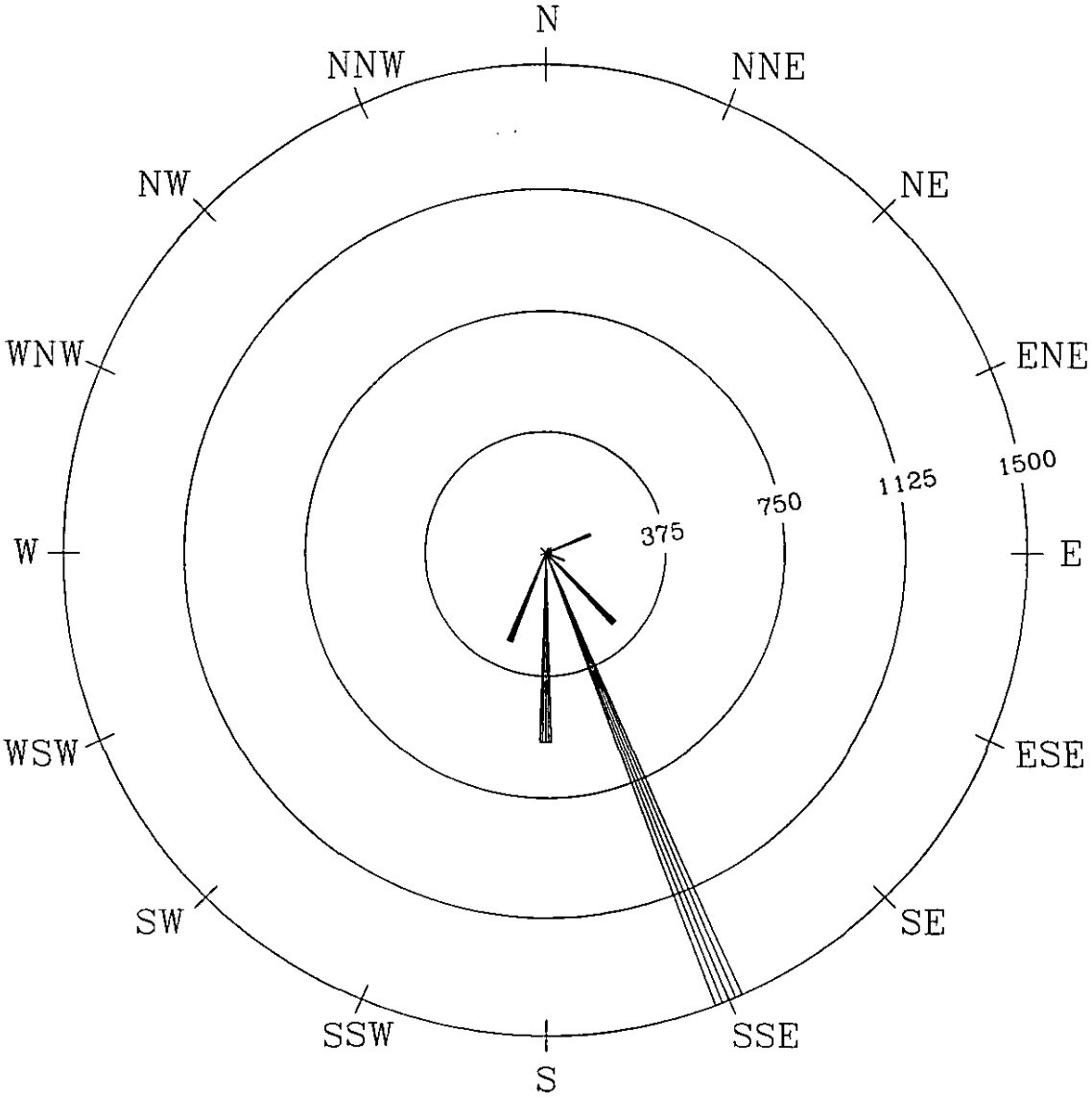


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Styrene Average Plot
Time Period Depicted: 5/1/05–12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Styrene concentrations as measured from HRVOC canister samples collected at the North site. Styrene was detected in 54 percent of the 98 canister samples collected over the 20–month project, averaging 8.2 percent of the total carbon in these samples. The Lion Copolymer plant is a significant source for Styrene emissions.

FIGURE 17: POLLUTANT ROSE OF MAXIMUM STYRENE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

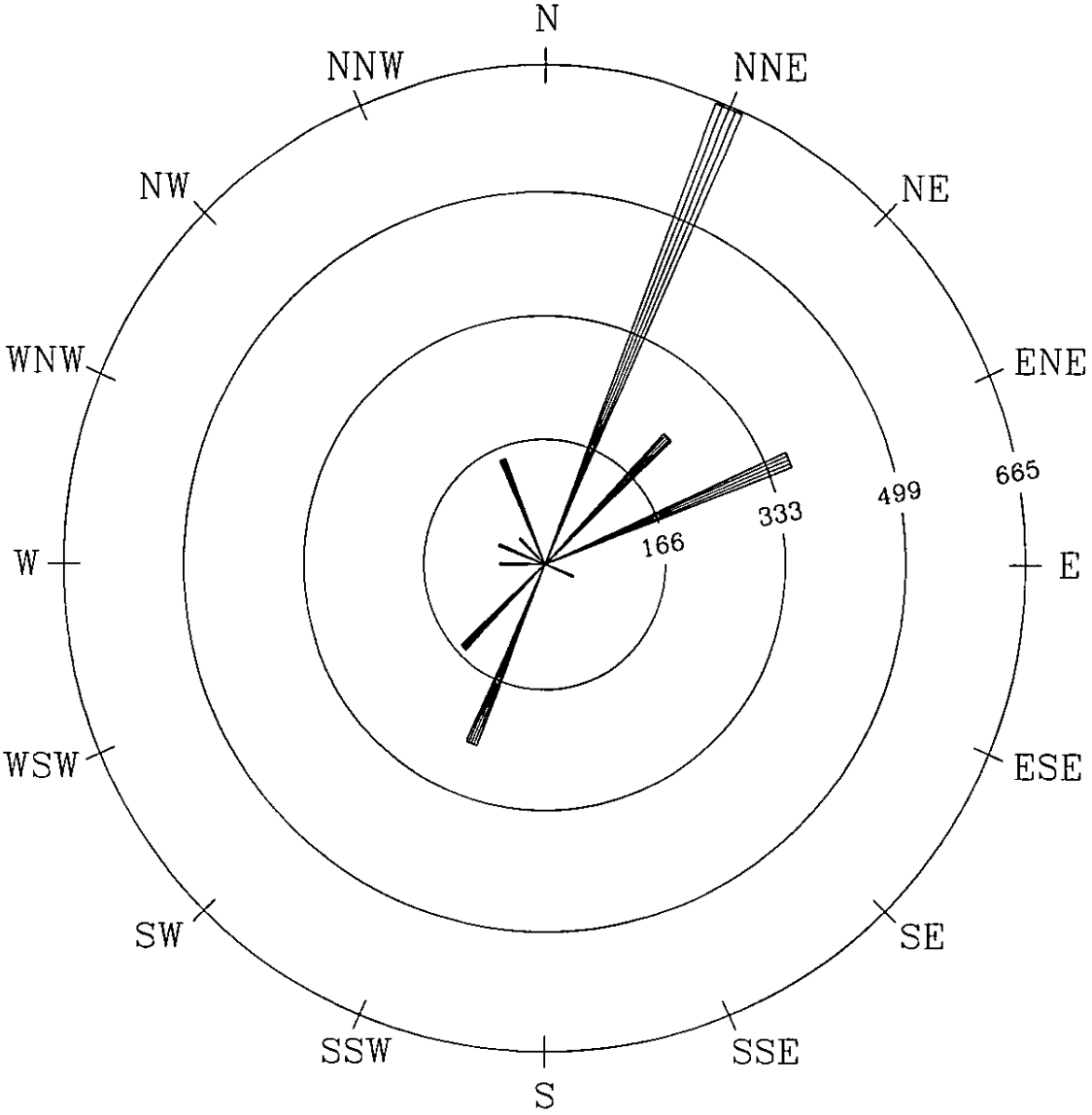


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Styrene Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum Styrene concentrations as measured from HRVOC canister samples collected at the North site. Styrene was detected in 54 percent of the 98 canister samples collected over the 20-month project, averaging 8.1 percent of the total carbon in these samples. The Lion Copolymer plant is a significant source for Styrene emissions.

FIGURE 18: POLLUTANT ROSE OF AVERAGE BUTANE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

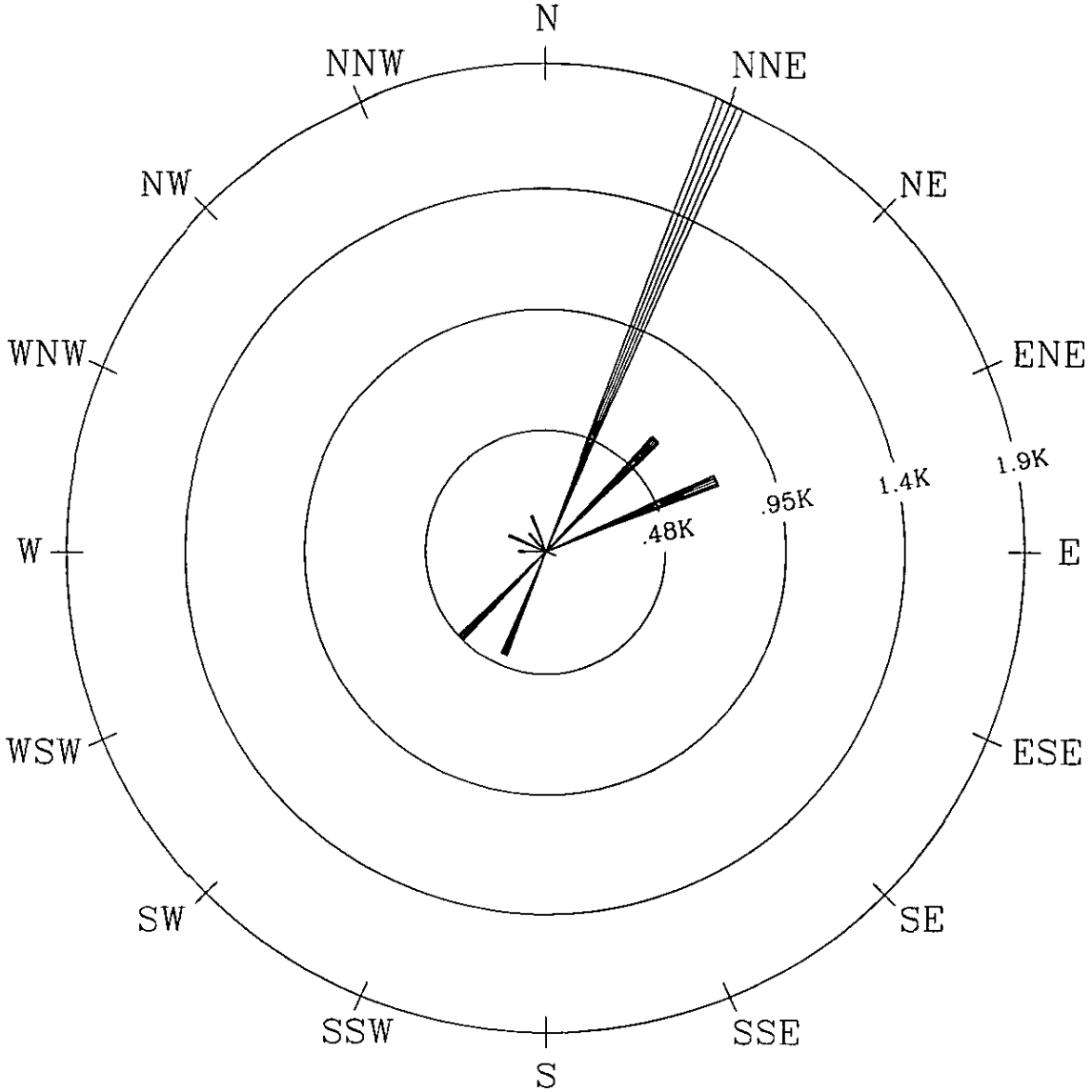


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Butane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Butane concentrations as measured from HRVOC canister samples collected at the North site. Butane was detected in 56 percent of the 98 canister samples collected over the 20-month project, averaging 12.1 percent of the total carbon in these samples. The Lion Copolymer plant is not a significant source for Butane emissions.

FIGURE 19: POLLUTANT ROSE OF MAXIMUM BUTANE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

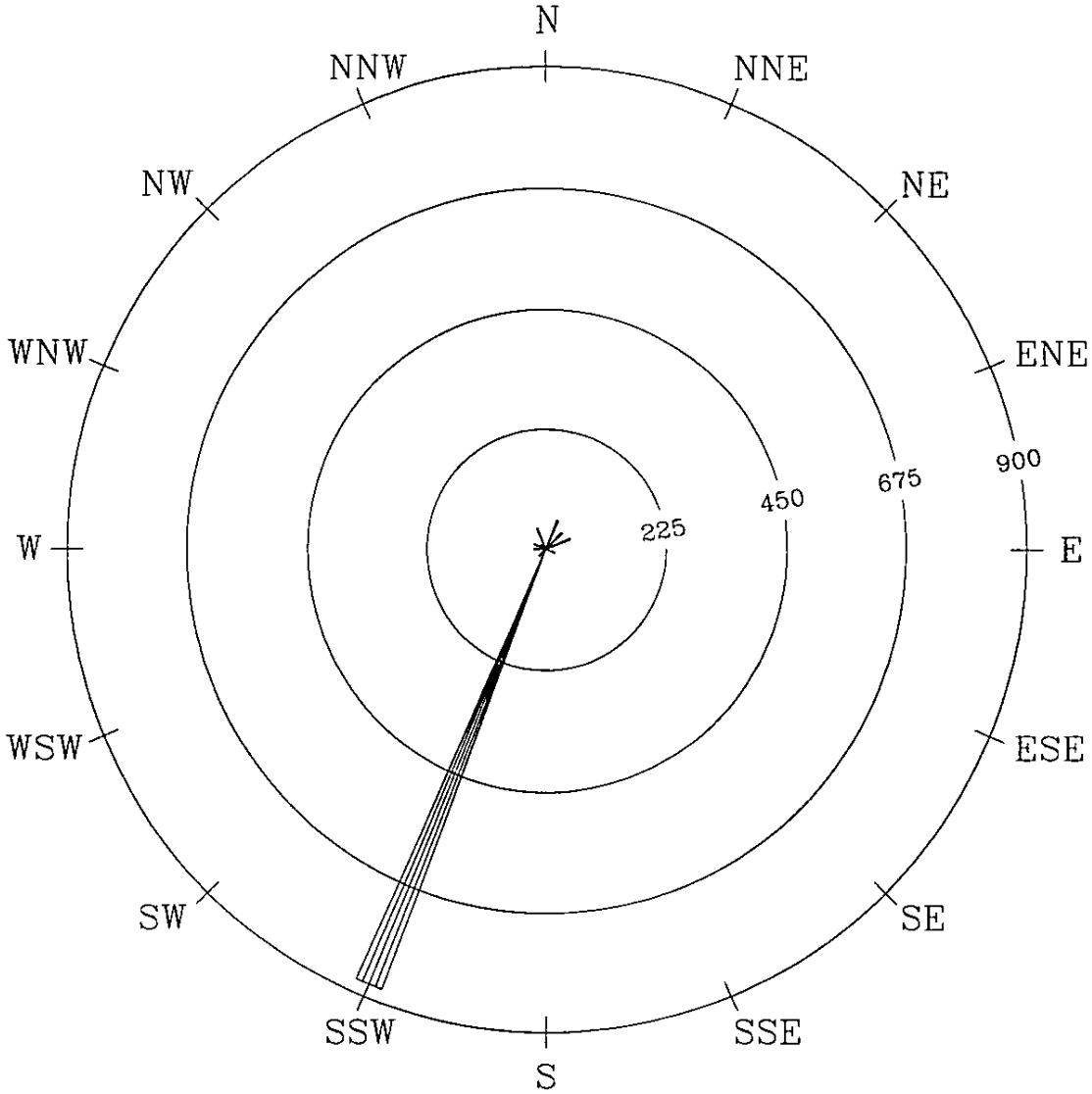


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Butane Maximum Plot
Time Period Depicted: 5/1/05–12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum Butane concentrations as measured from HRVOC canister samples collected at the North site. Butane was detected in 56 percent of the 98 canister samples collected over the 20-month project, averaging 12.1 percent of the total carbon in these samples. The Lion Copolymer plant is not a significant source for Butane emissions.

FIGURE 20: POLLUTANT ROSE OF AVERAGE ISOBUTANE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

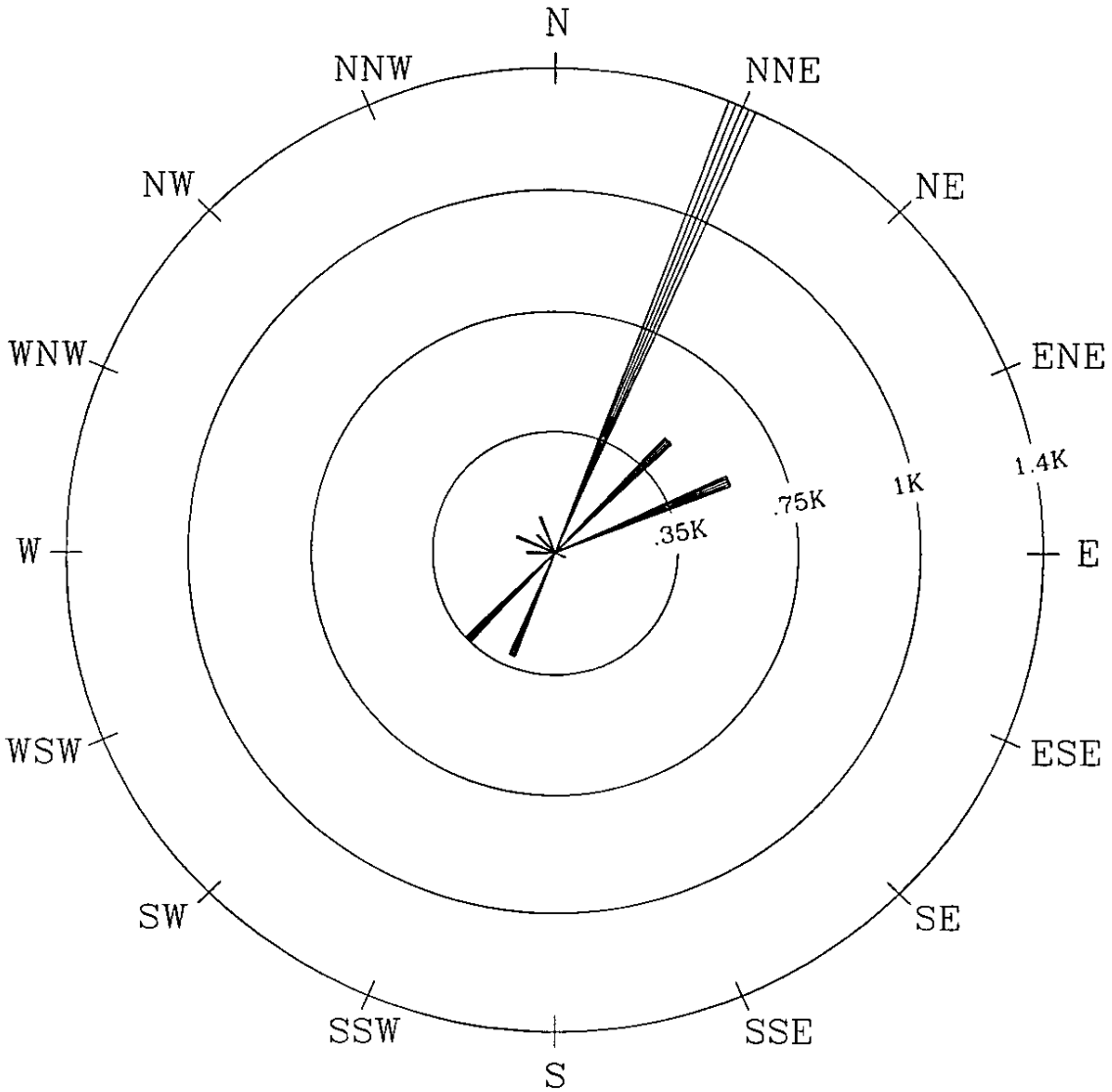


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Isobutane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Isobutane concentrations as measured from HRVOC canister samples collected at the North site. Isobutane was detected in 47 percent of the 98 canister samples collected over the 20-month project, averaging 4.7 percent of the total carbon in these samples. The Lion Copolymer plant is not a significant source for Isobutane emissions.

FIGURE 21: POLLUTANT ROSE OF MAXIMUM ISOBUTANE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

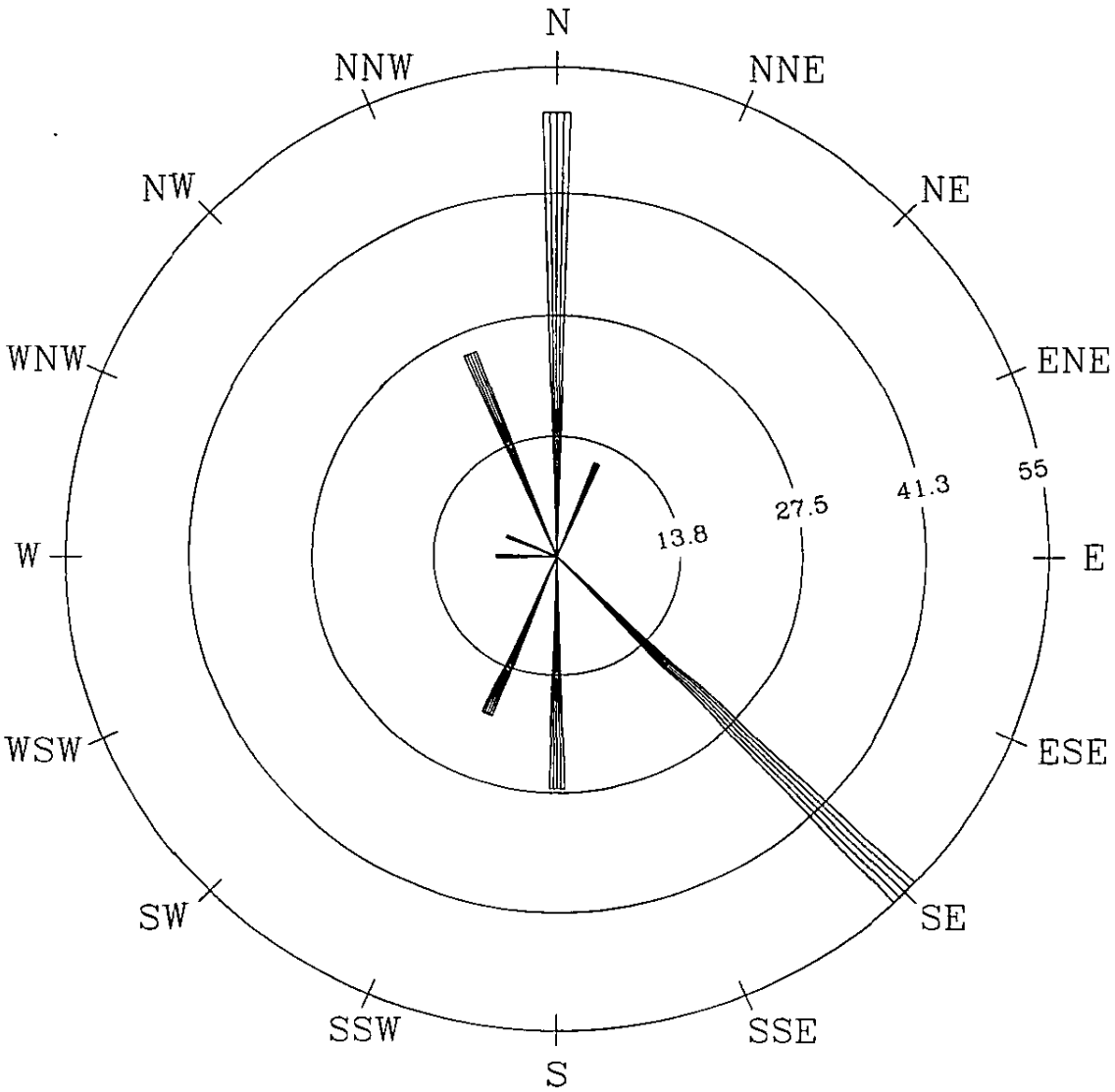


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Isobutane Maximum Plot
Time Period Depicted: 5/1/05–12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of averaged Isobutane concentrations as measured from HRVOC canister samples collected at the North site. Isobutane was detected in 47 percent of the 98 canister samples collected over the 20–month project, averaging 4.7 percent of the total carbon in these samples. The Lion Copolymer plant is not a significant source for Isobutane emissions.

FIGURE 22: POLLUTANT ROSE OF AVERAGE PROPYLENE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

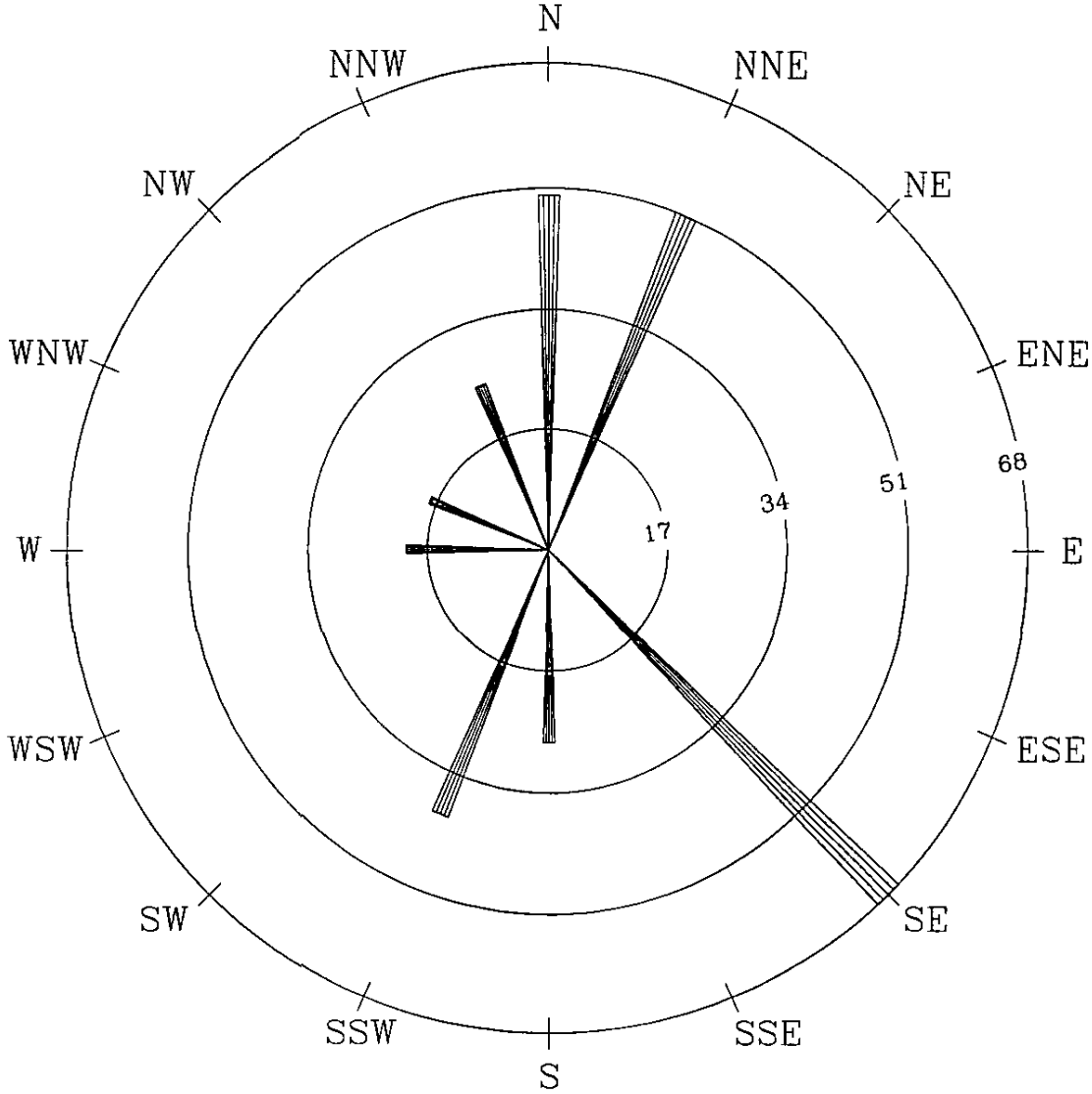


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Propylene Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Propylene concentrations as measured from HRVOC canister samples collected at the North site. Propylene was detected in 58 percent of the 98 canister samples collected over the 20-month project, averaging 11.8 percent of the total carbon in these samples. The Lion Copolymer plant is not a significant source for Propylene emissions.

FIGURE 23: POLLUTANT ROSE OF MAXIMUM PROPYLENE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

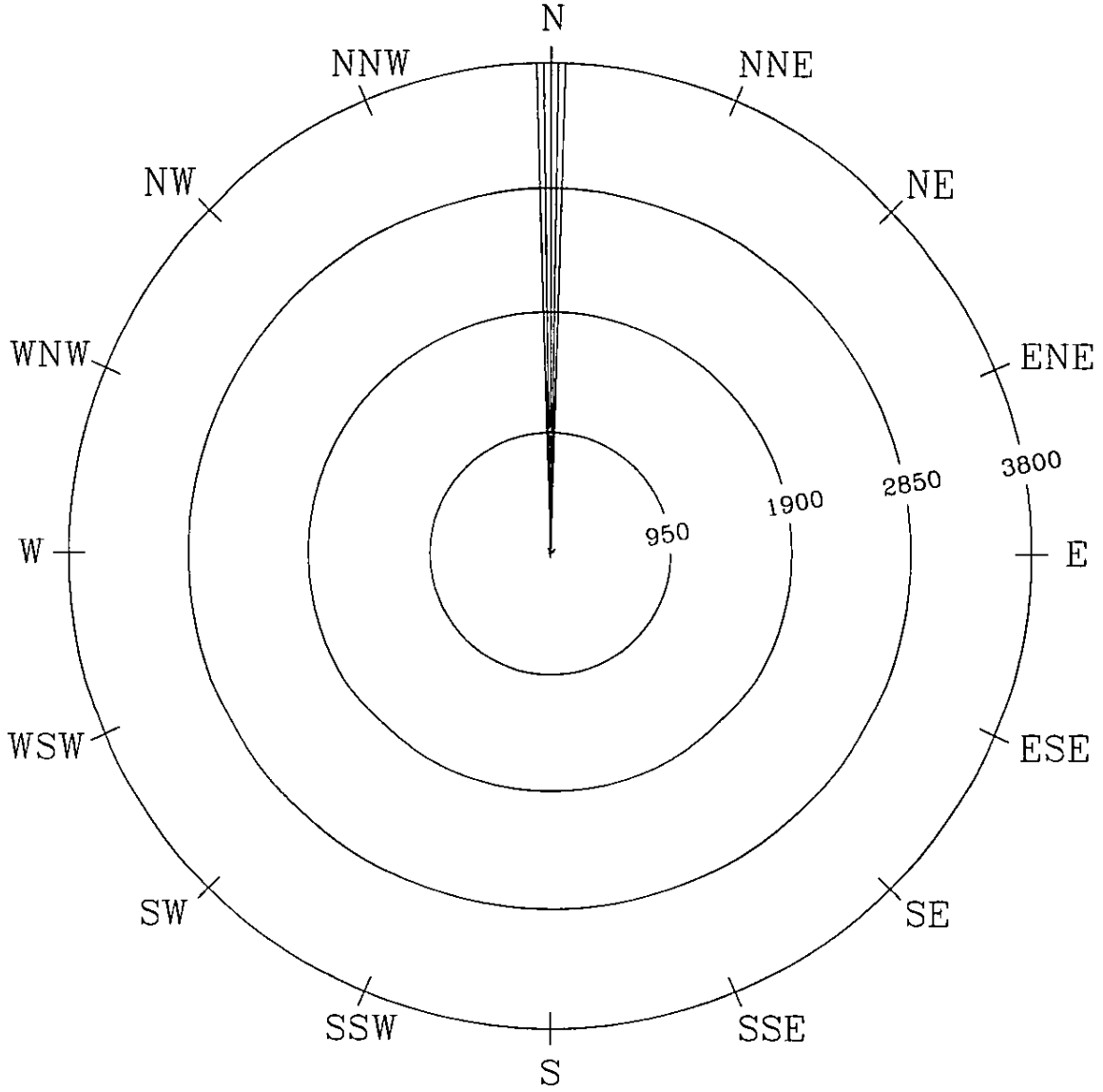


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Propylene Maximum Plot
Time Period Depicted: 5/1/05–12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum Propylene concentrations as measured from HRVOC canister samples collected at the North site. Propylene was detected in 58 percent of the 98 canister samples collected over the 20–month project, averaging 11.8 percent of the total carbon in these samples. The Lion Copolymer plant is not a significant source for Propylene emissions.

FIGURE 24:. POLLUTANT ROSE OF AVERAGE ETHENE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

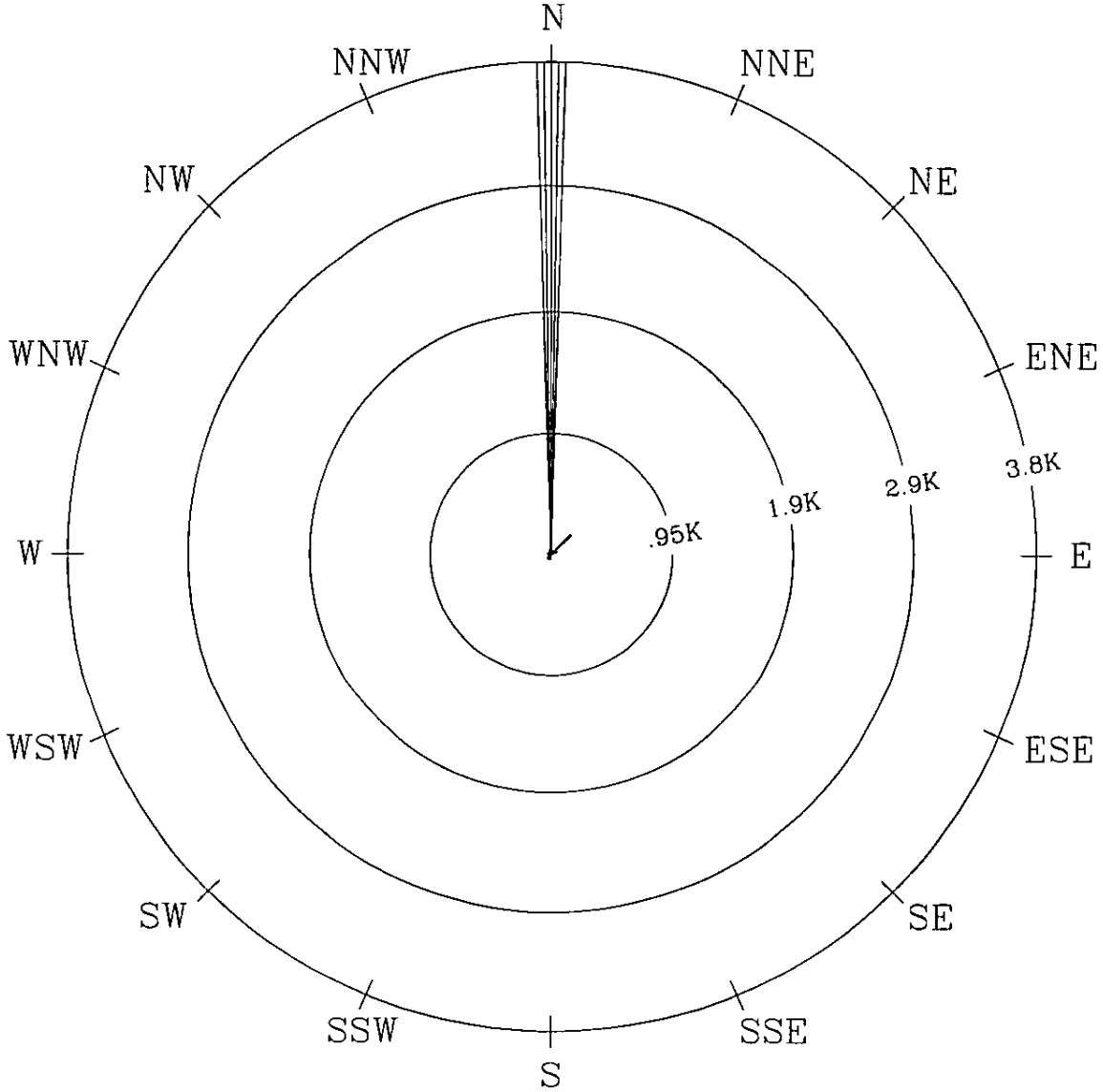


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Ethene Average Plot
Time Period Depicted: 5/1/05–12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Ethene concentrations as measured from HRVOC canister samples collected at the North site. Ethene was detected in 66 percent of the 98 canister samples collected over the 20-month project, averaging 11.2 percent of the total carbon in these samples. The Lion Copolymer plant is not a significant source for Propylene emissions.

FIGURE 25: POLLUTANT ROSE OF MAXIMUM ETHENE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

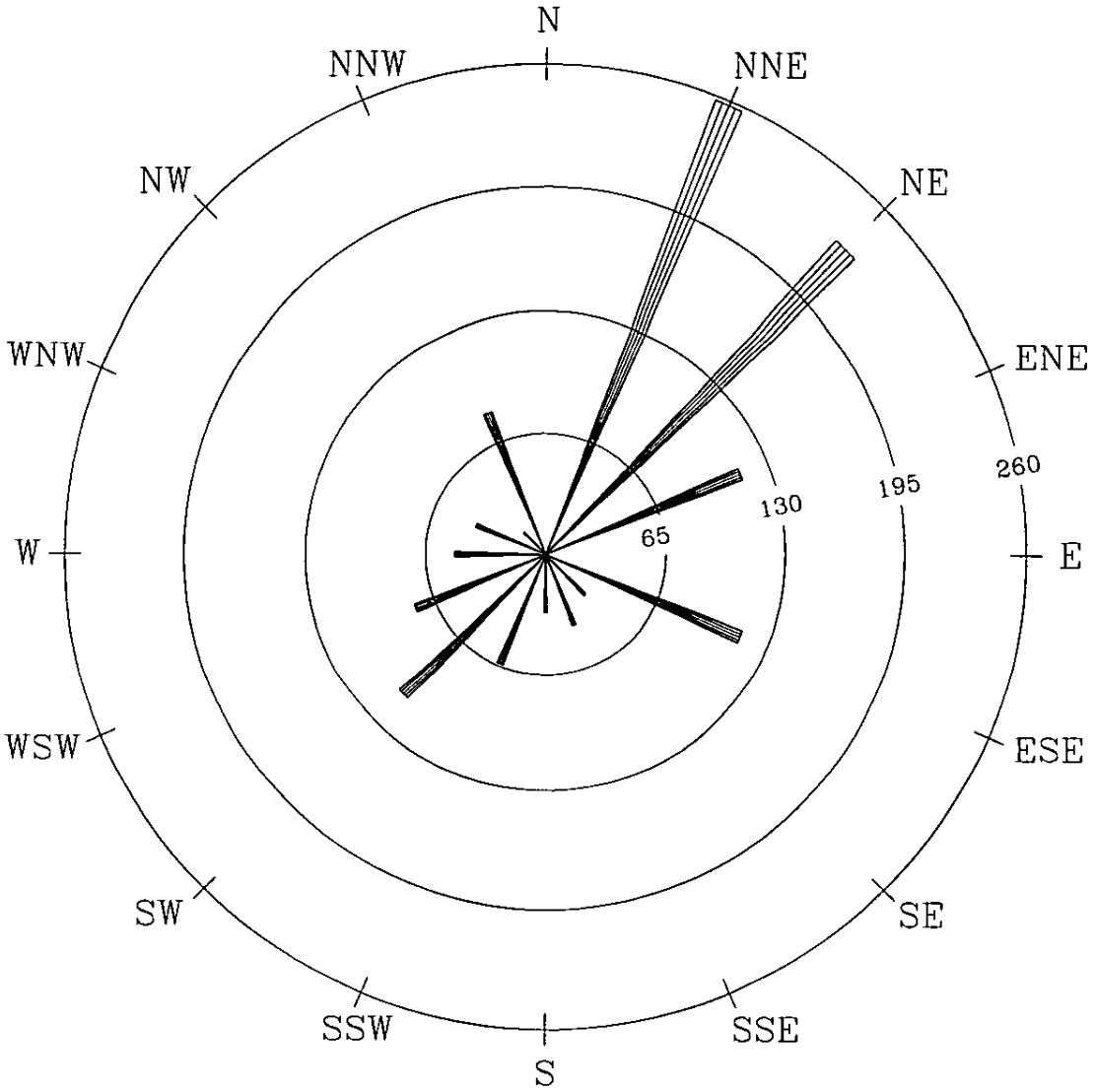


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Ethene Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum Ethene concentrations as measured from HRVOC canister samples collected at the North site. Ethene was detected in 66 percent of the 98 canister samples collected over the 20-month project, averaging 11.2 percent of the total carbon in these samples. The Lion Copolymer plant is not a significant source for Propylene emissions.

FIGURE 26: POLLUTANT ROSE OF AVERAGE ISOPENTANE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

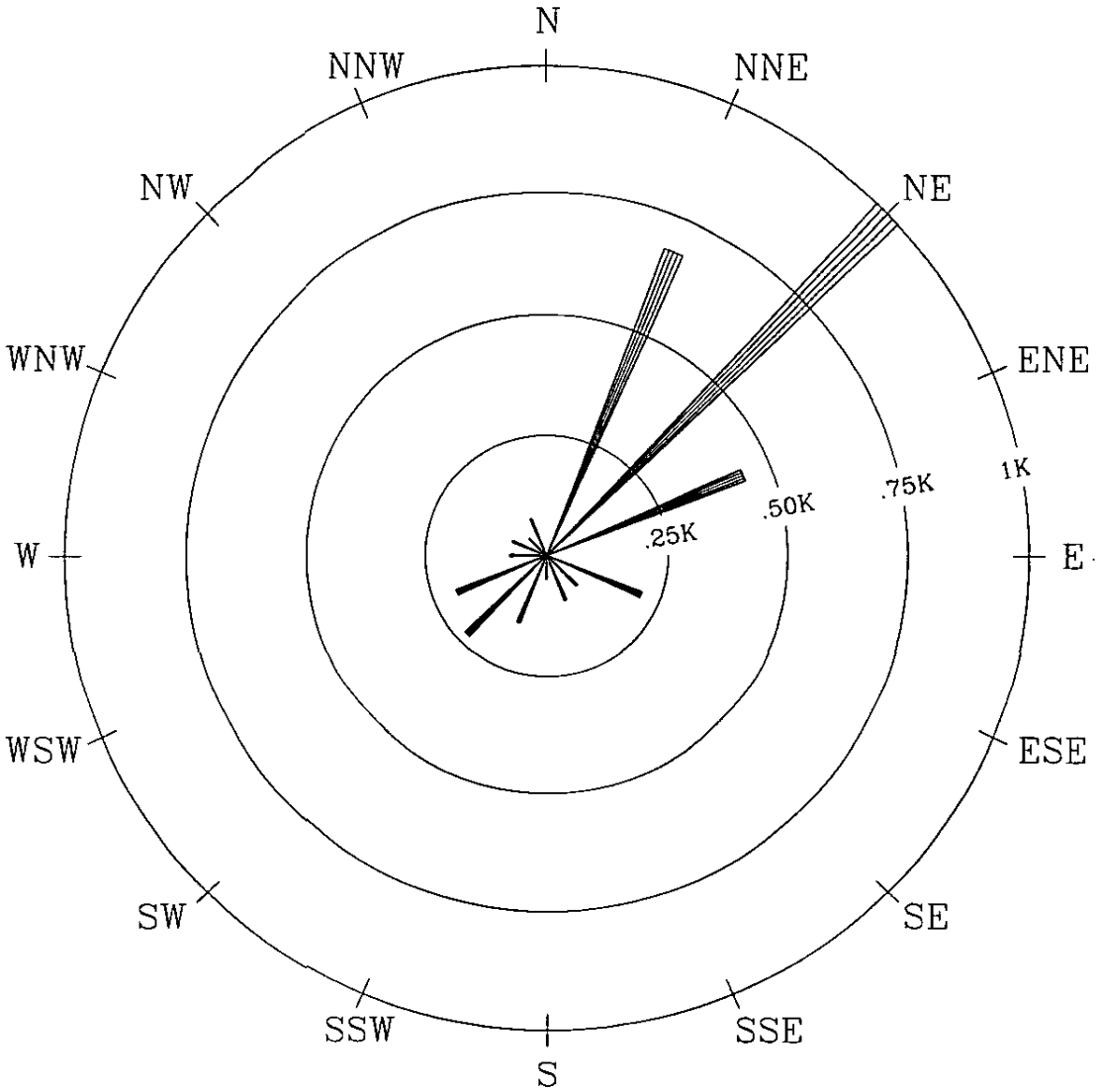


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Isopentane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Isopentane concentrations as measured from HRVOC canister samples collected at the North site. Isopentane was detected in 74 percent of the 98 canister samples collected over the 20-month project, averaging 7.4 percent of the total carbon in these samples. The Lion Copolymer plant is not a significant source for Isopentane emissions.

FIGURE 27: POLLUTANT ROSE OF MAXIMUM ISOPENTANE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

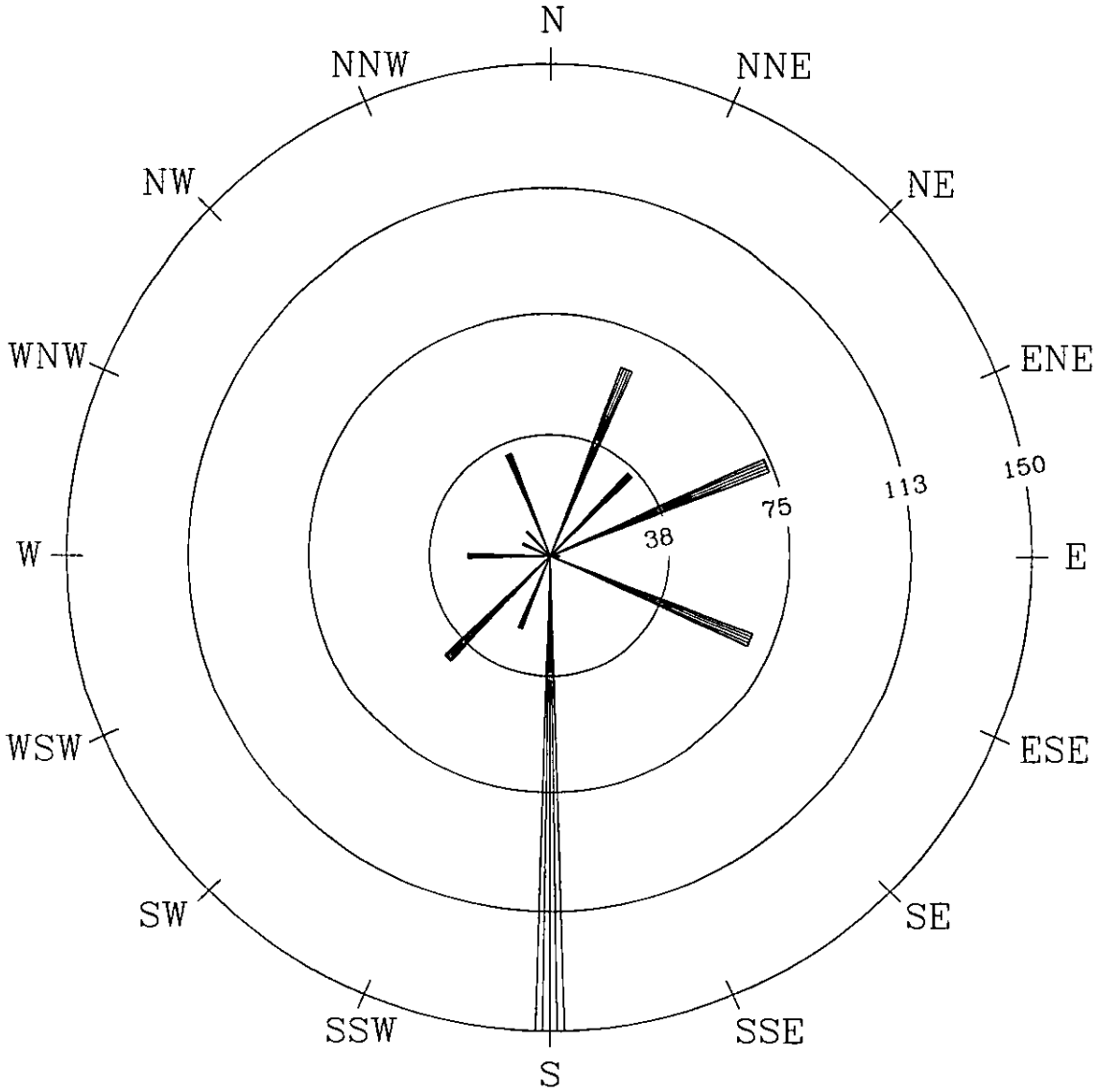


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Isopentane Maximum Plot
Time Period Depicted: 5/1/05–12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum Isopentane concentrations as measured from HRVOC canister samples collected at the North site. Isopentane was detected in 74 percent of the 98 canister samples collected over the 20-month project, averaging 7.4 percent of the total carbon in these samples. The Lion Copolymer plant is not a significant source for Isopentane emissions.

FIGURE 28: POLLUTANT ROSE OF AVERAGE PENTANE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE

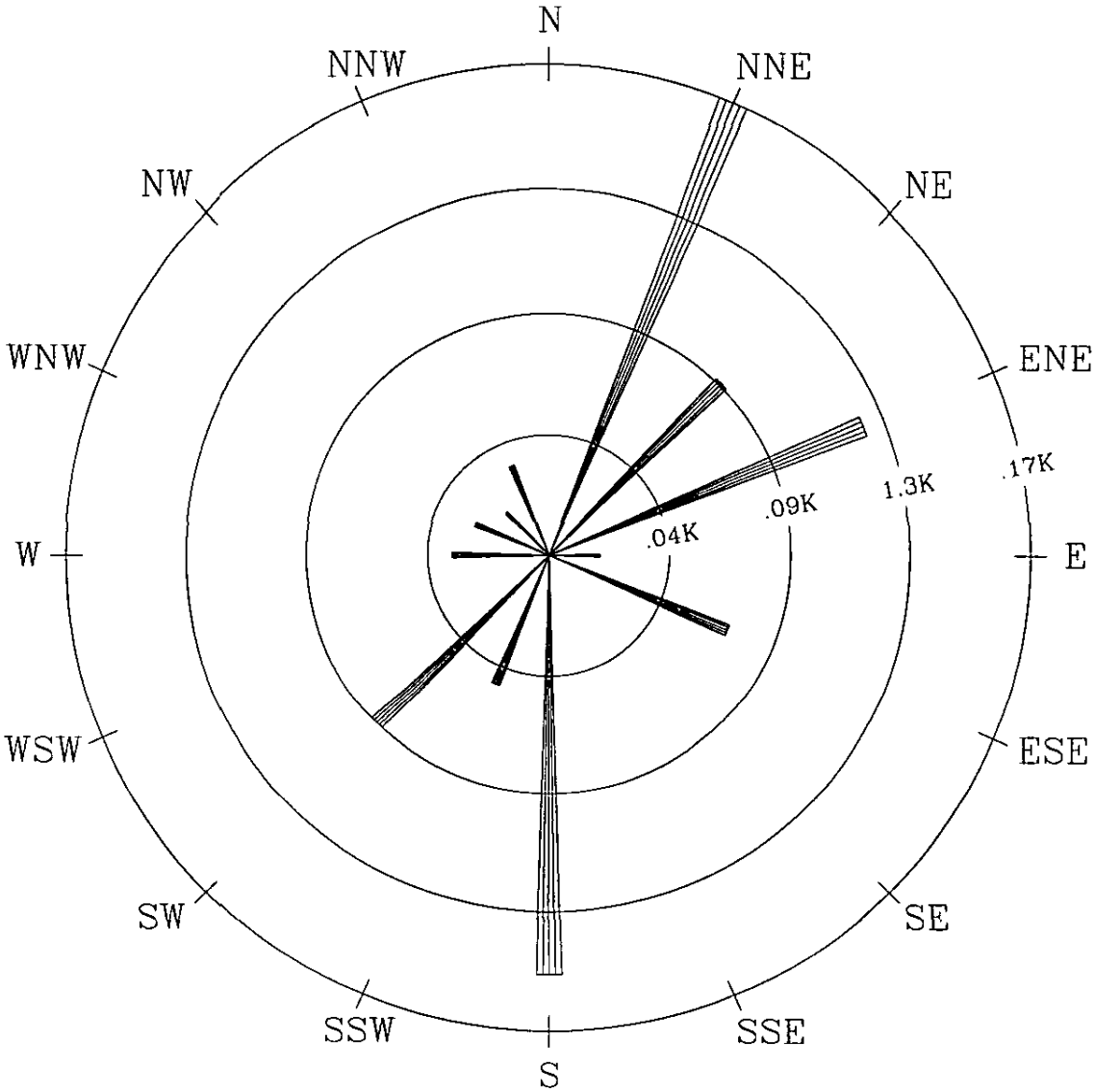


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Pentane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Pentane concentrations as measured from HRVOC canister samples collected at the North site. Pentane was detected in 69 percent of the 98 canister samples collected over the 20-month project, averaging 4.6 percent of the total carbon in these samples. The Lion Copolymer plant is not a significant source for Pentane emissions.

FIGURE 29: POLLUTANT ROSE OF MAXIMUM PENTANE MEASUREMENTS COMPILED FROM 98 CANISTER SAMPLES COLLECTED AT NORTH SITE



POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Lion Copolymer
Monitoring Site: North Site
Pollutant: Pentane Maximum Plot
Time Period Depicted: 5/1/05–12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum Pentane concentrations as measured from HRVOC canister samples collected at the North site. Pentane was detected in 69 percent of the 98 canister samples collected over the 20–month project, averaging 4.6 percent of the total carbon in these samples. The Lion Copolymer plant is not a significant source for Pentane emissions.

Appendix D – Facility Final Reports

Placid Refining Company, L.L.C.

PLACID

February 1, 2007

Certified Receipt 7004 2890 0000 8051 1452

Ms. Peggy Hatch, Administrator
Louisiana Department of Environmental Quality
Enforcement Division
P.O. Box 4312
Baton Rouge, LA 70821

Re: Placid Refining Company LLC (AI 2366), Ambient Air Fenceline Monitoring, Administrative Order on Consent, AE-AOA-050010; Summary Report

Dear Ms. Hatch:

Placid appreciates the department's consideration in allowing the early termination of the Ambient Air Fenceline Monitoring Program and has prepared the following summary report as per your request (Attachment A).

Overview of the Program

On or about October 6, 2004 Placid Refining Company LLC (Placid) received an Administrative Order on Consent, AE-AOA-05-0010, from The Louisiana Department of Environmental Quality (LDEQ).

At the time of the Order, the Baton Rouge Air Quality Control Region was in violation of both the 1-hour and 8-hour National Ambient Air Quality Standards for Ozone. Upon reviewing its own data for the previous three (3) year period (prior to 2004) LDEQ determined concentration spikes of highly reactive volatile organic compounds (HRVOC) were associated with peaking episodes of elevated ozone, leading to the exceedance of the 1-hour and 8-hour standards.

In an effort to determine the origin of the HRVOCs, the Order required Placid install and maintain fenceline monitoring stations at various locations adjacent to the Port Allen Refinery capable of continuously monitoring total non-methane organic carbon (TNMOC). These stations were also equipped with summa canister samplers capable of automatically collecting a 20-minute air sample (trigger/strike sample) when the analyzer

exceeded a predetermined concentration threshold. These samples were then analyzed via gas chromatograph/flame ionization detection for compounds specified by LDEQ. Of particular interest to LDEQ were the HRVOCs: 1,3 butadiene, butenes, ethylene, propylene, toluene and xylenes.

Continuous monitoring data was reported to LDEQ monthly in 10-minute averages as required by the Order. Likewise, summa canister data was reported to LDEQ in ppbc as required. Meteorological data was also continuously monitored and reported.

Placid and LDEQ agreed on three (3) monitoring stations for the Port Allen Refinery as follows:

Station	Location	Lat/Long	Trigger Set Point	Met Station
N1	Northwest Corner	30° 28' 41"N 91° 12' 37"W	13	Yes
N2	NorthEast Corner	30° 28' 37"N 91° 12' 69"W	15	No
S	South	30° 28' 33"N 91° 12' 8"W	17	Yes

See Attachment B for more detail

Placid installed the follow equipment in each station:

TNMOC Analyzer	Thermo Electron Model 55 C
Summa Canister Sampler	RM Environmental Services Model 911A
Data Logger	Environmental Systems Model 8832
Meteorological	Young Instruments Model 05305
Radio System	Phoenix Contact Rad-ISM-900

Operation

Air is continually sampled and monitored using the RM Model 911A which sends the air to the Model 55 C hydrocarbon analyzer. If the hydrocarbon concentration exceeds Placid's set "trigger" point the 911 A canister sampler will collect a 20 minute sample for analysis. Each station included a five (5) canister carousel to prevent samples from being missed if there was a delay after a trigger. A maximum of one canister per station per 24-hours was required to be collected regardless of the number of exceedances. Canisters were sent overnight to Air Toxics Ltd., 180 Blue Ravine Road, Ste. B, Flosom, CA 95630 for analysis. Eagle Environmental Services, 18369 Petroleum Drive, Baton Rouge, La 70809 conducted quarterly Quality Assurance Audits on each of Placid's monitoring stations.

Radio signals from each station transmitted data to the Honeywell TDC 3000 process control computer located in Placid's main control room. Refinery operations personnel monitored the incoming data 24 hours a day, 7 days a week. When a set point was

exceeded an audible alarm would sound in the control room. Board operators would then print the readings, including station and wind direction and notify Placid's shift foreman of the need to investigate. Placid's shift foremen were equipped with Minirae 2000™ handheld VOC monitors with a detection limit down to 0.5ppm total VOC and were required to immediately respond to all alarms, in which the wind direction was from the refinery, in an attempt to determine a source. Placid developed a log sheet for the shift foreman to record each response (see Attachment C). If the shift foreman's investigation found a potential correctable source they would initiate a work request to address the issue.

Results and Findings

Analysis from Placid's summa canisters was conducted by Air Toxics Ltd. Rarely, if ever, was any concentration of HRVOCs (1,3 butadiene, butanes, ethylene, propylene, toluene, and xylene) above the applicable detection limits.

Placid's data, consistently showed Butane, Isopentane, and Isobutane as the three most detectable analyites, with butane generally in the highest concentration (albeit that concentration was still extremely low in the ppbc range).

After a detailed review of Placid's shift foremen investigation reports a potential relationship between product movement and/or gasoline blending through above-ground tankage and strikes was discernable. Placid's above-ground storage tank emissions are permitted under Placid's Part 70 permit, 3120-00012-V1. Likewise, all storage tanks are in compliance with the required emission control technology for the types of product stored.

Other factors support the potential relationship between tank movements and strikes. First, the proximity of the monitoring stations to Placid's tank storage area. The South station in particular was located only several hundred feet from primary gasoline blend tanks. Second, various environmental and motor fuels regulations require lower RVP gasoline for the Baton Rouge non-attainment area during summer months (the ozone season). Lower RVP gasoline generally contains less Butane than higher RVP winter gasoline. A review of Attachment D, Station N1 shows there were actually more strikes during the winter months (high RVP) than summer (low RVP). High RVP winter gasoline contains more butane and lighter fractions which is at least somewhat consistent with strike sample analytical data reviewed.

Voluntary Remedial Actions

Placid is committed to supporting LDEQ's efforts to achieve ozone attainment in the Baton Rouge area. Accordingly, even though Placid's VOC air emissions sources controls meet existing regulatory requirements, Placid is already in the process of working with LDEQ to voluntarily enhance some of those controls, notwithstanding fenceline monitoring revelations. Through LDEQ's SPRI (Small Petroleum Refinery Initiative) and a current LDEQ authorization to construct related to a Placid expansion

project, Placid is proposing to enhance controls on certain existing petroleum liquid storage tanks. This proposal includes retrofitting up to nine (9) vertical fixed roof tanks with internal floating roofs, in addition to enhancing vapor recovery and control on those tanks. Furthermore, Placid is also proposing retrofitting up to four (4) external floating roof tanks with fixed roofs, leaving the floating roofs in place, and controlling those vaporous emissions with enclosed vapor combustion (Attachment B). Although final approval and scheduling will be prescribed by your Offices of Enforcement and Services (i.e., permitting), Placid aspires to beginning those enhancements later this year with a 2008 year end completion. Placid emphasizes that Placid will expend a currently estimated $6.8MM if all tank modifications are completed as described above, in addition to substantial costs for other unrelated environmental projects.

Conclusions

Placid's participation in LDEQ's voluntary fenceline monitoring program showed no detectable episodic releases of HRVOCs associated with the Port Allen Refinery. The program did show a potential relationship between gasoline blending/product movement in above-ground storage tanks and permitted emissions of VOCs which EPA tanks models have shown to be expected. Placid has voluntarily proposed to install up to $6,800,000 in enhanced emissions controls to reduce permitted emissions from above ground storage tanks (final amount and scope is yet to be finalized). This will assist LDEQ and the Baton Rouge Air Quality Control Region in achieving attainment with the eight-hour ozone standard. Likewise, Placid looks forward to continued cooperation with LDEQ in working toward the mutual goal of a cleaner environment and positive economic growth for Baton Rouge and all of Louisiana.

If you have any questions or require any additional information please contact Mr. Barry Joffrion at your convenience.

Sincerely,

Gary B. Fuller
Vice President/General Manager

BJ/users/joffrb/PRC2007/PRC0701.011

Cc: Misc Project AE-AOA-050010
Jane Lacour, LDEQ (7004 2890 0000 8051 1483)
Maurice Oubre, LDEQ (7004 2890 0000 8051 1476)
Gary Fuller
Ron Hurst
Kyle Beall, KeanMiller
Chronological

Attachment A

DEPARTMENT OF ENVIRONMENTAL QUALITY

KATHLEEN BABINEAUX BLANCO
GOVERNOR

MIKE D. McDANIEL, Ph.D.
SECRETARY

January 4, 2007

Mr. Gary Fuller
Vice President
Placid Refining Company LLC
1940 Louisiana Highway 1 North
Port Allen, Louisiana 70767

Re: Document Tracking Numbers AE-AOA-05-0010
Agency Interest Number 2366

Dear Mr. Fuller:

Please find enclosed a copy of the letter signed by Assistant Secretary Harold Leggett approving the request by Placid Refining Company LLC to terminate early the Ambient Air Fenceline Monitoring Administrative Order on Consent (AOC). We look forward to receiving the facility's Final Report by February 15, 2007.

Sincerely,

Peggy M. Hatch
Administrator
Enforcement Division

PMH/JL/jl
Enclosure

RECEIVED
JAN 08 2007
PLACID REFINING COMPANY LLC
PORT ALLEN, LA

ENVIRONMENTAL **COMPLIANCE**
: PO BOX 4312, BATON ROUGE, LA 70821-4312
P:225-219-3700 F:225-219-3708
WWW.DEQ.LOUISIANA.GOV

DEPARTMENT OF ENVIRONMENTAL QUALITY

KATHLEEN BABINEAUX BLANCO
GOVERNOR

MIKE D. McDANIEL, Ph.D.
SECRETARY

RECEIVED

DEC 26 2006

Placid Refining Co. LLC
Port Allen, LA

December 20, 2006

Mr. Gary Fuller
Vice President
Placid Refining Company LLC
1940 Louisiana Highway 1 North
Port Allen, Louisiana 70767

Re: Administrative Order on Consent Number AE-AOA-05-0010
Agency Interest Number 2366

Dear Mr. Fuller:

The Louisiana Department of Environmental Quality (Department) received your letter dated December 12, 2006, and sent to Assistant Secretary Dr. Harold Leggett requesting early termination of the Ambient Air Fenceline Monitoring Administrative Order on Consent (AOC). In accordance with Paragraph XII of the AOC, the Department approves your request to terminate the program on December 31, 2006.

Further, in consideration of this early termination approval, the Placid Refining Company LLC shall provide to the Department a Final Report by no later than February 15, 2007. An outline for the Final Report is provided on the attached page. This report will be in lieu of the Annual Report required by the AOC.

Please sign as indicated below and return to the Department to Ms. Jane LaCour, Office of Environmental Compliance, Post Office Box 4312, Baton Rouge, Louisiana 70821-4312. This approval shall be effective the date Dr. Leggett affixes his signature. Please contact Maurice Oubre of the Office of Air Quality Assessment at (225) 219-3434 or Jane LaCour of the Office of Environmental Compliance at (225) 219-3716 should you have any questions.

PLACID REFINING COMPANY LLC

By: _____
Gary Fuller, Vice President

Date: 12/26/06

STATE OF LOUISIANA
DEPARTMENT OF ENVIRONMENTAL QUALITY

By: _____
Harold Leggett, Ph.D., Assistant Secretary

Date: 1-3-07

OFFICE OF THE SECRETARY
LEGAL AFFAIRS DIVISION
: PO BOX 4302, BATON ROUGE, LA 70821-4302
P:225-219-3985 F:225-219-4068
WWW.DEQ.LOUISIANA.GOV

Outline for Final Report

Overview of Program
- Monitoring System Design including Latitude-Longitude for each Station
- Description of Trigger Response Procedures

Summary of Results
- Significant Findings
- Summary of Data Collected - Statistics, Graphs, Charts
- Description of Modifications (done or planned), Repairs, etc. to Correct Findings

Conclusions
- Summary of Emission Reductions Achieved or to be Achieved
- Description of On-Going Programs to Prevent Back-Sliding
- Positives and Negatives of the Program

Attachment B

DRAFT

STATION - 51
30° 28' 41.4" N
91° 12' 37.8" W

STATION - 52
(50' TOWER)
30° 28' 37.2" N
91° 12' 6.6" W

STATION - 5
30° 28' 33.0" N
91° 12' 8.4" W

4TH STREET
3RD STREET
2ND STREET
1ST STREET
LA. 987.2
FAY STREET
PARKING
WAREHOUSE
WAREHOUSE#2
AVENUE A
PLANT ENTRANCE
ADMIN OFFICE
MAINT. BLDG.
OFFICE BLDG.
COGEN AREA
SAFETY OPER.
CONTROL ROOM
BOILER SHED
BOILER ADDN.
5TH STREET
ROSE UNIT
NORTH MANIFOLD
TK #18
TK #17
TK #16
TK #15
TK #14
TK #12
TK #10
TK #8
TK #7
TK #6
TK #5
TK #4
TK #13
TK #11
TK #9
TK #3
TK #2
NEW TERMINAL BLDG.
FIRE STATION
OLD LAB & TERMINAL
42"&47 TANKER DOCK
LA. HWY 1
AVENUE B
FORMER HTU/REFORMER UNIT
CRUDE PROCESS AREA
VACUUM UNIT
COOLING TOWER
FLARE
AERATION POND
AVENUE C
AVENUE D
LA. 986
MISSISSIPPI RIVER
ELECT. SUB-STATION
6TH STREET
7TH STREET
ALKYLATION UNIT
F.C.C. UNIT
HYDROTREATER, REFORMER, SPLITTER AREA
GASOLINE HTU AREA (FUTURE)
WASTEWATER TREATMENT FACILITY
TK #25
TK #24
TK #23
TK #21
TK #19
TK #22
TK #20
TRUCK LOADING
DOCK LANDING PLATFORM
AVENUE E
CRYO. UNIT
AMINE S.W.S. UNIT
SULPHUR UNIT
DIESEL HTU/ SULPHUR RECOVERY UNIT
GUARD SHACK
AVENUE F
TANKS
ROAD
LA. 987.3

SCALE: 1" = 120'
0 25' 100' 150' 200'

EXISTING CONE ROOF TANKS
TO BE FITTED WITH INTERNAL FLOATING ROOFS ON VAPOR CONTROLS

EXISTING FLOATING ROOF TANKS
TO BE DOMED ROOFS ON VAPOR CONTROLS

AIR MONITORING STATION

PLACID REFINING CO.
PORT ALLEN, LOUISIANA

Fenceline Summary Report
February 2007

DESIGNED BY MJS	DATE 04/96	SCALE 1" = 120'		
DRAWN BY MJS	DATE 04/96	DRAWING NO. SITE	REVISION	
CHECKED BY MJS	DATE 10/95			
APPROVED	DATE			

Placid Refining Company LLC
Total nonMethane Organic Carbon Fenceline Monitoring Set Point Alarm Response Report
Reference LDEQ Enforcement Tracking Number AE-AOA-05-0010

INSTRUCTIONS FOR ALARM RESPONSE AND REPORT COMPLETION AND SUBMITTAL

- Control Room operator immediately notifies Shift Foreman or Acting Shift Foreman of a fenceline monitoring station alarm.
- Control Room operator provides copy of faceplate 901, with alarm information, to Shift Foreman or Acting Shift Foreman.
- Shift Foreman or Acting Shift Foreman responds to a fenceline monitoring station alarm no later than 20 minutes after the alarm start time.
- Shift Foreman or Acting Shift Foreman investigates the alarm, distributes this completed form including faceplate 901 copy.

Alarming Monitor Identification and Alarm and Response Time Information		
Monitor identification (✓box to the left of only one)❶	➔	❑ Placid-N1 ❑ Placid-N2 ❑ Placid-S
Alarm date (month/day/year) and start time❷❸	➔	Date: Time (CST):
Responder's initial response time❷❸	➔	Time (CST):

❶N1=northwest corner, N2=northeast corner & S=south side of refinery property ❷ all dates are calendar days and all times are **CST** twenty four hour clock
❸all times are as synchronized with faceplate 901 times, **and** only entered on this form in **CST** twenty four hour clock

Total nonMethane Organic Carbon (TNMOC) and Meteorological Monitoring Information		
TNMOC alarm set point concentration at the alarming station	➔	ppmC
Actual TNMOC concentration at alarm start time❷❸	➔	ppmC
Prevailing wind speed at alarm start time❷❸	➔	miles/hour
Prevailing wind direction at alarm start time❷❸	➔	degrees compass

Is the alarming station downwind of the refinery (based on prevailing wind direction at the time of the alarm)?

(circle one ➔) YES NO

If NO, **STOP!**

Your response and report form are complete; distribute report forms according to instructions at bottom of page.

If YES, **CONTINUE** your investigation.

Investigate and attempt to locate within the refinery any local source of emissions responsible for triggering the alarm event. Correlate your findings with corresponding refinery operations and process information so as to better identify both the source and cause of the emissions event (if located within any of Placid's refinery activities, including but not limited to normal storage or transfer operations, waste management, maintenance or turnaround activities or flaring events or unauthorized discharges). Facilitate corrective action on the part of Placid, if necessary, to resolve the emissions source and prevent recurrence. State your findings below, and include any action you take to secure the emissions source [such as, but not limited to work requests initiated (state work request number) or MOC requests initiated (state MOC request number)].

_____

_____

_____

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_____

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_____

_____

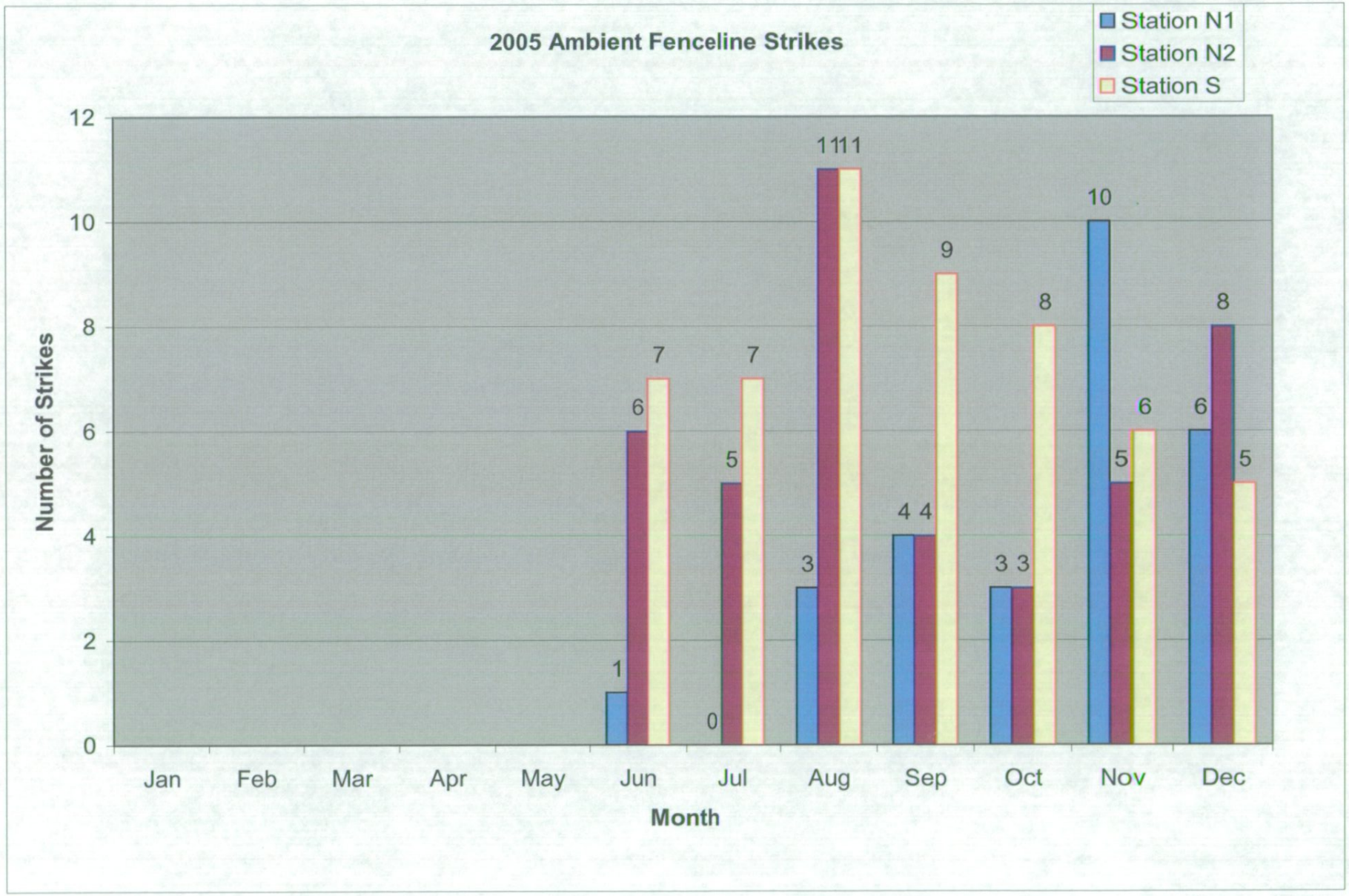
_____

Printed name of Shift Foreman or Acting Shift Foreman_____ Signed Initials_____

Immediately distribute original (white) and first copy (canary) to Placid's Environmental Department Secretary; maintain the remaining (pink) copy for your records.

Attachment C

Attachment D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Station N1
Station N2
Station S
Number of Strikes
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Mar
Apr
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Jul
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Sep
Oct
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Dec
Month
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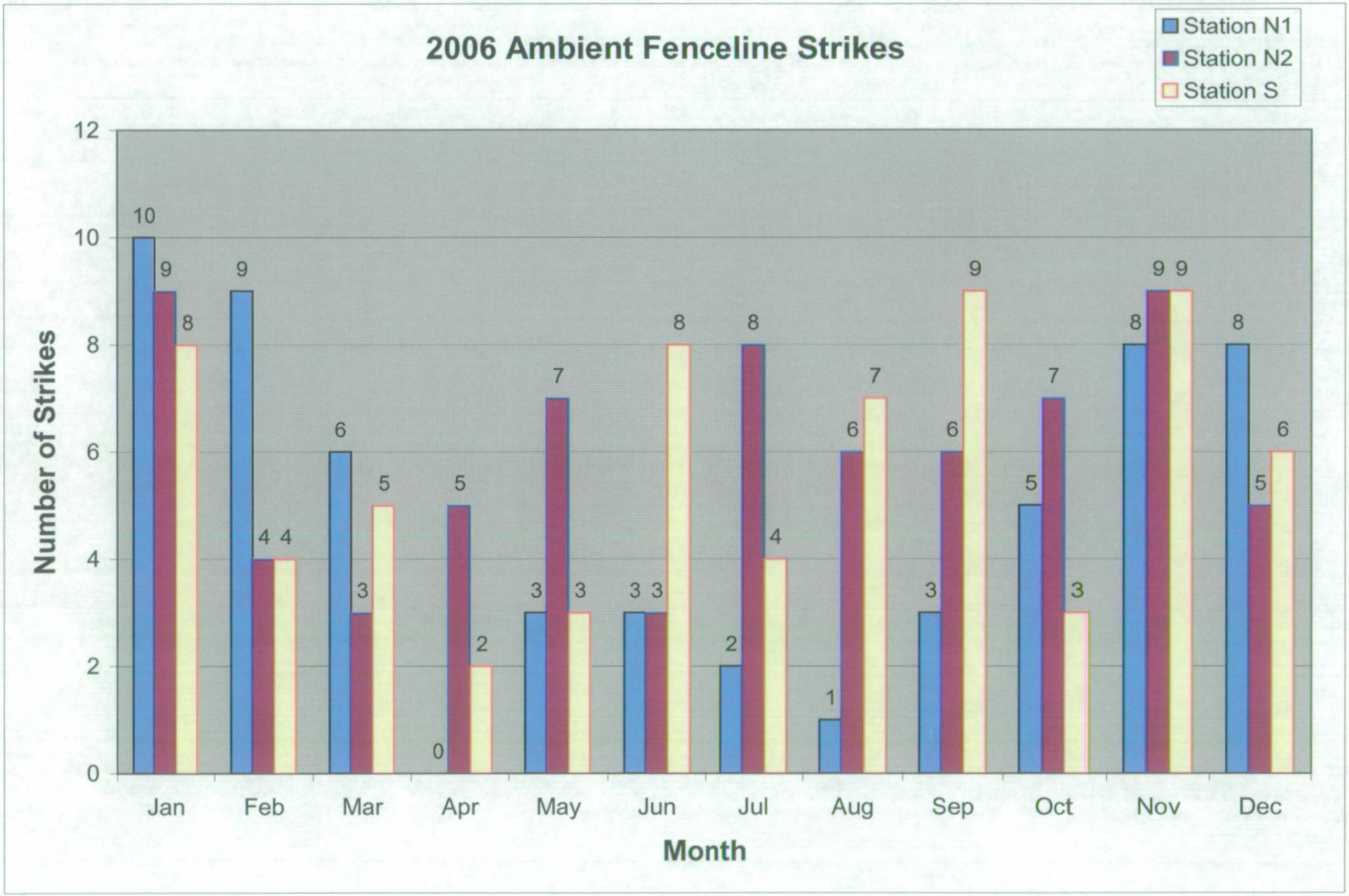
2006 Ambient Fenceline Strikes
Station N1
Station N2
Station S
Number of Strikes
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6 3 5
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3 7 3
3 3 8
2 8 4
1 6 7
3 6 9
5 7 3
8 9 9
8 5 6

Attachment E

DEPARTMENT OF ENVIRONMENTAL QUALITY

KATHLEEN BABINEAUX BLANCO
GOVERNOR

MIKE D. McDANIEL, Ph.D.
SECRETARY

Agency Interest (AI) No. 2366
Activity No.: PER20060002

Gary Fuller
Vice President
Placid Refining Company, LLC
1940 Louisiana Highway 1 North
Port Allen, Louisiana 70767

RE: Authorization to Construct, Port Allen Refinery
Placid Refining Company, LLC, Port Allen, West Baton Rouge Parish, Louisiana

Dear Mr. Fuller:

Placid Refining Company, LLC (Placid) has proposed to increase the capacity of its Port Allen Refinery. To expedite this effort, Placid has agreed to install controls sufficient to ensure the project results in a "positive human health or environmental benefit" and seeks approval from LDEQ in the form of an authorization to construct.

In order to ensure that an authorization to construct was a viable option, LDEQ requested by letter dated August 3, 2006, that Placid:

1. commit to a "permitted to permitted" reduction in NO_X, VOC, and TAP emissions and to a no net increase in PM_{10} and SO_2 emissions; and

2. certify that the project will either not trigger a netting analysis ("increases without respect to decreases" will not equal or exceed each regulated NSR pollutant's significance level); or if netting is required, that the "net emissions increase" will be less than each regulated NSR pollutant's significance level.

On August 31, 2006, Placid committed to the terms of this letter.

The Air Permits Division has reviewed Placid's submittal and noted that "baseline actual emissions" for the refinery's Fluid Catalytic Cracking Unit (FCCU) (1-77) are essentially identical to the limits established by Permit No. 3120-00012-V1.[1]

We are also aware that the Office of Environmental Assessment, Air Quality Assessment Division, has requested that Placid verify compliance with the FCCU's PM, NO_X, and CO permit limits via stack testing, and that these tests have been tentatively scheduled for October 17-18.

[1] Emissions of CO appear to be adjusted in accordance with subparagraph b.iii to account for the limit established by Permit No. 3120-00012-08, which was effective during the 24-month period selected by Placid.

ENVIRONMENTAL **SERVICES**
: PO BOX 4313, BATON ROUGE, LA 70821-4313
P:225-219-3181 F:225-219-3309
WWW.DEQ.LOUISIANA.GOV

If actual emissions are compliant with permit limits, Placid should reexamine "baseline actual emissions" attributed to the FCCU in light of the new data. It is highly likely that "baseline actual emissions" will need to be reduced; therefore, "potential to emit" and/or "projected actual emissions" for some emissions units may need to be revised such that the project does not result in a significant net emissions increase of any regulated NSR pollutant.

If actual emissions are in excess of permit limits, "baseline actual emissions" attributed to the FCCU should not be revised upward, as such rates must exclude "any non-compliant emissions that occurred while the source was operating above any emission limitation that was legally enforceable during the consecutive 24-month period."[2]

Pursuant to LAC 33:III.501.C.3 and LAC 33:III.507.D.2.c, an authorization to construct is hereby issued, conditioned as follows:

1. The project shall 1.) not trigger a netting analysis ("increases without respect to decreases" shall not equal or exceed the following thresholds); or 2.) if netting is required, the "net emissions increase" shall be less than the following thresholds:

Pollutant	Emissions (TPY)
PM/PM_{10}	25/15 (PM/PM_{10})
SO_2	40
NO_X	25
CO	100
VOC	25

2. Permitted emissions rates following the expansion shall not exceed the limits proposed by Placid (detailed below) in its August 31, 2006, response, even if achieving such rates requires reductions from the refinery's FCCU beyond those currently envisioned.[3] Further, permitted emissions rates following the expansion may be reduced in the event actual emissions from the FCCU are less than currently estimated.

Pollutant	Emissions (TPY)
PM_{10}	71.55
SO_2	281.00
NO_X	645.71
VOC	206.06

3. Operations shall not commence until a Part 70 permit modification is issued.

---

[2] See subparagraph b.ii of the definition of "baseline actual emissions."

[3] The limits proposed by Placid are based on the design engineering phase of the project. LDEQ understands that results of the detailed engineering, to be submitted with a permit application, may alter the numbers to a minor degree.

If you have any questions, please call Bryan D. Johnston of the Air Permits Division at (225) 219-3118.

Sincerely,

Chuck Carr Brown, Ph.D.
Assistant Secretary

9/21/06
Date

CCB:BDJ

Appendix D – Facility Final Reports

Plantation Pipe Line Company

PLANTATION PIPE LINE COMPANY
AMBIENT AIR MONITORING PROGRAM

FINAL REPORT

Prepared For:

The Louisiana Department of Environmental Quality (LDEQ)
Office of Environmental Compliance
602 North 5th Street
Baton Rouge, Louisiana 70802

Prepared By:

Enviroplan Consulting
81 Two Bridges Road
Fairfield, NJ 07004

February 15, 2007

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1. MONITORING PROGRAM OVERVIEW

Plantation Pipe Line Company (Plantation Pipe Line) is a common carrier of liquid refined petroleum products via an interstate pipeline system. The company owns a tank farm and pumping station adjacent to the intersection of Blount Road and Louisiana Highway 19 in Baton Rouge, Louisiana. The tank farm provides storage incident to interstate transportation. Products transported include gasoline, diesel fuel, and kerosenes.

In 2004, the Louisiana Department of Environmental Quality (LDEQ) and Plantation Pipe Line entered into an agreement under which Plantation Pipe Line agreed to conduct an air monitoring program for highly reactive volatile organic compounds (HRVOC) as measured at the fenceline of Plantation Pipe Line's tank farm. Monitoring for this program commenced on May 1, 2005 and concluded January 1, 2007. The purpose of the Plantation Pipe Line air monitoring program was to provide additional information concerning emissions of HRVOC in order to assist LDEQ with efforts to better assess and understand the potential contributory role of HRVOC with respect to the formation of ozone.

A number of other industrial plants in the Baton Rouge area with the potential to emit significant amounts of HRVOC agreed to conduct similar air monitoring programs during this period. These efforts were prompted by the goal of achieving attainment with the 8-hour National Ambient Air Quality Standard (NAAQS) for ozone within the 5-parish Baton Rouge Ozone Non-Attainment Area.

The Plantation Pipe Line Air Monitoring Program employed methods consistent with relevant sections of the EPA Technical Assistance Document For Sampling and Analysis of Ozone Precursors, EPA/600-R98/161 (Revised 1998). An Air Monitoring Plan (AMP) and Quality Assurance Project Plan (QAPP) were developed in accordance with EPA guidelines and approved by the LDEQ prior to commencing the field campaign. Implementation of the monitoring program was fully consistent with the approved AMP and QAPP.

The Plantation Pipe Line Air Monitoring Program consisted of two monitoring stations, each of which was similarly configured in terms of design features, instrumentation and monitoring parameters. The "North" monitoring station was located at the northwestern perimeter fenceline of the tank farm; the "South" monitoring station was located at the southwestern perimeter fenceline of the tank farm. Each station collected continuous and episodic measurement of HRVOC, as well as meteorological observables (i.e., horizontal wind speed, wind direction and sigma theta).

To assist in meeting the monitoring requirement, Plantation Pipe Line retained the services of Enviroplan Consulting (EC), an environmental consulting company specializing in the study and measurement of air pollution. EC designed and supplied the monitoring stations for this project and provided support services associated with operation of the monitoring stations for the duration of the project (i.e., field operation and maintenance, quality assurance (QA), quality control (QC), data analysis, data validation and data reporting activities).

Continuously-measured HRVOC and meteorological data and associated monitor operating status information were transmitted on a (minimum) daily basis to the EC central Data Management Center located in Fairfield, NJ. The data were reviewed daily by experienced data technicians. A program resident in each on-site data logger communicated notification to the Data Management Center whenever HRVOC concentrations reported from any of the sampling locations exceeded pre-determined threshold values. In the event of an HRVOC alarm, reported data were evaluated with respect to the location of the reported exceedance, the operating status of the associated monitoring system, and current meteorological conditions. Within 24 hours of each occurrence, this information was electronically transmitted to the Plantation Pipe Line Environmental and Facility Managers. Plantation Pipe Line reported confirmed emission events via email to LDEQ shortly following receipt of the information. Full descriptions of each event were presented to the LDEQ in monthly reports.

When an HRVOC exceedance event occurred, a whole air HRVOC sample was automatically collected at the station that reported the event. A local field operator responsible for monitoring station operation was subsequently dispatched by EC to confirm the integrity of the HRVOC sample and process the sample for speciated analysis at a contract laboratory retained for the project. Throughout the monitoring program, Plantation Pipe Line and its contractor maintained a log documenting the occurrence of each HRVOC exceedance event, associated monitoring data, and associated actions taken.

2. MONITORING SYSTEM DESIGN

As stated above, the Plantation Pipe Line Air Monitoring Program consisted of two major monitoring stations. Table 1 in this section lists the station locations and summarizes the parameters and measurement frequency for the monitoring systems operated at these sites. The following sections describe the design of each monitoring system.

2.1 MONITOR SITING

The Plantation Pipe Line tank farm occupies a rectangular plot approximately 6,100 feet (1,860m) in length along the east-west axis bordering Blount Road, a width of approximately 2,000 feet (610m) on the eastern end and approximately 2,200 feet (670m) along its western end. The site borders the corner of Louisiana Highway 19 (Scotland Avenue) and Blount Road. The facility is a breakout tank farm used for the temporary storage of liquid refined petroleum products incident to interstate transportation. There are 48 large breakout tanks on the site, with the eastern portion handling more volatile fuels, gasoline, and the western end handling less volatile fuels, diesel fuels and kerosene. Storage tanks are the primary emission source at the Plantation Pipe Line site. The facility does not contain any flares, cooling towers or other major point sources of HRVOC emissions.

Monitoring site locations were determined in conjunction with discussions between Plantation Pipe Line and the LDEQ, taking into account the geography and storage tank locations of the facility, potential sources of HRVOC emissions, and the seasonally predominant Southeasterly and Northerly winds for the Baton Rouge area.

Other nearby industrial potential sources of HRVOC emissions include the ExxonMobil Baton Rouge Plastics Plant, located across LA Hwy 19 to the west and slightly north of Plantation Pipe Line. The ExxonMobil plant posed a potential confounding source, depending on their chemical emissions profile.

Both the North and South monitoring stations were therefore located at the northwestern and southwestern corners along the perimeter of the Plantation Pipe Line facility. These locations were best for: 1.) detecting and quantifying potential HRVOC emissions from the Plantation Pipe Line storage tanks transported on the prevailing southeastern and northern winds; and 2.) detecting and quantifying any HRVOC transported from the ExxonMobil plant located to the west of the facility. Figure 1 provides an aerial view of the Plantation Pipe Line facility and depicts the monitoring station locations. Per EPA guidance, each station was located a minimum of 40 yards from LA Hwy 19 (approximately 30K vehicles per day) to minimize effects from vehicular traffic.

Each monitoring station was equipped with identical wind monitors mounted at 10 meters (m) above ground level. Excepting storage tanks and a tree row on the facility's northern perimeter, the Plantation Pipe Line facility occupied open, relatively level terrain. Meteorological monitors were sited within 10m of each station and as far as practicable from any obstructions.

2.2 EQUIPMENT SHELTERS

All monitoring equipment (except wind monitors and their support tower) was installed and operated inside EKTO Model 8812 temperature-controlled (20-30 °C) equipment shelters. The shelters were supplied with conventional electric utility service and featured interior electrical distribution circuits, lighting, workbench, a built-in equipment rack and sufficient space for housing, operating and maintaining the monitoring instruments.

Each shelter was securely anchored to a concrete pad for safety. Compressed support gases required for the continuous TNMOC analyzers (i.e., hydrogen, nitrogen and calibration gas mixtures) were housed in a locked exterior compartment attached to the rear wall of each shelter.

2.3 METEOROLOGICAL MEASUREMENT SYSTEM

Horizontal wind speed and wind direction were continuously measured at the North and South monitoring stations using Climatronics Model F-460 wind monitors. The monitors were interfaced with a meteorological signal processor module installed in an on-site Environmental Systems Corp. (ESC) Model 8832 data logger. The data loggers scanned the meteorological measurement signals at a rate of once per second, converted the signals to scaled digital values, and compiled and stored the measurement data in the form of 5-minute, vector-averaged values. The data logger also calculated and recorded the standard deviation of the wind direction (sigma theta) in accordance with a US EPA-approved convention.

2.4 HRVOC MEASUREMENT SYSTEMS

2.4.1 Sample Intake Probe and Delivery Systems

The design and operation of the HRVOC sample air probes and delivery systems for sample collection conformed to the guidance contained in Section 9 of 40 C.F.R. Part 58, Appendix E. Total sample residence time within each sample intake and distribution system was substantially less than 10 seconds. All surfaces in contact with the ambient sample air stream prior to analysis for HRVOC were comprised of either borosilicate glass or chromatographic grade stainless steel. O-rings or seals were Viton.

The elevation of each sample probe was 1.8m above the equipment shelter roofline and 4.3 m above ground level. Each probe inlet had a 360° unobstructed arc for sample air intake and was located a minimum of 45m away from the nearest obstructions: storage tanks and trees approximately 15m in height. The ratio of the distance between the nearest obstruction and a sample probe in comparison to the obstruction height minus probe height was equal to 4.2. A stainless steel rain hat with an integral, small mesh, stainless steel screen surmounted each probe inlet, preventing precipitation and large particles (e.g., insects) from entering the transport tube.

Each HRVOC sample inlet was at the top of a 10-foot long, one-inch diameter glass transport tube that extended vertically from the shelter interior through a perforation in the roof to the exterior ambient environment. The exterior segment of each transport tube was encased in closed cell foam within a rigidly braced PVC pipe for protection. Inside the shelters, the lower end of each transport tube connected to a 1-inch diameter glass manifold equipped with six threaded side ports. The bottom of each manifold connected to the inlet of a blower motor. In order to provide for proper operation of these systems, the sample flow rate through each probe and down tube was maintained at approximately 18 cubic feet per minute (cfm). The static pressure within each sample air transport tube and manifold was maintained at $\leq$0.5 inches of water. A differential pressure gauge connected to one of the manifold ports was installed to routinely verify proper operation of the sample air intake systems. The outlet of each blower was directed through flexible, 2-inch internal diameter tubing to a PVC exhaust manifold. The excess sample air stream was exhausted through the exhaust manifold to the exterior of each shelter.

The entire interior segment of each transport tube and manifold was heat traced and insulated. A temperature probe inserted into a port on each manifold allowed a heat trace temperature controller to maintain each sample air stream temperature at 35°C, thereby preventing condensation from occurring within the air transport systems.

Individual sample air streams for the continuous TNMOC monitor and episodic canister sampling system operated at each site were drawn from two separate, dedicated ports on the manifold through ¼" and $^1/_8$" O.D. chromatographic-grade stainless steel tubing, respectively. Unused sample ports on each manifold were capped by means of Teflon plug fittings with Viton O-rings.

2.4.2 Continuous (Non-Speciating) HRVOC Measurement Systems

Continuous measurement methane, total non-methane hydrocarbon (NMHC) and the sum of these parameters (total HC) were continuously monitored at each monitoring station using a Thermo Electron Corp. (TECO) Model 55C, an automated, non-speciating GC/FID monitor.

The Model 55C utilizes a fully automated, microprocessor-based gas chromatograph employing a Flame Ionization Detector (FID) for superior sensitivity and long-term stability of response. The Model 55C is specifically intended for long-term, unattended ambient air monitoring applications. It completes a sample/analysis cycle approximately every 70 seconds and provides separate output signals for methane, total non-methane and total hydrocarbon measurements.

Features of the TECO 55C include:

- Detection Levels of 20 parts-per-billion (ppb) for CH_4 (methane) and 50 ppb for NMHC (as propane).
- Complete separation of CH_4 (methane) from all C_2 and higher compounds.
- Measurement of hydrocarbons from C_1 through C_{12} (minimum).
- Fully automatic, microprocessor-controlled operation for stable, reliable measurement.
- 24-hour span drift (*without* auto-calibration) = 3% of span range.
- Accuracy = ±2% of measured value.
- Precision = ±2% of measured value.
- Status information displays and digital status signal outputs linked to integral fault-sensing and operating status monitoring circuitry.
- Flame-out sensor and automatic re-ignition for the hydrogen-fueled detector.
- Automatic correction for zero prior to every sample analysis cycle.
- Automatic span calibration capability (this feature was disabled for this project).

Each TECO 55C analyzer was operated in the continuous analysis mode. Full-scale measurement ranges were 0 to 15ppm for Methane and 0 to 45ppmC for total NMHC (referenced to propane). The TECO 55C analyzer monitors four different internal operating status conditions. The associated status output signal was routed to an on-site data logger, which in turn automatically flagged the data if the analyzer detected a malfunction in its operation.

At each monitoring station, NMHC concentration alarm functions were enabled in the on-site data logger and set to the pre-determined concentration for triggering a canister sample event.

Support gases maintained at each site for operation of the TNMOC analyzer included: 1.) research-grade compressed hydrogen for the FID fuel; 2.) ultra-high purity (UHP) compressed nitrogen for the carrier gas; and 3.) a certified (±2%) compressed calibration gas mixture consisting of approximately 4ppm Methane and 2ppm Propane in UHP/HC-free air. Combustion air and actuator air for the TNMOC monitors were supplied via a Teledyne/Advanced Pollution Instruments (API) Model 701 continuous zero air generator installed at each station.

2.2.3 Data Logging

At each monitoring station, an Environmental Systems Corp. (ESC) Model 8832 Data Logger served as the primary recording device for data collection for all continuously-monitored parameters. Each Model 8832 was operated in an automatic mode, scanning all analog input voltages and associated status inputs produced by the site monitoring instruments at a once-per second rate, converting the instantaneous voltages to scaled digital values, calculating and storing average values (and appending status flags, as appropriate) in accordance with user-defined configuration instructions.

Each data logger was programmed to automatically initiate, control and report the results of 2-point (span/zero), daily calibration checks on the TNMOC monitor. Automatic calibration checks were made by substituting certified calibration gases in lieu of ambient sample air in the sample delivery line to the TNMOC monitor. This was accomplished via solenoid valves under the control of the data logger. The monitor's responses were evaluated with respect to the known test gas concentrations. No adjustment was made to the analyzer during automatic calibration checks; rather, these checks provided support for data validation and decision-making with respect to any need for manual calibration of the analyzer.

Stored data values, status conditions and results of programmed automatic calibration checks were routinely downloaded to a central data computer via an on-site modem and a dedicated Ethernet port. The computer automatically retrieved the previous day's data summary report from the data logger at each station on a daily basis.

Each Model 8832 was initialized to collect 10-minute block-averaged data reported in parts-per-million carbon (ppmC) for continuously-monitored hydrocarbon parameters and 5-minute, vector block-averaged meteorological data. A minimum of 7.5 minutes of valid data per 10-minute block was required to report a valid 10-minute average. A minimum of 3.75 minutes (225 seconds) of valid data per 5-minute block was required to report a valid 5-minute average.

Each Model 8832 was additionally programmed to activate and control collection of episodic, 20-minute HRVOC canister samples, as discussed below.

2.2.4 Episodic (Time-Integrated) HRVOC Measurement System

HRVOC whole air samples were collected at the North and South air monitoring sites in accordance with the Administrative Order promulgated by the LDEQ and the methodology described in Section 2.5 in EPA Technical Assistance Document For Sampling and Analysis of Ozone Precursors, EPA/600-R98/161 (Revised 1998). HRVOC are defined here as organic compound having a vapor pressure greater than 10^{-1} Torr at 25°C and 760 mm Hg. This method applies to ambient concentrations of HRVOC above 10 ppbC.

The 43 target compounds of interest for this monitoring program have been identified by the U.S. EPA as ozone precursors. Minimum detection limits (MDLs) for each compound were ≤10 parts-per-billion by volume (ppbV). Speciated analysis results were reported in equivalent

carbon (ppbC). The target compounds and their associated data reporting limits are listed in Table 2 below.

At each monitoring site time-integrated (20-minute) pressurized HRVOC samples were collected into 1–liter passivated canisters on an episodic basis using a R.M. Environmental Systems, Inc. (RMS) Model 911A canister sampler in combination with the RMS Model 912 multi-canister sampling adaptor. At each site the HRVOC samples were collected from a dedicated port on the glass sample intake manifold through sample delivery lines constructed of 1/8" OD chromatographic grade stainless steel tubing equipped with a low-temperature sample control valve.

Each on-site data logger was programmed to initiate a canister sampling event by energizing the canister sampler when the continuously-measured, 10-minute, block-averaged ambient NMHC concentration (as measured at that station) exceeded a defined threshold value. Defined NMHC threshold concentrations that would trigger collection of a canister sample at the South site were approximately 5 ppmC. The NMHC threshold concentration at the North site was approximately 6ppmC.

Each monitoring station's sample intake probe and manifold distribution system served as the common source of ambient sample air delivered to both the canister sampler and the continuous TNMOC monitor. A variable orifice controlled sample air flow rate into the canister at approximately 50 cubic centimeters per minute (ccm) ±5% throughout the twenty-minute sampling event period. At the end of a sample event, each canister's "end" pressure was in the range of 10 to 20 pounds per square inch (PSI). Features of the Model 11a/112 canister sampler included sequential sample collection for up to sixteen separate canisters. This allowed multiple sample events to occur before the sampler required servicing in the field.

The HRVOC canister sample collection regime was consistent with obtaining statistically meaningful data to gain a better understanding of the relationship between HRVOC and local formation of tropospheric ozone. The following criteria were used for HRVOC canister sample collection at the North monitoring station:

- At either site, a single HRVOC canister sample was collected immediately following the first 10-minute-averaged non-methane hydrocarbon (NMHC) concentration reported from the TNMOC monitor on any given day provided the averaged concentration exceeded the pre-defined threshold value (approximately 5~6ppmC).

- A maximum of one HRVOC canister sample would be collected at any of the two monitoring sites on any given day (as measured midnight-to-midnight).

- In the first four months of data collection, the operating group adjusted the NMHC threshold concentration triggering a HRVOC canister sample event as-needed (within the range of 4.5 to 12.0ppmC) to obtain approximately 5 canister sample events each month at the monitoring site. Beginning August 23, 2005, a threshold value of 6.0ppmC was selected for the North site and 5.5ppmC for the South site. These threshold values were maintained for the remainder of the monitoring project.

2.2.5 Experimental HRVOC Measurement System

As an adjunct to the HRVOC monitoring program, an Analytical Specialists, Inc. MicroFast gas chromatograph (GC) was installed and operated at the North monitoring site. The MicroFast GC is a miniaturized, automated GC equipped with dual columns and flame ionization detectors (FIDs). It became available to the commercial market in late 2004. Due to the low thermal mass and configuration of its columns, trap, injectors and other sample-handling modules, the instrument was capable of relatively high-speed chromatography. Repetitive cycle times of approximately 3.3 minutes were achieved for analysis of 23 of the HRVOC target compounds.

The suitability of the MicroFast GC for unattended, continuous air monitoring applications was unproven; it was acquired and incorporated in the Plantation Pipe Line monitoring effort as an experimental adjunct to the more established HRVOC measurement methods described above. The objective of this application development was to determine if the instrument would reliably provide sufficiently high quality data for routine speciated measurement of HRVOC. It was anticipated that, if the instrument proved adequate, the continuously-measured speciation data it produced could eliminate the need for collection of HRVOC canister samples. Consequently, the MicroFast GC was initially operated in an on-going development and evaluation mode to assess if the desired measurement quality objectives could be met.

2.4 HRVOC THRESHOLD EXCEEDANCE PROCEDURES

When the current threshold concentration for NMHC measurements was exceeded by either continuous TNMOC monitor (a condition that, for the first occurrence on any given day, would trigger a canister sample collection event at the associated monitoring station) the on-site data logger at that station would automatically record the date and time of the event.

As previously stated, continuously-measured HRVOC and meteorological data and monitor operating status information were transmitted on a (minimum) daily basis to the EC central Data Management Center in Fairfield, NJ. Experienced data technicians reviewed the data daily and, in the event that the HRVOC threshold was exceeded, the data were evaluated with respect to the following:

- The identification of the monitoring station reporting the exceedance;
- The date, start time, end time, and overall duration of the HRVOC exceedance event;
- The operating status and HRVOC measurement data recorded by the continuous TNMOC monitor immediately prior to, during and after the exceedance;
- Confirmation of canister sample collection at the station, including sample start and end times;
- Concurrent meteorological data recorded at the station; and
- Inter-comparison of concurrent HRVOC and meteorological data recorded at the other monitoring station operated in the Plantation Pipe Line network.

Within one business day following an HRVOC exceedance event, the pertinent data were sent via email from EC to the Plantation Pipe Line Environmental and Facility Managers. Plantation

Pipe Line would then report confirmed emission events via email to LDEQ shortly following receipt of the information. Full descriptions of each event were presented to the LDEQ in monthly reports. These procedures are outlined in the approved Work Plan for the Plantation Pipe Line air monitoring program.

TABLE 1: MONITORING SITES AND PARAMETERS FOR THE PLANTATION PIPE LINE AIR MONITORING PROGRAM				
Site Designation and Location	**Monitoring Parameter (Same for Both Sites)**	**Measurement Frequency and Range**	**Probe Height (meters)**	**Instrument / Method**
North Site: Longitude: 91.17450° W Latitude 30.55067° N	Methane	Continuous: 0.00-15.00 ppmC	4.3	TEI Model 55C (GC/FID)
	Total Non-Methane (NMHC)	Continuous: 0.00-45.00 ppmC		
	Total Hydrocarbon (THC)	Continuous: 0.00-60.00 ppmC		
	Speciated HRVOC	Episodic (20-Minute, Time-Integrated Samples)	4.3	R.M. Environmental Systems, Inc. Model 911A/912 EPA/600-R98/161 (See Table 2 for a list of Target Compounds)
South Site: Longitude: 91.17532° W Latitude: 30.5445° N	Horizontal Wind Speed (Vector Averaging)	Continuous: 0.5-100.0 mph	10	Cup Anemometer (Climatronics F-460)
	Horizontal Wind Direction (Vector Averaging)	Continuous: 0-360°	10	Vane (Climatronics F-460)
	Sigma Theta	Continuous: 0-100°	10	Calculated by Data Logger

TABLE 2: TARGET HRVOC COMPOUNDS AND MINIMUM DETECTION LIMITS FOR CANISTER SAMPLE ANALYSIS

Target Compound	Minimum Detection Limit			Target Compound	Minimum Detection Limit		
	ppbC	ppbv	ug/m^3		ppbC	ppbv	ug/m^3
Ethylene	0.07	0.04	0.04	1-Hexene	0.26	0.04	0.11
Acetylene	0.06	0.03	0.03	n-Hexane	0.09	0.02	0.11
Ethane	0.20	0.10	0.04	Methylcyclopentane	0.12	0.02	0.10
Propylene	0.12	0.04	0.05	2,4-Dimethylpentane	0.28	0.04	0.11
Propane	0.18	0.06	0.05	Benzene	0.26	0.04	0.10
Isobutane	0.07	0.02	0.07	Cyclohexane	0.29	0.05	0.10
Isobutene/1-Butene	0.30	0.08	0.07	2-Methylhexane	0.18	0.03	0.12
1,3-Butadiene	0.52	0.13	0.07	2,3-Dimethylpentane	0.43	0.06	0.25
n-Butane	0.52	0.13	0.07	3-Methylhexane	0.23	0.03	0.14
trans-2-Butene	0.08	0.02	0.07	2,2,4-Trimethylpentane	0.43	0.05	0.15
cis-2-Butene	0.13	0.03	0.07	n-Heptane	0.26	0.04	0.14
Isopentane	0.32	0.06	0.09	Methylcyclohexane	0.13	0.02	0.13
1-Pentene	0.21	0.04	0.09	2,3,4-Trimethylpentane	0.36	0.05	0.15
n-Pentane	0.09	0.02	0.09	Toluene	0.35	0.05	0.12
Isoprene	0.17	0.03	0.08	2-Methylheptane	0.39	0.05	0.15
trans-2-Pentene	0.20	0.04	0.09	3-Methylheptane	0.28	0.04	0.15
cis-2-Pentene	0.12	0.02	0.09	n-Octane	0.25	0.03	0.15
2,2-Dimethylbutane	0.29	0.05	0.11	Ethylbenzene	0.19	0.02	0.16
Cyclopentane	0.12	0.02	0.09	m/p-Xylene	0.22	0.03	0.14
2,3,-Dimethylbutane	0.27	0.05	0.11	Styrene	0.81	0.10	0.14
2-Methylpentane	0.28	0.05	0.11	o-Xylene	0.19	0.02	0.14
3-Methylpentane	0.23	0.04	0.11				

FIGURE 1: AERIAL VIEW OF THE PLANTATION PIPE LINE FACILTY AND MONITORING STATION LOCATIONS

3. SUMMARY OF MONITORING RESULTS

This section presents and discusses significant findings and results for the Plantation Pipe Line HRVOC Air Monitoring Program. Analysis of the continuous TNMOC and associated canister sample data collected at each station over the course of the 20-month monitoring period is presented in the sections below. All data referenced or incorporated in this report meet the data quality objectives established in the Monitoring and QA Plans developed for the monitoring program. Despite extensive development effort, the MicroFast GC operated at the North monitoring site was unable to reliably produce data consistent with established data quality objectives. Those data are consequently excluded from the monitoring results discussed in this section. The unique aspects of the MicroFast GC and associated application development work performed in support of the HRVOC monitoring project will be discussed in a separate report.

3.1 RESULTS OF CONTINUOUS TNMOC AND CANISTER MONITORING EFFORT

From May 1, 2005 through December 31, 2006, a total of 257 exceedances of the threshold concentration established for the continuous TNMOC measurement system were recorded; 133 at the North site and 124 at the South site. Out of the 257 TNMOC "strike" events, 237 20-minute, time-integrated canister samples were successfully collected and analyzed; 126 at the North site and 111 at the South site. A total of 19 HRVOC strike canister samples were missed or invalidated (7 at the North site and 13 at the South site).

It should be noted that the number of TNMOC exceedances recorded is based on any single occurrence in which a TNMOC monitor's 10-minute, block-averaged measurement of non-methane organic compounds (NMOC) exceeded and *remained elevated above the threshold concentration, regardless of the number of consecutive measurements* recorded over time. For example, if NMOC measurements exceeded the threshold concentration at 10:20 and all subsequent measurements remained elevated above the threshold until 11:40, that event is treated here for statistical purposes as a single TNMOC exceedance recorded by that monitor.

Table 3 below summarizes the total number of exceedances recorded by TNMOC monitor during each month of the air monitoring program, as well as associated HRVOC canister samples collected and valid analysis results reported. Invalidated canister samples are excluded from the analyses.

HRVOC exceedance events recorded during at both Plantation Pipe Line monitoring stations were relatively brief; NMHC concentrations rarely remained elevated above threshold values for periods longer than 30 minutes, and exceedance events of 10 or 20 minutes total duration were common. This observation is supported by the time-series data collected from the continuous TNMOC monitor, presentation of which would unduly burden this summary report.

Figures 2 and 3 present scatter plots of TNMOC concentrations measured in the canister strike samples compared against corresponding TNMOC concentrations measured by the continuous monitor. The scatter plots show a high degree of agreement existed between these two measurement methods; correlation coefficients (r^2) for the TNMOC data comparisons being 0.95 and 0.84 for the North and South sites, respectively.

Trend line data for frequency of occurrence of HRVOC exceedance events over the course of the monitoring campaign and associated concentrations as measured by the TNMOC monitors at the North and South monitoring stations are presented in Figure 4 (for 2005) and Figure 5 (for 2006) below. The frequency of occurrence of the TNMOC exceedance events correlate strongly with tank-filling operations at the Plantation Pipe Line facility.

Table 3: Monthly HRVOC Canister "Strike" Sample Collection Frequency By Site

Month and Year	HRVOC Strike Events		Month and Year	HRVOC Strike Events		Month and Year	HRVOC Strike Events		Month and Year	HRVOC Strike Events	
	North Site	South Site		North Site	South Site		North Site	South Site		North Site	South Site
5/05	5/**5**	6/**4**	**10/05**	5/**5**	13/**11**	**3/06**	9/**7**	4/**4**	**8/06**	5/**5**	4/**4**
6/05	5/**5**	5/**5**	**11/05**	9/**9**	11/**11**	**4/06**	7/**6**	8/**8**	**9/06**	6/**6**	5/**4**
7/05	10/**10**	5/**5**	**12/05**	5/**5**	10/**8**	**5/06**	6/**6**	2/**2**	**10/06**	12/**12**	7/**7**
8/05	8/**8**	8/**7**	**1/06**	6/**5**	4/**3**	**6/06**	6/**6**	9/**8**	**11/06**	9/**8**	3/**2**
9/05	8/**7**	6/**4**	**2/06**	4/**4**	1/**1**	**7/06**	5/**4**	11/**11**	**12/06**	4/**3**	2/**2**

Site	**Total No. of TNMOC Strike Events**	**No. of Valid Canister Samples Collected**	**No. of Missed/Invalid Canister Samples**
North	133	**126**	7
South	124	**111**	13

FIGURE 2: SCATTER PLOT OF CONTINUOUS ANALYZER Vs CANISTER MEASUREMENTS OF TNMOC AT NORTH SITE

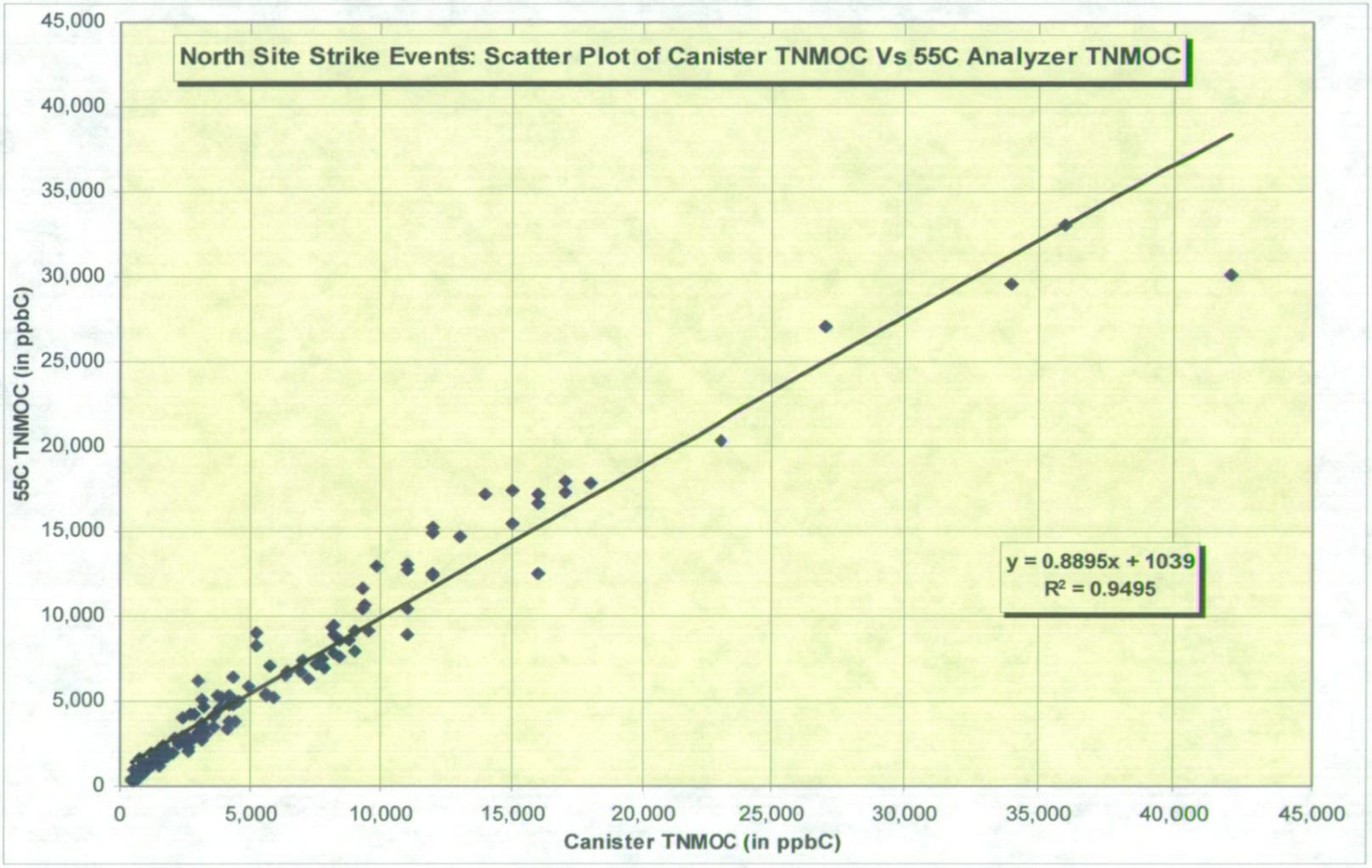


FIGURE 3: SCATTER PLOT OF CONTINUOUS ANALYZER Vs CANISTER MEASUREMENTS OF TNMOC AT SOUTH SITE

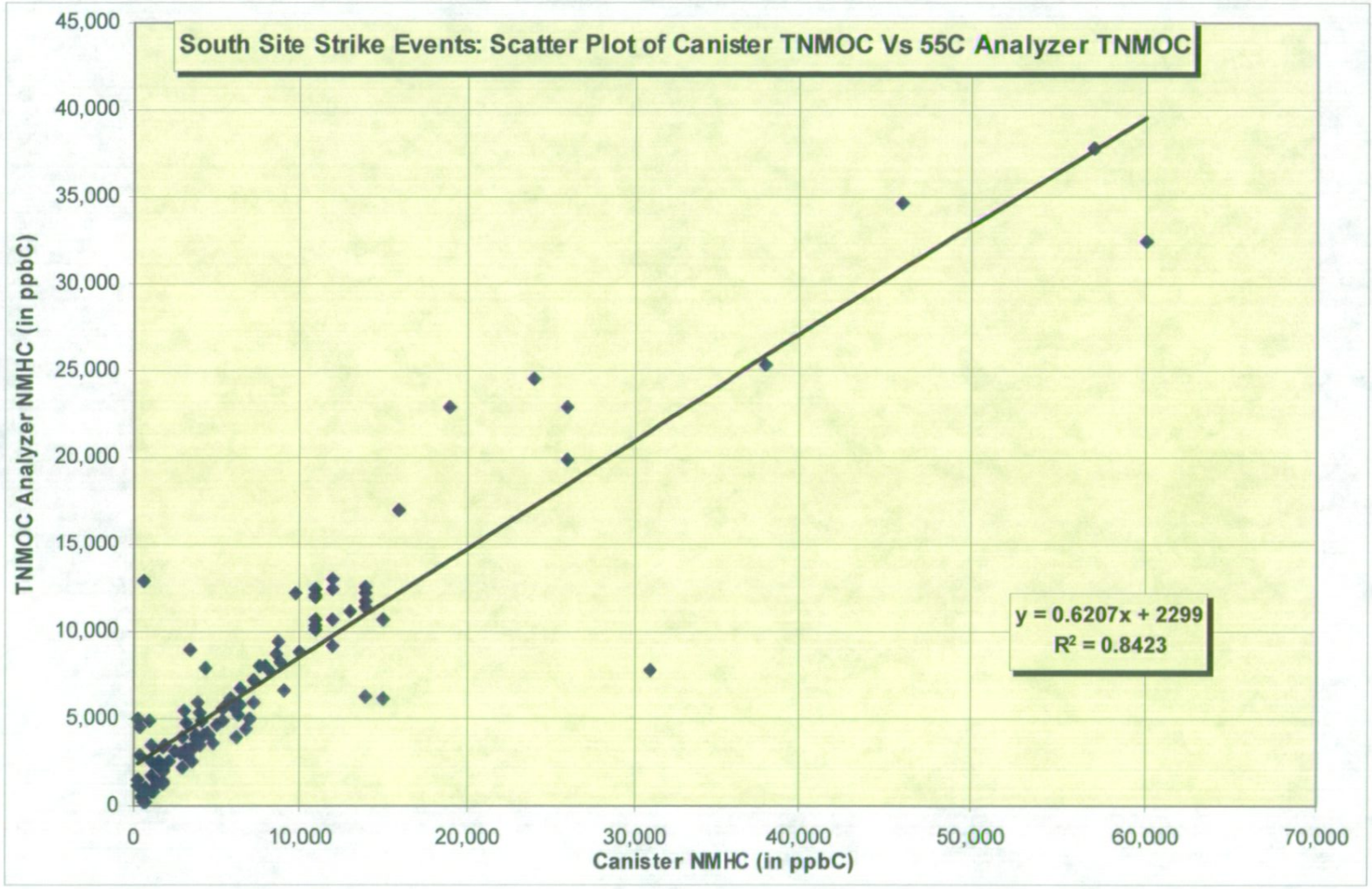


FIGURE 4: 2005 TNMOC EXCEEDANCE EVENTS AT PLANTATION PIPE LINE

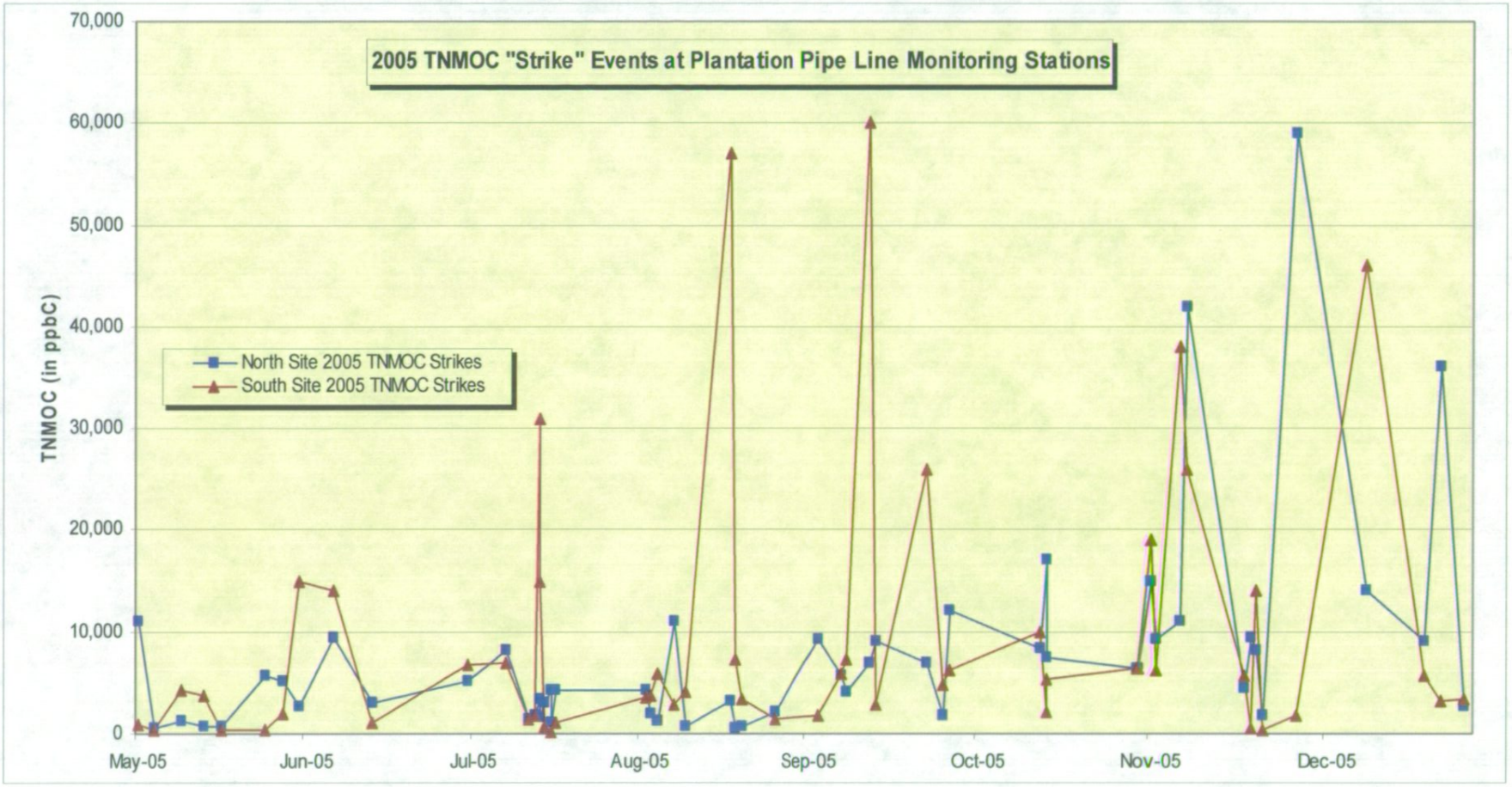
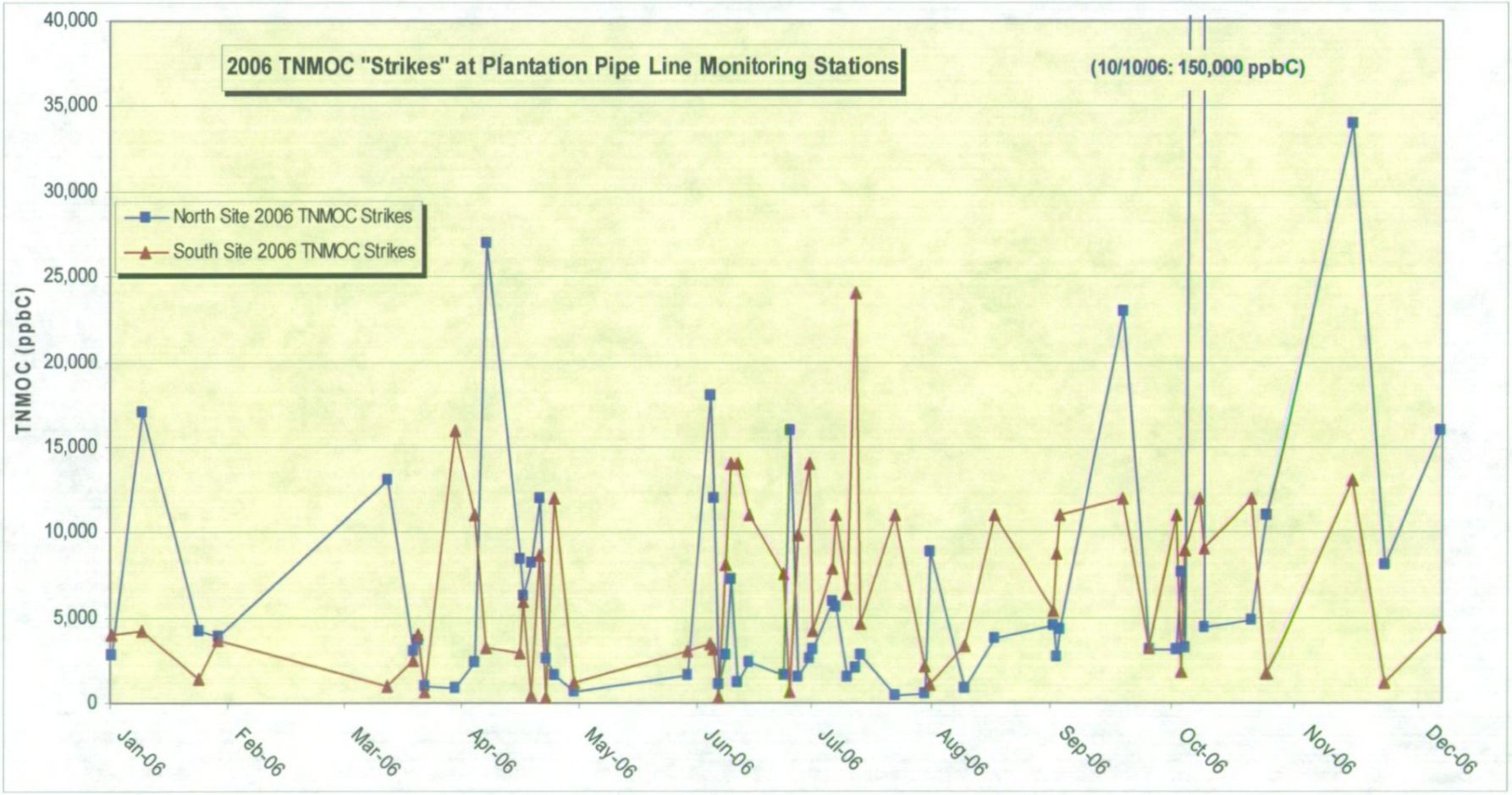


FIGURE 5: 2006 TNMOC EXCEEDANCE EVENTS AT PLANTATION PIPE LINE



Figures 6 and 7 below present profiles of the nine HRVOC compounds (Isobutane, Butane, Isopentane, Pentane, trans-2 Pentene, 2-Methylpentane, Hexane, 2,2,4-Trimethylpentane and Toluene) found to predominate in canister samples collected in conjunction with TNMOC exceedance events at both monitoring stations. Each of these nine compounds constitutes, on average, 2% or more of the total carbon present in the average of all HRVOC samples collected at the monitoring sites over the course of the field campaign. Butane and Isopentane accounted for substantial fractions (typically 33% and 24%, respectively) of the total carbon present in the vast majority of samples. Analysis results for the remaining 44 HRVOC target compounds comprised, with some exceptions, less than 2% of the HRVOC in the samples. Consequently, the analysis presented in this report for canister sample data focuses on this group of nine predominant compounds.

Figures 8 through 19 below graphically present the concentrations (in ppbC) of the nine predominant compounds found in canister samples collected at the North and South sites over the course of the 20-month field monitoring campaign. Figures 20 through 59 below present joint frequency distribution plots (i.e., pollutant roses) for average and maximum concentrations of TNMOC and the nine predominant compounds referenced above.

The pollutant rose illustrating the frequency distribution of average TNMOC measured at the North site (refer to Figure 20) indicates elevated concentrations mainly occur when winds are east, east-southeast and south. Lesser, but significant, vectors for average TNMOC concentrations measured at this site are associated with winds from the west. The corresponding pollution rose of maximum TNMOC measured at the North site (refer to Figure 21) indicates maximum concentrations occurred almost exclusively when winds were from the east.

Figure 22 illustrates the frequency distribution of average TNMOC as measured at the South site. Elevated concentrations at this site are associated with winds from within a 90-degree arc extending from the northeast to the southeast, with TNMOC from the southeast predominating.

The corresponding frequency distribution of maximum TNMOC as measured at the South site (refer to Figure 23) indicates maximum concentrations occurred when winds were within a 60-degree arc extending from the east-northeast to the southeast. As all of Plantation's storage tanks are east and north of the South site, these patterns suggest the Plantation facility was the likely source for the majority of the TNMOC. The southeast vectors in the average and maximum frequency distribution plots for TNMOC may, however, indicate an off-site secondary source of HRVOC impacting the South site.

Figures 24 through 59 are frequency distribution plots of average and maximum concentrations of the nine compounds that constituted the preponderance of HRVOC measured at the North and South sites: Isobutane, Butane, Isopentane, Pentane, trans-2 Pentene, 2-Methylpentane, Hexane, 2,2,4-Trimethylpentane and Toluene.

The frequency distribution plots of maximum concentrations of these compounds as measured at both sites suggest the primary sources for these HRVOC emissions were Plantation storage tanks located east and southeast of the monitoring stations.

The frequency distribution plots of the *average* concentrations of the nine major compounds as measured at the North site also suggest primary emission sources were storage tanks located to the east and south of the monitoring station, however, significant *average* concentrations of Isobutane, Isopentane, Pentane, 2-Methylpentane, 2,2,4-Trimethylpentane, Toluene and Hexane were associated with winds from the southwest and west. The plot data suggest a significant fraction of these compounds may have been emitted at an off-site source and contributed to the HRVOC impacting the North site.

Similarly, the frequency distribution plots of both *average* and *maximum* concentrations of the nine dominant HRVOC compounds as measured at the South site indicate primary emission sources for these events were storage tanks located to the east and northeast of the site. The high concentrations associated with winds from the southeast in these plots are unexpected, considering that the Plantation storage tanks are located to the east and north of the South site. This leaves open the possibility that some of these compounds may have been transported to the site from one or more off-site sources.

4. CONCLUSIONS

Emissions from the Plantation Pipe Line tank farm are, in large part, the result of storage tank operations. In particular, storage tank refilling episodes can result in brief, but elevated, periods of TNMOC emissions. TNMOC spikes at the air monitoring stations, which originated from within the facility, frequently correlate well with tank refilling operations.

In 2003, facility-wide emissions were 1,760 tons of VOC. In 2004, Plantation modified its operations to reduce emissions related to tank refilling. By 2005—the year the HRVOC monitoring program began—facility-wide emissions had been reduced to 691 tons of VOC, a reduction of nearly 61% from 2003 levels. Plantation Pipe Line intends to continue its current operational practices and thereby maintain emissions near their current levels.

FIGURE 6: COMPOSITION OF AVERAGE HRVOC STRIKE SAMPLE (NORTH SITE)

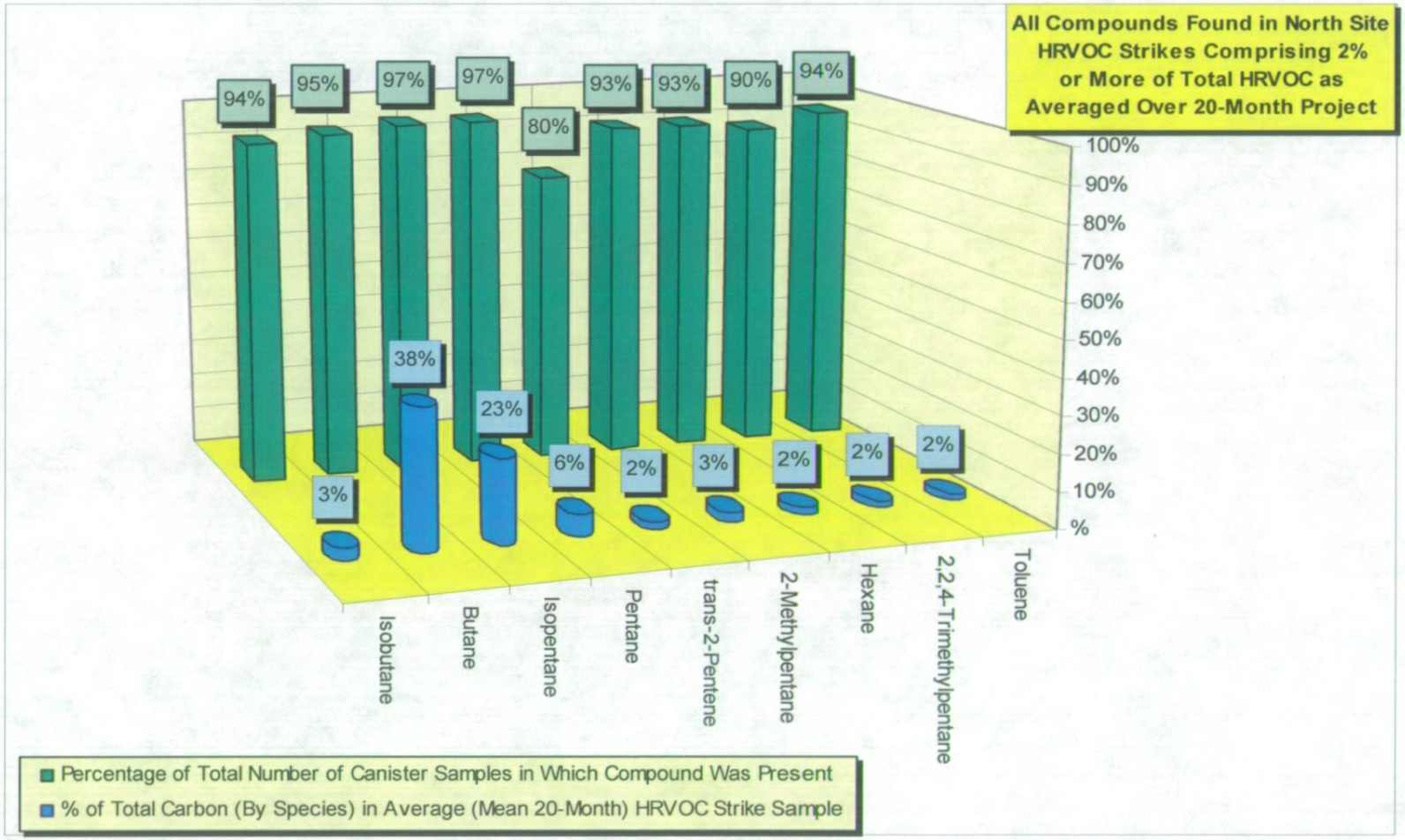


FIGURE 7: COMPOSITION OF AVERAGE HRVOC STRIKE SAMPLE (SOUTH SITE)

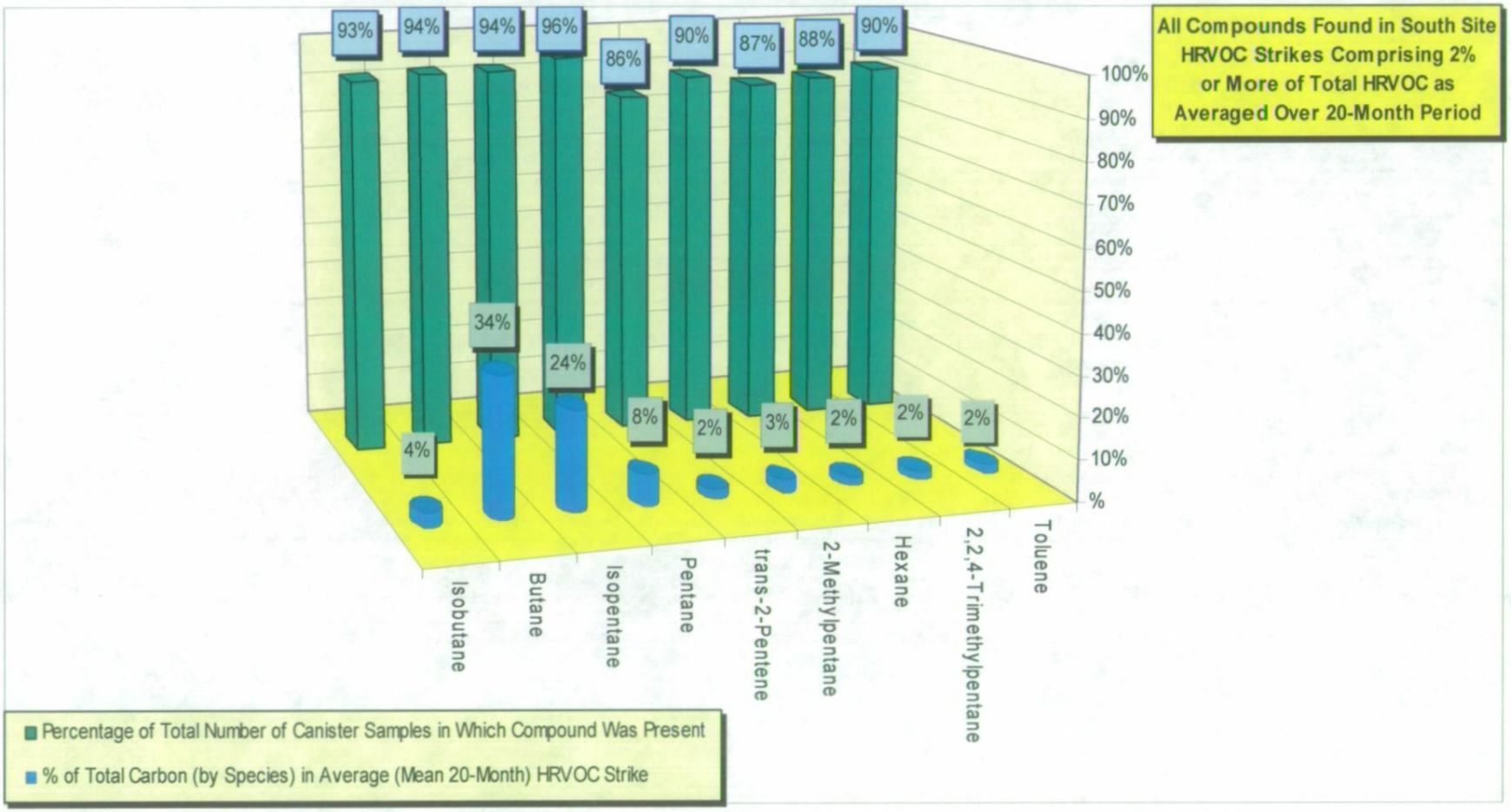


FIGURE 8: COMPOSITION OF NORTH SITE HRVOC STRIKE SAMPLES MAY 2005 – AUGUST 2005

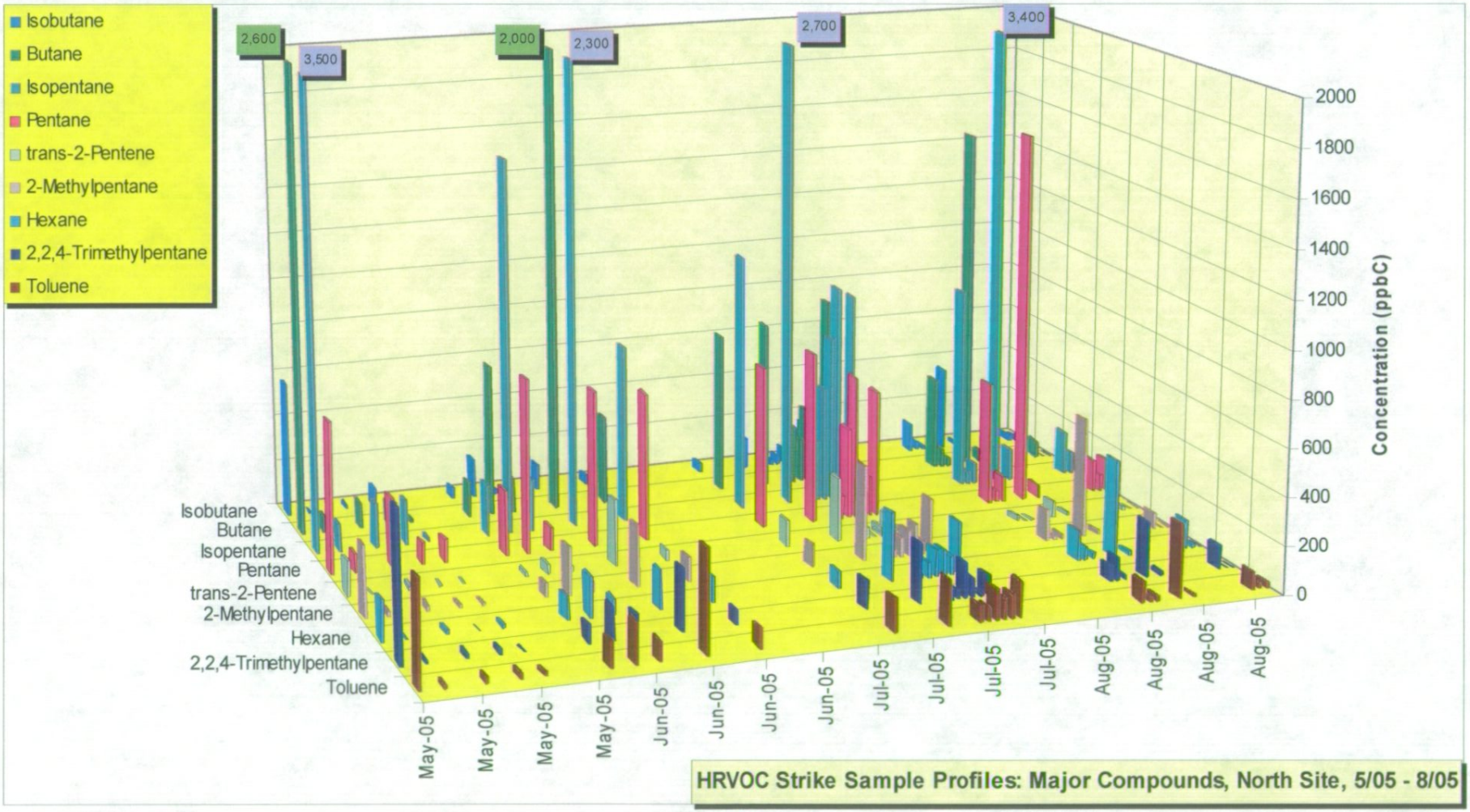


FIGURE 9: COMPOSITION OF SOUTH SITE HRVOC STRIKE SAMPLES MAY 2005 – AUGUST 2005

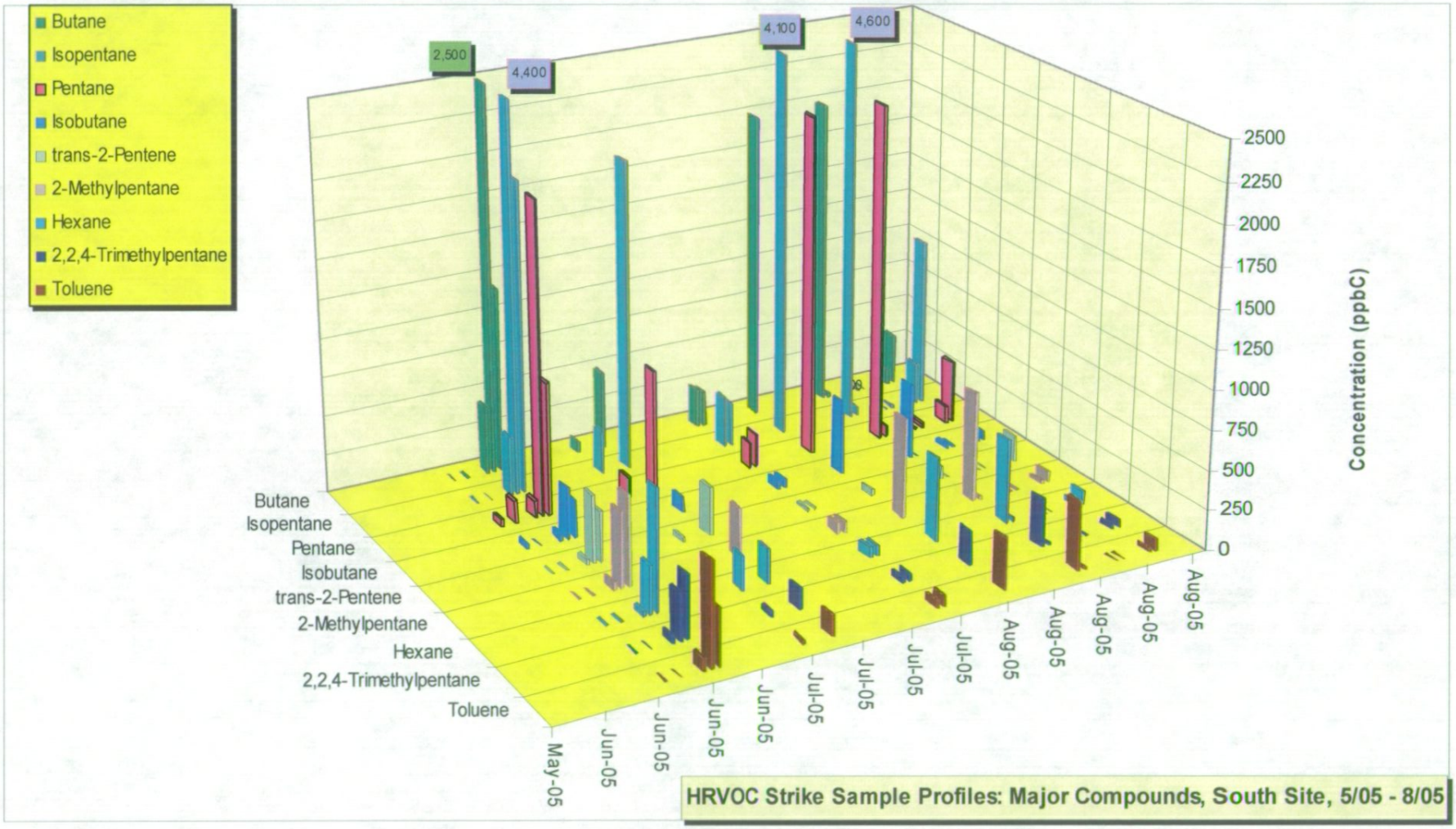


FIGURE 10: COMPOSITION OF NORTH SITE HRVOC STRIKE SAMPLES: SEPTEMBER-DECEMBER 2005

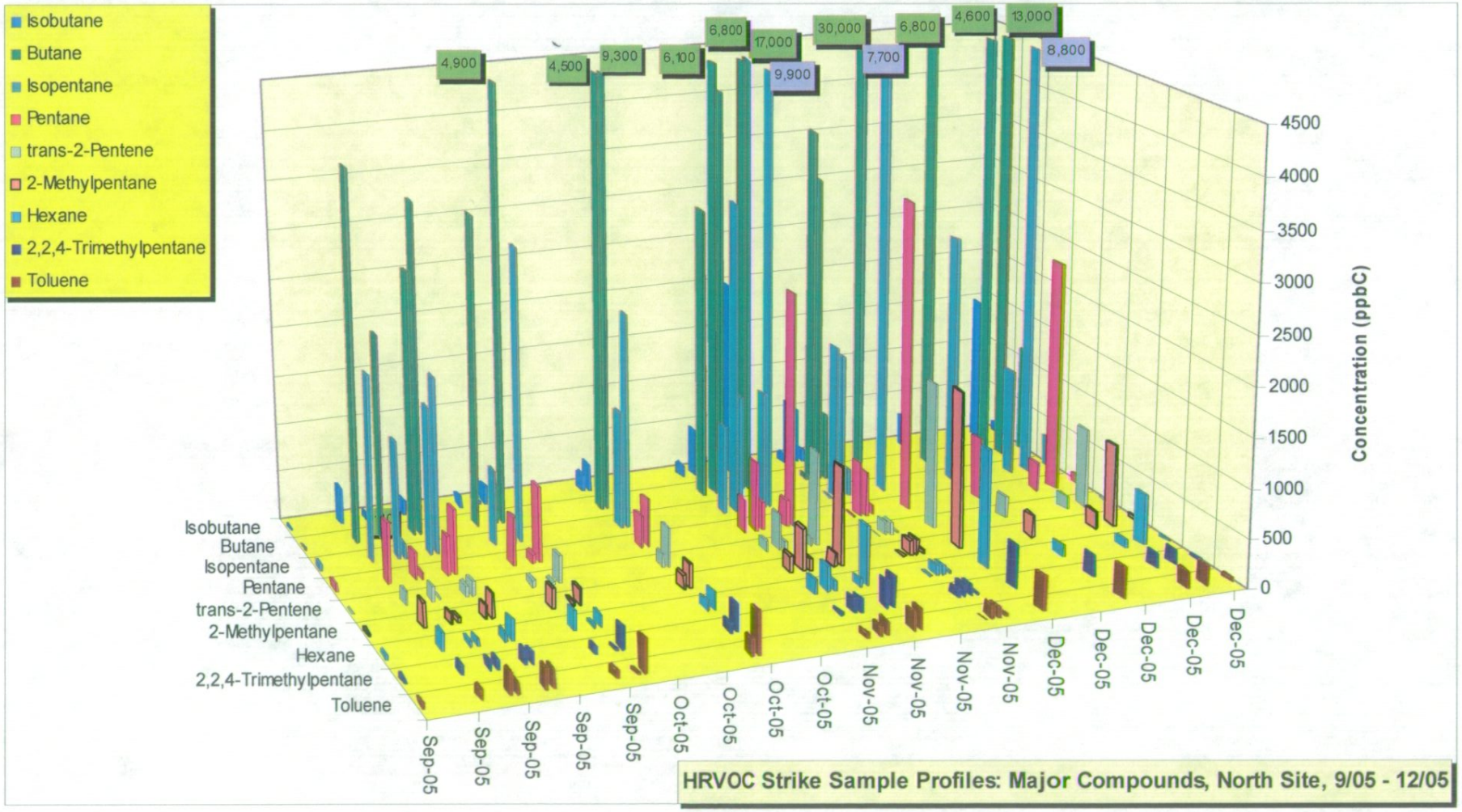


FIGURE 11: COMPOSITION OF SOUTH SITE HRVOC STRIKE SAMPLES: SEPTEMBER-DECEMBER 2005

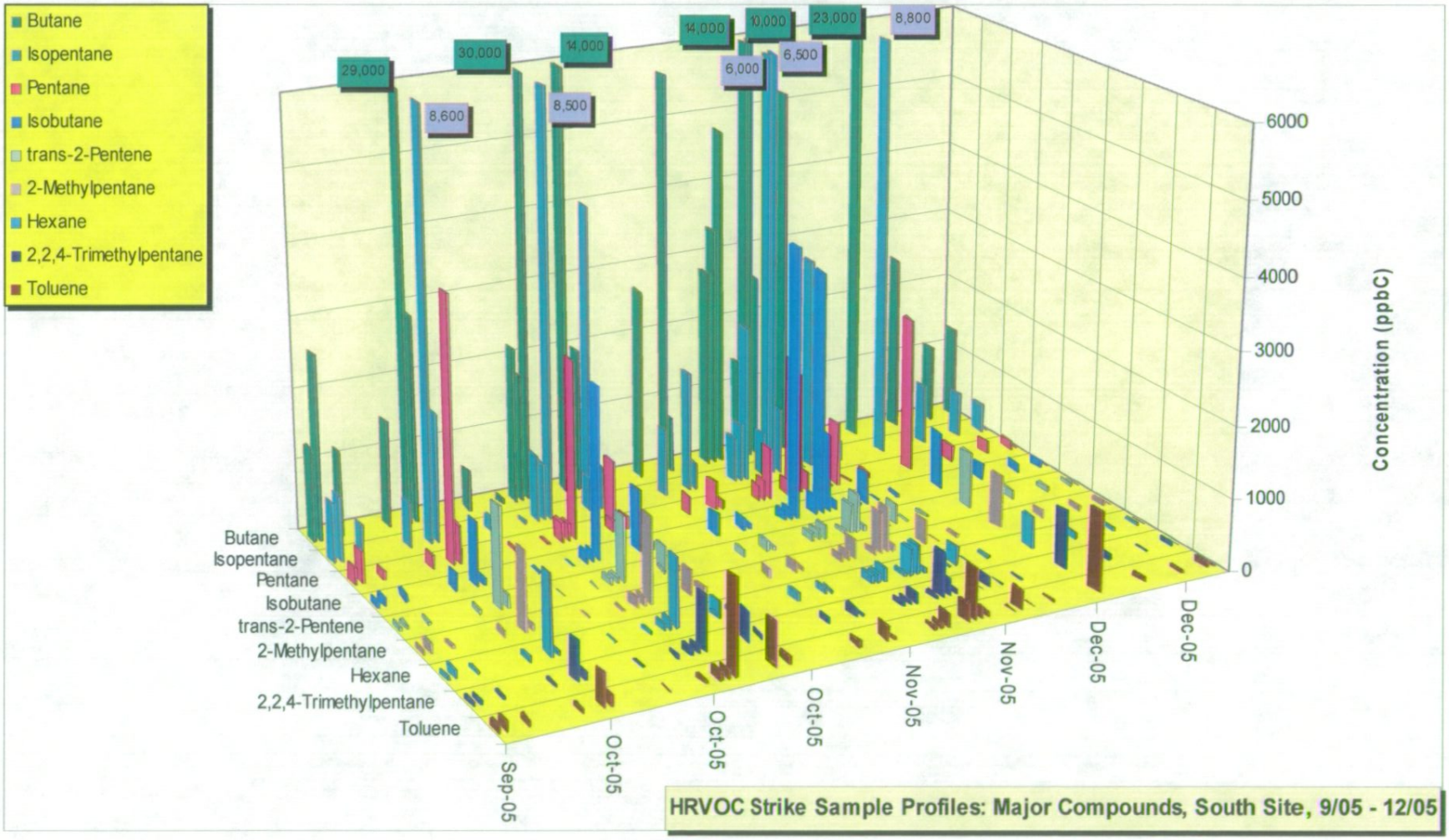


FIGURE 12: COMPOSITION OF NORTH SITE HRVOC STRIKE SAMPLES: QUARTER 1, 2006

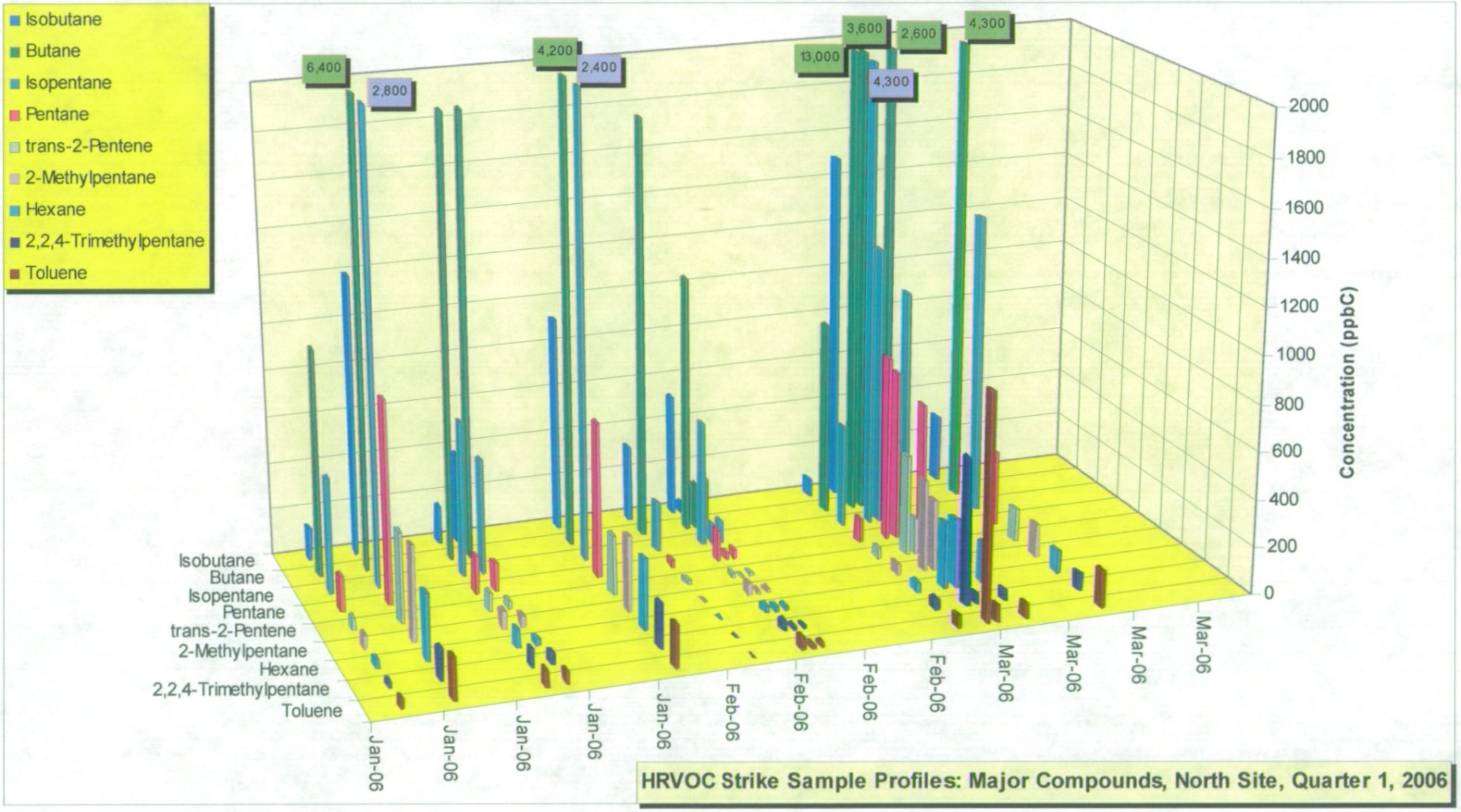


FIGURE 13: COMPOSITION OF SOUTH SITE HRVOC STRIKE SAMPLES: QUARTER 1, 2006

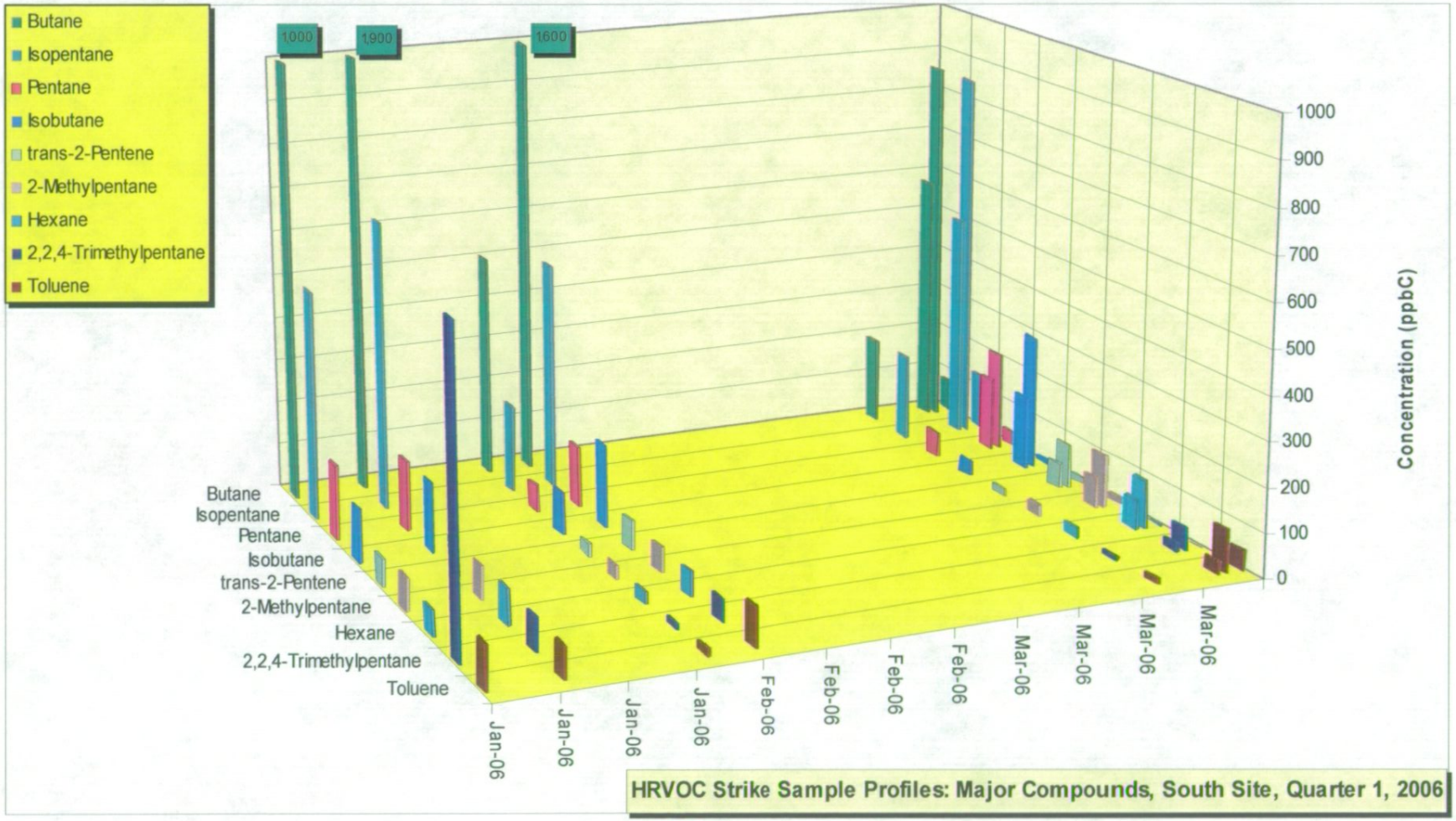


FIGURE 14: COMPOSITION OF NORTH SITE HRVOC STRIKE SAMPLES: QUARTER 2, 2006

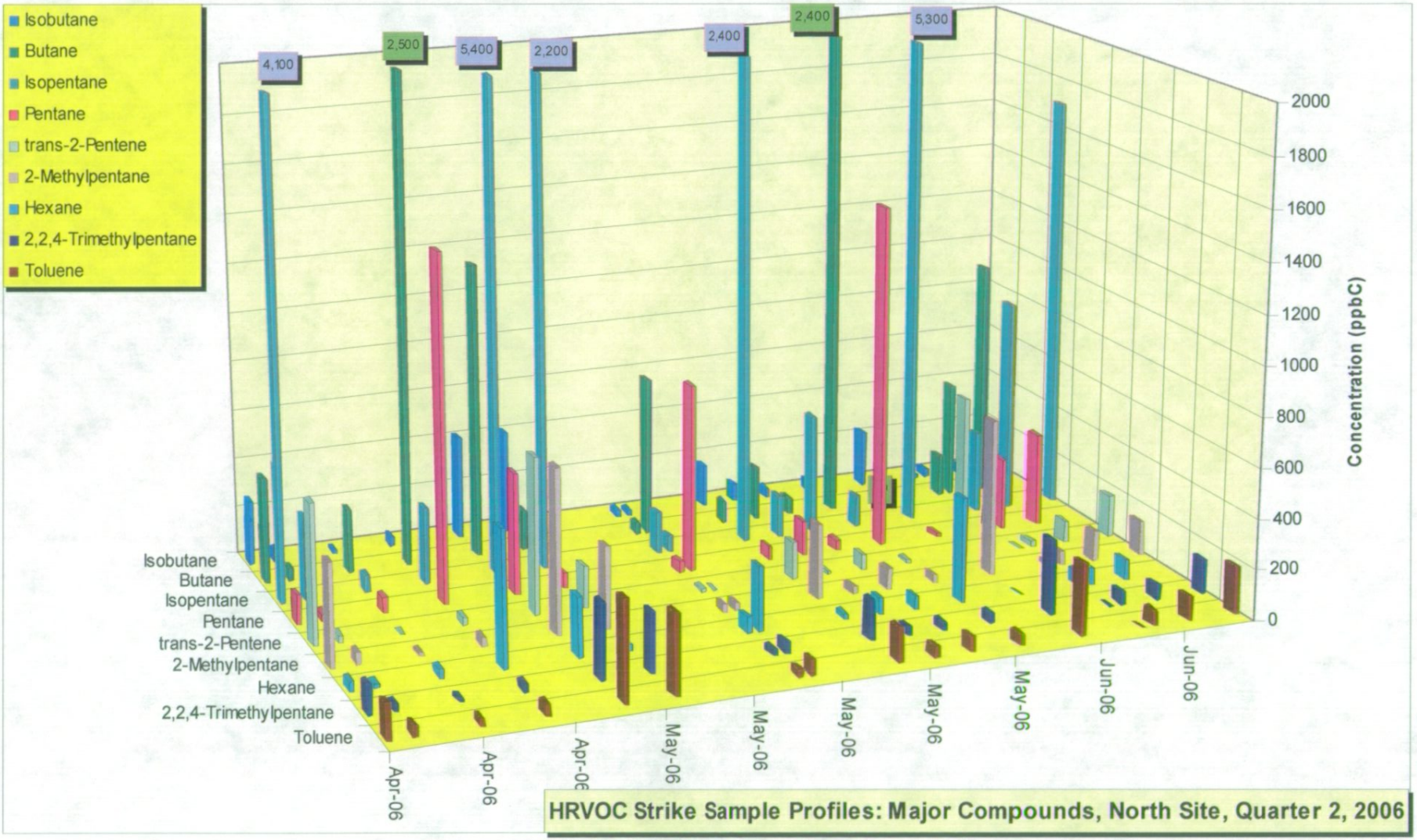


FIGURE 15: COMPOSITION OF SOUTH SITE HRVOC STRIKE SAMPLES: QUARTER 2, 2006

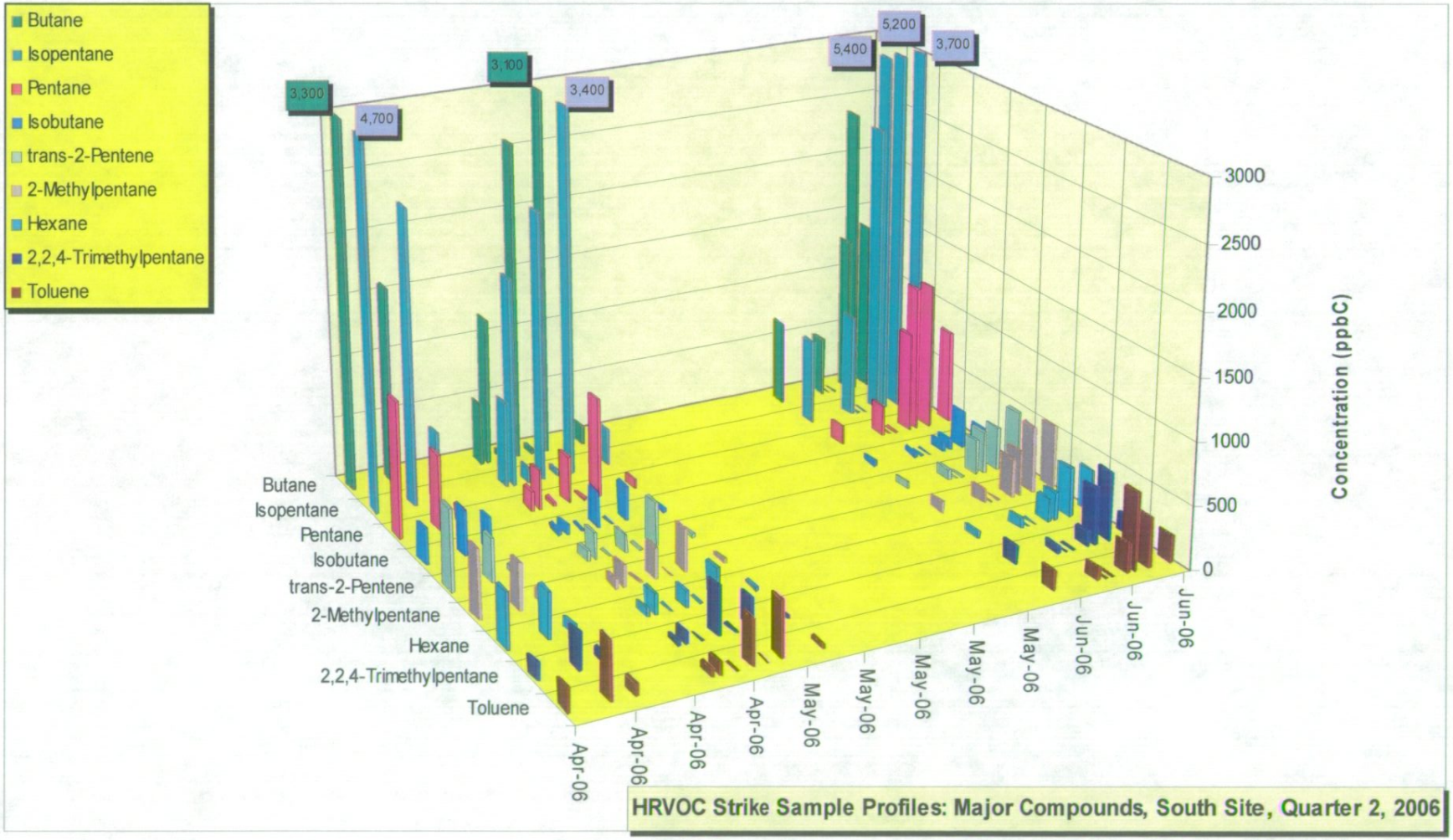


FIGURE 16: COMPOSITION OF NORTH SITE HRVOC STRIKE SAMPLES: QUARTER 3, 2006

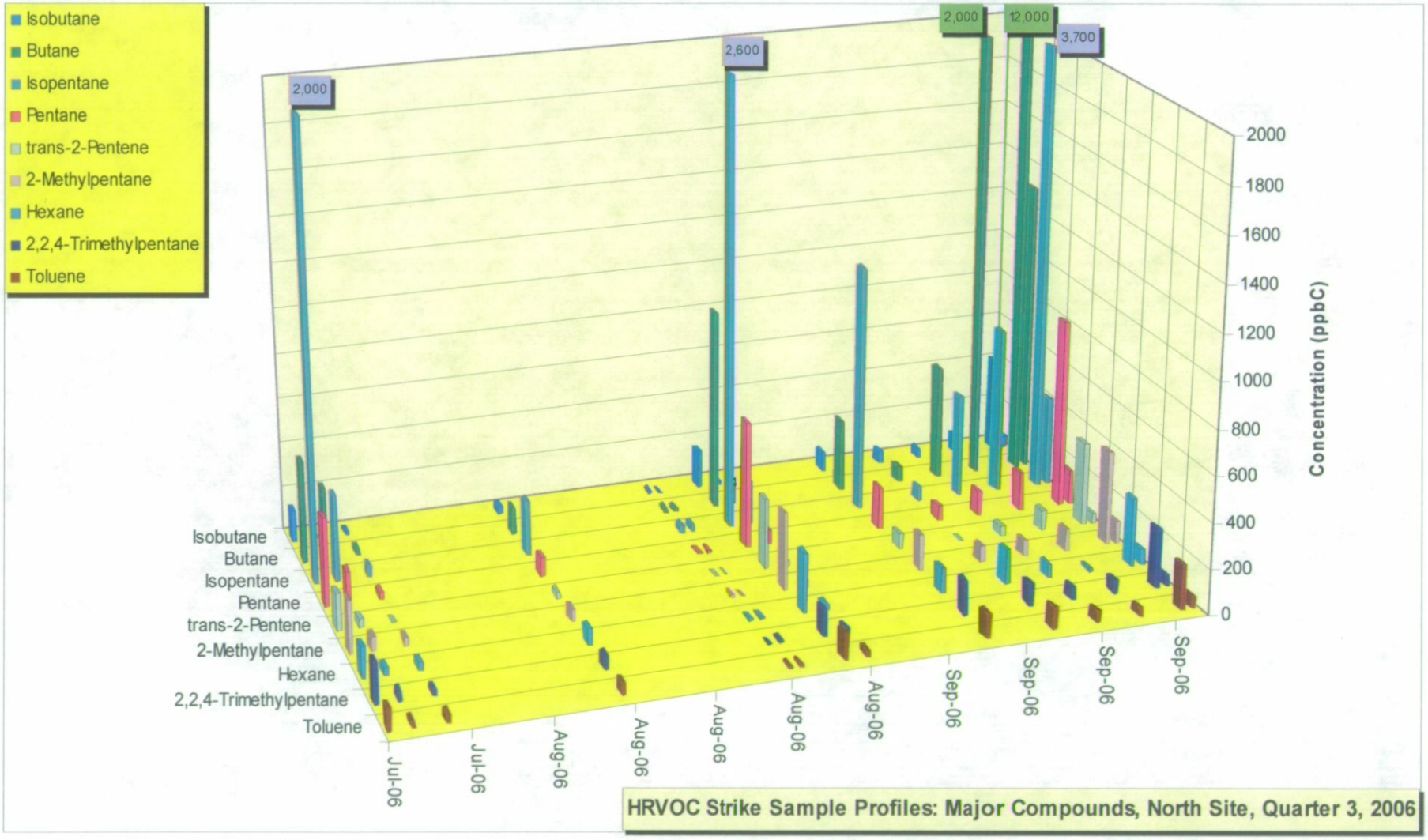


FIGURE 17: COMPOSITION OF SOUTH SITE HRVOC STRIKE SAMPLES: QUARTER 3, 2006

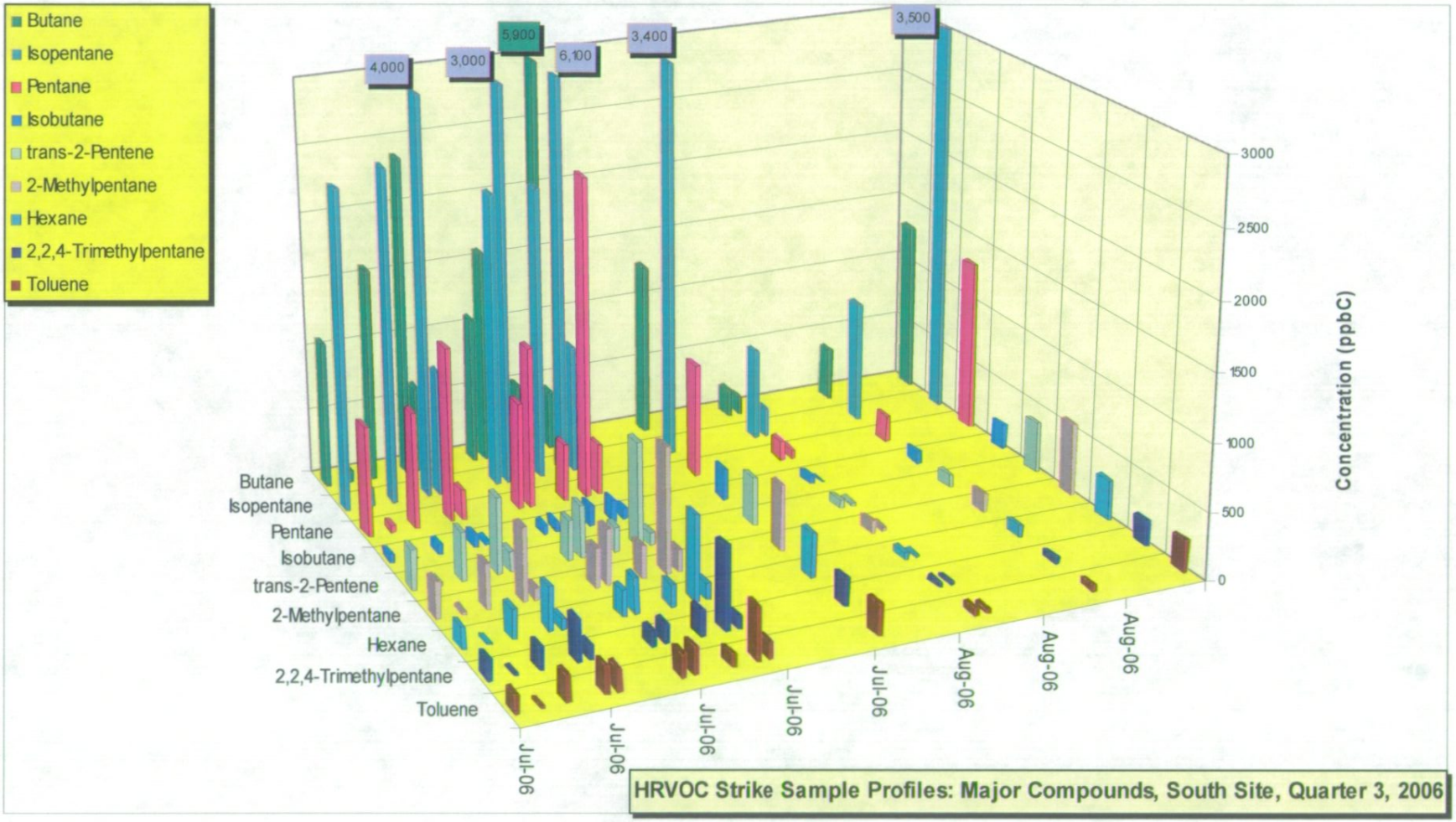


FIGURE 18: COMPOSITION OF NORTH SITE HRVOC STRIKE SAMPLES: QUARTER 4, 2006

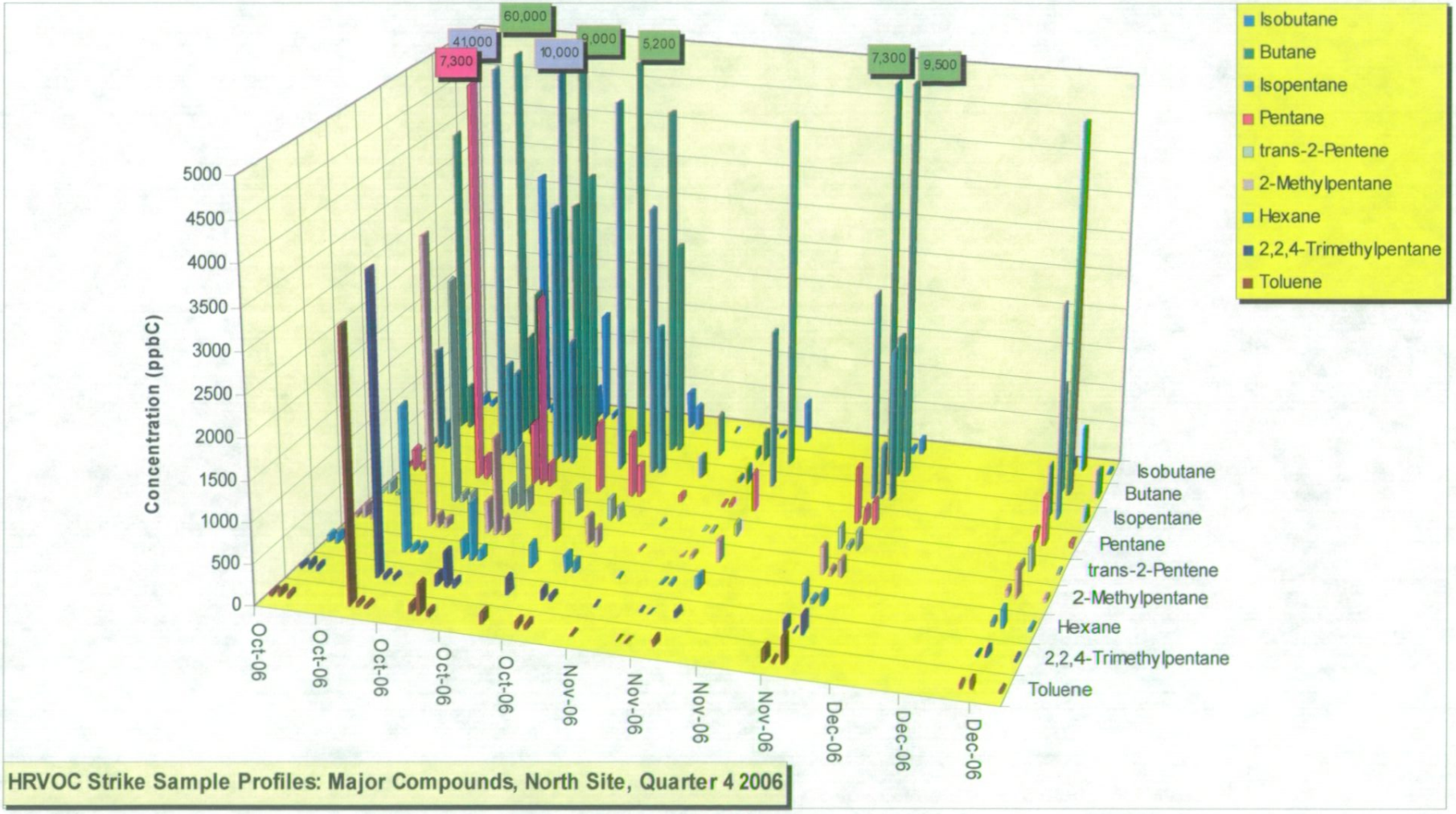


FIGURE 19: COMPOSITION OF SOUTH SITE HRVOC STRIKE SAMPLES: QUARTER 4, 2006

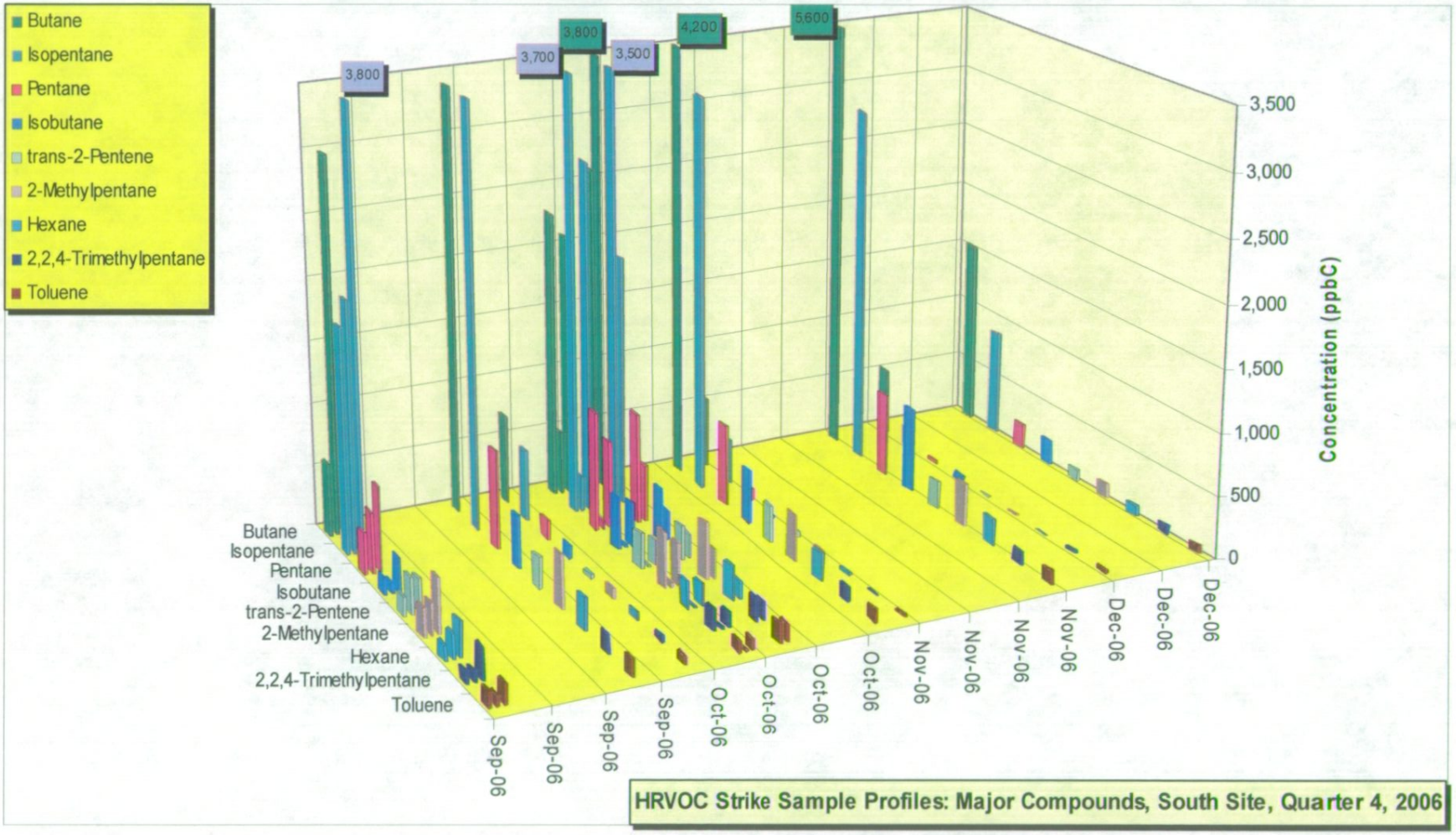
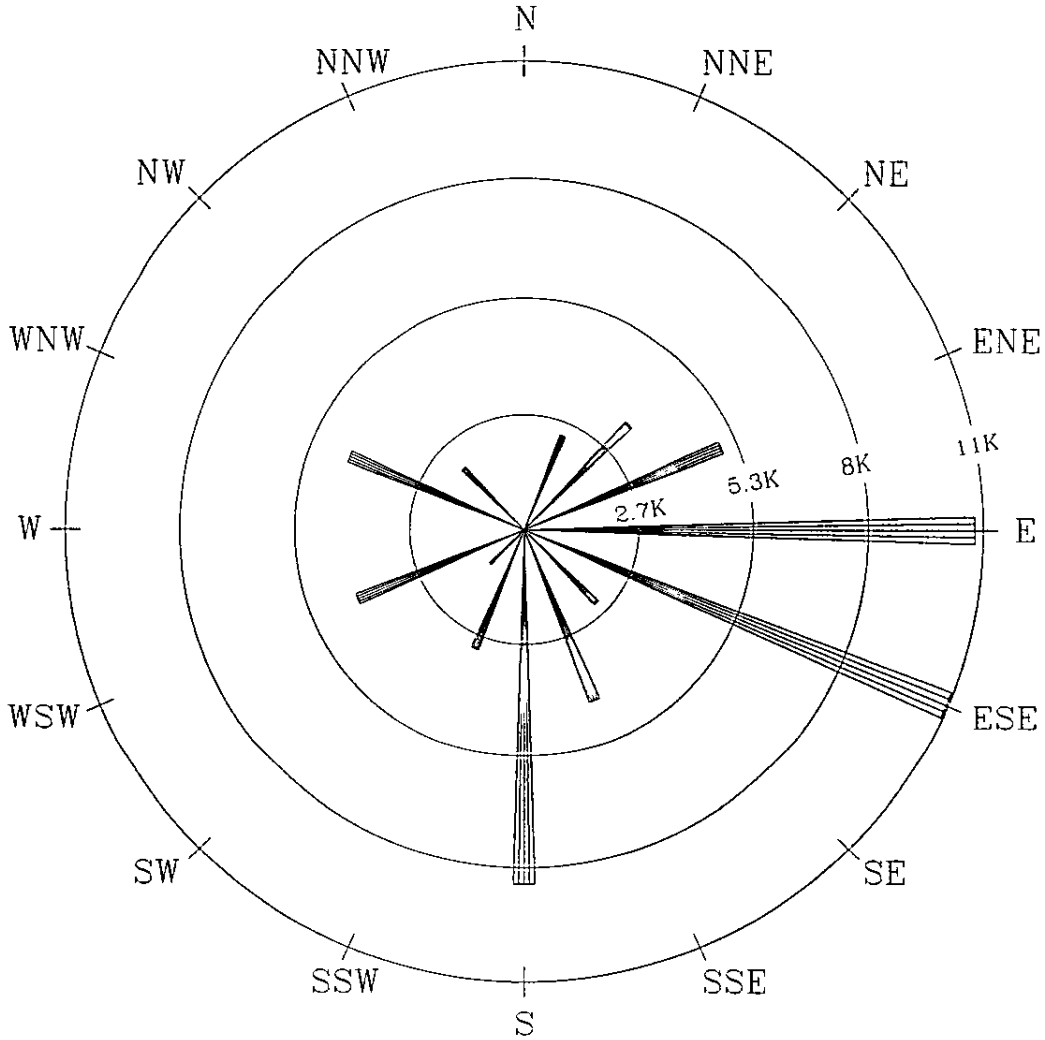


FIGURE 20: POLLUTANT ROSE OF AVERAGED TNMOC MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

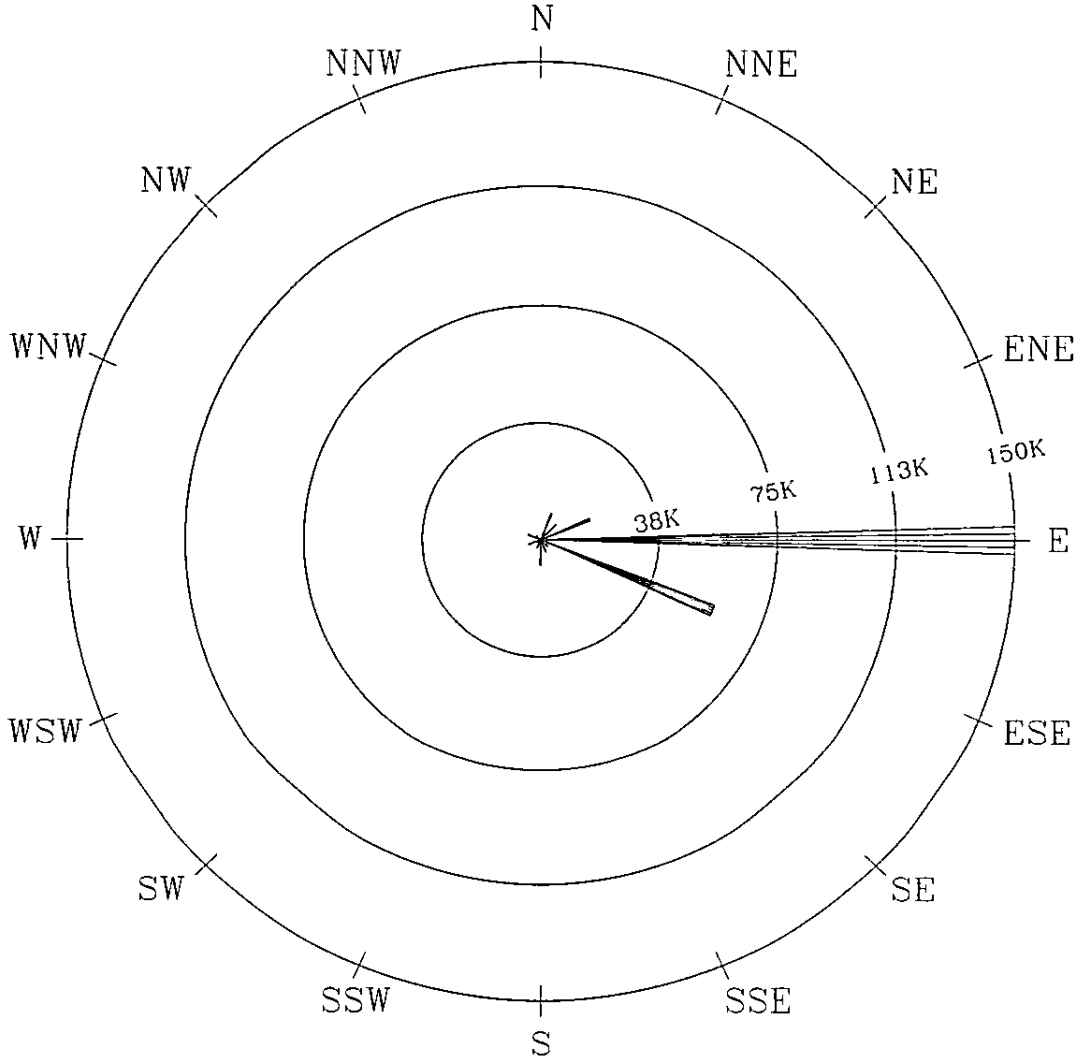


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: TNMOC Average Plot
Time Period Depicted: 5/ 1/05 - 12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of averaged TNMOC concentrations (C2–C12) collected in canisters at the North site during HRVOC strike events. A total of 126 samples were collected over 20 months (6.3 samples per month). HRVOC strikes were predominantly associated with easterly winds. Significant additional strike events are associated with winds from the south and west.

FIGURE 21: POLLUTANT ROSE OF MAXIMUM TNMOC MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

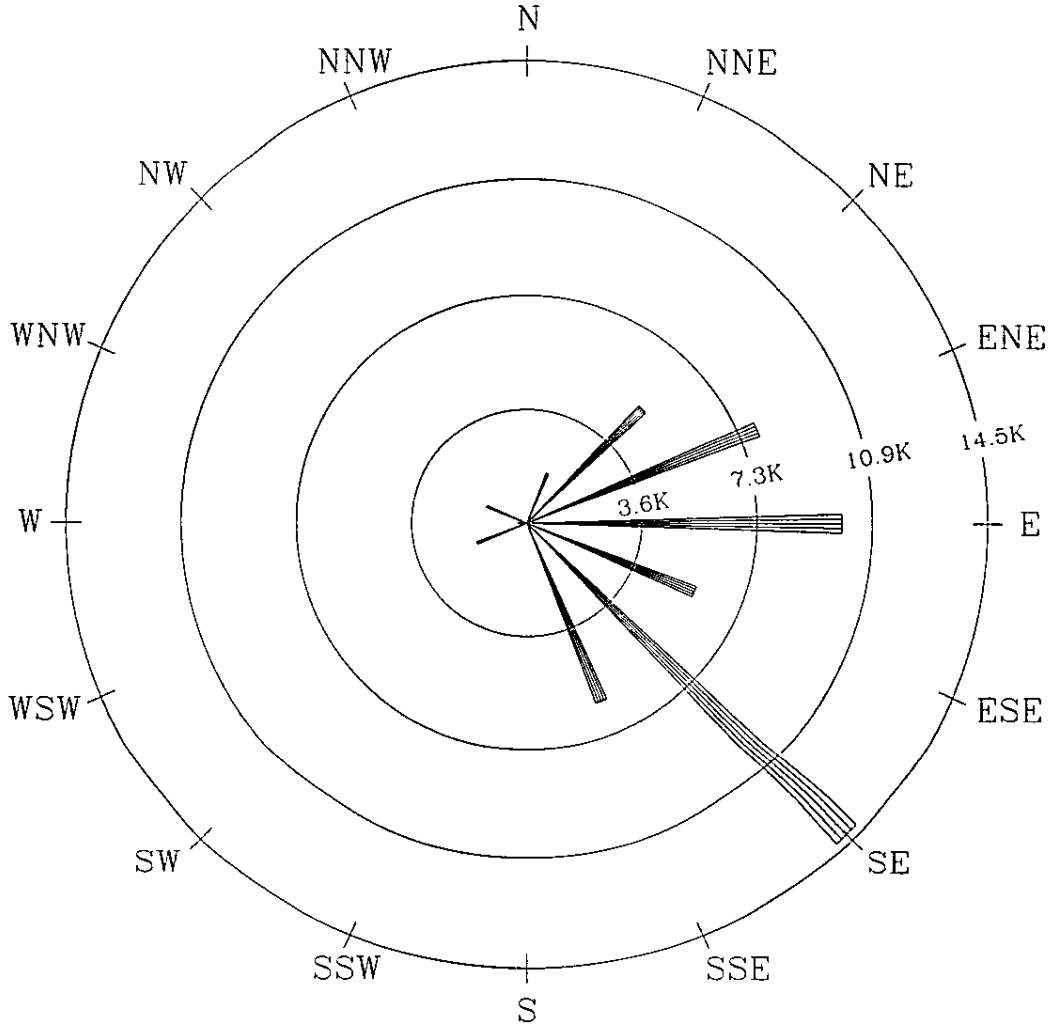


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: TNMOC Maximum Plot
Time Period Depicted: 5/ 1/05 - 12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum TNMOC concentrations (C2-C12) collected in canisters at the North site during HRVOC strike events. A total of 126 samples were collected over 20 months (6.3 samples per month). Maximum HRVOC strikes were clearly associated with easterly winds.

FIGURE 22: POLLUTANT ROSE OF AVERAGED TNMOC MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

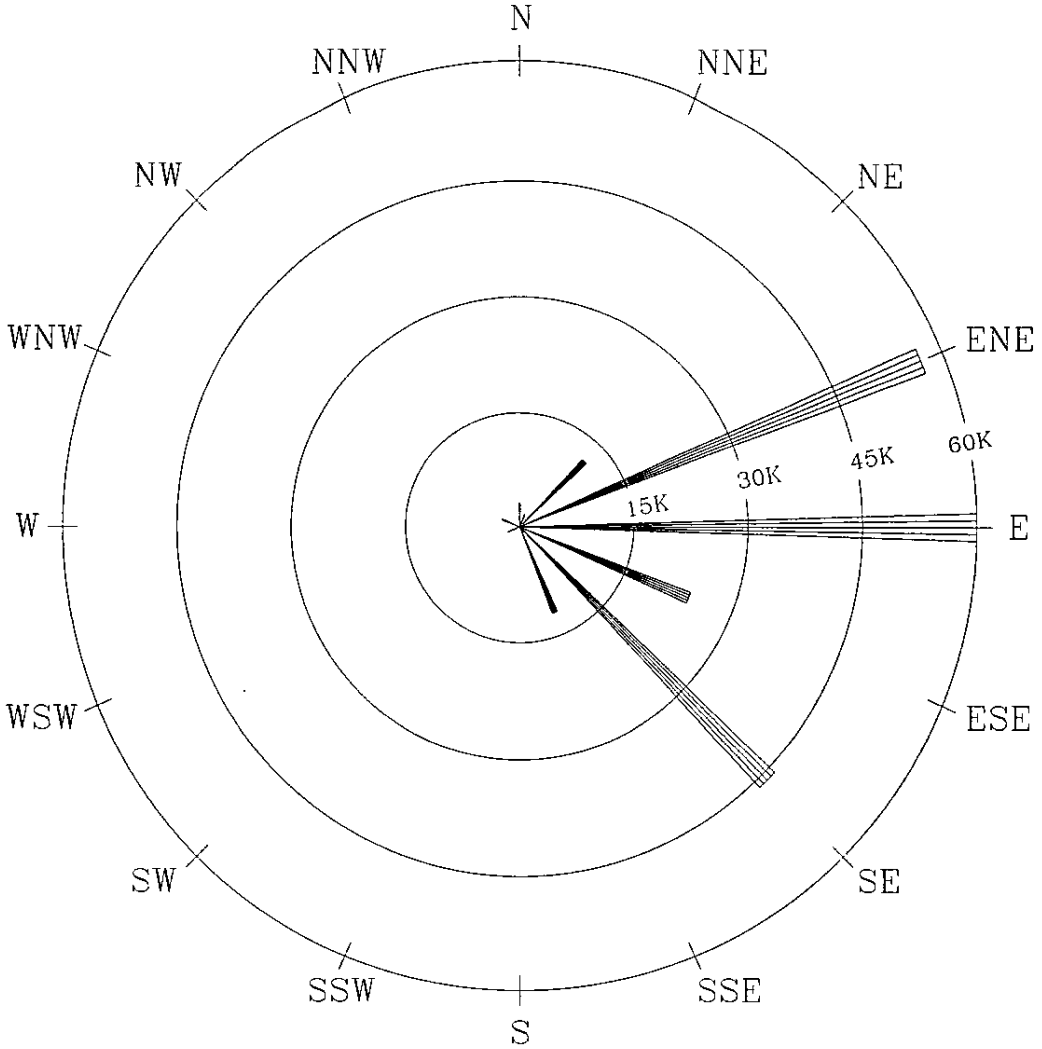


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: TNMOC Average Plot
Time Period Depicted: 5/1/05 -12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of averaged TNMOC concentrations (C2-C12) collected in canisters at the South site during HRVOC strike events. A total of 111 samples were collected over 20 months (5.6 samples per month). HRVOC strikes were predominantly associated with easterly and southeasterly winds.

FIGURE 23: POLLUTANT ROSE OF MAXIMUM TNMOC MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

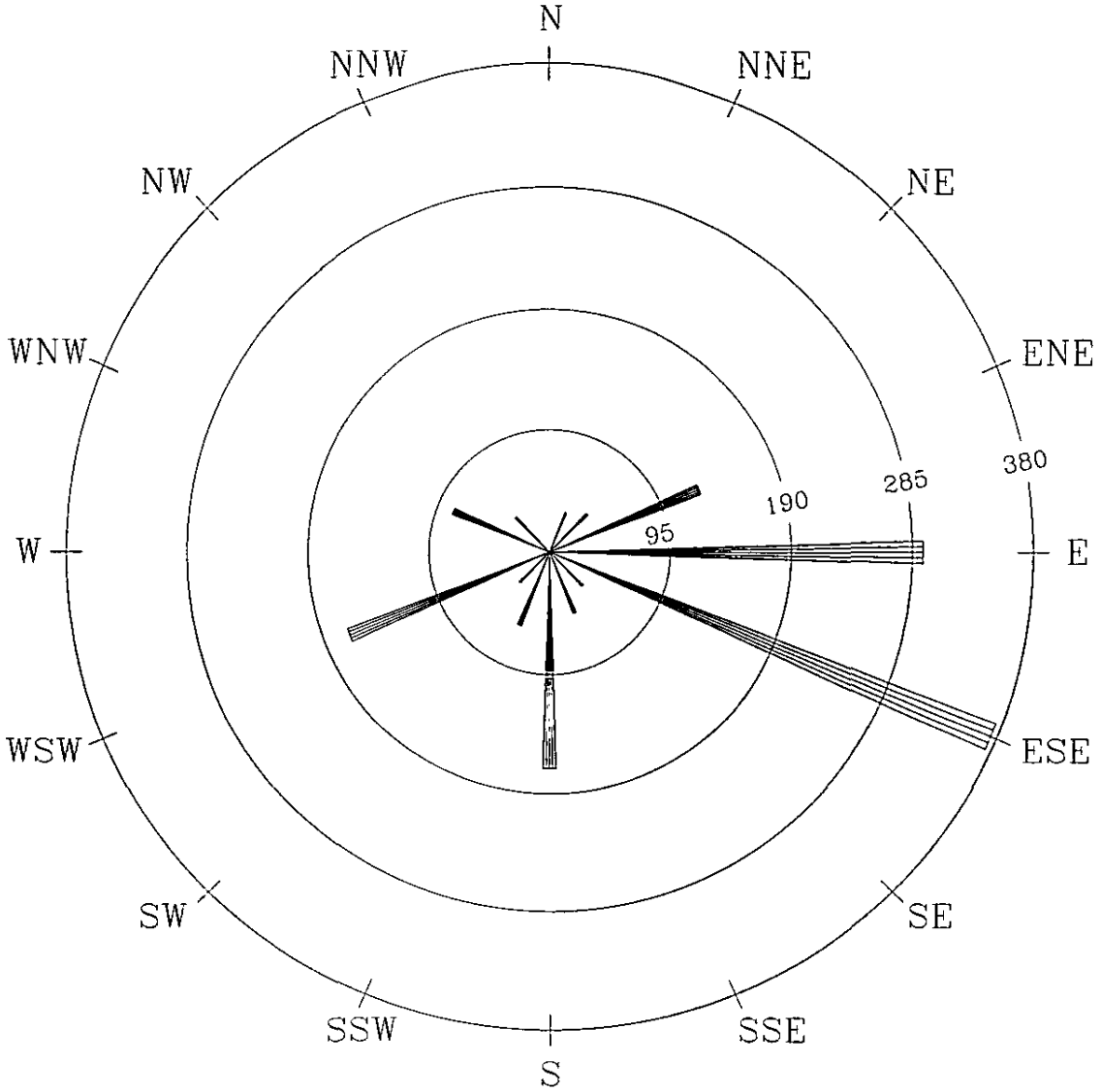


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: TNMOC Maximum Plot
Time Period Depicted: 5/1/05 -12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum TNMOC concentrations (C2-C12) collected in canisters at the South site during HRVOC strike events. A total of 111 samples were collected over 20 months (5.6 samples per month). HRVOC strikes were predominantly associated with easterly winds. Significant additional strike events are associated with winds from the south and west.

FIGURE 24: POLLUTANT ROSE OF AVERAGE ISOBUTANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

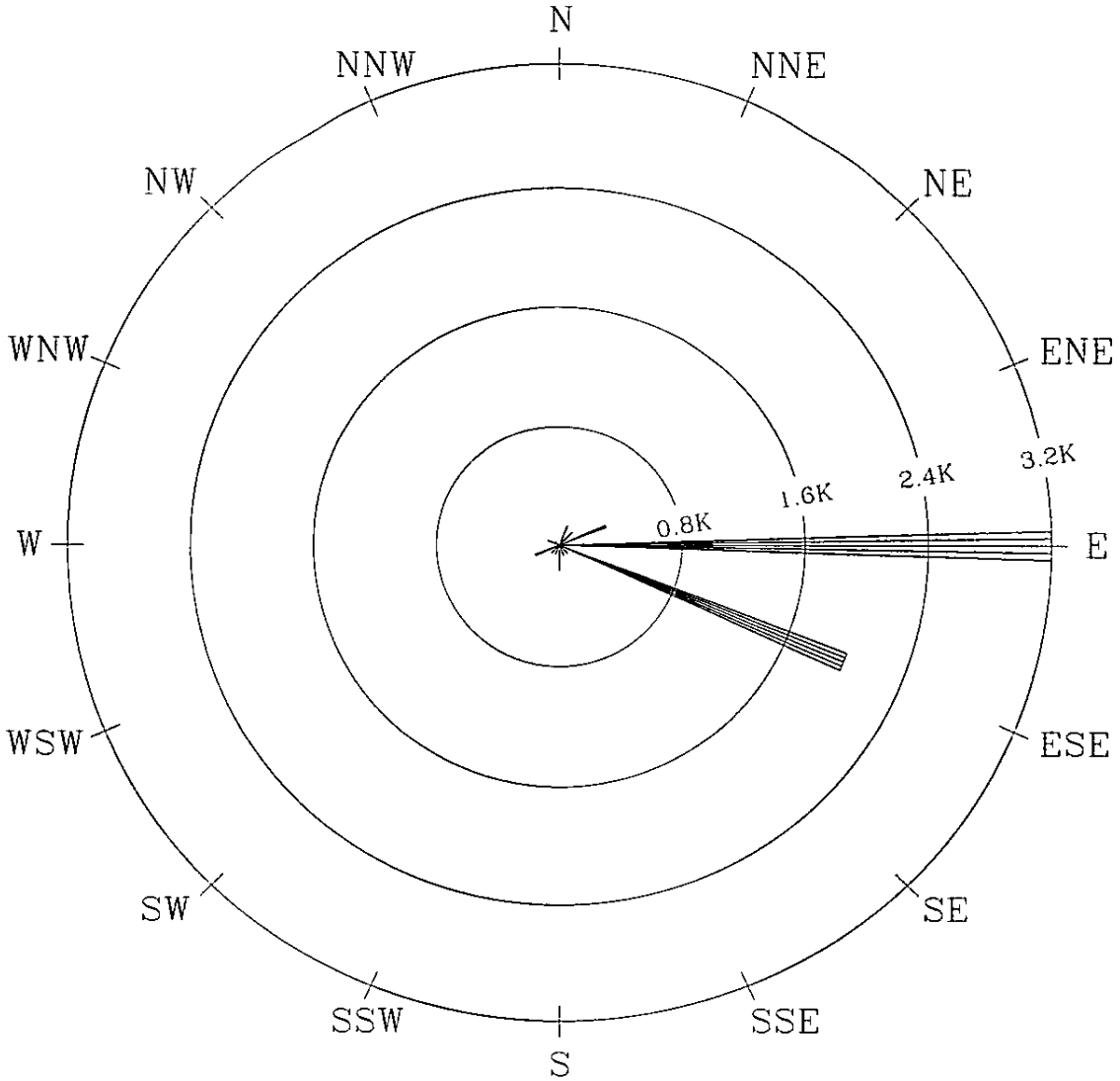


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: Isobutane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Isobutane concentrations collected in canisters at the North site during HRVOC strike events. Isobutane was detected in 118 of 126 samples collected over 20 months, averaging 3.3 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Isobutane

FIGURE 25: POLLUTANT ROSE OF MAXIMUM ISOBUTANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

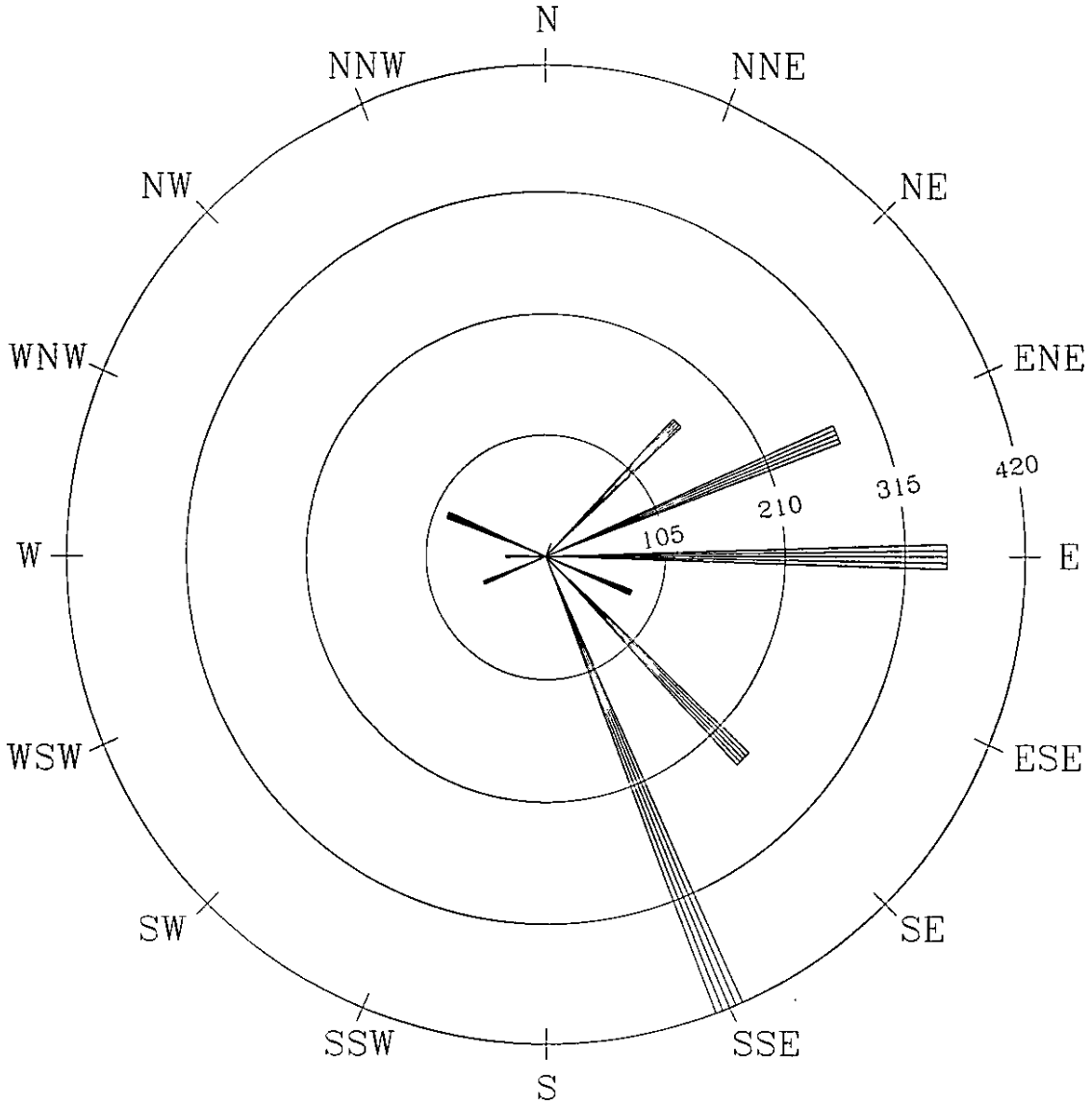


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: Isobutane Maximum Concentration Plot
Time Period Depicted: 5/1/05 - 12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum Isobutane concentrations collected in canisters at the North site during HRVOC strike events. Isobutane was detected in 118 of 126 samples collected over 20 months, averaging 3.3 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Isobutane

FIGURE 26: POLLUTANT ROSE OF AVERAGE ISOBUTANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

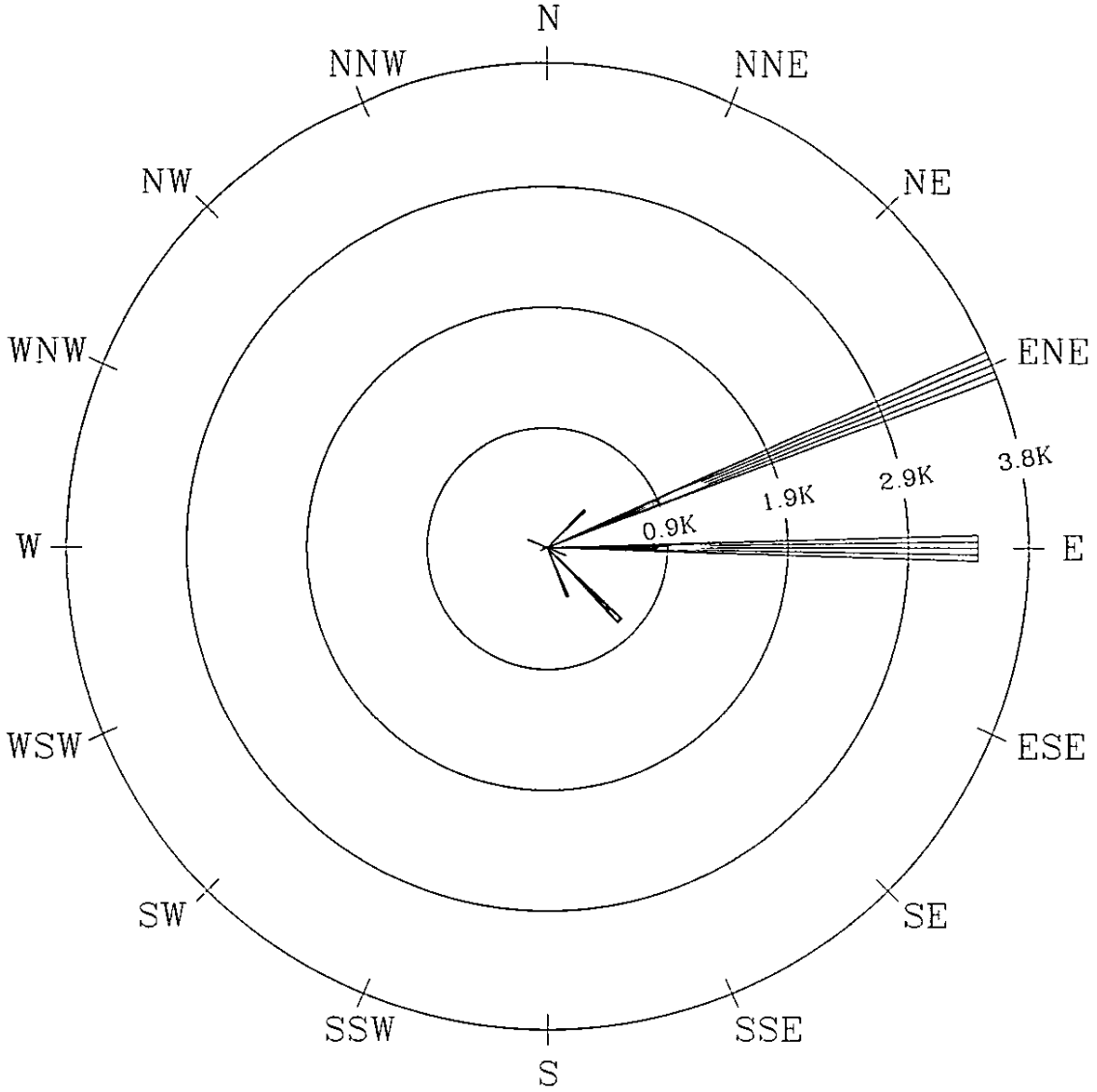


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: Isobutane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Isobutane concentrations collected in canisters at the South site during HRVOC strike events. Isobutane was detected in 103 of 111 samples collected over 20 months, averaging 3.6 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Isobutane

FIGURE 27: POLLUTANT ROSE OF MAXIMUM ISOBUTANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

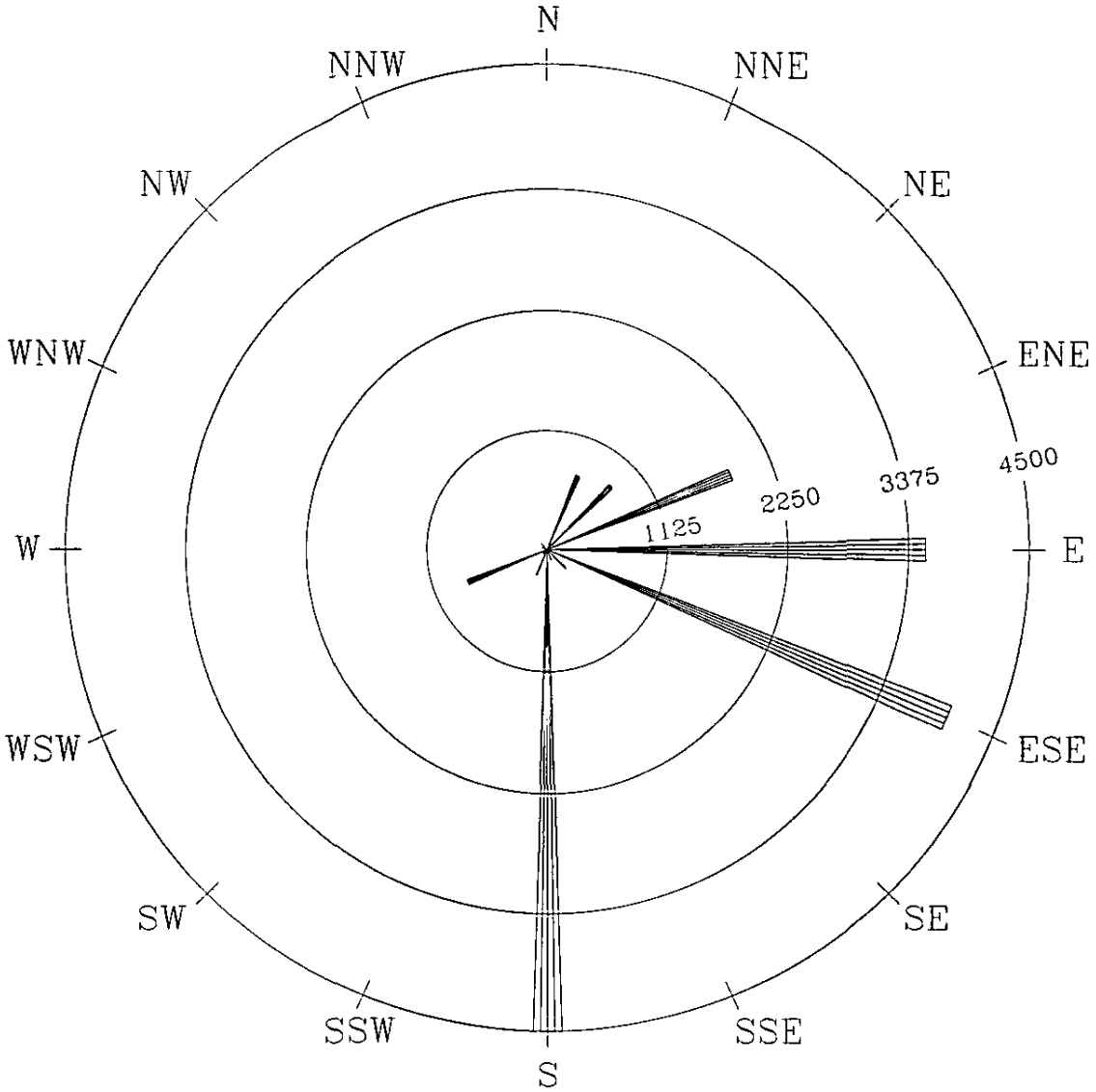


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: Isobutane Maximum Concentration Plot
Time Period Depicted: 5/1/05 – 12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum Isobutane concentrations collected in canisters at the South site during HRVOC strike events. Isobutane was detected in 103 of 111 samples collected over 20 months, averaging 3.6 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Isobutane

FIGURE 28: POLLUTANT ROSE OF AVERAGE BUTANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

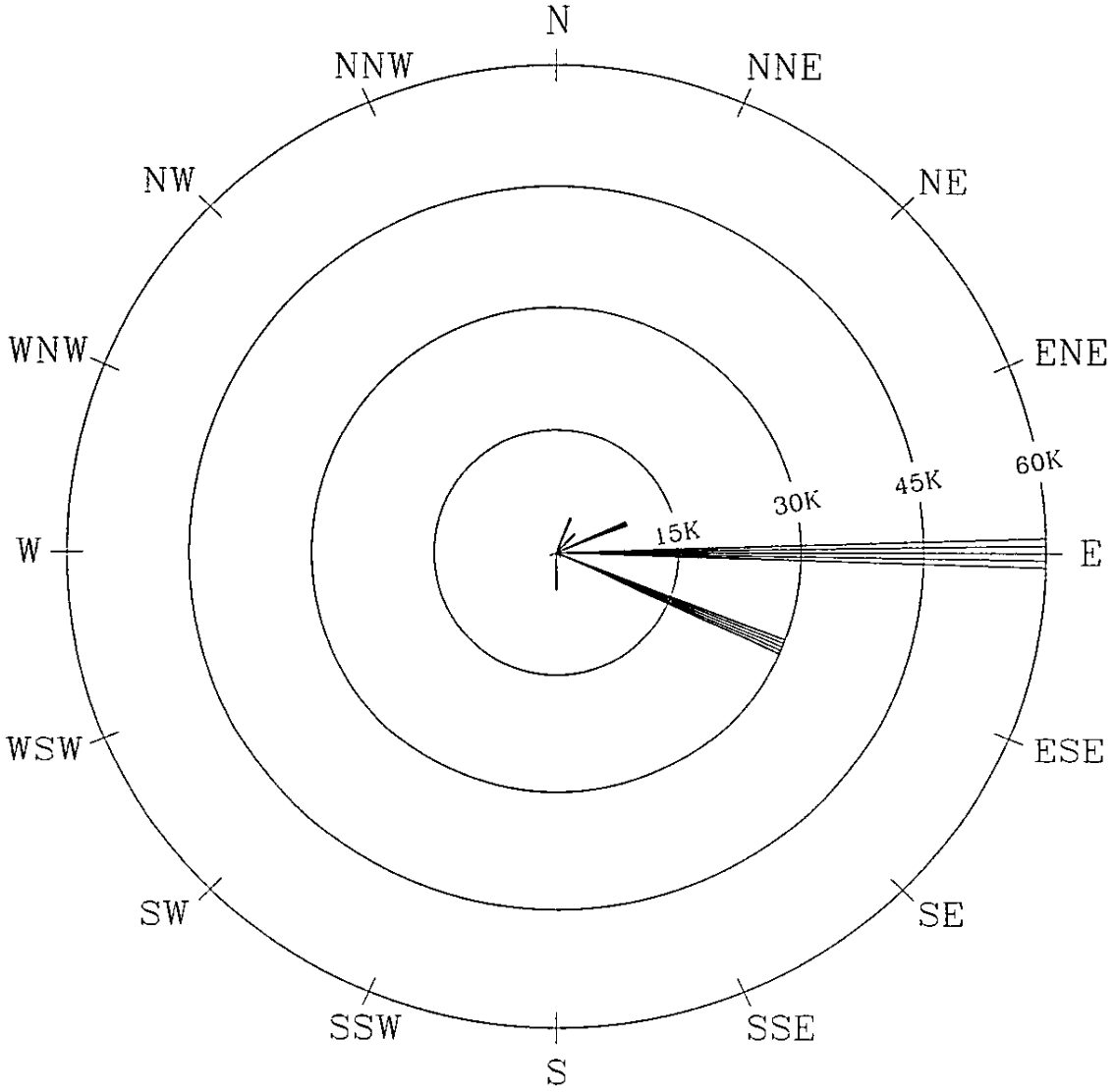


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: Butane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Butane concentrations collected in canisters at the North site during HRVOC strike events. Butane was detected in 120 of 126 samples collected over 20 months, averaging 37.8 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Butane

FIGURE 29: POLLUTANT ROSE OF MAXIMUM BUTANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

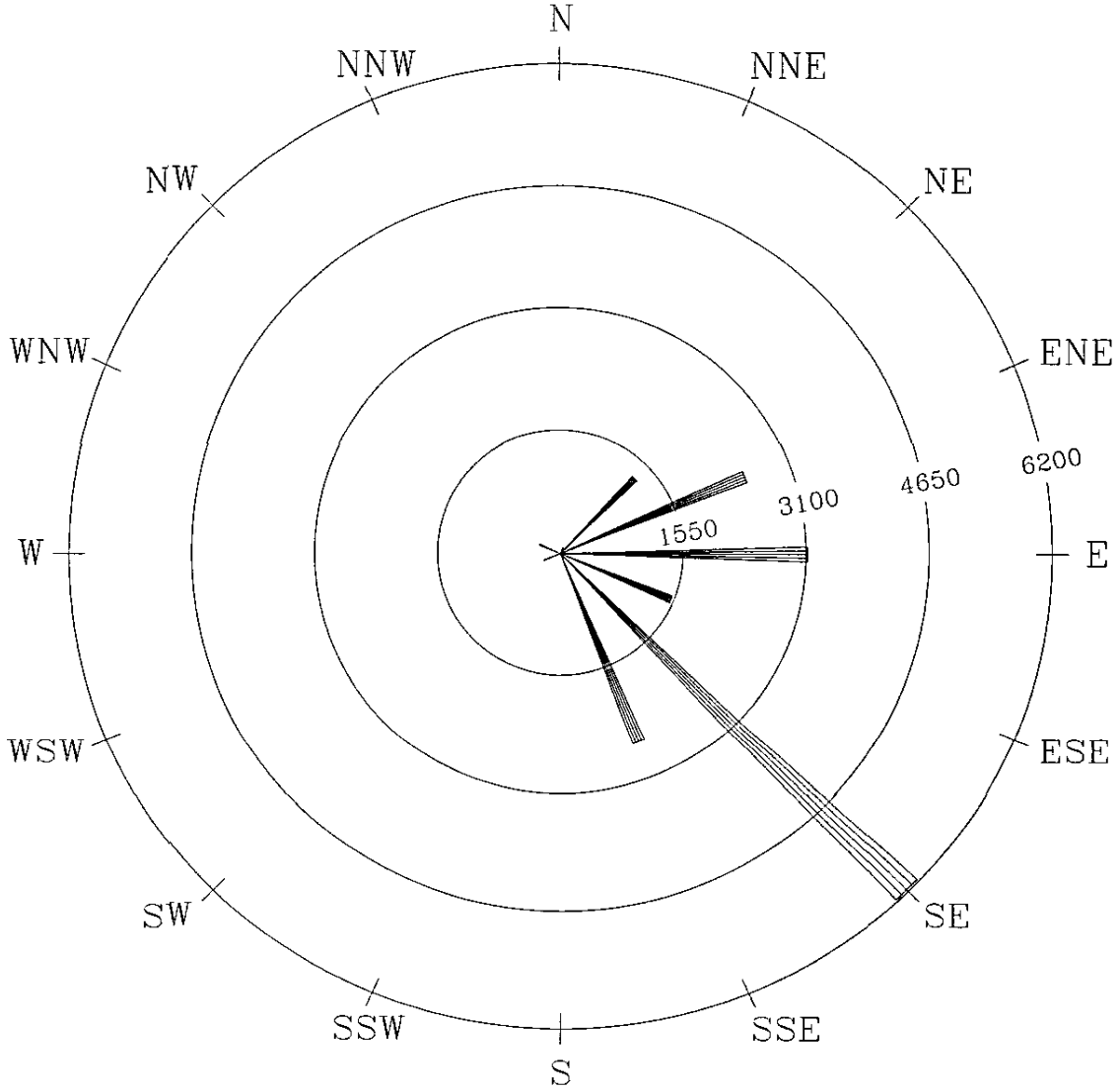


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: Butane Maximum Concentration Plot
Time Period Depicted: 5/1/05 – 12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum Butane concentrations collected in canisters at the North site during HRVOC strike events. Butane was detected in 120 of 126 samples collected over 20 months, averaging 37.8 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Butane

FIGURE 30: POLLUTANT ROSE OF AVERAGE BUTANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

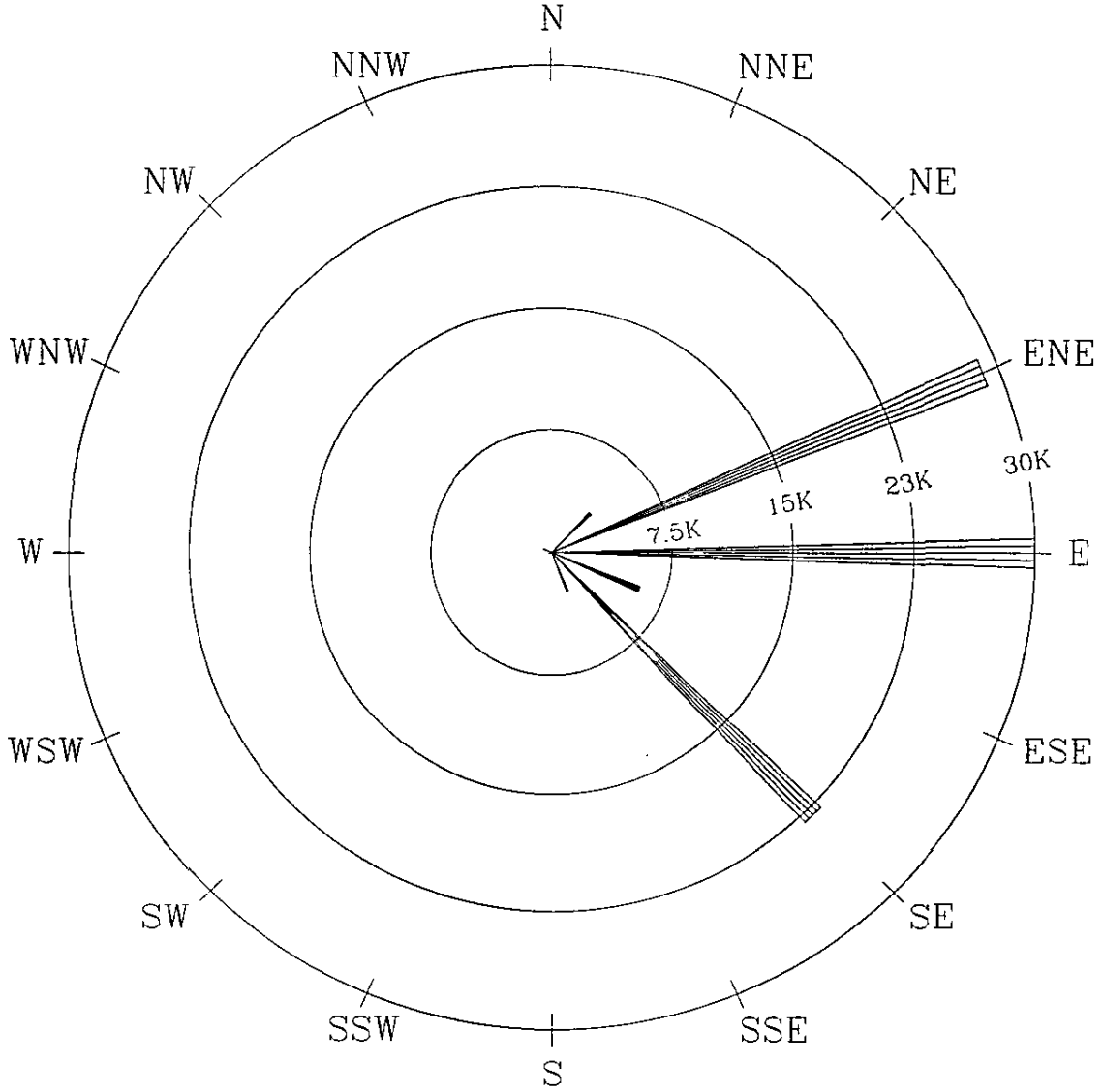


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: Butane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Butane concentrations collected in canisters at the South site during HRVOC strike events. Butane was detected in 104 of 111 samples collected over 20 months, averaging 33.9 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Butane

FIGURE 31: POLLUTANT ROSE OF MAXIMUM BUTANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

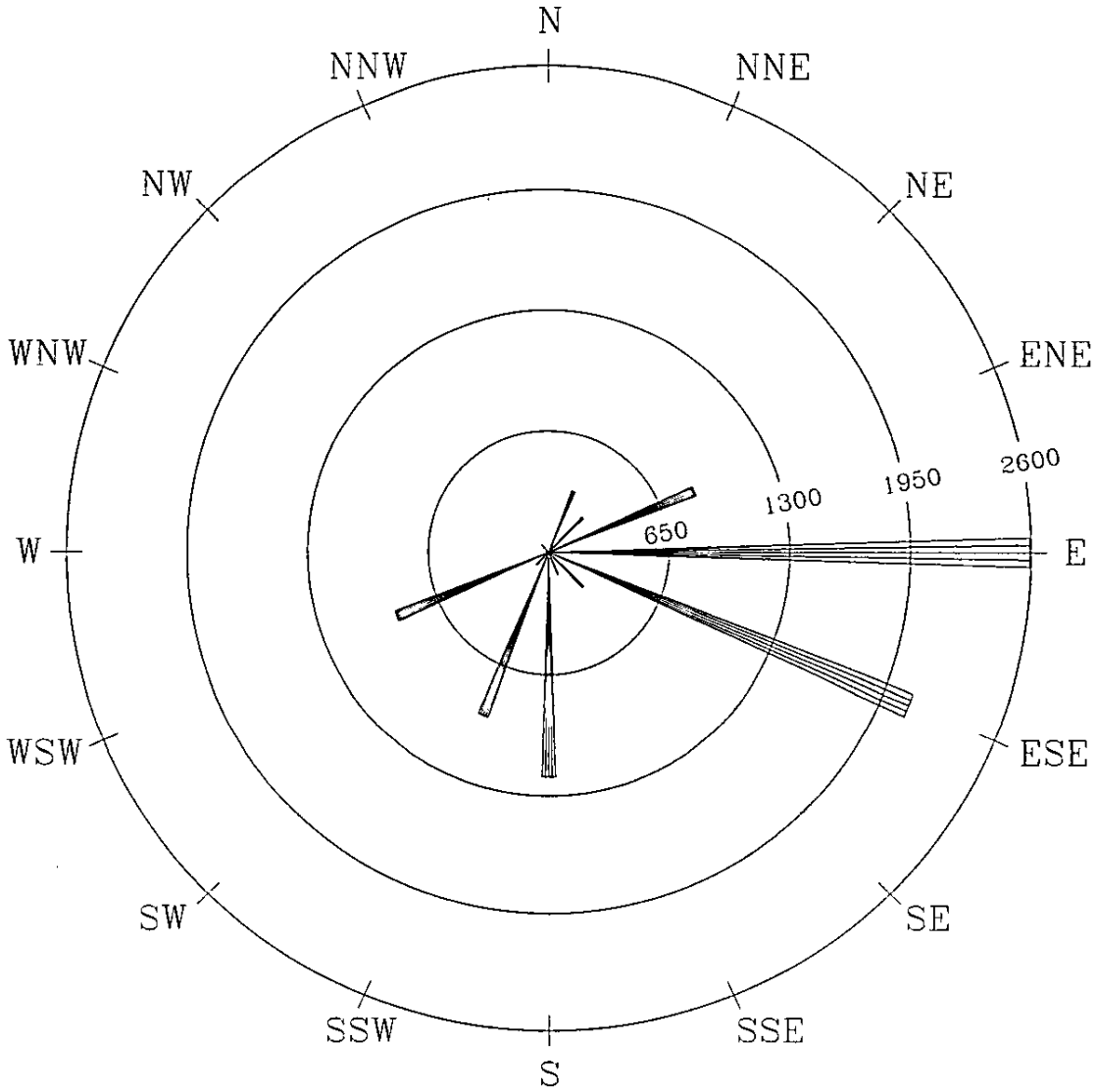


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: Butane Maximum Concentration Plot
Time Period Depicted: 5/1/05 - 12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum Butane concentrations collected in canisters at the South site during HRVOC strike events. Butane was detected in 104 of 111 samples collected over 20 months, averaging 33.9 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Butane

FIGURE 32: POLLUTANT ROSE OF AVERAGE ISOPENTANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

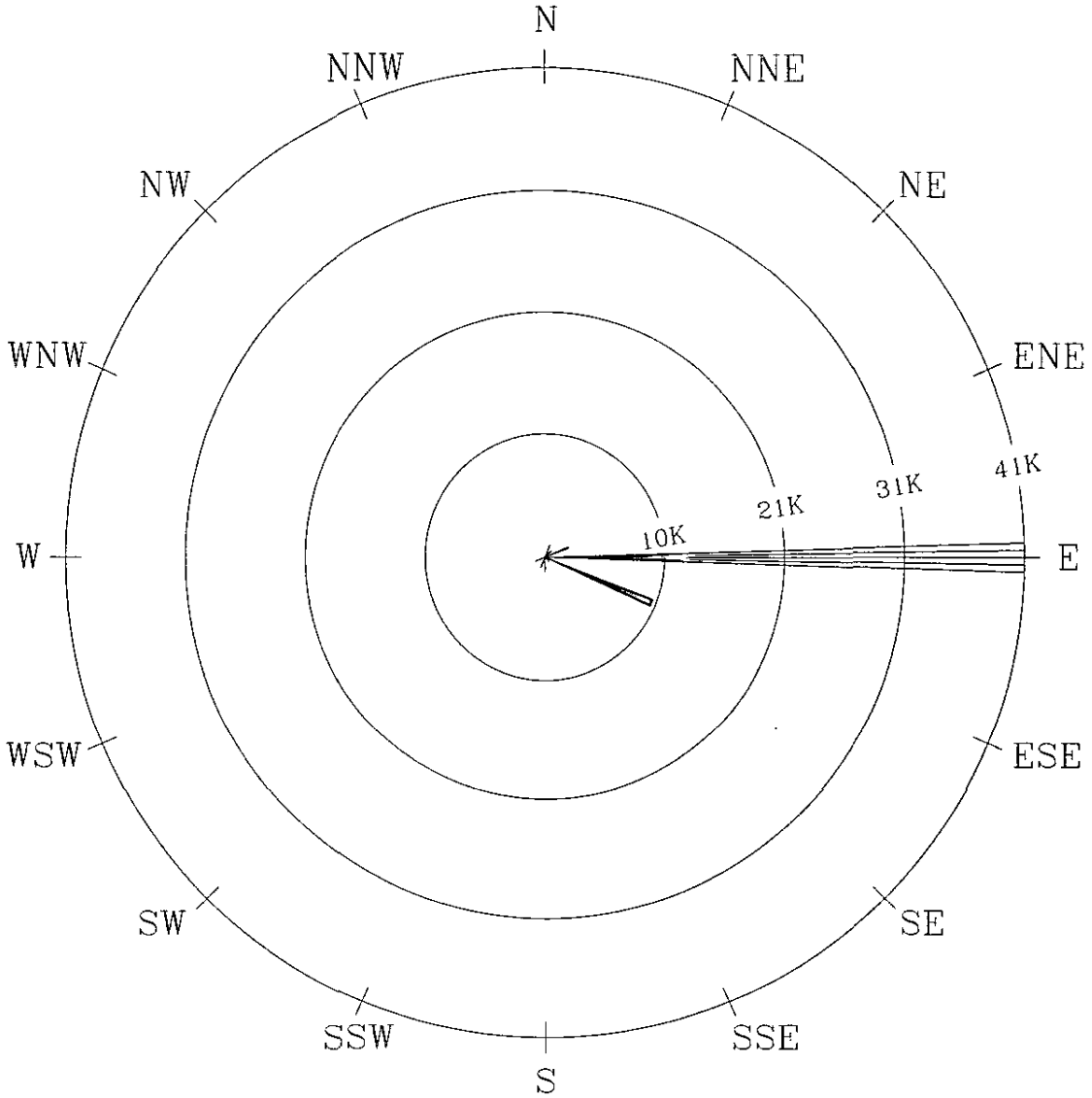


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: Isopentane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Isopentane concentrations collected in canisters at the North site during HRVOC strike events. Isopentane was detected in 122 of 126 samples collected over 20 months, averaging 3.3 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Isopentane

FIGURE 33: POLLUTANT ROSE OF MAXIMUM ISOPENTANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

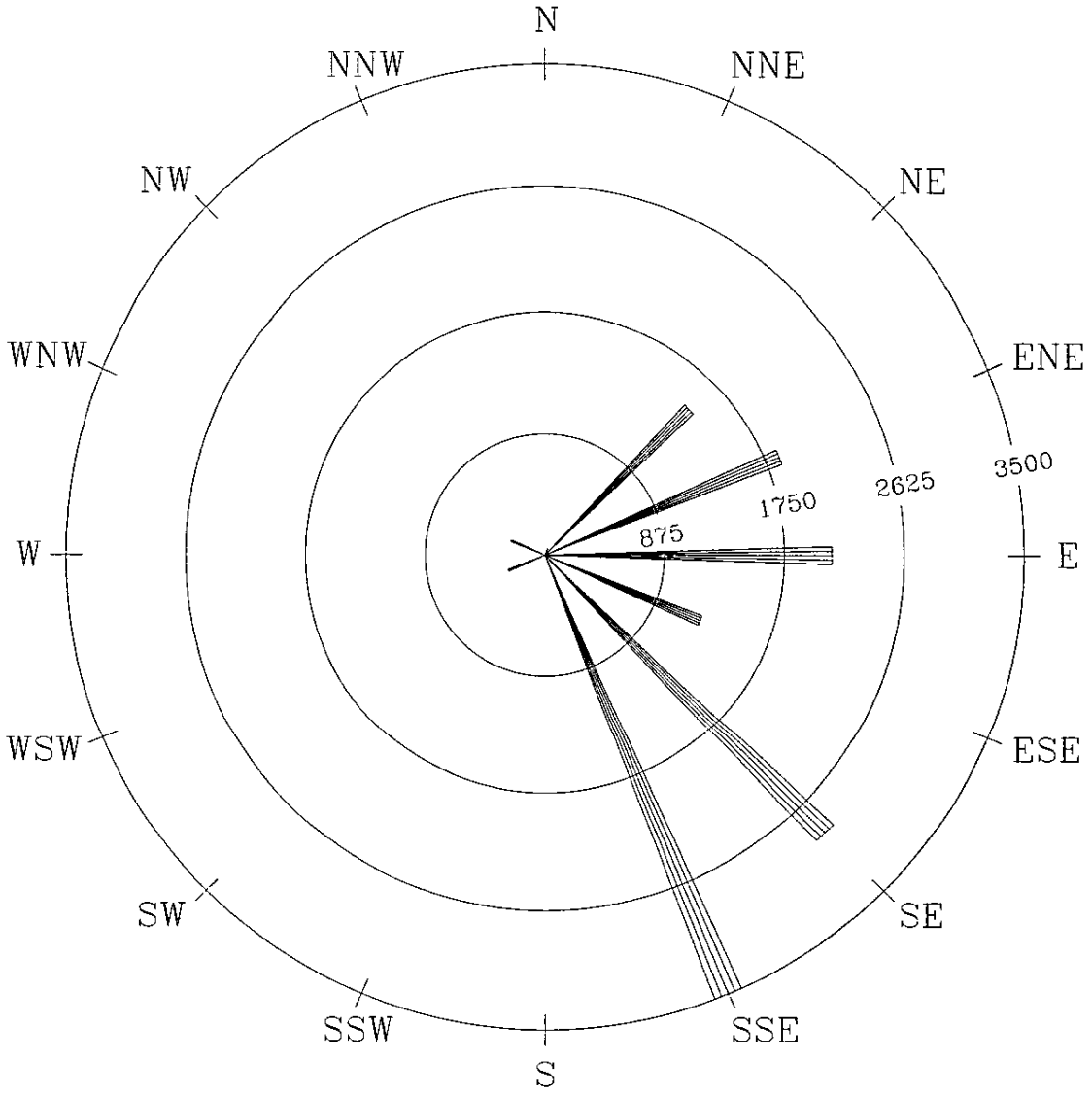


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: Isopentane Maximum Concentration Plot
Time Period Depicted: 5/1/05 - 12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum Isopentane concentrations collected in canisters at the North site during HRVOC strike events. Isopentane was detected in 122 of 126 samples collected over 20 months, averaging 3.3 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe Line facility are a potential emissions source for Isopentane

FIGURE 34: POLLUTANT ROSE OF AVERAGE ISOPENTANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

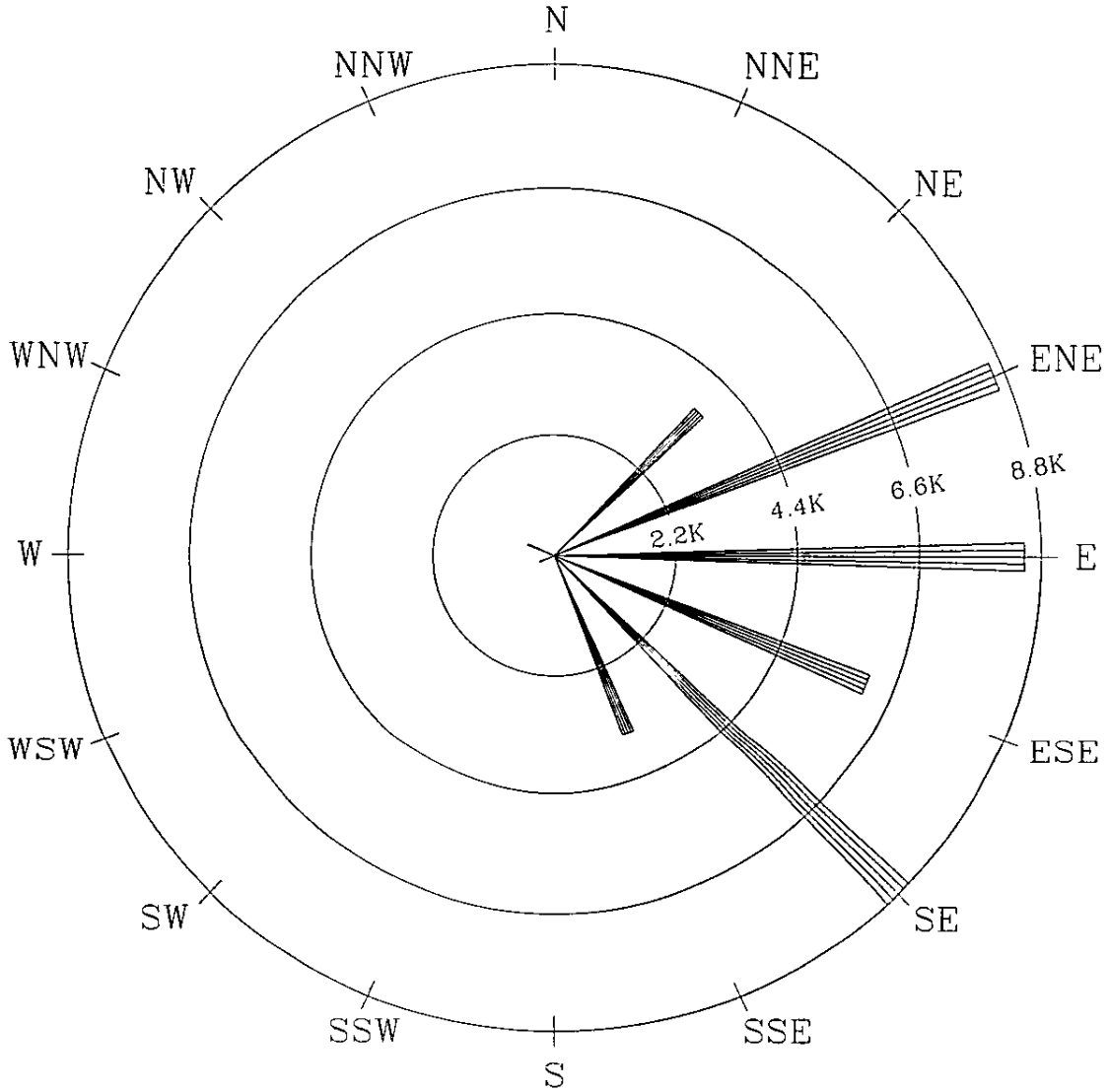


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: Isopentane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Isopentane concentrations collected in canisters at the South site during HRVOC strike events. Isopentane was detected in 104 of 111 samples collected over 20 months, averaging 24.5 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Isopentane

FIGURE 35: POLLUTANT ROSE OF MAXIMUM ISOPENTANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

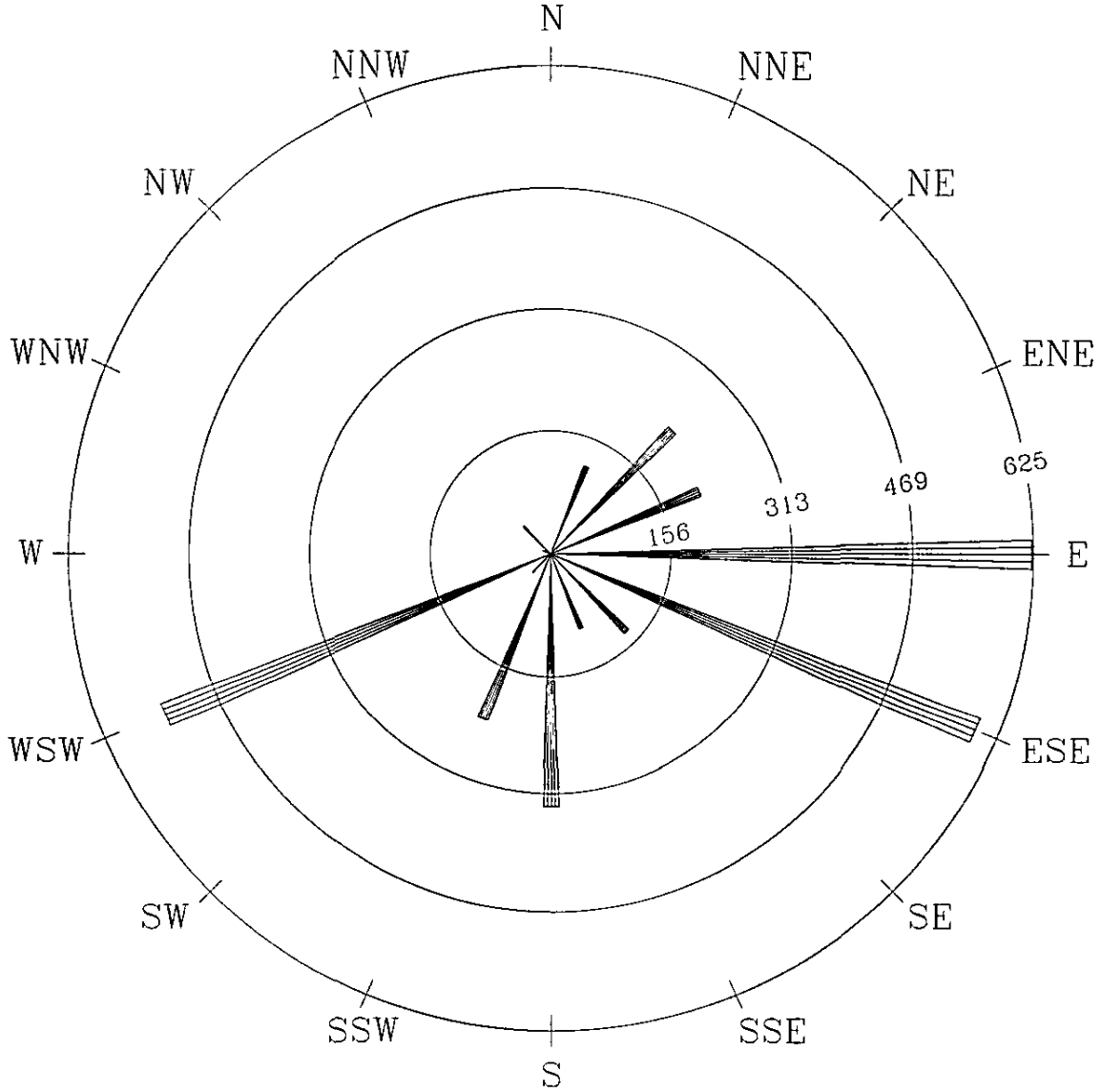


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: Isopentane Maximum Concentration Plot
Time Period Depicted: 5/1/05 - 12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum Isopentane concentrations collected in canisters at the South site during HRVOC strike events. Isopentane was detected in 104 of 111 samples collected over 20 months, averaging 24.5 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Isopentane

FIGURE 36: POLLUTANT ROSE OF AVERAGE PENTANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

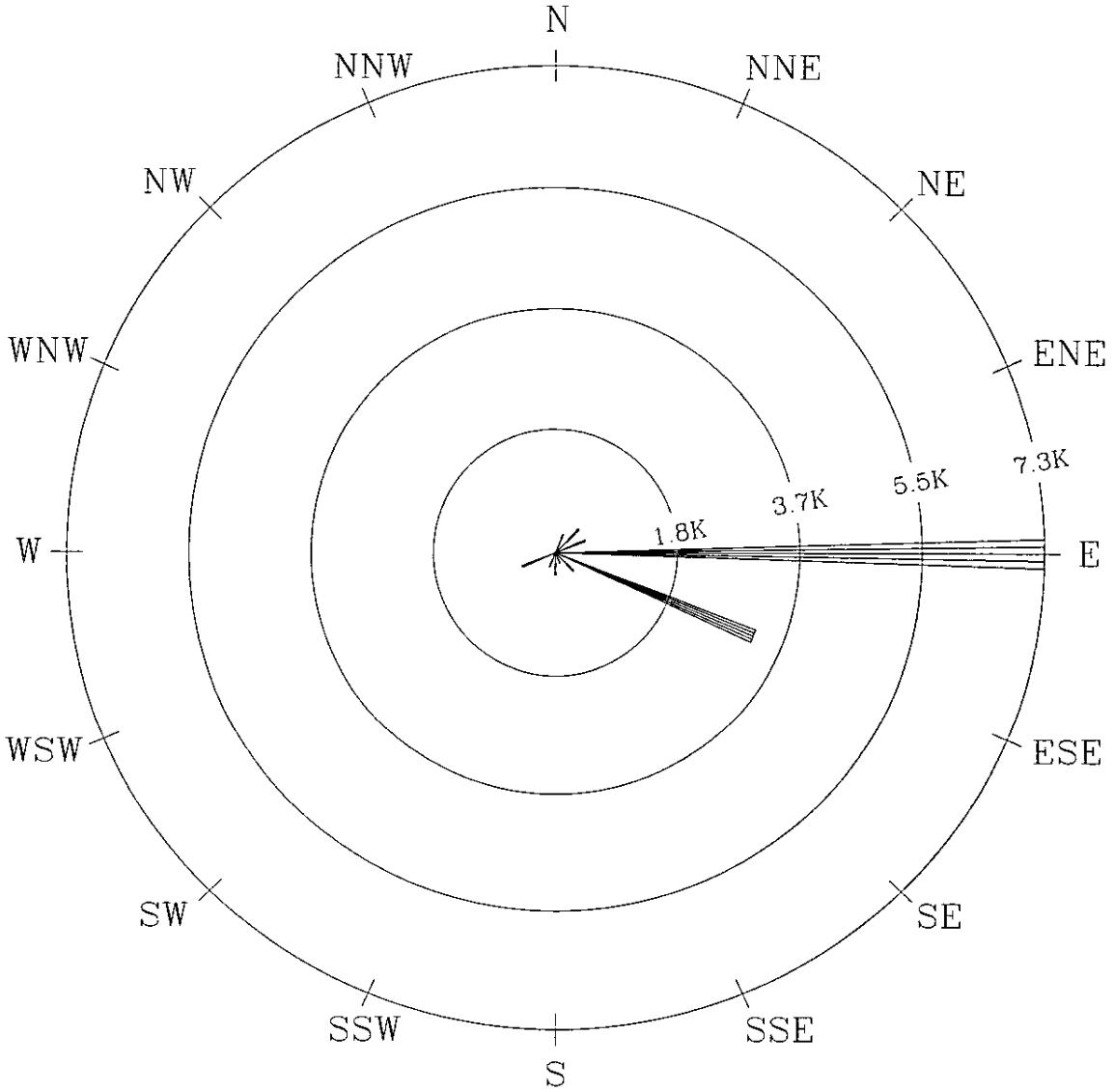


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: Pentane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Pentane concentrations collected in canisters at the North site during HRVOC strike events. Pentane was detected in 122 of 126 samples collected over 20 months, averaging 6.1 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Pentane

FIGURE 37: POLLUTANT ROSE OF MAXIMUM PENTANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

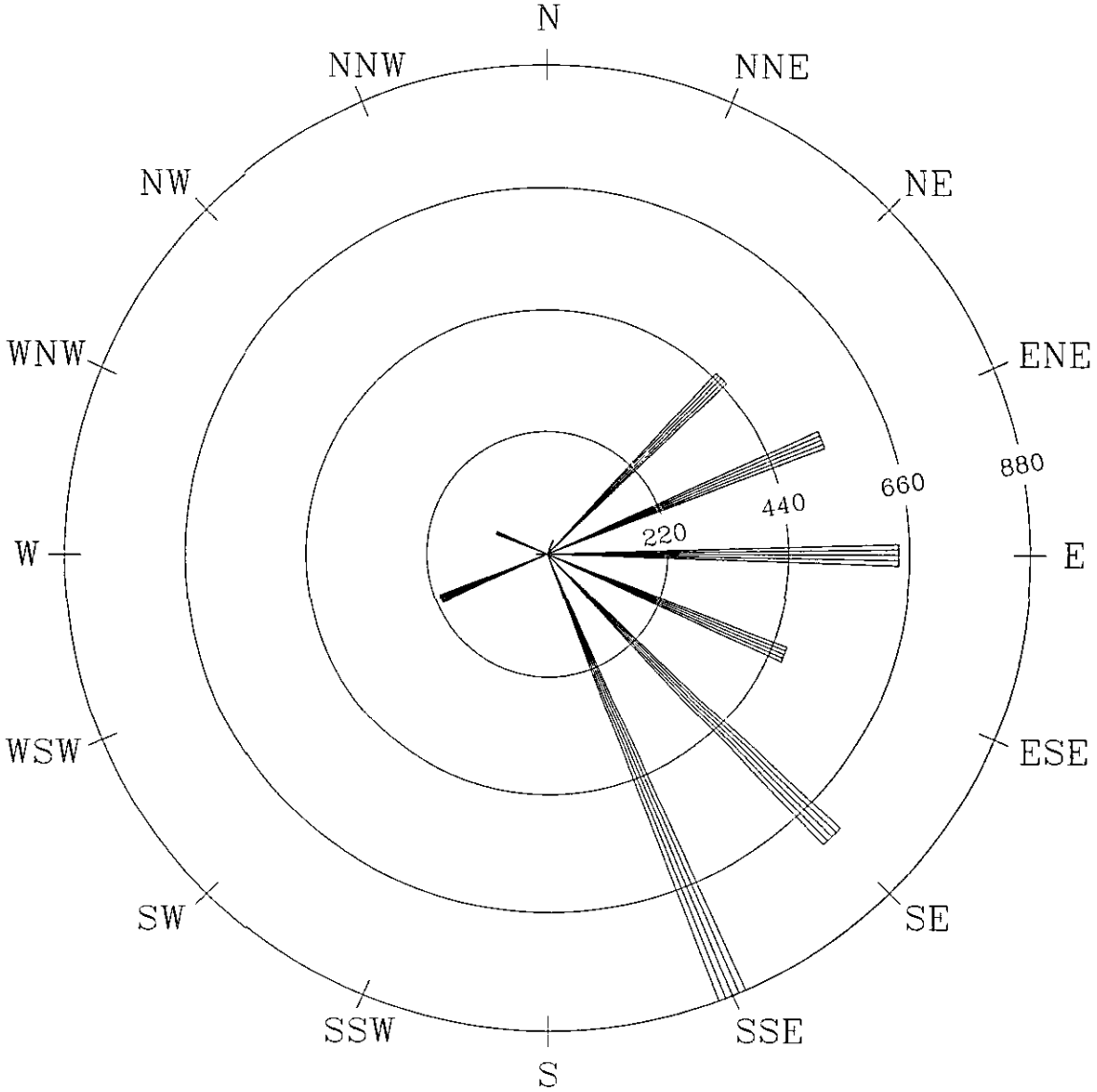


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: Pentane Maximum Concentration Plot
Time Period Depicted: 5/1/05 – 12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum Pentane concentrations collected in canisters at the North site during HRVOC strike events. Pentane was detected in 122 of 126 samples collected over 20 months, averaging 6.1 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Pentane.

FIGURE 38: POLLUTANT ROSE OF AVERAGE PENTANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

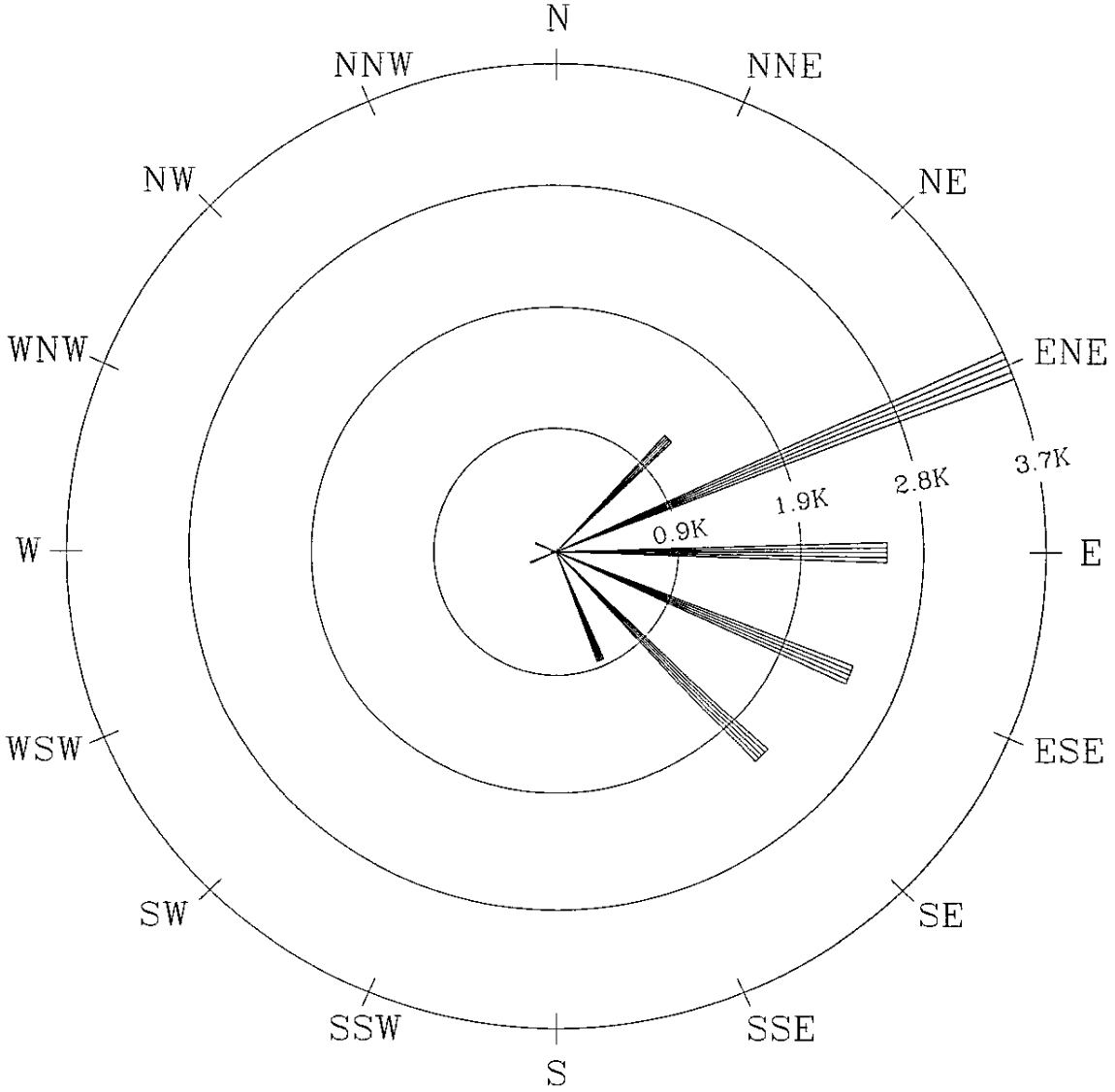


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: Pentane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Pentane concentrations collected in canisters at the South site during HRVOC strike events. Pentane was detected in 107 of 111 samples collected over 20 months, averaging 7.5 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Pentane

FIGURE 39: POLLUTANT ROSE OF MAXIMUM PENTANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

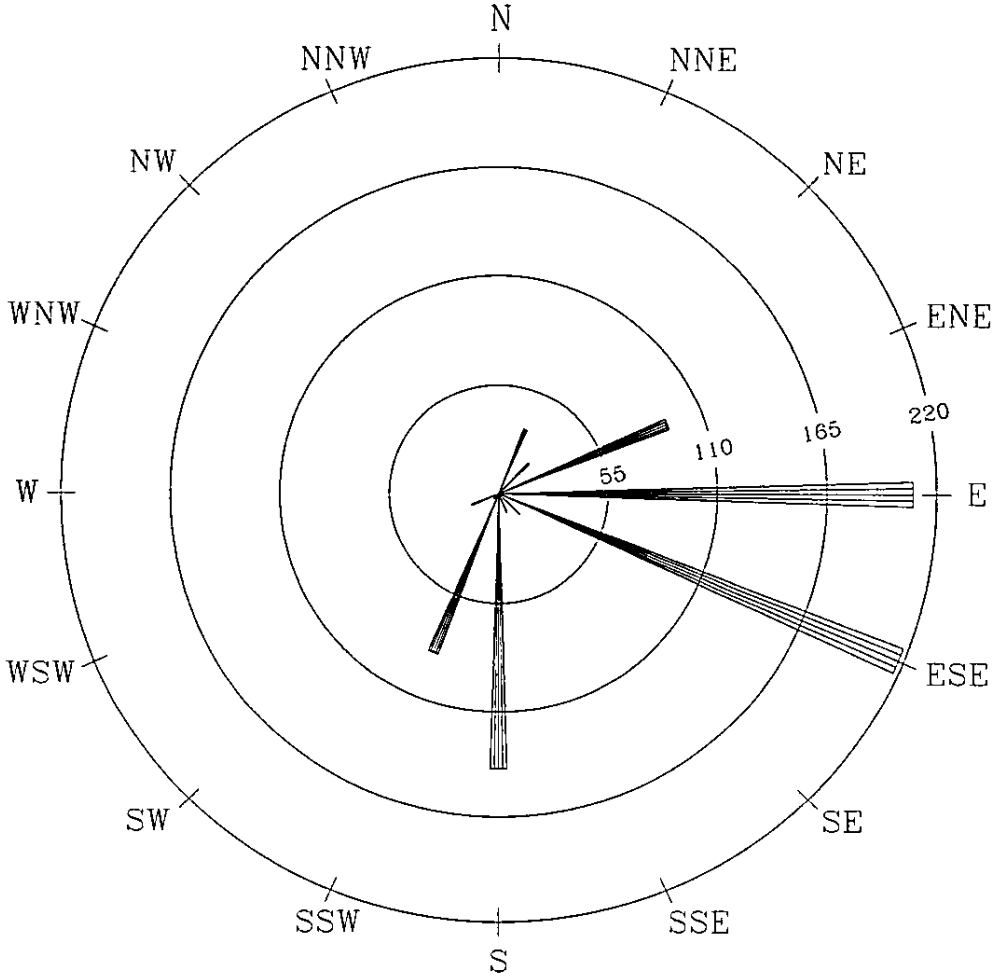


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: Pentane Maximum Concentration Plot
Time Period Depicted: 5/1/05 – 12/31/06
All Pollutant Concentrations Are In Thousands of ppbC

Notes:
Frequency distribution plot of maximum Pentane concentrations collected in canisters at the South site during HRVOC strike events. Pentane was detected in 107 of 111 samples collected over 20 months, averaging 7.5 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Pentane

FIGURE 40: POLLUTANT ROSE OF AVERAGE TRANS-2-PENTENE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

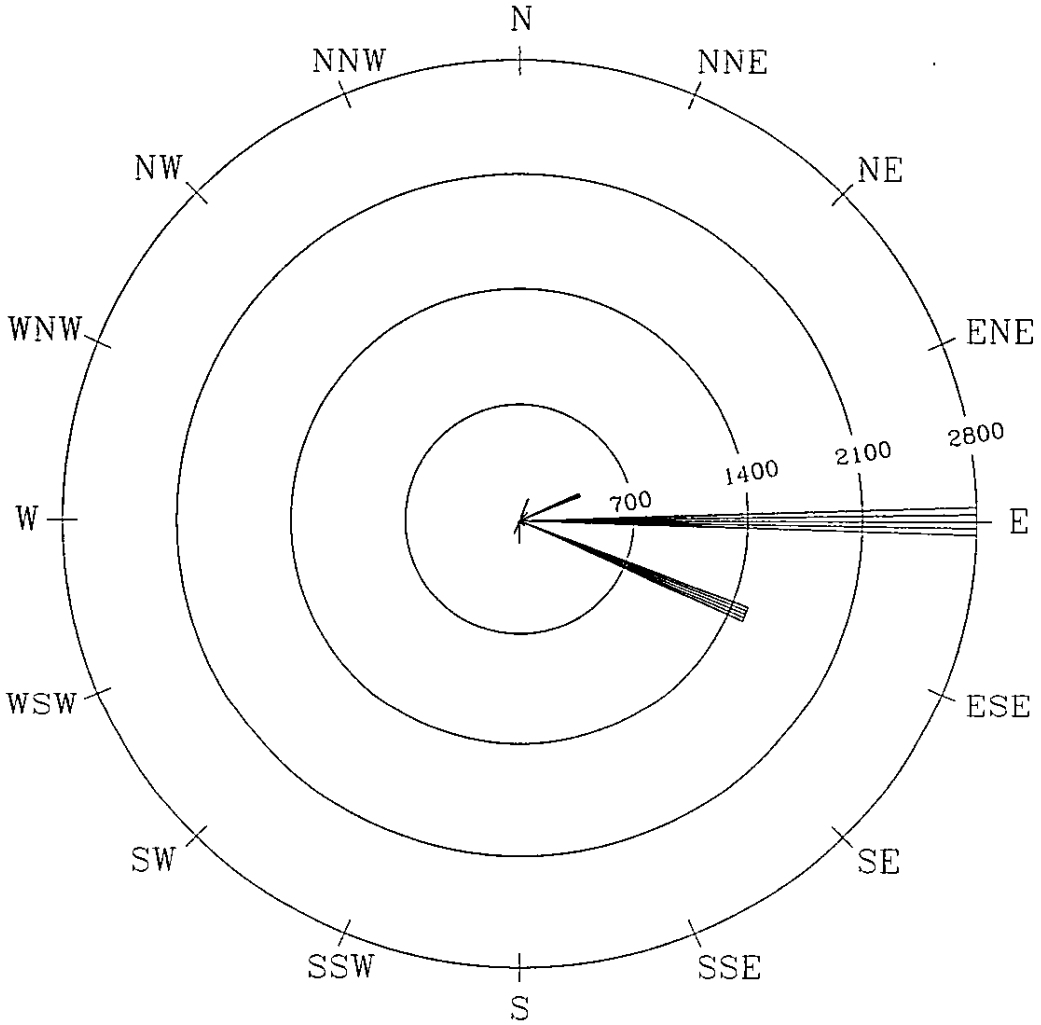


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: trans-2-Pentene Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged trans-2-Pentene concentrations as measured from HRVOC canister samples collected at the North site. trans-2-Pentene was detected in 47 percent of the 98 canister samples collected over the 20-month project, averaging 4.7 percent of the total carbon in these samples. The Plantation Pipeline plant is not a significant source for trans-2-Pentene emissions.

FIGURE 41: POLLUTANT ROSE OF MAXIMUM TRANS-2-PENTENE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

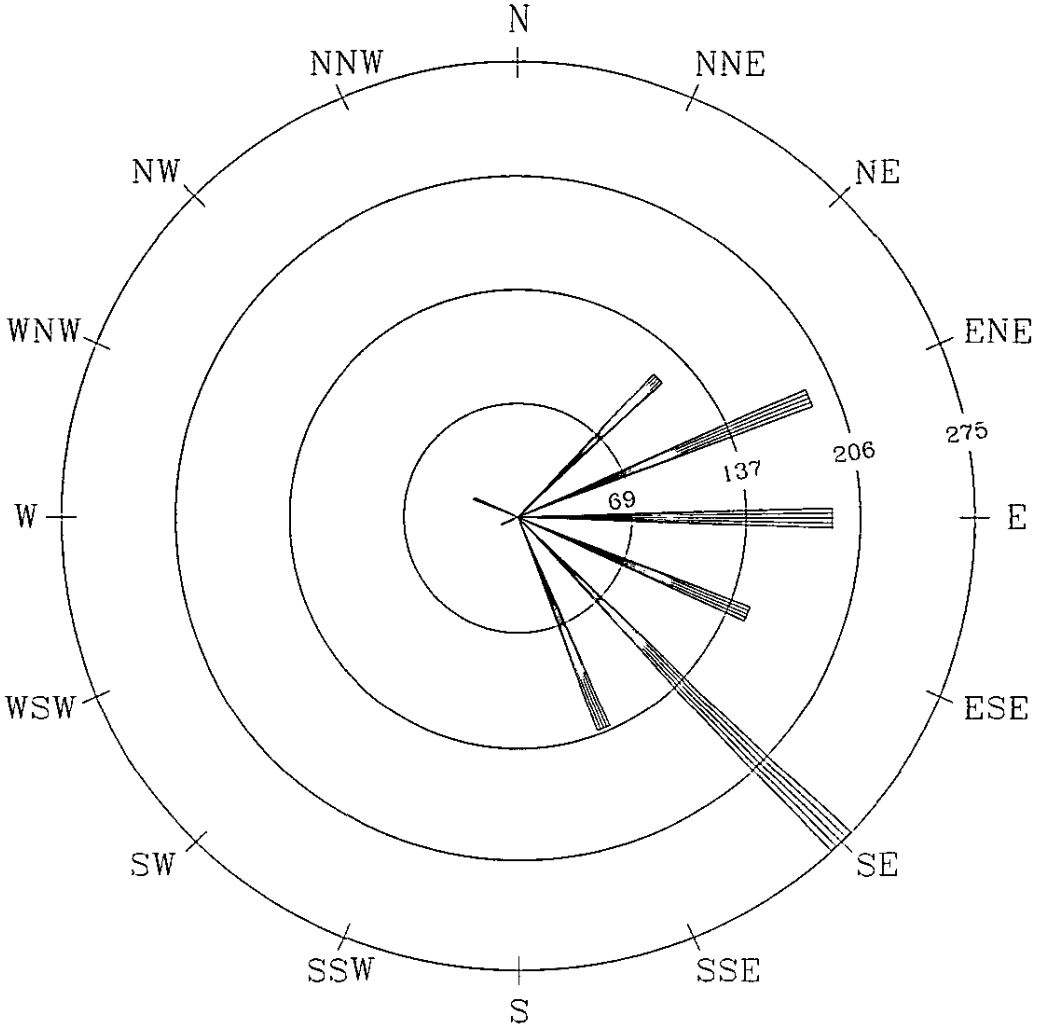


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: trans-2-Pentene Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum trans-2-Pentene concentrations collected in canisters at the North site during HRVOC strike events. Trans-2-Pentene was detected in 101 of 126 samples collected over 20 months, averaging 2.1 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for trans-2-Pentene.

FIGURE 42: POLLUTANT ROSE OF AVERAGE TRANS-2-PENTENE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

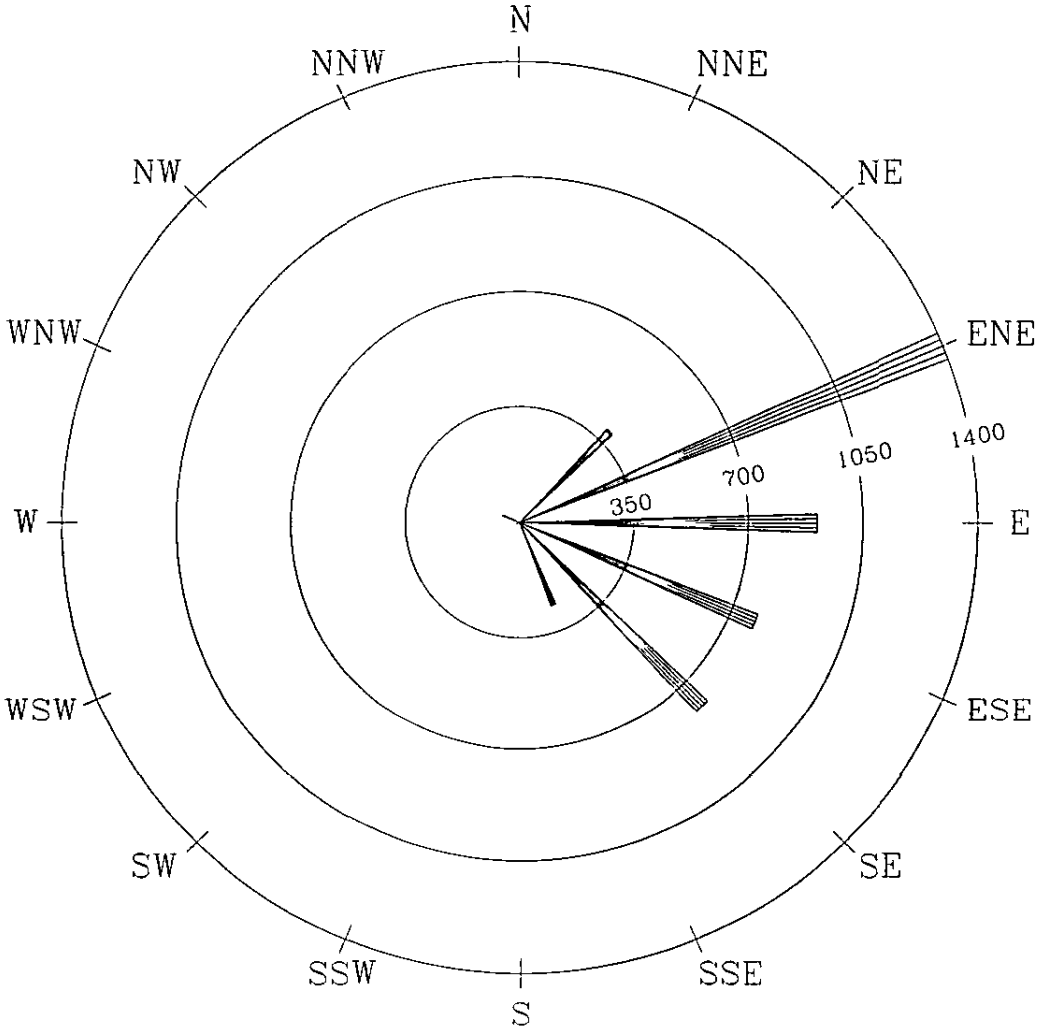


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: trans-2-Pentene Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged trans-2-Pentene concentrations collected in canisters at the South site during HRVOC strike events. Trans-2-Pentene was detected in 95 of 111 samples collected over 20 months, averaging 2.4 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe Line facility are a potential emissions source for trans-2-Pentene.

FIGURE 43: POLLUTANT ROSE OF MAXIMUM TRANS-2-PENTENE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

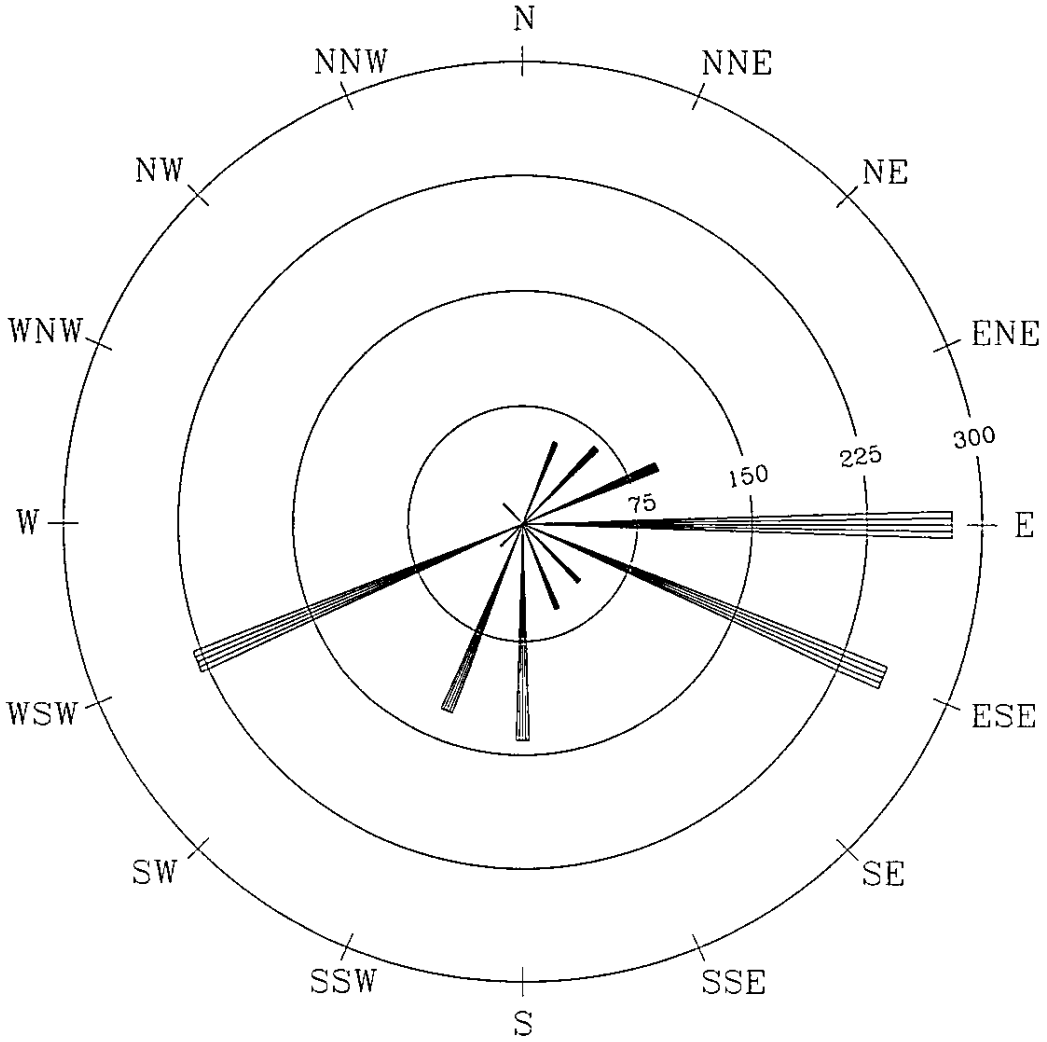


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: trans-2-Pentene Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum trans-2-Pentene concentrations collected in canisters at the South site during HRVOC strike events. Trans-2-Pentene was detected in 95 of 111 samples collected over 20 months, averaging 2.4 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for trans-2-Pentene.

FIGURE 44: POLLUTANT ROSE OF AVERAGE 2-METHYLPENTANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

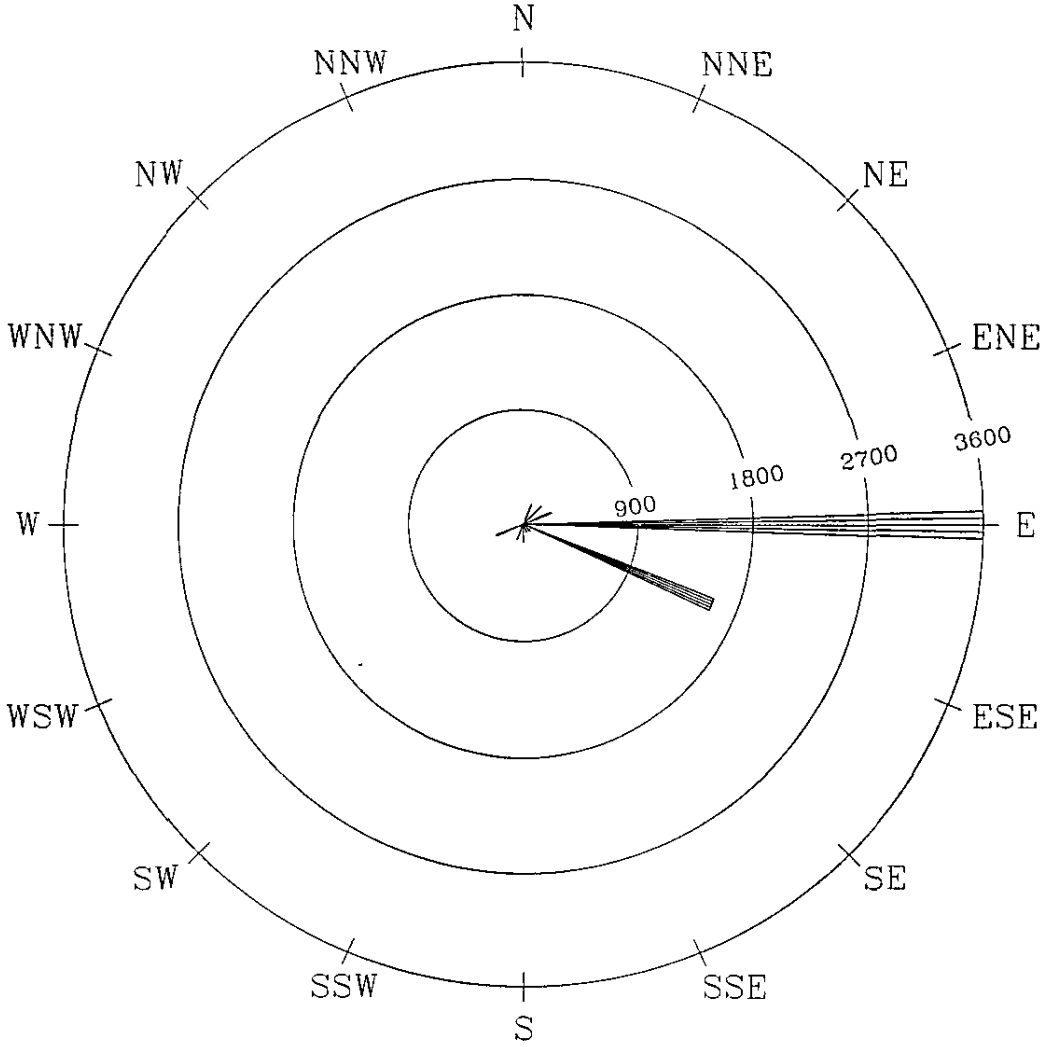


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: 2-Methylpentane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged 2-Methylpentane concentrations collected in canisters at the North site during HRVOC strike events. 2-Methlypentane was detected in 117 of 126 samples collected over 20 months, averaging 2.7 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for 2-Methylpentane.

FIGURE 45: POLLUTANT ROSE OF MAXIMUM 2-METHYLPENTANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

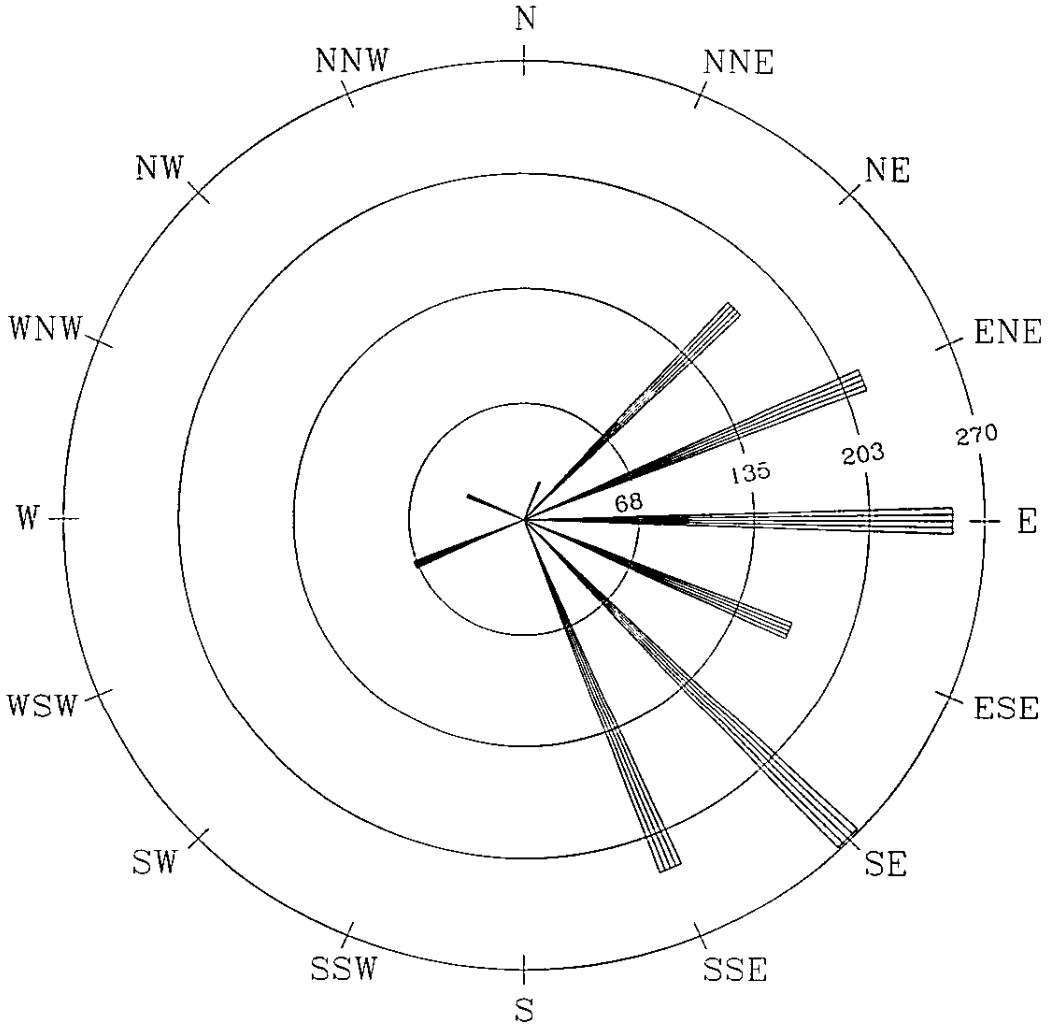


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: 2-Methylpentane Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum 2-Methylpentane concentrations collected in canisters at the North site during HRVOC strike events. 2-Methlypentane was detected in 117 of 126 samples collected over 20 months, averaging 2.7 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for 2-Methylpentane.

FIGURE 46: POLLUTANT ROSE OF AVERAGE 2-METHYLPENTANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

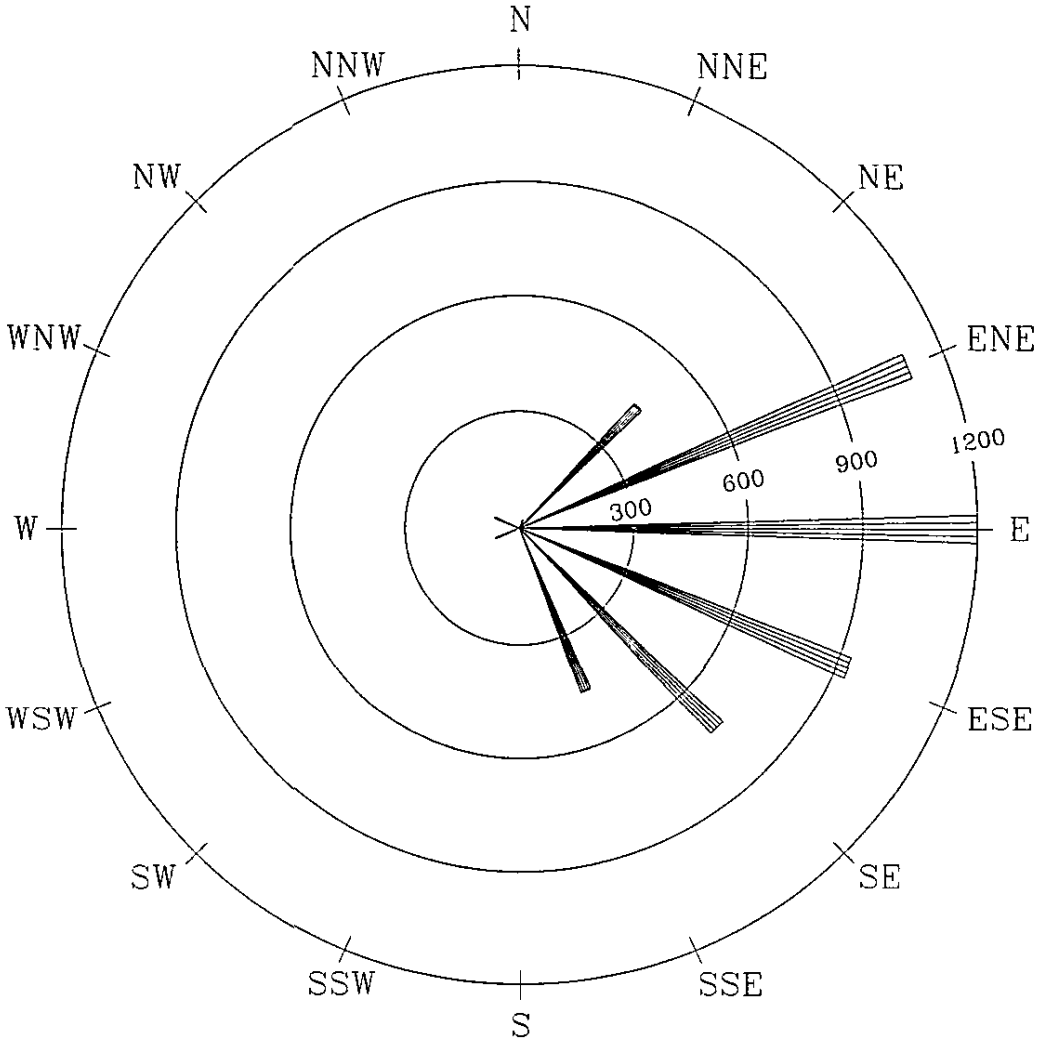


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: 2-Methylpentane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged 2-Methylpentane concentrations collected in canisters at the South site during HRVOC strike events. 2-Methlypentane was detected in 100 of 111 samples collected over 20 months, averaging 3.0 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe Line facility are a potential emissions source for 2-Methylpentane.

FIGURE 47: POLLUTANT ROSE OF MAXIMUM 2-METHYLPENTANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

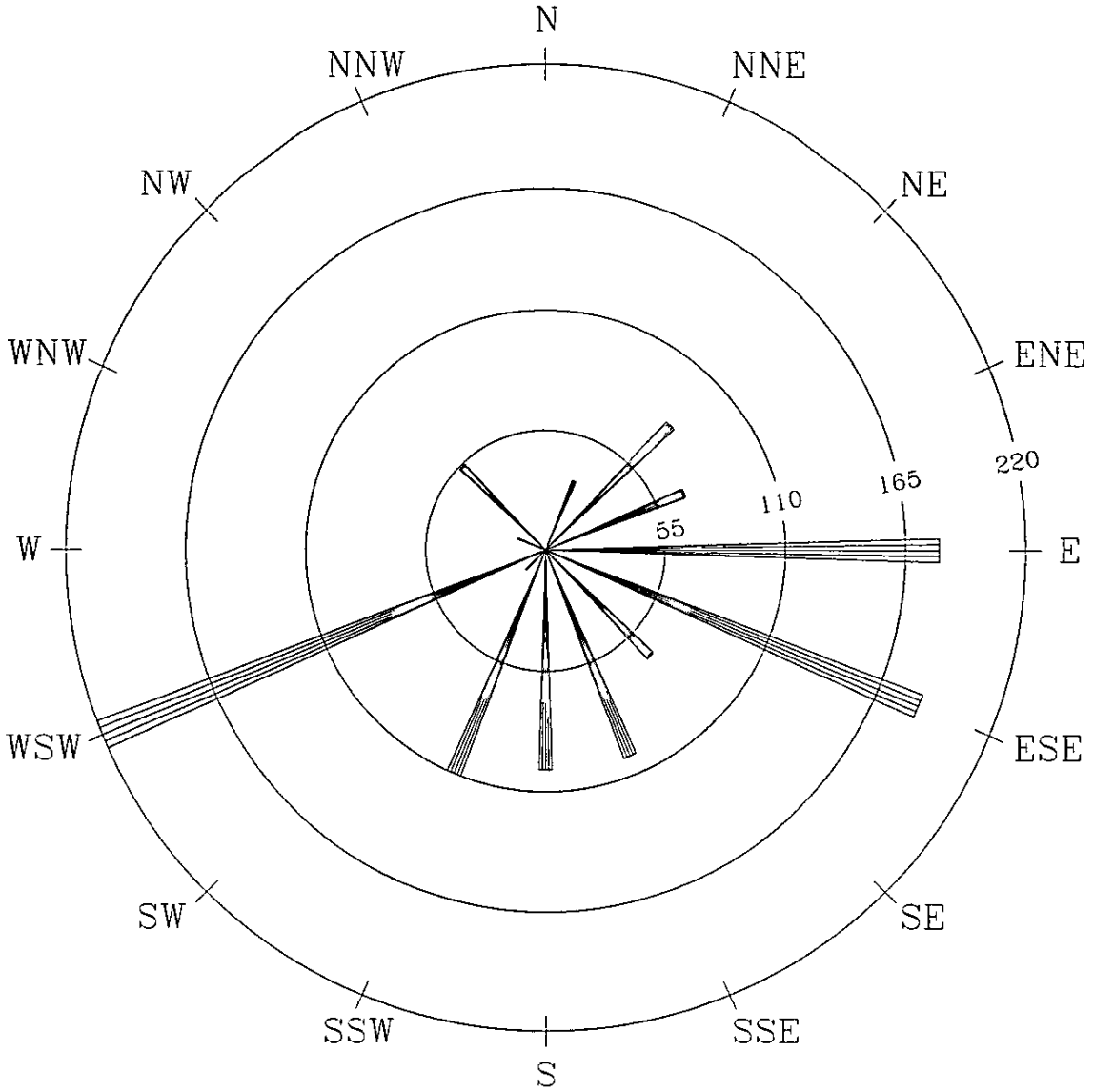


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: 2-Methylpentane Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum 2-Methylpentane concentrations collected in canisters at the South site during HRVOC strike events. 2-Methlypentane was detected in 100 of 111 samples collected over 20 months, averaging 3.0 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe Line facility are a potential emissions source for 2-Methylpentane.

FIGURE 48: POLLUTANT ROSE OF AVERAGE HEXANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

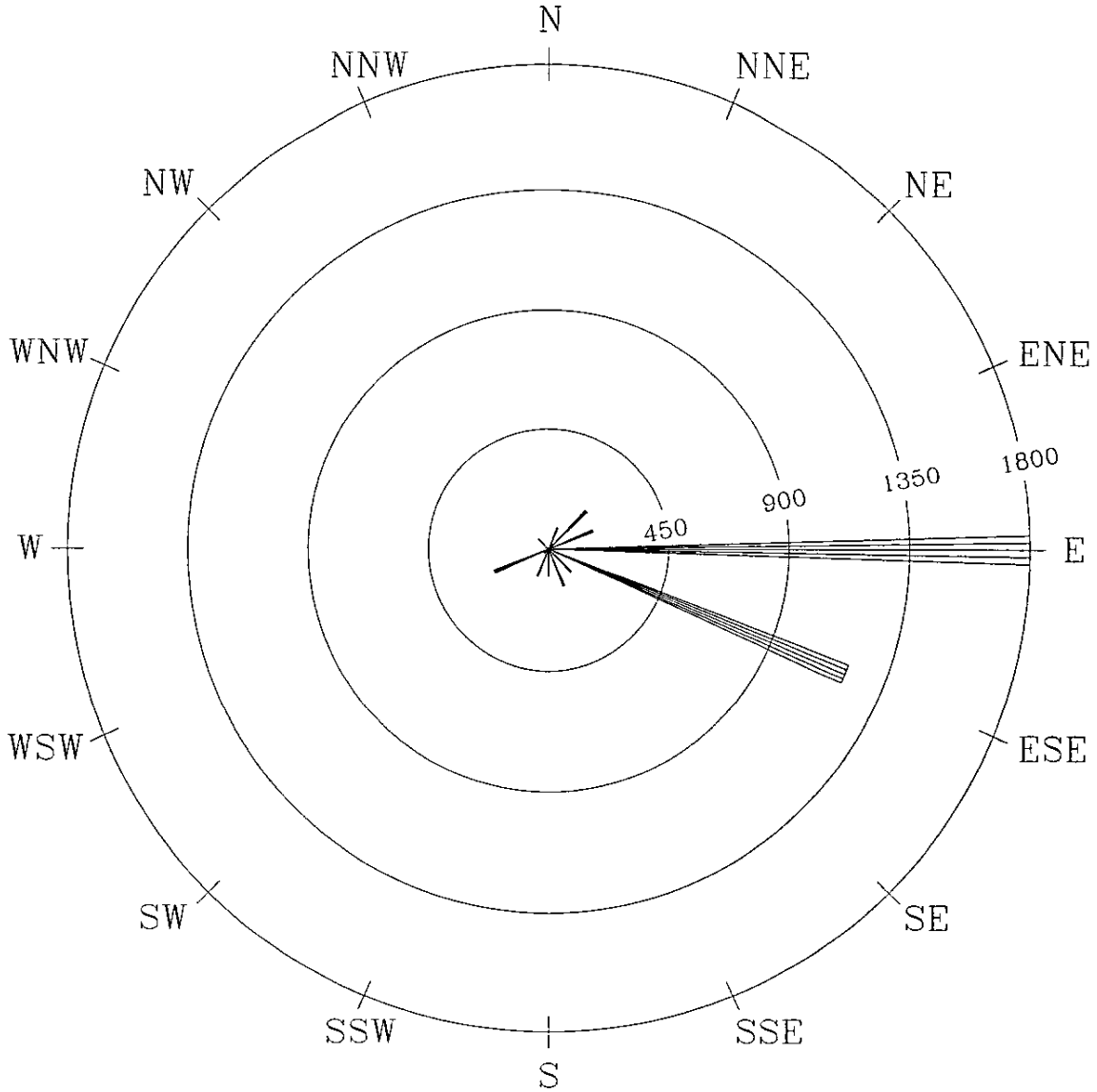


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: Hexane Average Plot
Time Period Depicted: 5/1/05–12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Hexane concentrations collected in canisters at the North site during HRVOC strike events. Hexane was detected in 117 of 126 samples collected over 20 months, averaging 1.9 percent of the total carbon in these samples. Tank–filling activities at the Plantation Pipe LIne facility are a potential emissions source for Hexane.

FIGURE 49: POLLUTANT ROSE OF MAXIMUM HEXANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

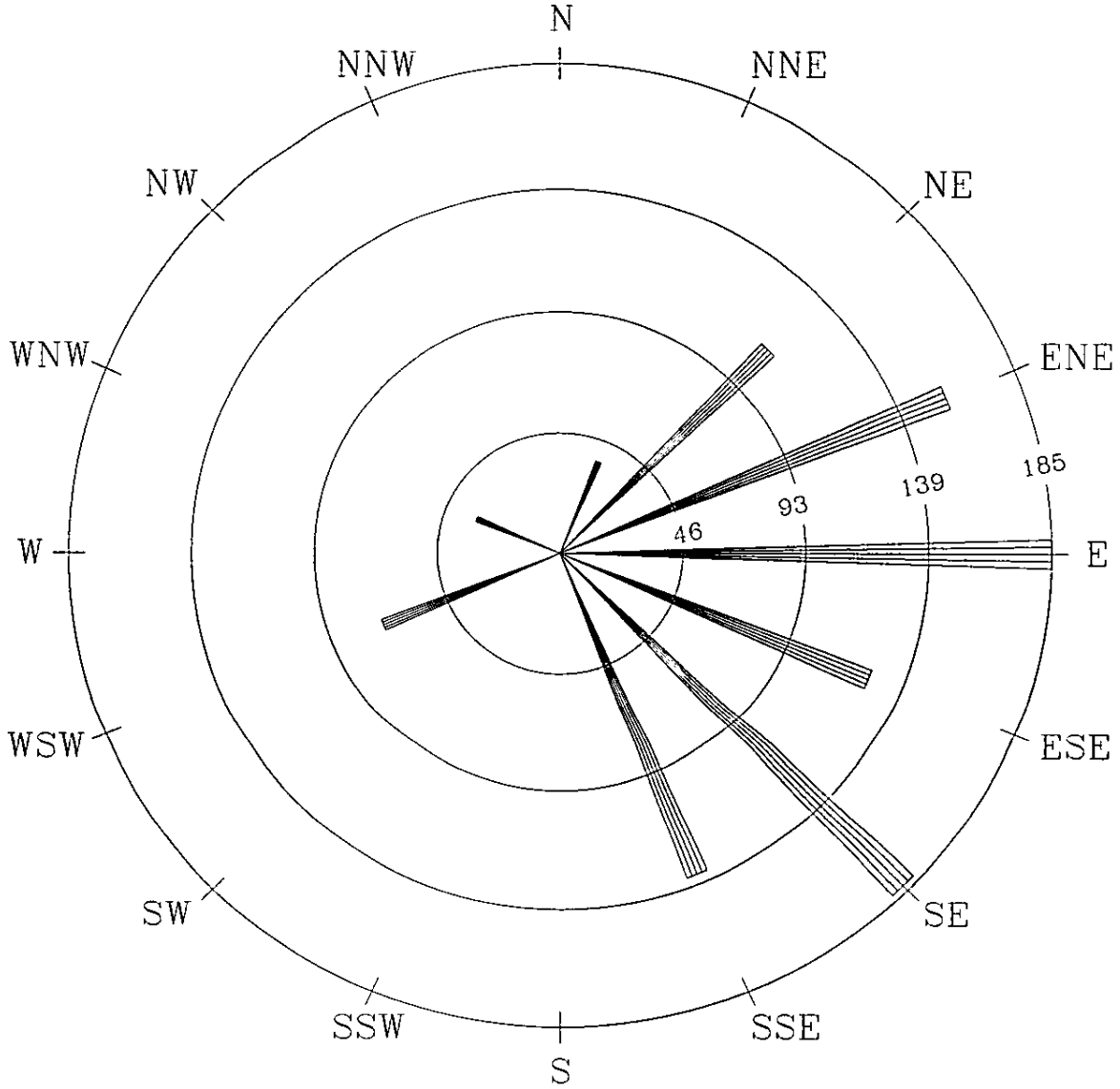


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: Hexane Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum Hexane concentrations collected in canisters at the North site during HRVOC strike events. Hexane was detected in 117 of 126 samples collected over 20 months, averaging 1.9 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Hexane.

FIGURE 50: POLLUTANT ROSE OF AVERAGE HEXANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

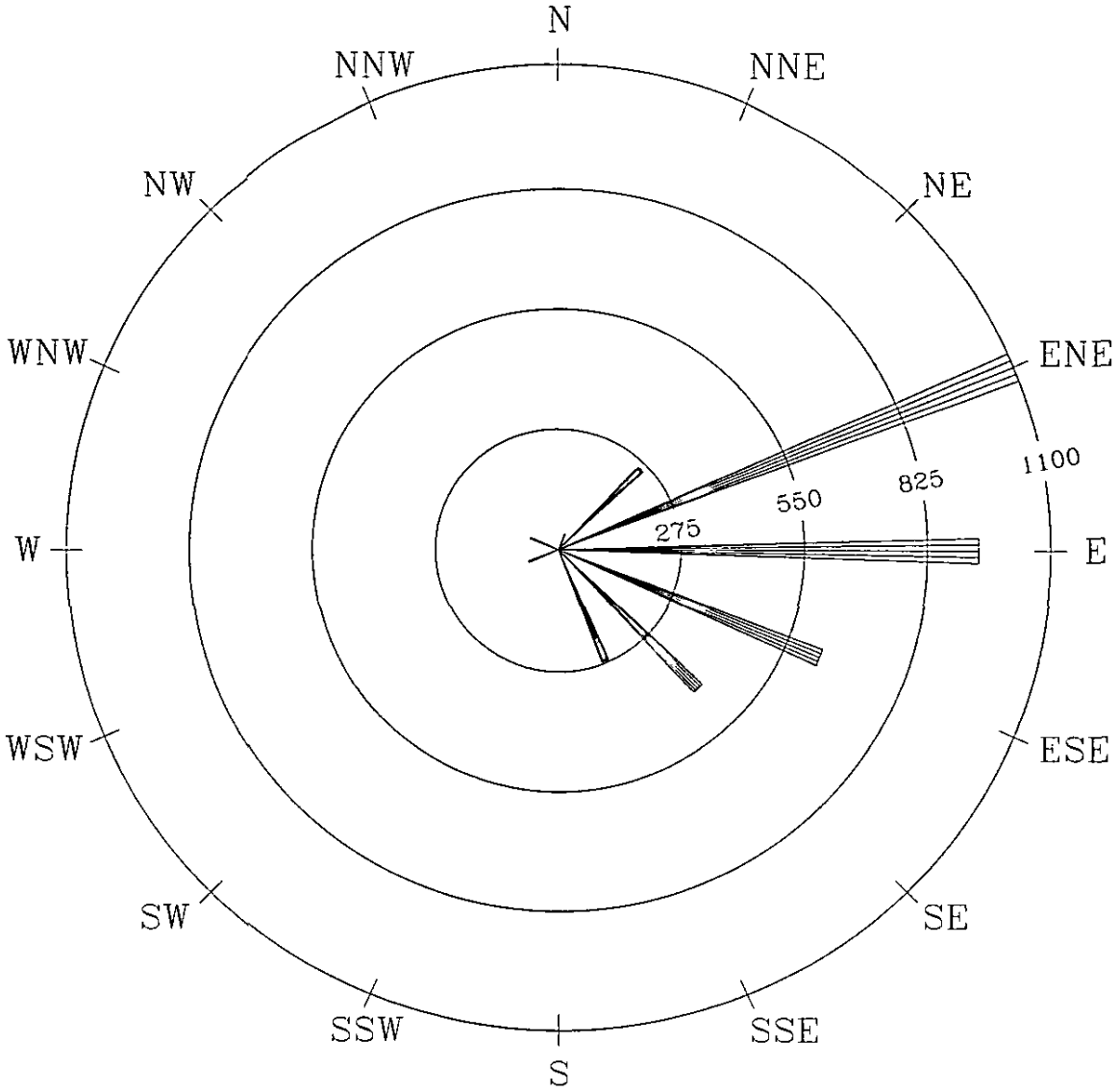


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: Hexane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Hexane concentrations collected in canisters at the South site during HRVOC strike events. Hexane was detected in 97 of 111 samples collected over 20 months, averaging 2.2 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Hexane.

FIGURE 51: POLLUTANT ROSE OF MAXIMUM HEXANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

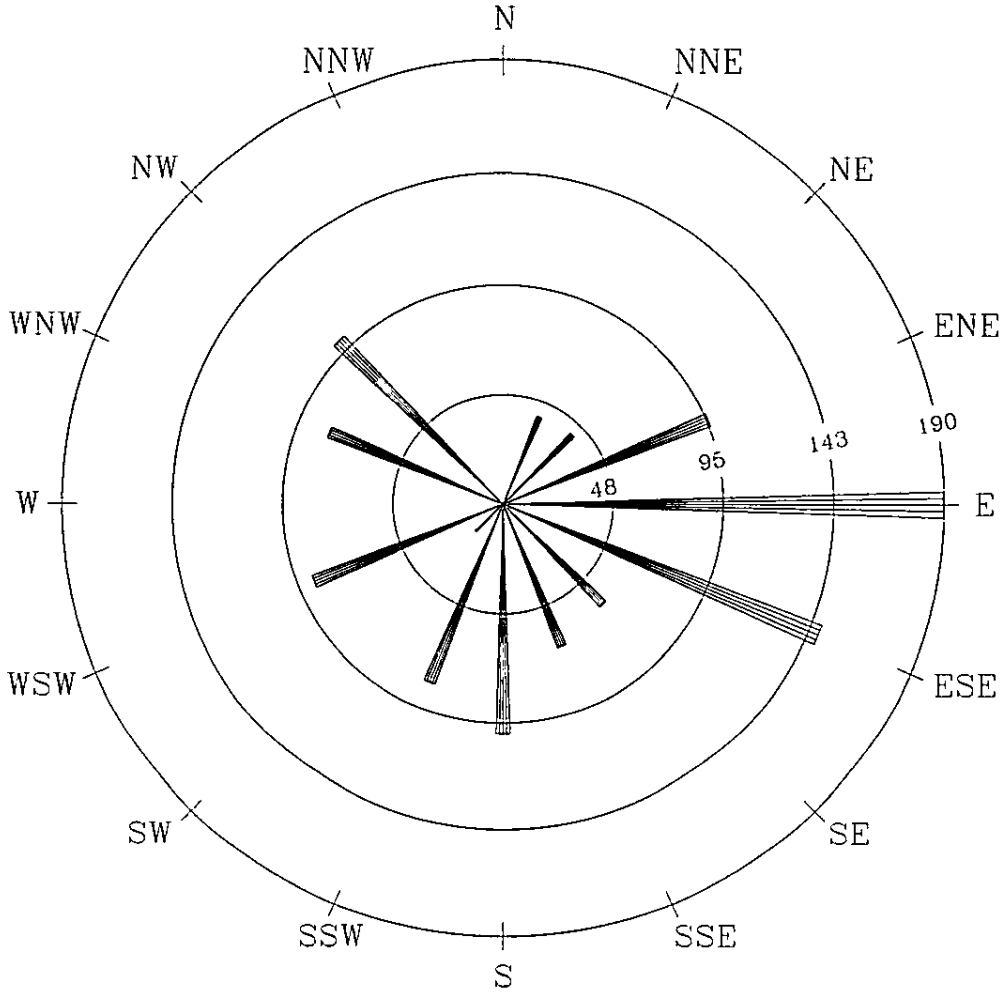


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: Hexane Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum Hexane concentrations collected in canisters at the South site during HRVOC strike events. Hexane was detected in 97 of 111 samples collected over 20 months, averaging 2.2 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Hexane.

FIGURE 52: POLLUTANT ROSE OF AVERAGE 2, 2, 4-TRIMETHYLPENTANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

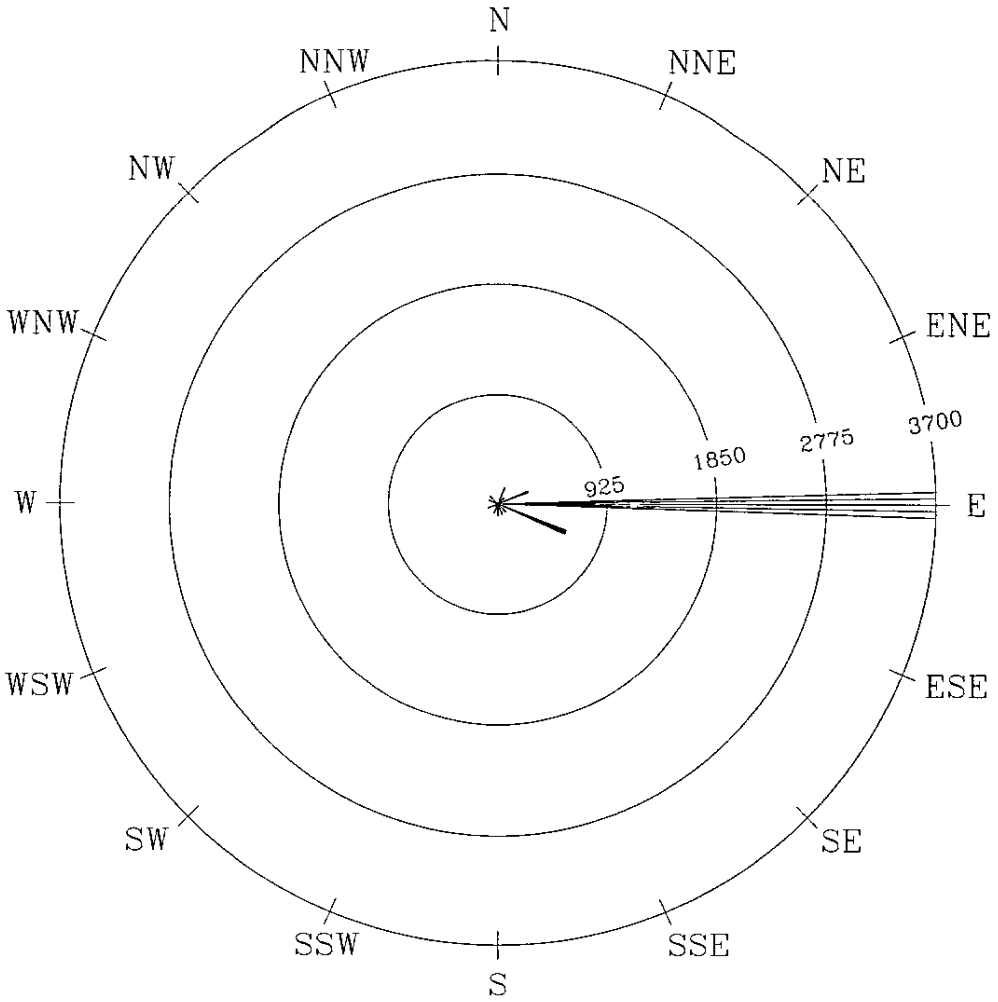


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: 2,2,4-Trimethylpentane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged 2,2,4-Trimethylpentane concentrations collected in canisters at the North site during HRVOC strike events. 2,2,4-Trimethylpentane was detected in 114 of 126 samples collected over 20 months, averaging 1.8 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe Line facility are a potential emissions source for 2,2,4-Trimethylpentane.

FIGURE 53: POLLUTANT ROSE OF MAXIMUM 2, 2, 4-TRIMETHYLPENTANE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

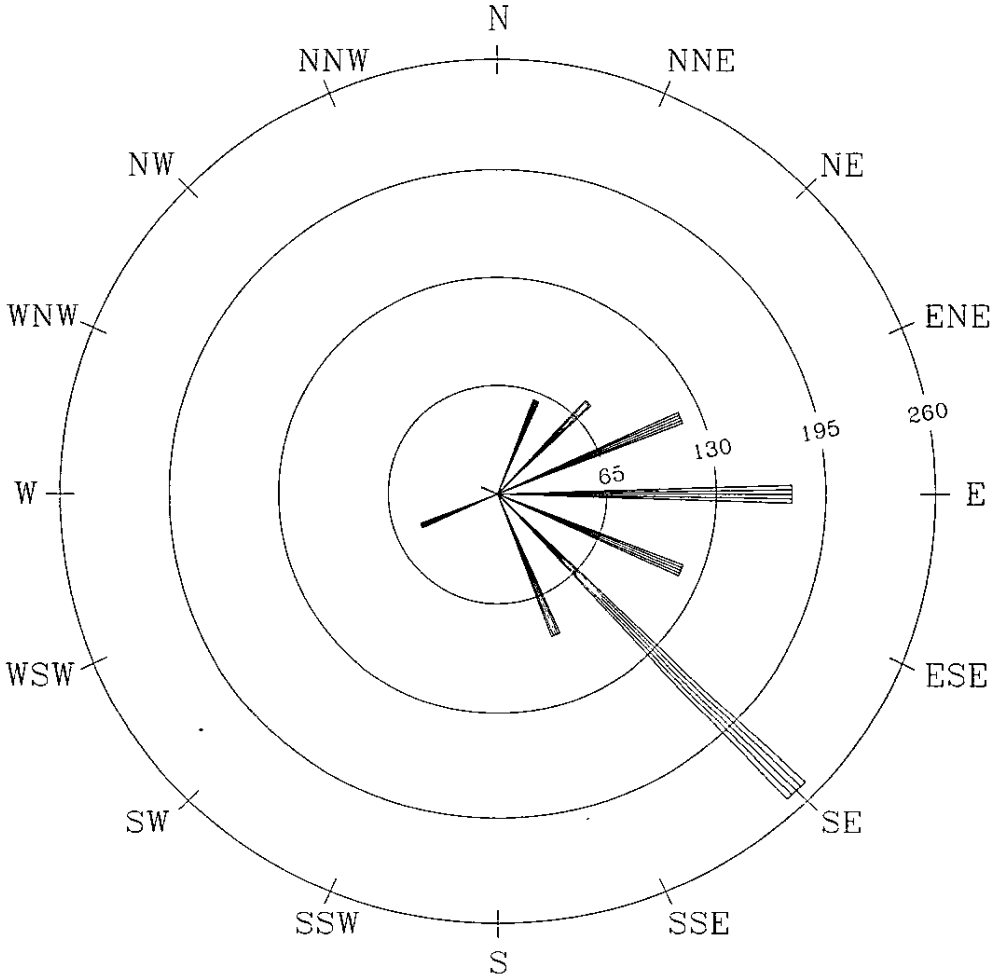


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: 2,2,4-Trimethylpentane Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum 2,2,4-Trimethylpentane concentrations collected in canisters at the North site during HRVOC strike events. 2,2,4-Trimethylpentane was detected in 114 of 126 samples collected over 20 months, averaging 1.8 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for 2,2,4-Trimethylpentane.

FIGURE 54: POLLUTANT ROSE OF AVERAGE 2, 2, 4-TRIMETHYLPENTANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

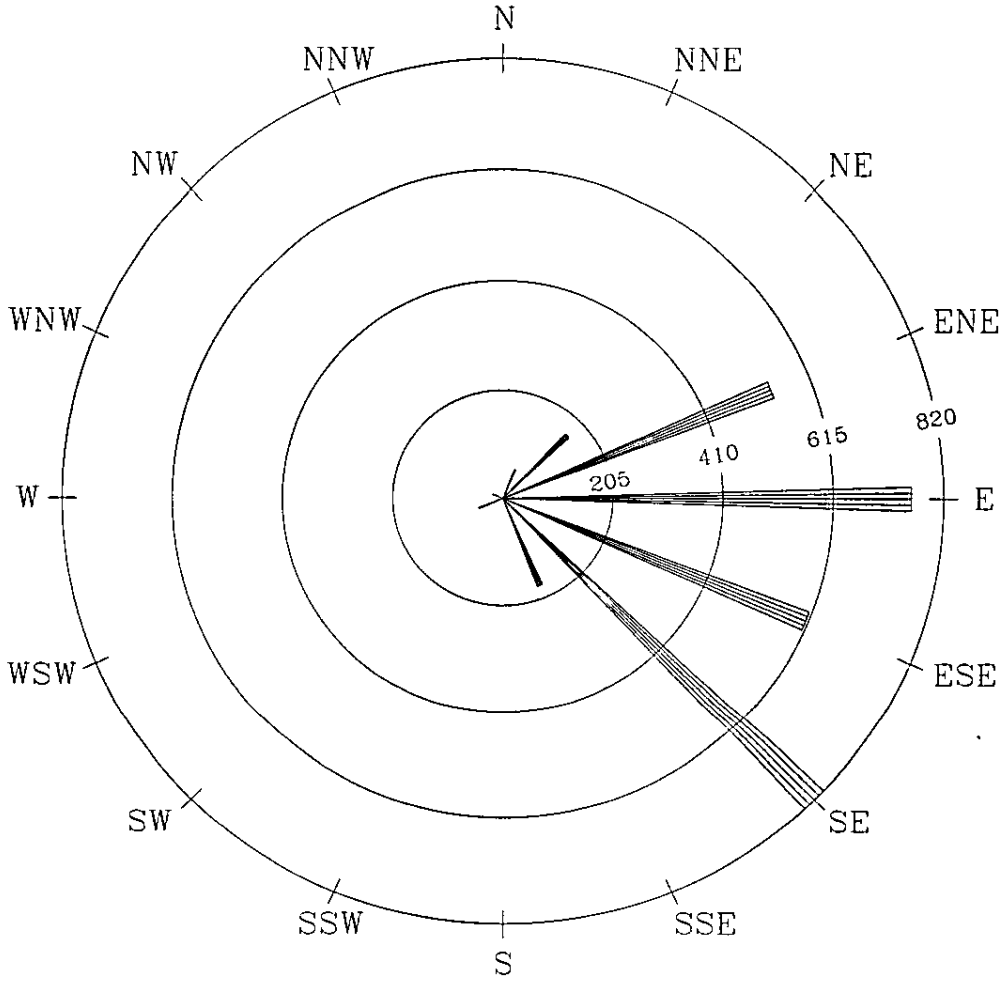


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: 2,2,4-Trimethylpentane Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged 2,2,4-Trimethylpentane concentrations collected in canisters at the South site during HRVOC strike events. 2,2,4-Trimethylpentane was detected in 98 of 111 samples collected over 20 months, averaging 1.9 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for 2,2,4-Trimethylpentane.

FIGURE 55: POLLUTANT ROSE OF MAXIMUM 2, 2, 4-TRIMETHYLPENTANE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

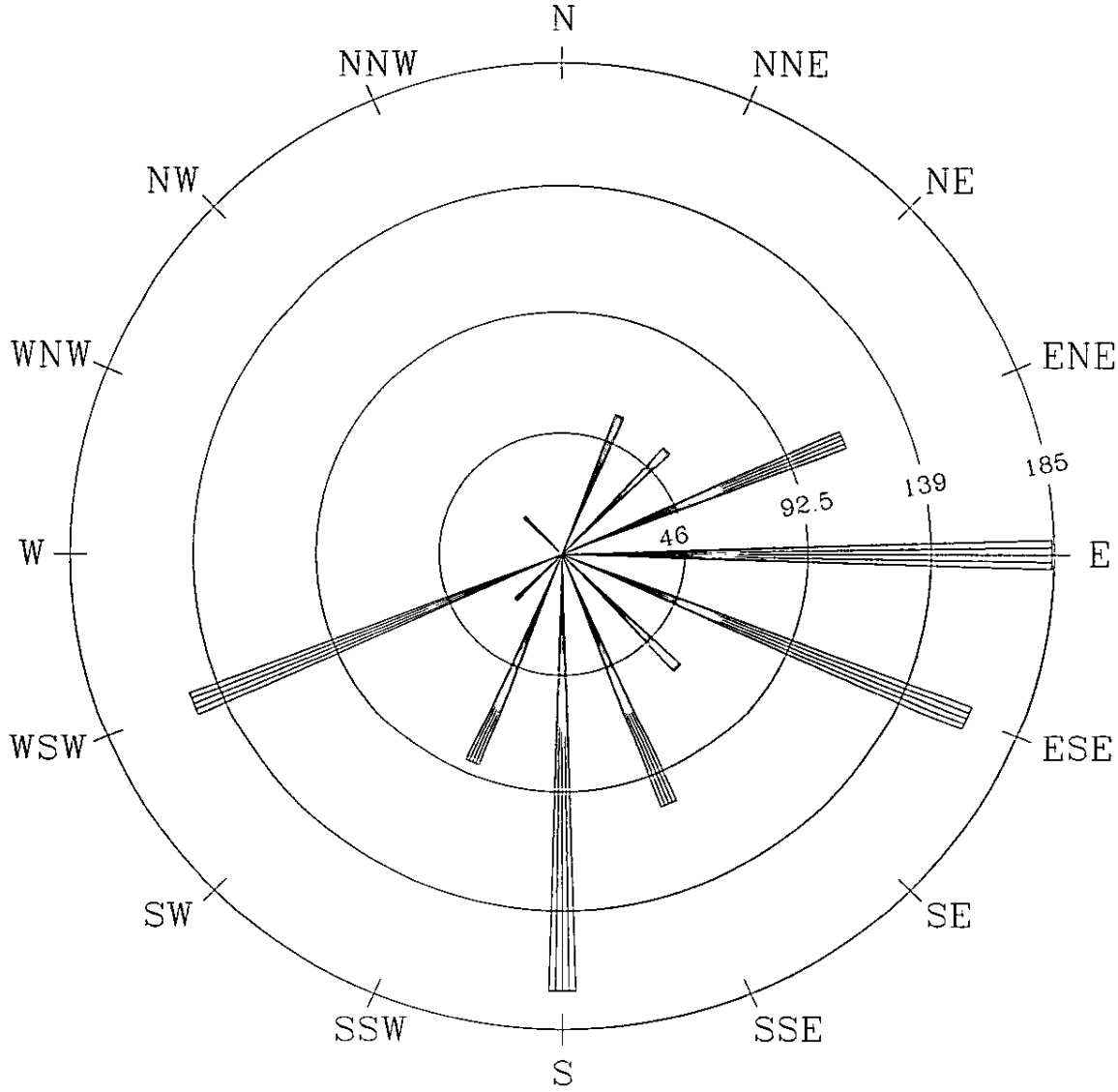


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: 2,2,4-Trimethylpentane Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum 2,2,4-Trimethylpentane concentrations collected in canisters at the South site during HRVOC strike events. 2,2,4-Trimethylpentane was detected in 98 of 111 samples collected over 20 months, averaging 1.9 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe Line facility are a potential emissions source for 2,2,4-Trimethylpentane.

FIGURE 56: POLLUTANT ROSE OF AVERAGE TOLUENE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

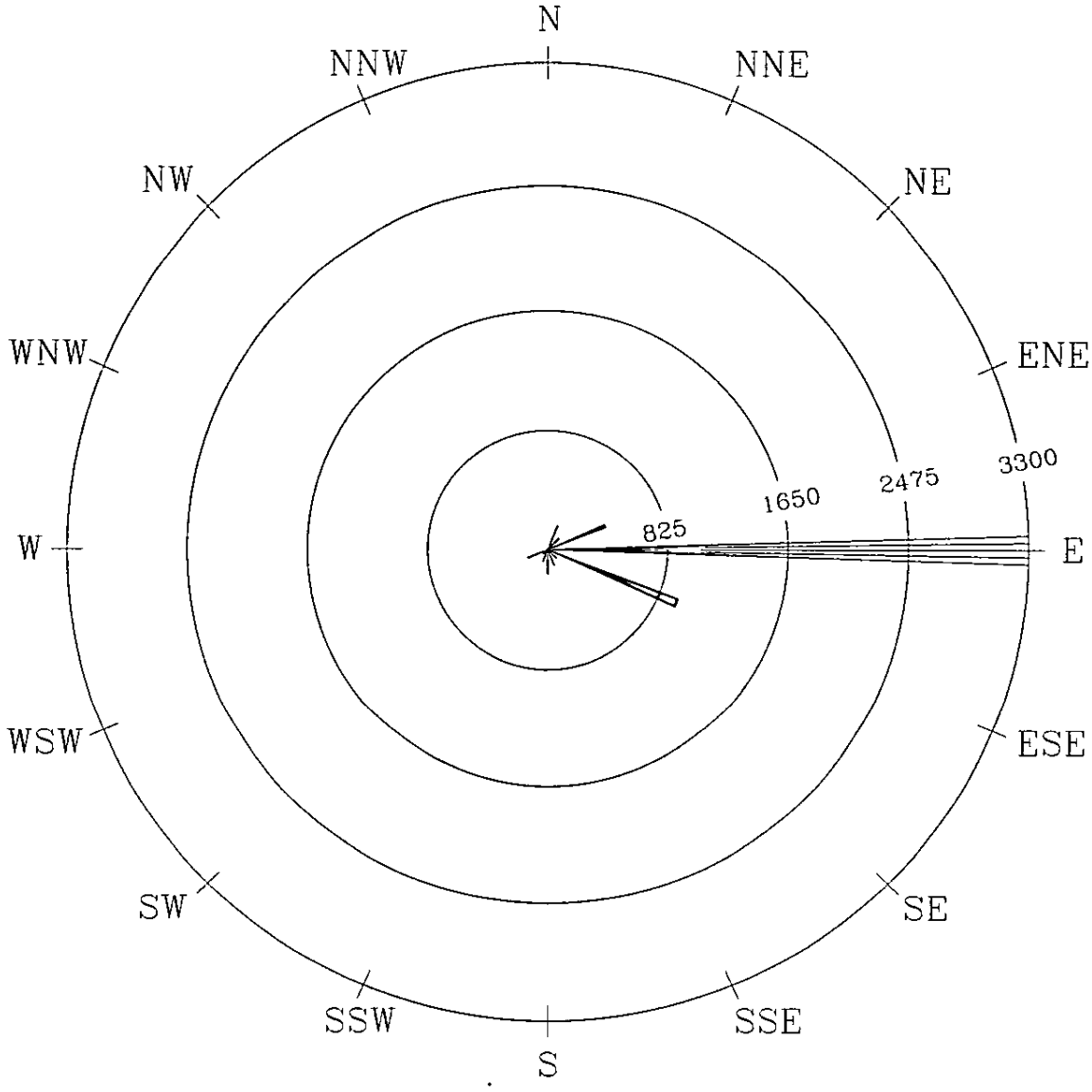


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: Toluene Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Toluene concentrations collected in canisters at the North site during HRVOC strike events. Toluene was detected in 119 of 126 samples collected over 20 months, averaging 1.9 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Toluene.

FIGURE 57: POLLUTANT ROSE OF MAXIMUM TOLUENE MEASUREMENTS COMPILED FROM 126 CANISTER SAMPLES COLLECTED AT NORTH SITE

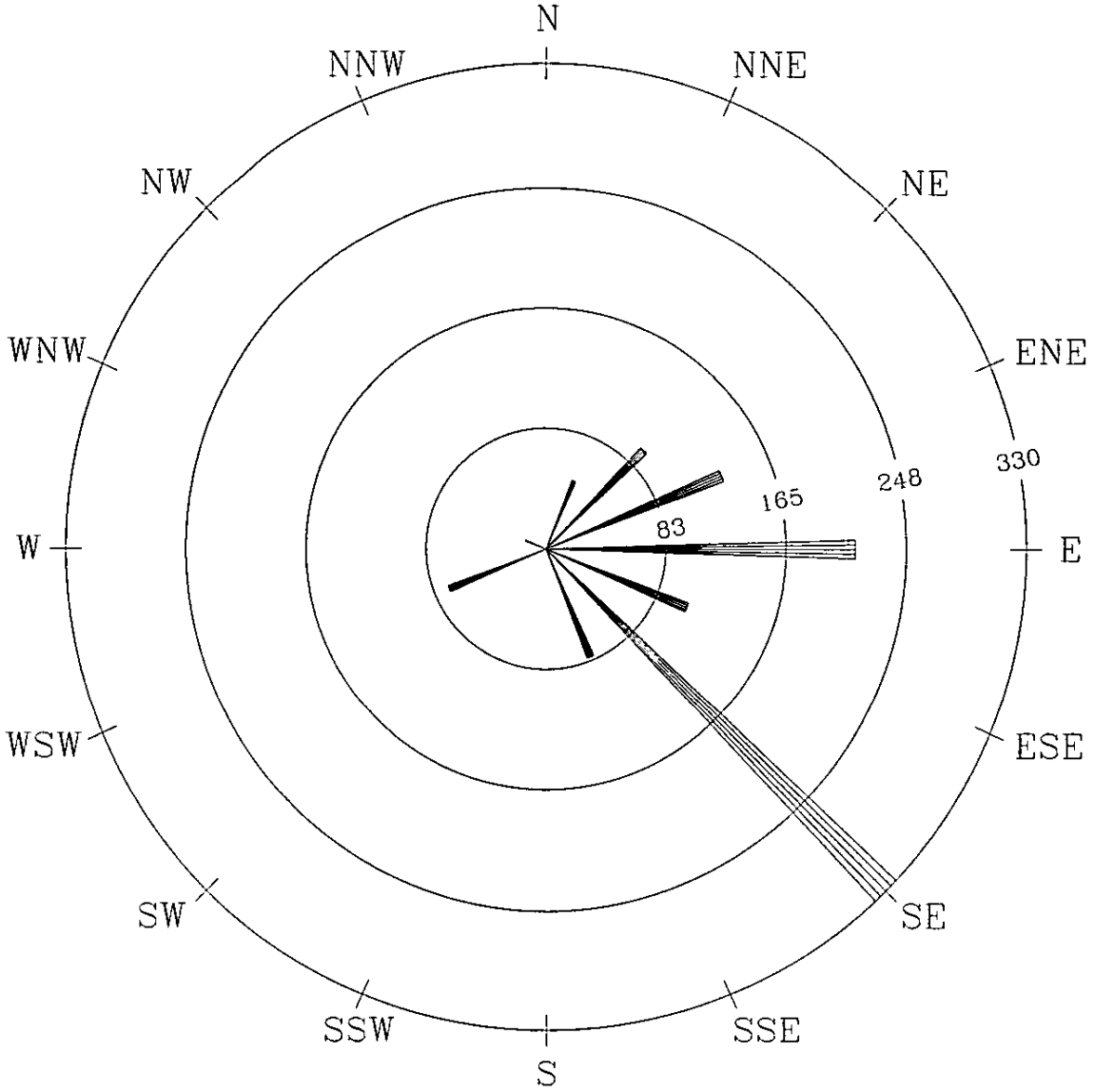


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: North Site
Pollutant: Toluene Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum Toluene concentrations collected in canisters at the North site during HRVOC strike events. Toluene was detected in 119 of 126 samples collected over 20 months, averaging 1.9 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Toluene.

FIGURE 58: POLLUTANT ROSE OF AVERAGE TOLUENE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE

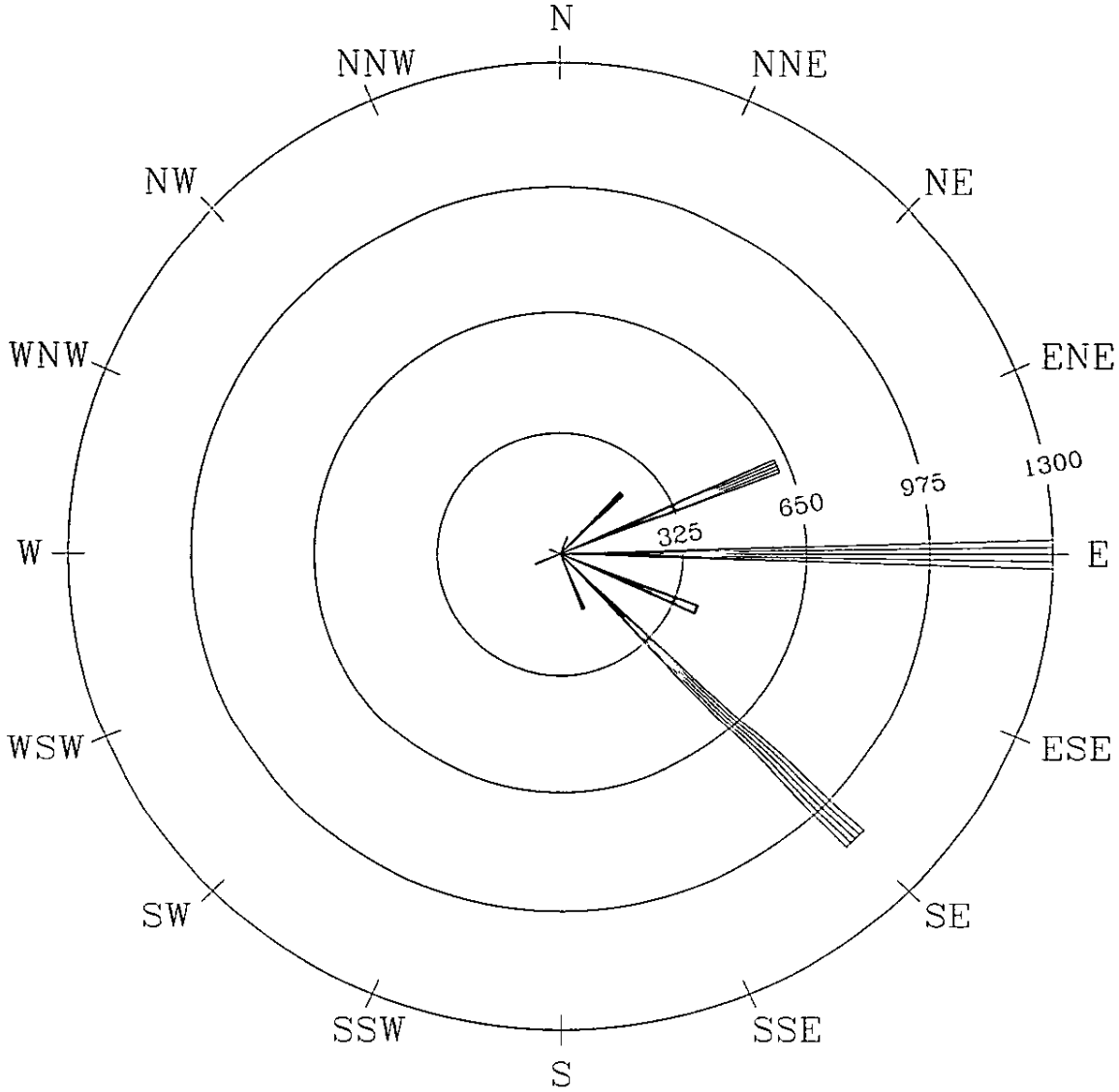


POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: Toluene Average Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of averaged Toluene concentrations collected in canisters at the South site during HRVOC strike events. Toluene was detected in 100 of 111 samples collected over 20 months, averaging 2.2 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Toluene.

FIGURE 59: POLLUTANT ROSE OF MAXIMUM TOLUENE MEASUREMENTS COMPILED FROM 111 CANISTER SAMPLES COLLECTED AT SOUTH SITE



POLLUTANT ROSE
(JOINT FREQUENCY DISTRIBUTION OF MEASURED POLLUTANT CONCENTRATION AND WIND DIRECTION)

Monitoring Network: Plantation Pipeline
Monitoring Site: South Site
Pollutant: Toluene Maximum Plot
Time Period Depicted: 5/1/05-12/31/06
All Pollutant Concentrations Are In ppbC

Notes:
Frequency distribution plot of maximum Toluene concentrations collected in canisters at the South site during HRVOC strike events. Toluene was detected in 100 of 111 samples collected over 20 months, averaging 2.2 percent of the total carbon in these samples. Tank-filling activities at the Plantation Pipe LIne facility are a potential emissions source for Toluene.

APPENDIX A

A dispersion modeling study was conducted by Enviroplan Consulting on behalf of Plantation Pipe Line in December 2005. Modeling results for two HRVOC exceedance events that occurred at the Plantation Pipe Line North site are summarized below.

SUMMARY OF DISPERSION MODELING RESULTS FOR THE JULY 8, 2005 AND NOVEMBER 12, 2005 AMBIENT TNMOC EPISODES

Enviroplan Consulting has operated two fence line monitors at the Plantation Pipe Line facility, along with 10-meter meteorological towers, since April, 2005. These monitors are located along the western boundary of the facility at the northwest and southwest corners. TNMOC data collected at these two sites (i.e., the "North" site and the "South" site) thus far indicate a predominance of episodes of high concentrations, which tend to be correlated with wind directions from the facility. Poor inter-site correlation between the two monitor sites further suggests that highly localized sources are primarily contributing to these high TNMOC strikes. During these episodes, summa canister sampling (20-minute samples) was triggered to obtain a speciation of the major ozone precursors and highly reactive VOCs.

Preliminary investigation of these TNMOC episodes suggests that the Plantation Pipe Line facility is a major contributor, although other local and regional sources likely contribute as well. The objective of this study is to estimate, through air dispersion modeling, the relative contribution of the Plantation Pipe Line facility to the TNMOC episodes.

This memorandum summarizes the methodology and results of the air dispersion modeling conducted for ambient TNMOC episodes monitored at the Plantation Pipe Line facility North site on July 8, 2005 and November 12, 2005.

Methodology

Dispersion modeling was conducted using the U.S. EPA ISCST3 Model, using source emissions information and meteorological data as described below. The storage tank emissions were modeled as elevated area sources, based on the subject tank height and diameter. In accordance with the ISC User's Manual, the initial vertical dispersion coefficient (σ_z) was set equal to tank height (48 ft) divided by 2.15, or 22.3 ft.

Storage tank TNMOC emission rates were estimated using a storage tank landing loss algorithm provided by Plantation Pipe Line. Other source parameters required for dispersion modeling were based on tank locations and dimensions, as provided by Plantation Pipe Line. Source parameters used in the dispersion modeling are summarized in Table 1.

The meteorological data used in the dispersion modeling consisted of onsite wind speed and wind direction data (5-minute block averages) and hourly National Weather Service (NWS) temperature and cloud cover data for the Baton Rouge Metropolitan Ryan Field Airport. NWS data was obtained from the National Climatic Data Center. Default mixing heights of 10,000 meters were assumed. The meteorological data was processed into a format suitable for input

into the air dispersion model. For each episode, modeling was conducted for three Pasquill stability classes (D, E, and F). Table 2 provides a summary of the hourly average meteorological data used in the modeling.

Modeling Results

The hourly average monitored and dispersion model-predicted TNMOC concentrations for each episode are summarized in Table 3. The results clearly indicate that the model significantly under-predicts the measured concentrations, by approximately one order of magnitude or greater. Model predictions under stability class D (neutral stability) are higher (and closer to monitored concentrations) than those under classes E and F (stable conditions). This suggests that the mechanical turbulence created by neighboring storage tanks results in a less stable and more neutral atmosphere affecting the dispersion of tank emissions.

Table 3 indicates that the dispersion model performed considerably better for the second episode, for which the difference between the vector wind direction and storage tank vector angle to the monitor site was 6 degrees, compared to a 10 degree angular difference for the first episode (e.g., episode 2 vector wind direction = 180 + 103 = 283 deg; episode 2 tank vector angle to monitor = 289 deg). This suggests that model performance is highly sensitive to wind direction. To further investigate this model sensitivity, a second set of model runs was made in which the angular difference between the vector wind direction and tank-monitor orientation was set to zero (i.e., the wind direction was directly along the tank-monitor direction). The results of these model runs, summarized in Table 4, show significantly better model performance, particularly for the first episode. The predicted concentration for the first episode under stability class E (i.e., 18,419 $\mu g/m^3$) is very close to the monitored concentration of 18,722 $\mu g/m^3$. For the second episode, the prediction under stability class F of 20,391 $\mu g/m^3$ was closest to the measured value of 25,097 $\mu g/m^3$. In contrast to the first set of modeling runs, these results indicate increasing predicted concentrations under increasing atmospheric stability. For these straight-line impact predictions, the more compact plumes under stability classes E and F result in higher predicted concentrations at the monitor site, compared to the less compact plumes under class D.

Summary

In summary, the dispersion modeling results for two ambient TNMOC episodes at the Plantation Pipe Line facility indicate that the U.S. EPA ISCST3 Model can predict with reasonable accuracy the concentrations of TNMOC at the North monitor site, within the range of expected meteorological input parameters and using Plantation Pipe Line TNMOC storage tank landing loss estimates. Model predictions are highly sensitive to wind direction and atmospheric stability class.

This dispersion modeling analysis did not include the impacts of neighboring Plantation Pipe Line storage tanks, as well as the contributions from off-site TNMOC emission sources. More comprehensive dispersion modeling analyses of these other sources and/or receptor modeling of speciated TNMOC canister samples collected during these episodes may help to quantify the background-source ambient impacts.

Table 1: Summary of Source Parameters Used in the Dispersion Modeling

Episode Date and Time	Tank No.	TNMOC Emission Rate (lbs)	Tank Height (ft)	Tank Diameter (ft)	Tank Distance to Monitor (ft)	Tank Vector Angle to Monitor (deg)
7/8/05 22:40 – 23:40	10	1353	48	90	2,720	299
11/12/05 07:00 – 08:00	11	1246	48	90	2,750	289

Table 2: Summary of Meteorological Data Used in the Modeling

Episode Date and Time	Wind Speed (mph)	Meteorological Wind Direction (deg)	Temperature (F)	Mixing Height (m)	Stability Class
7/8/05 22:40 – 23:40	4.5	109	74	10,000	D, E, and F
11/12/05 07:00 – 08:00	5.5	103	56	10,000	D, E, and F

Note: Meteorological wind direction represents the direction *from* which the wind is blowing; to get the vector wind direction, 180 deg must be added to these values.

Table 3: Summary of Monitored and Dispersion Model-Predicted TNMOC Concentrations (Based on Actual Measured Hourly On-Site Wind Directions)

Episode Date and Time	Monitored TNMOC Concentration ($\mu g/m^3$)	Model-Predicted TNMOC Concentration ($\mu g/m^3$)		
		Stability Class D	Stability Class E	Stability Class F
7/8/05 22:40 – 23:40	18,722	504	68	0
11/12/05 07:00 – 08:00	25,097	2,876	1,839	247

Note: Model predictions based on actual measured hourly on-site wind direction

Table 4: Summary of Monitored and Dispersion Model-Predicted TNMOC Concentrations (Based on Straight-Line Impact from Source to Receptor)

Episode Date and Time	Monitored TNMOC Concentration ($\mu g/m^3$)	Model-Predicted TNMOC Concentration ($\mu g/m^3$)		
		Stability Class D	Stability Class E	Stability Class F
7/8/05 22:40 – 23:40	18,722	12,027	18,419	27,345
11/12/05 07:00 – 08:00	25,097	8,906	13,678	20,391

Note: Model predictions based on straight-line impact from source to receptor.